wasteless

Waste Quantification Solutions to Limit Environmental Stress

Lead Partner: FAZLA GIDA

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D2.4 - Surplus Tool - optimised set of tools and methodologies

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Executive Summary

More than one third of food produced for human consumption globally goes to waste each year while 821 million people suffers from hunger and approximately 2 billion people are obese or overweight [1]. While the food industry accounts for one third of total greenhouse gas emissions [2], the problem of food loss and waste contributes to climate crisis by causing approximately 8% of global greenhouse gas emissions [3].

Funded by the European Union's Horizon Europe Research and Innovation programme, WASTELESS (Waste Quantification Solutions to Limit Environmental Stress) aims to measure and track food loss and waste generation across European Union and diminish the environmental stress caused by food loss and waste generation. As an applied research project, innovative tools and methodologies are developed and tested under the WASTELESS project.

As a part of Work Package 2, Surplus Tool – optimized set of tools and methodologies (D2.4), a software tool has been developed to monitor waste generation at the food industries, the retailer and HORECA (HOTEL-RESTAURANT-CAFE) levels of the food supply chain and selected food supply chains. The tool, Surplus Stock Measurement and Management Tool, helps selected food supply chain partners to measure surplus food and food waste generation and recommends the best-suited recovery method with AI technologies in line with the Food Recovery Hierarchy developed by the United States Environmental Protection Agency, to manage surplus food and food waste by creating the highest environmental, social, and financial value possible. The tool requires product-based information including SKU (Stock Keeping Unit), the ingredients of the products and allergen information, and waste/surplus generation point and reason to provide the appropriate management approach while taking into the account of the principles of the hierarchy.

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List of Acronyms

Abbreviation / acronym	Description
CS	Case Study
FAO	Food and Agriculture Organization
HORECA	HOTEL-RESTAURANT-CAFE
IPCC	Intergovernmental Panel on Climate Change
OECD	Organization for Economic Co-operation and Development
SKU	Stock Keeping Unit
WASTELESS	Waste Quantification Solutions to Limit Environmental Stress

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1. Introduction

Food Loss and Waste Problem

In today's world, humanity is living as though there are 2.3 Earths available, depleting the resources necessary to sustain the well-being of all living beings, with little regard for future generations and with detrimental effects on the environment, society, and economy [4]. The surge in human activities since the Industrial Revolution has led to a build-up of greenhouse gases in the atmosphere, resulting in the urgent global issue of the climate crisis. In the sixth assessment report from the Intergovernmental Panel on Climate Change (IPCC), released in March 2023, it was noted that the average global surface temperature had increased by 1.1°C between 2011 and 2022, compared to the period between 1850 and 1900, which marks the post-Industrial Revolution era [5].

According to the Emissions Gap Report 2022 titled "The Closing Window – Climate crisis calls for rapid transformation of societies," published by the United Nations Environment Programme, to limit global warming to 1.5°C, greenhouse gas emissions must decrease by 45% compared to current projections based on nationally determined contributions [2]. Achieving this requires immediate, systemic, and comprehensive transformation. Tackling the climate crisis demands substantial investment, with the Organization for Economic Co-operation and Development (OECD) estimating an annual expenditure of €6.35 trillion to meet the targets set by the Paris Agreement by 2030 [6].

In this context, reducing waste generation and responsibly managing waste become crucial, with particular emphasis on the food industry, as food ecosystems contribute significantly to global emissions, accounting for one third of the total [2].

The production of food necessitates the use of natural resources such as land and water, while the transportation of food emits greenhouse gases. Additionally, food production and processing require the utilization of raw materials. When food is lost or wasted, all the resources used in its production and distribution are also lost, and if not managed properly, food loss and waste can lead to environmental pollution. According to the Food and Agriculture Organization (FAO) of the United Nations, agricultural activities require 5 billion hectares of land surface, covering 38% of global land surfaces. The FAO's report, Food Loss and Waste and its Linkage to Global Ecosystems, highlights that 30% of global energy is consumed by food systems [7]. The report also reveals that 28% of agricultural land area and

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38% of the energy consumed are used to produce food that is ultimately lost or wasted [8]. Moreover, the entire food ecosystem contributes to over 30% of global emissions, and food loss and waste generation further amplify the environmental impact of these systems [2].

