BIO4HUMAN

D4.2. Gap Analysis Report
Annex 2. Gap analysis for solid waste management in humanitarian actions - basic approach (Task 4.3)

Disclaimer:

Scope:

This document presents a gap analysis conducted within the Bio4HUMAN project. This analysis serves to bridge previously established findings with the anticipated deliverables of future project phases, thereby guaranteeing a cohesive alignment of all project outputs. Furthermore, it pinpoints crucial shortcomings within existing humanitarian solid waste management (SWM) systems, with a specific focus on the limitations of bio-based solutions. Subsequently, it formulates precise and targeted recommendations designed to rectify these identified deficiencies. This analysis also functions as a guide, shaping the development of practical and actionable outputs that will inform and direct subsequent project activities. Finally, it delineates the methodology by which the derived results will be used to establish and prioritize areas requiring improvement. The analysis utilizes insights from previous assessments within the Bio4HUMAN project, integrating data from earlier deliverables to highlight challenges. The primary data source for the challenges are reports on the current situation in two documents: the "D3.3. Humanitarian Sector Needs Assessment Report" and the "Task 4.2.2. Identification of Supply Chain Gaps in Solid Waste Management (SWM) Systems for Humanitarian." To provide a comprehensive assessment, the analysis uses a 1-5 rating scale to assess the severity of each gap across six key dimensions: resource availability, technology for SWM, supply chain and operational efficiency, stakeholder engagement, environmental sustainability and policy alignment, and community needs and impact assessment. The results of the gap analysis are presented in tables, prioritizing gaps based on their overall severity to guide targeted interventions.

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

Contents

1 Introduction 2
2 Gaps definition 3
2.1 Challenges in Solid Waste Management in the Humanitarian Sector . 3
2.2 Dimensions for Assessing Solid Waste Management Gaps in Humanitarian Contexts 6
2.3 Rating Scales 7
3 Conclusions 15

List of tables

Table 1: Gap Analysis of SWM Challenges in Humanitarian Contexts: Severity Assessment Across Key Dimensions. 9
Table 2. Prioritization of Gaps in Humanitarian SWM Based on Severity Scores. 13

1 Introduction

The Bio4HUMAN project aims to identify bio-based solutions for solid waste management (SWM) applicable in humanitarian settings. This gap analysis explicitly connects past findings with future deliverables, ensuring alignment across project outputs. It identifies key deficiencies in humanitarian SWM systems, particularly concerning bio-based solutions, to guide targeted recommendations and shape upcoming project activities.

This analysis directly utilizes insights from previous assessments within the Bio4HUMAN project, integrating data from deliverable D3.3 to spotlight the challenges. Furthermore, the analysis serves as a roadmap for subsequent project activities, mainly for coming project deliverables: 5.2. Hotspot analysis of the current and innovative solutions, 5.3. Identification of the best available innovative solutions based on LCA, 6.1. Socio-economic and governance aspects analysis report and 6.3. SWOT analysis report. It outlines how results will guide the development of actionable outputs, by defining priority areas for improvement based on past insights. This gap analysis ensures that future deliverables effectively address identified deficiencies and contribute

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

meaningfully to the overarching goal of improving SWM practices in humanitarian contexts.

The data on challenges are the primary source of information, taken from reports on the current situation in the two documents below from the Bio4HUMAN project:

- ✓ D3.3. Humanitarian Sector Needs Assessment Report, which provides insights into the needs within the humanitarian sector.
- ✓ Task 4.2.2. Identification of Supply Chain Gaps in Solid Waste Management (SWM) Systems for Humanitarian Actions.

2 Gaps definition

First, we need to define what we mean by the gap within the context of sustainable humanitarian SWM initiatives. The gap represents the difference between the current state and the desired state:

Current State: This is where things stand today. It involves an assessment of existing SWM systems in humanitarian settings, providing a clear understanding of the present situation.

Desired State: This is the goal or target, reflecting effective, sustainable, and environmentally friendly SWM practices in humanitarian settings.

Gap: The gap is defined as "The difference between these two states." It highlights areas for improvement that need to be addressed to achieve sustainable and environmentally responsible SWM outcomes.

