wasteless

Waste Quantification Solutions to Limit Environmental Stress

Lead Partner: EuroFIR AISBL

Month 12 – December 2023

D4.1 – WASTELESS data collection, interoperability, and governance plan

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4. Executive Summary

Work Package (WP) 4 is dedicated to optimising re-use of WASTELESS data to the highest standards of openness and contribute to the broader efforts to reduce food loss and waste. The primary goal this **Data Collection, Management, and Integration Plan** is to ensure the FAIRness (findability, accessibility, interoperability, and reusability) of WASTELESS WP3 use case data specifically, leading to a robust protocol for populating the Joint Research Centre (JRC) model. However, the proposed approach can also serve as a foundation for the future exploitation of food loss and waste data by user communities generally.

The report examines the intricacies of Food Loss and Waste (FLW) data as related to WASTELESS WP3 use cases, exploring collection requirements essential for interoperability, data formats, languages, integration, and governance. It encompasses development, execution, and oversight of strategic plans, policies, and best practice to deliver, manage, protect, and maximise the value and re-use of WP3 data and supporting information (meta data). Practical application of FAIR principles has been considered as well as the significance of data collection, interoperability, and governance in obtaining, maintaining, and sharing high-quality data that can underpin exploitation and re-use.

Key findings and recommendations encompass data collection strategies, regulatory and policy compliance, interoperability, FAIRification, governance, risk management, and monitoring and evaluation. However, it must be recognised that WP3 case studies are immature at this stage of the project, Month12 (M12). There is ambiguity around not only the nature of the case studies in each environment but also data likely to be generated by WP2 solutions for the various food commodities. Until these have been elaborated, characteristics of the WP3 use case data and support information cannot be considered fully, or the collection, management, and integration specific to each environment or commodity. Also, continuous monitoring will be essential to stay at the forefront of regulatory changes and maintain the highest standards of governance.

In conclusion, this data collection, interoperability, and governance plan sets out foundation for efficient, secure, and FAIR-compliant management of FLW data, both generally and specifically related to WP3 use cases. The lack of specificity in WP3 use cases, however, has posed a significant challenge, requiring that most aspects must be updated or detailed in parallel with their progress (M12-M24).

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6. List of Acronyms

Abbreviation / acronym	Description
AI/ML	Artificial Intelligence/Machine Learning
API(s)	Application Programming Interface(s)
FAIR	Findable, Accessible, Interoperable, Reusable
FLW	Food Loss and Waste
GDPR	General Data Protection Regulation
IoT	Internet of Things
JRC	Joint Research Centre
KPI(s)	Key Performance Indicator(s)
M	Month
WP	Work Package

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7. Introduction

The report considers the intricacies of FAIR (findable, accessible, interoperable, reusable) food loss and waste (FLW) data, exploring collection requirements essential for interoperability, and dimensions such as data format and languages (e.g., vocabularies, ontologies) as well as integration and governance, serving as a foundation that can enhance future exploitation of FLW data by user communities.

7.1 Background

The overarching objective of Work Package 4 (WP4) Data collection, management, and integration is to enhance the FAIRness of WASTELESS WP3 datasets specifically and FLW generally. Activities include reviewing datasets generated by WP3 demo pilots to determine if these are distinct at macro- and micro-levels compared with one another and other FLW data generally, which will facilitate exchange and exploitation within and amongst user communities (e.g., Joint Research Centre, JRC). WASTELESS is committed to developing and publishing comprehensive guidelines for the future FAIRification of FLW data, rooted in best (data) practices and supporting open science. A critical outcome of this work is development of a robust protocol for populating the JRC model (De Jong, et al., 2023), and this plan ensures a systematic and structured approach to sharing data with the model, enhancing its accuracy and reliability, as well as ensuring the sustainability of datasets through interoperability with datasets describing FLW or other aspects of food such as composition (nutrients, bioactive or botanical compounds). In essence, WP4 is dedicated to optimising utilisation of WASTELESS data by ensuring they not only meet the highest standards of openness, but also contribute significantly to the broader scientific community through adherence with FAIR principles and development of practical guidelines.

7.2 Purpose of the Report

This report encompasses development, execution, and oversight of strategic plans, policies, programmes, and practices geared towards delivering, managing, protecting, and maximising the value and utilisation of WASTELESS (WP3) data and associated supporting information (meta data). Within this framework, robust consideration is given to practical application of FAIR principles, as they might be applied to WASTELESS WP3 case studies. However, it should be noted that WP3 case studies are immature at this stage of the project. There is ambiguity around not only the nature of the case studies in each environment (primary production, agri-food manufacturers, food retailers, and food services and consumers) but also data likely to be generated by WP2 (tools/technical) solutions for the various food commodities.