Globally, more than one third of all food produced for human consumption is wasted [1]. The extent of food loss and waste varies depending on the economic development level of regions and the stage at which it occurs in the supply chain. In developed countries, levels of loss during harvest and post-harvest increase due to stringent quality standards set by retailers, while levels of food waste also rise, mainly driven by food availability and affordability [9]. In contrast, in developing and underdeveloped countries, food loss occurs primarily at the processing and distribution stages due to inadequate infrastructure and technologies [9]. This correlation between food loss/waste and economic growth underscores the need for governments to collaborate on advancements and technological developments to address this global issue and ensure that every community worldwide is on an equal footing in addressing it.

Food loss and waste play a significant role in exacerbating the climate crisis, contributing to nearly 8% of global greenhouse gas emissions [3], making it the third-largest emitter worldwide [9]. When food is left to decompose or disposed of in landfills, it releases methane (CH_4), a more potent greenhouse gas than carbon dioxide (CO_2), thus altering the chemical composition of the atmosphere [10]. According to Project Drawdown, addressing food waste and implementing sustainable waste management practices are crucial steps in reducing global greenhouse gas emissions to limit the rise in global temperatures to 1.5°C [11].

Moreover, the consequences of food waste extend beyond environmental concerns. The Food and Agriculture Organization of the United Nations estimates that globally, 1.3 billion tons of food intended for human consumption are lost or wasted [3], while over 820 million people suffer from hunger and more than 2 billion face food insecurity [1]. This disparity underscores issues related to the unequal distribution of food, varying levels of infrastructure, and economic development across different regions of the world.

In addition to its environmental and social impacts, food loss and waste significantly affect economies. The Food and Agriculture Organization of the United Nations' Global Initiative on Food Loss and Waste Reduction reports that the cost of food loss and waste amounts to US$1 trillion [12]. Furthermore, the Boston Consulting Group estimates that

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annual food loss and waste will increase to 2.1 billion tons by 2030, with associated costs reaching $1.5 trillion [13].

Supported by the European Union's Horizon Europe Research and Innovation program, WASTELESS (Waste Quantification Solutions to Limit Environmental Stress) endeavours to quantify and monitor food loss and waste production throughout the European Union, with the objective of mitigating the environmental impact stemming from such waste. Serving as an applied research initiative, WASTELESS is dedicated to crafting and trailing innovative tools and methodologies to address the issue at hand.

For that purpose, the Surplus Stock Measurement and Management Tool has been developed to guide businesses in the value chain to manage their stocks and adopt innovative practices to eliminate food waste generation. To achieve this purpose, the tool is designed to give AI-based recovery recommendations for managing surplus food in line with the principles of Food Recovery Hierarchy developed by the United States' Environmental Protection Agency.