2.1 Challenges in Solid Waste Management in the Humanitarian Sector

The gap analysis begins with the identification of challenges. Below are the identified challenges, along with their descriptions:

1. **Challenges in Waste Management Infrastructure (G1)** – Humanitarian contexts face significant challenges in waste management, including inadequate systems for segregation, collection, recycling, and disposal. This often leads to harmful practices, like open dumping and burning, resulting in waste accumulation, unsanitary conditions, and increased health risks. Technical barriers, such as non-recyclable packaging and

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

materials that cannot be separated further, increase improper disposal, often in unsanitary landfills or through open burning.

2. **Limited Adoption of Advanced Technologies (G2)** – There is a notable gap in the documentation and implementation of advanced tools and bio-based technologies, such as anaerobic digestion systems and automated waste tracking, across multiple supply chain stages.
3. **Underrepresentation of Intermediate Stages (G3)** – Key supply chain stages, such as customs clearance and goods in warehouses at the destination, are often under-documented and overlooked, leading to inefficiencies and missed opportunities for optimization.
4. **Insufficient Financial Resources (G4)** – Both national SWM systems and humanitarian organizations face significant funding shortages, which hinder their ability to implement sustainable waste management practices. This financial shortfall impacts all aspects of SWM, including waste collection, recycling, and disposal. High operational costs, low user fee collection, and limited private investment further exacerbate the issue for municipalities, while short-term funding cycles and donor reluctance to support long-term initiatives challenge humanitarian organizations. The heavy reliance on external donors, coupled with minimal local investment and limited diversification of funding sources, threatens the sustainability and scalability of SWM efforts.
5. **Shortage of Human Resources (G5)** – There is a shortage of trained personnel and qualified local suppliers capable of managing waste effectively. This gap in human resources impacts the operational capacity of SWM initiatives.
6. **Weak Policy Framework and Enforcement (G6)** – Although some national and local SWM policies exist, enforcement mechanisms are often weak or absent, leading to inconsistent implementation and limited accountability, particularly in rural and low-capacity settings. Additionally, insufficient coordination among local authorities results in fragmented efforts, further hindering effective waste management.
7. **Lack of Strategic Planning (G7)** – SWM activities often lack proactive, long-term strategies, with most interventions being reactive to immediate crises. There is little structured prioritization of activities, insufficient integration of bio-based technologies into planning, and

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

inadequate consideration of waste generation during the conceptualization and planning stages.

8. **Insufficient Data and Inconsistent Monitoring (G8)** – The absence of comprehensive waste data, standardized reporting and proper monitoring systems reduce the effectiveness, challenges, and needs of SWM. Inconsistent documentation across key SWM dimensions, including tools, innovative approaches and supply chain stages create gaps in understanding and optimizing waste management processes.
9. **Limited Awareness of and Education about SWM (G9)** –Communities, refugees, and humanitarian workers often have minimal understanding of sustainable SWM practices and lack a sense of responsibility for waste management. Many aid operations and policy documents overlook waste management considerations, affecting multiple supply chain stages. Additionally, waste management is often deprioritized in humanitarian settings due to more pressing needs such as food, water, shelter, and healthcare. Insufficient education on waste generation, prevention, recycling, and sustainable options further hinders effective SWM, highlighting the need for comprehensive awareness and training initiatives.
10. **Lack of Coordination among Facilities (G10)** – Stakeholders in SWM, including non-governmental organizations (NGOs), governments, and private entities, often operate in silos without cohesive collaboration. This lack of coordination leads to duplicated efforts, resource wastage, and missed opportunities for synergy. Additionally, many humanitarian settings lack designated disposal sites, exposing organizations, local communities, and displaced persons to unmanaged waste.
11. **Challenges in Sustainable Procurement and Planning (G11)** – Some humanitarian organizations lack green procurement practices and sufficient information to ensure the environmental sustainability of procured products. Furthermore, ineffective coordination during the needs identification, conceptualization, and planning stages hampers efforts to reduce plastic waste and ensure the timely availability of essential goods and products.
12. **Inadequate Waste Management at the End of the Supply Chain (G12)** – Waste collection systems are often absent at the end of the supply

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

chain, where the largest amount of waste is generated, leading to reliance on incineration. Biodegradable packaging frequently breaks down too early, necessitating repackaging and generating additional waste. NGOs, whose primary focus is not waste management, face challenges in addressing waste while managing their core activities. Additionally, waste from local workshops, such as vehicle maintenance, is often improperly managed by NGOs at the final destination.