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7.3 Scope and Objectives

In the context of this report, scope refers to the extent and boundaries of WASTELESS data collection, which is limited to data coverage, interoperability, governance, FAIR principles, and data security and privacy. The objectives are to (1) optimise data collection, enhanced interoperability, and promote open science and FAIRness in respect of WASTELESS data but also FLW data in general, (2) establish a governance framework to oversee data management processes and compliance with legal and ethical standards, (3) minimise and mitigate risks, (4) facilitate continuous improvement, and (5) support documentation (i.e., meta data contextualising data) and reporting (e.g., key performance indicators). By defining a clear scope and objectives, this data collection, interoperability, and governance plan sets out a foundation for efficient, secure, and FAIR-compliant management of project FLW data throughout its lifecycle generally and specifically as related to WP3 case studies.

7.4 Significance of Data Collection, Interoperability, and Governance

The significance of data collection, interoperability, and governance for FLW data lies in more efficient, transparent, and impactful approach to addressing complex challenges associated with minimising both food loss and waste. Integrating these elements can enhance informed decision-making, promote resource optimisation, reveal more holistic insights, meet FAIR principles, enable strategic planning and policy development, reduce risk, support public awareness and engagement with evidence-based knowledge, and stimulate international collaboration. In essence, more robust collection of FLW data, greater interoperability (as well as findability, accessibility, and re-use), and good governance practices can lead to a more sustainable, resilient, and equitable food system by addressing the challenges of food loss and waste.

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8. Data Collection Strategies

Data collection strategies refer to systematic approaches and methods employed to gather relevant and accurate information for analysis and decision-making. Selection of collection strategies is critical for the quality and reliability of data collected and factors including the nature of data, objectives, resources, and ethical considerations, influence the choices. Effective data collection strategies contribute to generation of reliable, relevant, and actionable information, supporting informed decision-making.

8.1 Definition of Data Collection

Data collection refers to the systematic process of gathering and measuring information or data on variables of interest (food loss and food waste) often to answer specific research questions, test hypotheses, or evaluate outcomes. Collection involves acquisition of relevant information in various forms (numerical values, textual descriptions, images, other observations) from different sources.

Key elements of data collection that must be considered include (1) **purpose** since clearly defining the goals of data collection helps guide selection of methods and tools; (2) **variables** (i.e., identifying and defining parameters that are relevant and can be measured or observed); (3) **methods**, which include surveys, interviews, observations, experiments, or analysis of existing and emerging datasets; (4) **instruments** (e.g., questionnaires, sensors, or software applications); (5) **sampling**; (6) quality control; and (7) **ethical consideration**, i.e., adhering to guidelines, especially when dealing with personal and sensitive information. Data collection is a crucial step in research and decision-making processes, as the quality and reliability of collected data significantly impacts the validity of subsequent analyses and conclusions.

8.2 Types of Data to be Collected

Data collection regarding FLW involves capturing information about quantities and types, but also – ideally – reasons for losses or waste throughout the supply chain, from production to consumption. In the case of WP3 case studies in France, Spain, Hungary, Italy, Estonia, Slovenia, Portugal, and Turkey amongst primary producers, agri-food manufacturers, food retailers, food services and consumers, FLW data for specific food commodities and products (i.e., fruits & vegetables, chicken, meat products, potato products, fruit juices, dairy, and cereal products) are likely to include:

1. Quantitative data

- Weight (kilograms, tonnes) or volume (cubic meters)
- Number of individual food items

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2. Categories of food

- Perishable vs. non-perishable (to understand the nature of the losses)
- Food types (i.e., fruits, vegetables, grains, dairy, meat, etc., which might be linked to FoodEX2 codes and increased interoperability with other food data, e.g., composition) to identify specific areas for improvement or valorisation.

3. Location

- Geographical area
- Supply chain stages

4. Reasons for Loss or Waste

- Spoilage including inadequate storage, temperature fluctuations, or humidity
- Damage, e.g., transportation, mishandling, improper packaging, or delays
- Quality standards, i.e., appearance
- Expiration dates, i.e., retail management, best before, use by

5. Economic Data

- Monetary value, which facilitates calculation of economic impacts
- Costs of prevention

6. Environmental Impact

- Greenhouse gas emissions generated during production, transportation, and disposal, and land and water usage, which would enable life-cycle analysis.