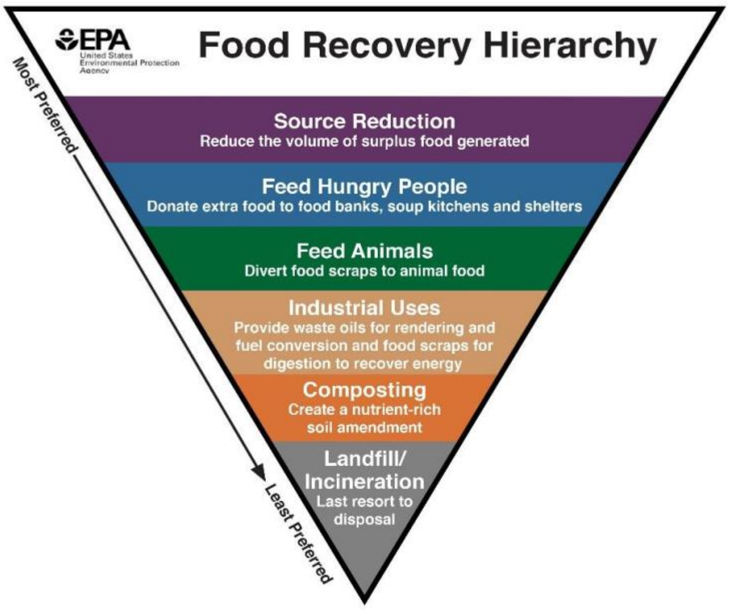

Figure 1: Food Recovery Hierarchy [14]

The Surplus Stock Measurement and Management tool requires its users to provide product-based information including name and category of the product, its SKU, the recommended last consumption date type, content metric unit, content metric unit quantity, quantity unit, whether it is packaged or not, its nutritional values, and ingredient at the first

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level. After this entry, the sector of the user, the point of the product turning into waste/surplus, and the reason behind the waste/surplus generation are required for the measurement process and for the tool to provide an AI-based guidance to manage the surplus product.

2. Surplus Stock Measurement and Management Tool

2.1. Tool Users

The tool covers two types of users for a smoother experience throughout its platform: Case Study (CS) Leader and Store User. Since CS Leaders are responsible for the coordination of the store users and monitoring the whole process, an inclusive permission list is required for these types of users. Meanwhile, store users are only required to create the products' SKUs and add surplus/waste information expected.

Table 1: The User Types and Descriptions of Their Roles

User Type	Definition	Permission(s)
CS Leader	It is the user attribute of CS Leaders in the scope of Work Package 3 (WP3).	● Ability to view/download all surplus product data of all locations ● Create/edit/delete CS store locations ● Create/edit/delete store user accounts ● Ability to enter surplus product on behalf of CS location ● Ability to add/edit/delete SKUs
Store User	These are the users who will enter their waste in the locations determined for the Case Study. These users' organization may be a Food Service, Food Industry, Food Retailer or Food Supply Chain.	● Ability to define and edit SKUs ● Ability to enter Surplus data ● Ability to view historical data

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2.2. Store User Flow

To begin measuring and managing surplus product, the Store Users will login to the platform via https://app.fazla.com/en/login with their e-mail addresses and passwords. After logging in to the platform, the Store Users will provide product-based information requested under the New SKU page which includes category and SKU of the product, its ingredients and allergen information.