2.2 Dimensions for Assessing Solid Waste Management Gaps in Humanitarian Contexts

Key dimensions were defined based on the project's objectives, stakeholder inputs, and the unique challenges faced in SWM in the humanitarian context. These dimensions formed the foundation of the gap analysis. Below is the refined list of dimensions used for the analysis:

1. **Resource availability:** Refers to the access and adequacy of key resources (financial, human, and material) required for SWM. This dimension focuses on whether there are enough funds, skilled personnel, and necessary infrastructure for SWM, from the domestic/household level to the municipal level, to deploy sustainable biological solutions.
2. **Technology for SWM in humanitarian context:** Examines the extent to which both current and advanced technologies are adopted in SWM in humanitarian actions. This dimension evaluates not just the adoption of innovative technologies, such as anaerobic digestion and automated waste tracking, but also the availability and effectiveness of existing technologies for collection, sorting, recycling, and disposal. The assessment aims to identify technological deficiencies and highlight areas where existing processes, such as waste collection or sorting, can be improved to enhance overall efficiency in waste handling.
3. **Supply chain and operational efficiency:** This dimension focuses on the effectiveness and smooth functioning of the entire waste management system, from procurement to final disposal. It looks at how well the various stages of the supply chain are integrated, coordinated, and optimized. Also, people's awareness has a direct impact on several operational stages of the waste management supply chain, from the

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

collection and segregation of waste, to the coordination with waste management entities.

4. **Stakeholder engagement:** Stakeholder Engagement and Capacity Building assesses the level of collaboration among various stakeholders (e.g., governments, NGOs, local communities, and private sector actors) and the capacity-building efforts aimed at strengthening stakeholder capabilities.
5. **Environmental sustainability and policy alignment**: It examines the strength and enforcement of local, national, and international policies related to sustainable waste management.
6. **Community needs and impact assessment:** This dimension involves understanding the needs of the communities affected by waste management. It also involves evaluating the social, economic, and environmental impacts of waste management solutions on local communities.

2.3 Rating Scales

Furthermore, for the gap analysis, a 1–5 rating scale was used to assess the severity of each gap across the 6 dimensions. The results are presented in Table 1. The scale is as follows:

Minimal Gap (1): Indicates a very small or negligible gap in the performance or operations of humanitarian actors. The issue is not significant or widespread, and minimal attention is needed.

Minor Gap (2): This represents a small gap in the performance or operations of humanitarian actors that may require some attention but is not critical. It has a relatively low impact on overall humanitarian activities and can be managed with limited intervention.

Moderate Gap (3): This represents a noticeable gap that moderately impacts the performance or operations of humanitarian actors. Addressing it will likely require more effort, and there may be some long-term consequences for humanitarian efforts if left unaddressed.

Significant Gap (4): Reflects a substantial gap that significantly affects the performance or operations of humanitarian actors. Immediate attention is

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

required, as leaving the gap unaddressed will likely lead to inefficiencies or issues in humanitarian service delivery.

Critical Gap (5): This represents a major and critical gap that severely impacts the performance or operations of humanitarian actors. These gaps threaten the overall functioning or sustainability of humanitarian projects and must be addressed urgently.

To ensure a comprehensive and objective gap analysis, this report evaluates the identified challenges in SWM in the humanitarian sector through the lens of 6 key dimensions. The 12 challenges serve as the core of the analysis, with each dimension assessed to determine its contribution to or impact on each gap as shown in **Table 1**. This approach ensures that the impact of resource availability, technology, supply chain efficiency, stakeholder engagement, policy alignment, and community needs of each gap is highlighted, providing a structured understanding and facilitating targeted interventions. **Table 2** ranks the gaps identified in Table 1 based on their overall severity, calculated by summing the scores for each row and column. Gaps with higher total scores are more critical and require urgent attention and action. This analysis helps prioritize the key challenges in SWM within the humanitarian sector.

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

Table 1: Gap Analysis of SWM Challenges in Humanitarian Contexts: Severity Assessment Across Key Dimensions.