7. Consumer Behaviour

- Consumer practices such as over-purchasing, improper storage, or misinterpretation of expiration dates (i.e., equating best before an use by).
- Awareness and education to measure the effectiveness of initiatives aimed at reducing consumer food waste.

8. Regulatory and Policy Compliance

- Adherence to regulations and whether these are associated with FLW
- Policy impact

Collecting comprehensive and accurate data in these areas helps stakeholders develop strategies to minimise FLW throughout the supply chain as well as at home. Not all the above will be relevant to the WP3 use cases. However, until the nature of the case studies in each environment and data generated by WP2 solutions for the various food commodities have been elaborated in any detail, meta data (data about data), characteristics of the FLW data cannot be expanded (e.g., descriptive,

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administrative, technical, structural, contextual, provenance, accessibility, interoperability, preservation, security, re-use) or plans published for each use case.

8.3 Data Sources

There are various data sources that can provide information on FLW across the supply chain and offer valuable insights into causes, quantities, and patterns. These include government agencies, international organisations (e.g., FAO), research organisations, industry reports and publications, non-governmental organisations (e.g., World Food Programme), supply chain actors (i.e., retailers and supermarkets, food manufacturers, food recovery and redistribution organisations (e.g., food banks and charities), and technology and innovation platforms (e.g., FoodWasteEXplorer). In the case of WASTELESS WP3 use cases, data will be derived from aspects of each environment, i.e., primary production, agri-food manufacturers, food retailers, and food services and consumers, and the application of WP2 solutions therein. The outputs will be shared with user communities including JRC for their research or other re-use.

8.4 Collection Methods and Tools

Collecting FLW data involves various methods and tools to capture information accurately including surveys and questionnaires, interviews and focus groups, on-site observatories, data logging and sensors, waste audits, supply chain analysis, point-of-sale systems, remote sensing and satellite imagery, mobile apps and platforms, and data analytics and machine learning. Combining multiple methods and tools can provide a more comprehensive understanding of FLW data, helping to develop targeted interventions and strategies for improvement. The selection of methods depends on the specific context, objectives, and available resources. For WASTELESS WP3 use cases, WP2 solutions include (1) an **electronic registry** supported by a blockchain (food supply chains); (2) computer vision-based **image analysis** (household); (3) **AI/ML** (Artificial Intelligence/Machine Learning) **model** (retail & services); (4) **surplus measurement and management tool** (retail & services); and (5) **automated FW assessment** (households). However, how these will be implemented in each of the environments and, specifically, which data will be monitored and measured, has yet to detailed.

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8.5 Data Quality Assurance

Ensuring data quality is crucial, as poor data quality can lead to inaccurate analyses and ineffective decision-making. Key considerations for data quality include (1) data **accuracy** [range, format, and consistency]; (2) standardised **definitions and measurements** [clearly define terms, standardised units]; (3) **training and calibration** [human and machines, e.g., proper use of equipment, calibration of instruments or validated dataset used to train algorithm]; (4) **documentation** reporting methodologies, sources, and any adjustments; (5) data **completeness**, i.e., missing data that are properly specified [e.g., unknown not zero]; (6) **consistency and comparability**; (7) data **security and privacy**; (8) **traceability and transparency**; and (9) **auditing** or peer-review, continuous monitoring and feedback responses. However, until more detail can be added to the proposed WP3 use cases, and the likely sources and nature of data generated, these aspects cannot be particularised at this stage.

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9. Interoperability Framework

An interoperability framework for FLW data will establish a standardised approach to share and integrate information across food supply chains and, beyond, into user communities' systems. Such a framework requires adoption of common data standards, technologies, and models to ensure consistent communication, transparency, and collaboration amongst actors. The framework should promote efficient data exchange, facilitate cross-sector cooperation, and enhance the overall effectiveness of initiatives aimed at reducing FLW with imposing a burden on providers. However, currently, until more detail can be added to the proposed WP3 use cases, interoperability needs and gaps are unknown.

9.1 Importance of Interoperability

Interoperability is central for integration of data from diverse sources in different formats throughout the food supply chain actors, which facilitates efficient re-use among stakeholders, including policymakers, government agencies, and researchers.

An interoperable framework allows for more holistic understanding of factors contributing to FLW and enables stakeholders including actors to view the entire supply chain, identify critical points of inefficiency, and implement targeted solutions.