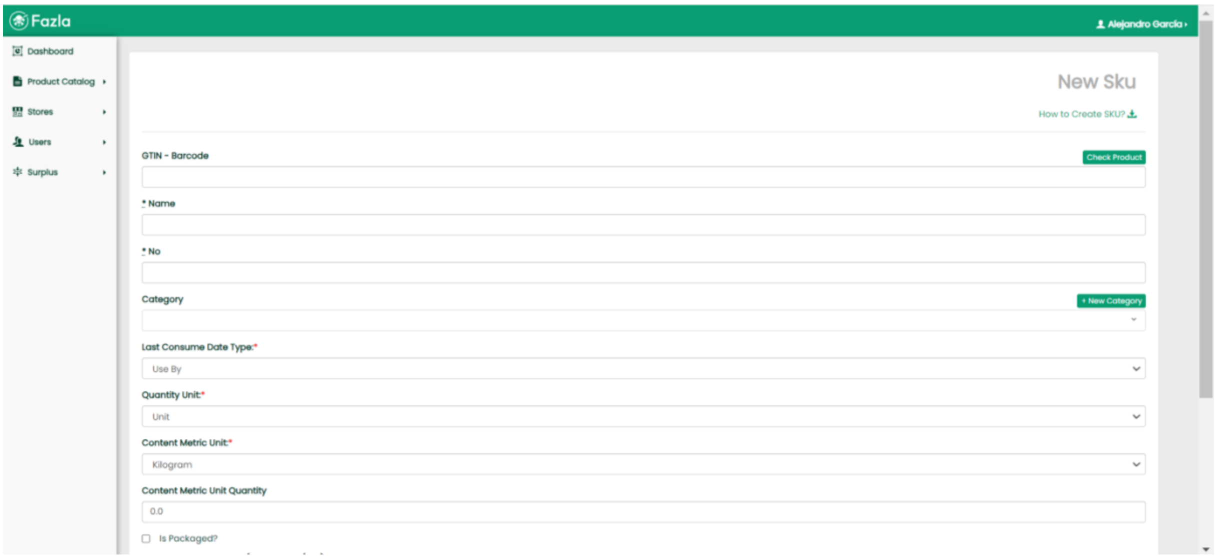

Figure 2: New SKU Page

Figure 3: New SKU Page Cont.

With the SKUs created by the Store Users, surplus products/wastes are added to the platform under the Add Surplus page by providing the surplus/waste reason and generation point for the Surplus Stock Measurement and Management tool to advise the proper recovery methods.

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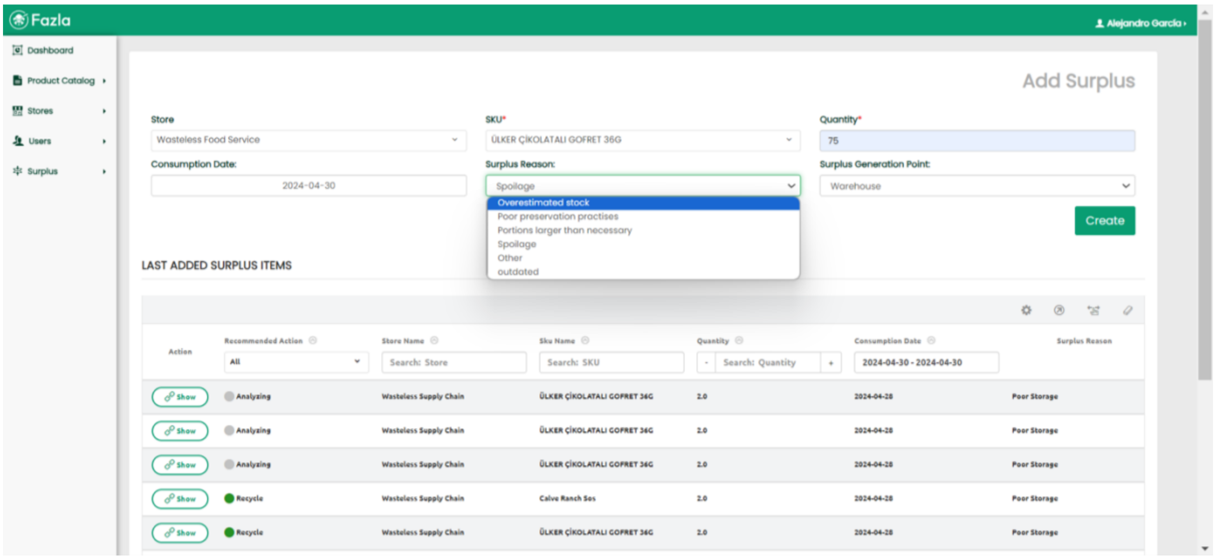

Figure 4: Add Surplus Page

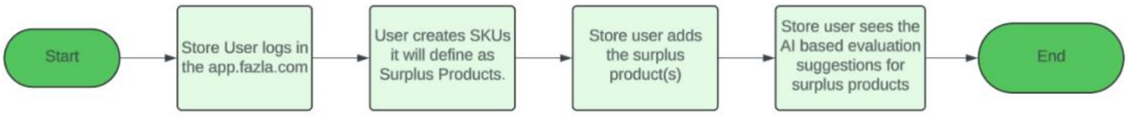

Figure 5: The Flow of The Tool Usage

2.3. Features

2.3.1. Add a SKU

SKU stands for Stock Keeping Unit which is a unique alphanumeric code assigned to a product by a retailer, distributor, or manufacturer. This code helps with inventory management by allowing them to track individual items. For each store to receive customized recommendations for the SKU in its inventory, each store must create the SKUs that it will define as Surplus Products in advance. After that, SKU information will not be received every time the Store User defines the same products as Surplus.