Challenges in SWM	Resource Availability	Technology for SWM	Supply Chain Efficiency	Stakeholder Engagement	Environmental sustainability and policy alignment	Community Needs
G1	**4**: Inadequate systems for segregation, collection, recycling, and disposal due to insufficient funds, personnel, and facilities.	**3**: Limited advanced technologies hinder efficient recycling and disposal processes.	**4**: Poor infrastructure leads to inefficiencies in collection and disposal processes.	**3**: Collaboration is hindered by resource constraints and lack of coordination.	**4**: Poor infrastructure leads to harmful environmental practices like open burning.	**4**: Health risks from unmanaged waste significantly affect communities.
G2	**3**: Moderate resource limitations affect technology adoption.	**5**: Severe gap as most humanitarian contexts lack access to advanced SWM technology.	**3**: Reduces efficiency in waste tracking and management.	**3**: Stakeholders often lack the capacity for technology adoption.	**3**: Lack of advanced technology impedes sustainable waste management practices.	**3**: Communities miss out on the benefits of efficient and sustainable waste management systems.
G3	**3**: Insufficient resources for monitoring and documenting intermediate stages like customs	**3**: Lack of technology for tracking intermediate supply chain stages.	**4**: Poor documentation leads to inefficiencies and missed optimization opportunities.	**3**: Limited stakeholder collaboration on intermediate processes.	**3**: Policy gaps in addressing supply chain stages.	**2**: Service delivery is affected due to missing data on intermediate stages.

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

Challenges in SWM	Resource Availability	Technology for SWM	Supply Chain Efficiency	Stakeholder Engagement	Environmental sustainability and policy alignment	Community Needs
	clearance and warehousing.					
G4	**5**: Severe funding shortages hinder all aspects of SWM, including collection, recycling, and disposal.	**3**: Limited funds for tech adoption.	**4**: Budget constraints reduce operational efficiency.	**4**: Funding shortages limit stakeholder initiatives capacity-building efforts.	**4**: Financial gaps hinder the implementation of sustainable policies.	**4**: Communities suffer from reduced SWM service quality due to financial constraints.
G5	**4**: Lack of trained personnel and qualified local suppliers affects SWM operations.	**3**: Limited expertise in adopting and managing SWM technologies.	**3**: Operational gaps due to workforce shortages.	**3**: Training gaps limit stakeholder capacity and engagement.	**4**: Policy adherence weak due to staff shortages.	**4**: Service quality suffers due to a lack of skilled personnel, impacting communities.

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

Challenges in SWM	Resource Availability	Technology for SWM	Supply Chain Efficiency	Stakeholder Engagement	Environmental sustainability and policy alignment	Community Needs
G6	**3**: Limited resources for developing and enforcing SWM policies.	**3**: Technology is not effectively integrated into existing policies.	**4**: Inconsistent policy implementation affects operational efficiency.	**4**: Stakeholder coordination is weakened by weak policy frameworks.	**5**: Poor enforcement of policies severely impacts environmental sustainability.	**4**: Communities face risks due to inconsistent and weak policy enforcement.
G7	**3**: Insufficient resources for proactive, long-term planning.	**3**: Limited use of technology in strategic planning processes.	**4**: Poor planning leads to inefficiencies in waste management operations.	**3**: Limited stakeholder input in planning processes.	**4**: Planning gaps hinder the integration of sustainable practices into policies.	**4**: Unplanned waste management harms communities and exacerbates environmental issues.
G8	**3**: Resource gaps in data collection and monitoring systems.	**3**: Lack of technology for comprehensive waste data collection and reporting.	**4**: Poor data availability reduces operational transparency and efficiency.	**3**: Limited stakeholder collaboration on data collection and monitoring.	**3**: Policy development is weakened due to insufficient data.	**4**: Communities are affected by inadequate monitoring and inconsistent reporting.