Interoperability promotes use of standardised data formats and structures, ensuring consistency in how data are handled, interpreted, and exchanged, which – in turn – the enables data exchange, providing decision-makers with timely and accurate information. Such an approach is necessary for responding promptly to emerging challenges and implementing interventions in different environments. Better integrated data also supports more effective resource management to reduce operational costs, improve sustainability, and enable better utilisation of resources.

Interoperability fosters collaboration across sectors involved in food supply chains, including agriculture, transportation, and retail, but also amongst user communities (e.g., researchers and data, industry in valorisation of waste products), which is essential for implementing comprehensive and effective strategies to reduce FLW. Similarly, interoperable data and systems support innovation, aiding adoption of new technologies and methodologies, evolving practices, and addressing emerging issues.

Interoperability promotes transparency by ensuring that data are represented and shared consistently. This transparency enhances accountability, as actors can better understand and address challenges collectively, facilitates analysis of large datasets, revealing data-driven insights into patterns, trends, and areas for improvement, which are valuable for developing effective strategies and policies for FLW reduction.

In the global context, interoperability facilitates collaboration and information exchange amongst countries and regions. Regional and global cooperation are essential for addressing FLW as a shared, interconnected challenge.

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9.2 Definition of Interoperability

Generally, interoperability is the capability of diverse systems, components, or organisations (humans) to work together cohesively, allowing exchange and utilisation of information in a standardised manner. Data interoperability refers to the capacity of different machine systems, applications, or data sources to share information and support inter/exchange, interpretation, and (re-)use data. Standardised data formats, structures, and protocols are used to achieve interoperability, allowing for consistent interpretation and (re-)use of data across different systems. The goal is to facilitate flow of information that is efficient and meaningful, regardless of underlying systems.

9.3 Interoperability Standards

Interoperability standards are established specifications and protocols that define how different systems, technologies, or components should interact with each other to enable data inter/exchange. These standards ensure compatibility and consistency, fostering a common framework for diverse entities to work together effectively. In any industry, including technology, healthcare, and finance, interoperability standards have a role in promoting integration, innovation, and collaborative efforts. Ultimately, FLW standards must also encompass data formats, communication protocols, interfaces, and other specifications that facilitate cohesive and standardised interactions. Currently, such universal interoperability standards tailored explicitly for FLW data do not exist and there are no standards within WASTELESS, but broader data interchange and sharing principles still apply:

1. Semantic web standards such as the resource description framework (RDF) for describing resources on the web, and structuring and linking FLW datasets.

2. Geospatial standards (GeoJSON) for encoding geographic data structures.

3. Time series data standards, e.g., ISO 8601 (dates and times)

4. Data exchange standards including JSON (JavaScript object notation) and XML (eXtensible markup language), which are widely used data interchange formats.

5. Supply chain standards such as GS1 standards (e.g., GTIN) for identification of products and can contribute to supply chain traceability.

6. Food data standards for food description (LanguaL, FoodEX2, FoodON) or food data exchange, which captures information about quality, expiration, and logistics.

7. IoT (Internet of Things) **standards,** e.g., MQTT (message queuing telemetry transport), which is a lightweight and efficient protocol for data exchange.

In general, the landscape of data standards is evolving, including industry and domain-specific or research initiatives that might contribute to or impact expectations around FLW data interoperability, e.g., needs of Joint Research Centre (JRC) model.

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9.4 Integration Technologies

Integration technologies are vital in consolidating, connecting, and streamlining FLW data across stages of the various supply chains within different environments as well as reuse by user communities. Key integration technologies that can be applied are:

1. Application programming interfaces (APIs), e.g., Representational state transfer (REST) APIs, which facilitate data exchange between systems over HTTP and are commonly used for real-time data integration and communication.

2. Message queuing systems such as Apache Kafka, which is a distributed streaming platform capable of handling large volumes of data and facilitating real-time data integration where there is a need for high-throughput and fault-tolerant streaming.

3. Middleware such as enterprise service bus that enables applications to communicate by serving as a transit system, facilitating integration of diverse systems.

4. Data integration platforms, e.g., Apache Nifi, which is an open-source data integration tool with a web-based interface for designing data flows.

5. Data warehousing, e.g., Amazon Redshift, Google BigQuery, Snowflake, all of which are cloud-based warehousing solutions providing scalable storage and processing capabilities that can integrate data from various sources.