While creating the SKU, the parameters that affect the way the SKU is evaluated are expected as input in the SKU form so that AI-based suggestions can make the most accurate and suitable for real-life predictions.

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Parameters and descriptions are as follows:

GTIN - Barcode: A GTIN (Global Trade Item Number) is a unique identifier for products in the global supply chain. It's typically encoded in a barcode for easy scanning and tracking. Barcodes are visual representations of these GTINs, typically displayed as a series of parallel lines and spaces of varying widths.

Name: A product name is a specific term used to identify a particular good or service offered by a company.

No: This is the numerical code that identifies a product in CS locations'(stores') inventory systems. It should be unique and easy to identify.

Category: A product category is a grouping of similar products that share related features. It is taken as input to analyse the category distribution of Surplus Products. CS Leaders can create new category if they want to analyse a specific category. Also, Store Users in the CS locations can create category based on their own inventory systems.

Last Consume Date Type: The Last Consume Date Type field can be selected as Best Before and Use By in the platform. This information can be obtained from the statement on the packaging of the SKU. The reason why the parameter is taken from the user is that this information has an important place in the surplus evaluation method that AI will suggest. For example, if the Last Consume Date Type of a product is Best Before and this date has passed, as an evaluation suggestion, Donation can be suggested if other parameters are also appropriate. If there is no problem with the content of the product but the Use By date has passed, some recovery methods such as donation and resell would not be suggested, otherwise a life-threatening risk will occur. Therefore, last consume date type is quite important for platform to find the best recovery recommendation.

Content Metric Unit: The content metric unit refers to standardized units of measurement such as kilograms, grams, units, litres, or millilitres. These units are used to quantify the amount, weight, volume, or count of a product. For example, if you're measuring a liquid, the content metric unit could be litres or millilitres. If you're measuring a solid item, it could be kilograms or grams. Units are used for countable items. These content metric units are essential for accurate inventory management and surplus recommendation.

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Content Metric Unit Quantity: Content Metric Unit Quantity refers to the amount of a specific product or item in a standardized unit of measurement. This data is crucial for various aspects of inventory management and analysis. For instance, during the analysis phase, knowing the content metric unit quantity allows us to calculate the total surplus weight for each Stock Keeping Unit (SKU).

Quantity Unit: A quantity unit is basically a way to measure how much of something there is. It refers to the standardized measurement used to quantify the amount or volume of a product or item. The platform has various quantity units such as unit, gram, millilitre, ton, kilogram, box, litre, packet, case, and unknown. This information is being taken from the user to determine how much surplus is from which SKU.

Is Packaged: Whether the SKU is packaged or unpackaged has an important place in the dataset for recommendations to be made.

Nutritional Values: In the European Union (EU), it is mandatory to declare the nutritional value of food products on the back of the packaging. This regulation is set out in Regulation (EU) No 1169/2011 on the provision of food information to consumers. This regulation requires and recommends the following nutrients to be listed on the food labels:

- Energy: in kilojoules (kJ) and kilocalories (kcal)
- Fat: saturated, monounsaturated, and polyunsaturated fats
- Carbohydrates
- Sugar
- Protein
- Salt

Also, this regulation states that the nutrient values must be declared per 100 grams or 100 millilitres of the product.

Based on these sources, Energy, Fat, Protein, Carbohydrate, Sugar and Salt (Sodium) values will be obtained from the user for each SKU. The received SKU data will be used as one of the recommendation parameters in the decision tree that feeds the AI recommendation system.