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

Challenges in SWM	Resource Availability	Technology for SWM	Supply Chain Efficiency	Stakeholder Engagement	Environmental sustainability and policy alignment	Community Needs
G9	**3**: Limited funds for awareness and education programs.	**3**: Lack of technology in education and awareness initiatives.	**4**: Awareness gaps reduce operational efficiency and community participation.	**4**: Poor engagement with communities and stakeholders on SWM practices.	**4**: Awareness gaps hinder adherence to sustainable policies.	**4**: Community participation is critically impacted due to a lack of education and awareness.
G10	**4**: Resource gaps hinder coordinated SWM efforts and facility development.	**3**: Limited technology for improving coordination among stakeholders.	**4**: Lack of coordination leads to operational inefficiencies and duplicated efforts.	**5**: Severe gaps in stakeholder collaboration and coordination.	**4**: Policy gaps in coordinated efforts hinder environmental sustainability.	**4**: Unmanaged waste due to poor coordination negatively affects communities.
G11	**3**: Financial gaps limit the adoption of green procurement practices.	**3**: Lack of technology for tracking and ensuring sustainable procurement.	**4**: Supply chain sustainability is affected by poor procurement practices.	**4**: Stakeholders face challenges in implementing sustainable procurement.	**4**: Policy gaps in green procurement hinder environmental sustainability.	**3**: Community access to sustainable goods is reduced due to procurement challenges.

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

Challenges in SWM	Resource Availability	Technology for SWM	Supply Chain Efficiency	Stakeholder Engagement	Environmental sustainability and policy alignment	Community Needs
G12	**4**: Resource gaps at the end of the supply chain hinder effective waste management.	**3**: Technology gaps in handling waste at the final stages.	**4**: Poor efficiency in final disposal processes.	**3**: Stakeholder capacity is reduced at the end stages of the supply chain.	**4**: Policy gaps in managing end-stage waste harm environmental sustainability.	**4**: Communities bear the burden of unmanaged waste at final destinations.

Table 2. Prioritization of Gaps in Humanitarian SWM Based on Severity Scores.

Gap/Challenge	Resource Availability	Technology	Supply Chain Efficiency	Stakeholder Engagement	Environmental sustainability and policy alignment	Community Impact	Total Score
G1	4	3	4	3	4	4	**22**
G2	3	5	3	3	3	3	**20**
G3	3	3	4	3	3	2	**18**
G4	5	3	4	4	4	4	**24**
G5	4	3	3	3	4	4	**21**
G6	3	3	4	4	5	4	**23**

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

G7	3	3	4	3	4	4	**21**
G8	3	3	4	3	3	4	**20**
G9	3	3	4	4	4	4	**22**
G10	4	3	4	5	4	4	**24**
G11	3	3	4	4	4	3	**21**
G12	4	3	4	3	4	4	**22**
Total Score	**42**	**38**	**46**	**42**	**46**	**44**	

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

3 Conclusions

The prioritization based on total scores ensures that interventions are focused on the most pressing gaps, while also acknowledging the cumulative impact of each dimension on these challenges.

The gap analysis reveals varying levels of challenges across the 12 gaps **(G1 to G12**). The gaps with the highest total scores are "Insufficient Financial Resources" and "Lack of Coordination among Facilities", both scoring 24 points. These gaps highlight their significant impact on operations due to limited resources, high financial dependency, and insufficient relationships between facilities throughout the supply chain. Following closely is "Weak Policy Framework and Reinforcement" with 23 points, emphasizing coordination challenges and the need to involve local governments and institutions to strengthen policy alignment and enforcement. On the other hand, the lowest-scored gap is "Insufficient Data and Inconsistent Monitoring," with 18 points. This gap appears to be a secondary effect of the more critical challenges, such as resource limitations and weak policy frameworks, which hinder effective data collection and monitoring efforts. Another gap, "Limited Adoption of Advanced Technologies," scores 20 points, reflecting the challenges of implementing technological solutions in resource-constrained humanitarian settings, where financial and infrastructural barriers often limit the use of advanced systems.

Dimension wise, Supply Chain Efficiency and Environmental sustainability and policy alignment emerge as the most critical categories, both with total scores of 46. This indicates that inefficiencies in the supply chain and misalignment in policies are major obstacles affecting the organization's performance. Community Impact follows closely with a score of 44, underscoring the significant effect these gaps have on the community, which must be carefully managed. Resource Availability and Stakeholder Engagement both score 42, suggesting moderate challenges in these areas. While resources are somewhat available, their allocation or utilization may need optimization, and stakeholder engagement could be strengthened to foster better collaboration. Technology for SWM in Humanitarian Context, with the lowest total score of 38, is still a notable challenge, indicating a need for technological upgrades or better integration of existing systems.

These scores are subjectively chosen from the information collected in the challenges and dimensions description of prior reports.

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.