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Ingredients: While making evaluation recommendations, especially for foods suitable for human consumption, allergen information must be obtained to warn user about allergen information. However, most products do not contain allergen information. Therefore, to understand allergens, the ingredient list on the packaging of each food product was selected to infer allergens. On the other hand, there are an average of 50 ingredients behind each product, therefore, to enter 50 ingredients will not be feasible or efficient for the user. For this reason, the most common food allergens and their main ingredients in Europe were investigated. According to the results, the most common allergens in Europe are [15]:

1. Milk
2. Eggs
3. Peanuts
4. Nuts
5. Soy
6. Wheat
7. Fish
8. Shellfish

For this reason, these ingredients were included in the form. Instead of making the user choose 50 ingredients, the user will be asked to choose a maximum of 8 ingredients.

2.3.2. Add Surplus

The users enter surplus products for their own organization with the SKU(s) they create. When logging in, the Surplus Reason and Surplus Generation Point fields are selected appropriately to have deeper information about surplus products, to make inferences and to determine action with the help of the tool.

Surplus Reason is a short code that explains why the product is surplus/waste.

Surplus Generation Point indicates at which stage of the supply chain the product is wasted or becomes a surplus.

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Surplus Reasons and Surplus Generation Points have been determined based on Fazla's 8 years of know-how and Case Study explanations in Project Proposal. It's important to note that both surplus reasons and surplus generation points in the table are provided by Fazla solely to provide a basis for analysis. This is a first draft, and all these entries are dynamic, which means they can be edited, deleted, or new ones can be added from the platform. Therefore, these surplus reasons and generation points provided are initial suggestions meant to serve as a starting point for analysis.

Table 2: The Surplus Reason and Generation Point Alternatives

Surplus Reason	**Surplus Generation Point**	**Focused Sector in CS**
• *Overproduction* • *Overordering of Raw Materials* • *Poor Quality Control* • *Insufficient Production Technology and Equipment* • *Problematic Raw material* • *Unsold Problematic SKUs* • *Other*	• *Purchasing* • *Production Line* • *Post-Production*	*Food Industry*
• *Consumption Date Close* • *Mold* • *Rotten* • *Damaged Package* • *Excess Stock* • *Other*	• *Shelf* • *Warehouse*	*Food Retailer*
• *Overestimated stock* • *Poor preservation practises* • *Portions larger than necessary* • *Spoilage* • *Other*	• *Kitchen* • *Plate* • *Warehouse*	*Food Service*
• *Deficiencies in Slaughtering Technology* • *Inability to Detect with Deficient Quality Conditions and Conservation Degree* • *Poor Storage* • *Other*	• *Slaughterhouse* • *Packaging Stand* • *Warehouse* • *Distribution Center*	*Food Supply Chain*

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3. Conclusion

The Surplus Measurement and Management Tool, developed under the WASTELESS project, represents a significant advancement in addressing the critical issue of food loss and waste within the European Union. By providing a systematic approach to monitor, measure, and manage surplus food and waste, the tool leverages AI-based recommendations to enhance the efficiency of food recovery processes. This aligns with the principles of the Food Recovery Hierarchy, aiming to maximize environmental, social, and financial benefits.

The tool's comprehensive data requirements, including SKU, nutritional values, and allergen information, ensure precise and tailored management strategies for surplus food. By involving key stakeholders across the food supply chain, from food service providers to retailers, the tool fosters a collaborative effort towards minimizing food waste and its associated environmental impacts.

Furthermore, the project underscores the importance of technological innovation in mitigating food waste, contributing to the broader goals of sustainability and climate change mitigation. As the WASTELESS project continues to evolve, the insights and methodologies developed through this tool will be crucial in shaping policies and practices aimed at achieving a more sustainable food system across the EU.

The successful implementation of this tool can serve as a model for similar initiatives globally, reinforcing the imperative of integrating advanced technological solutions with strategic policy frameworks to combat food waste and its far-reaching consequences.

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