6. IoT Platforms, e.g., Microsoft Azure IoT Hub can be used to integrate and manage data from sensors and devices monitoring conditions, such as temperature, humidity, and storage conditions in the food supply chain.

7. Event-driven architectures such as Apache Pulsar, an open-source event streaming platform, which facilitates real-time data integration and reactions to FLW events.

8. Blockchain technology can be used to create transparent and secure distributed ledgers for food supply chains, maintaining immutable records of transactions, enhancing traceability, and reducing the risk of fraud but also outputs such as waste.

9. Data virtualisation allows integration of data from disparate sources without physically moving datasets, which is often a concern for food businesses.

10. API management platforms facilitate the creation, publishing, and monitoring of APIs, ensuring secure and controlled access to data, which is essential for integration.

The choice of integration technology will depend on WP3 use case specific requirements and implementation of WP2 solutions therein, existing infrastructure, and the intricacy of data and extent of integration needed. Not all of these will be relevant to WASTELESS WP3 use cases, but it is common for a combination of these technologies to be used to create comprehensive and efficient data integration solutions.

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9.5 Challenges and Solutions

Achieving interoperability for FLW data generally and WASTELESS specifically comes with challenges, but addressing these challenges will be crucial for creating a cohesive and efficient FLW data ecosystem. In addition to the existing ambiguity, challenges and potential solutions for WP3 use cases specifically include:

Challenge 1: Diverse data sources including farms, processing facilities, retailers, catering (i.e., hotels, restaurant, catering [e.g., hospitals, schools]), and consumers.

> **Solution:** Develop standardised data formats and taxonomies to ensure consistency across sources. Encourage the adoption of common data models.

Challenge 2: Lack of data standards, specifically the absence of universally accepted standards specific to FLW data hampers data exchange and integration.

> **Solution:** Collaborate with actors to establish data standards and promote adoption, leveraging existing standards where applicable.

Challenge 3: Data privacy and security, particularly personal and sensitive data, whilst ensuring findability, accessibility, integration, and re-use by user communities.

> **Solution:** Implement robust data governance practices, encryption, and access controls to adhere to data protection regulations.

Challenge 4: Legacy systems and technologies exist at various stages of the supply chain that not easily integrate with modern technologies and each other.

> **Solution:** Implement middleware or integration layers that can bridge the gaps and introduce system upgrades and adoption of standardised interfaces.

Challenge 5: Lack of interoperability culture, where organisations may not prioritise interoperability in data management practices or regulations do not require data to be published at a level that is useful for analysis and/or valorisation subsequently.

> **Solution:** Promote awareness about the benefits of interoperability and encourage initiatives and collaborations to foster a culture of interoperability.

Challenge 6: Geographical and language diversity as well as different geographical/ regional practices and regulatory frameworks.

> **Solution:** Develop multilingual interfaces and documentation. Engage with local, regional, and global communities to understand and address needs.

Challenge 7: Variability in data quality

> **Solution:** Implement data standardisation and harmonisation methodologies as well as quality assurance measures, such as validation checks, and audits.

Challenge 8: Lack of funding and resources:

> **Solution:** Advocate for public and private funding for interoperability initiatives; promoting collaborate amongst stakeholders such as governments, NGOs, and industry partners to share resources and expertise.

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Challenge 9: Resistance to change

> **Solution:** Engage in stakeholder communication, provide training programmes, and demonstrate tangible benefits of interoperability.

Challenge 10: Scalability becomes a concern for interoperability solutions as food supply chains evolve or more data/sources are added.

> **Solution:** Design interoperability frameworks to be scalable, allowing for the incorporation of new technologies and accommodating growing complexity/volume of FLW data.

Addressing these challenges requires a collaborative effort involving stakeholders to build consensus on standards, best practices, and fostering a culture of interoperability to create an effective and connected food supply chain data ecosystem. However, within WASTELESS there is a more specific challenge arising from use case scenario and tool integration immaturity**.** Lack of details describing the scenarios, and likely data outputs, has posed a significant challenge in elaborating this data collection, interoperability, and governance plan, especially in respect of strategies for data collection, processing, governance, security, and FAIRification as well as user community needs (e.g., develop a protocol for populating the JRC model, Task 4.4). Consequently, aspects for consideration and subsequent definition and decision-making have been described that will be updated in parallel with WP3 use case development, progress, and execution to achieve a data collection, interoperability, and governance plan for each scenario and inform sharing with JRC.

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10. Governance Framework

A governance framework is a structured set of policies, processes, and guidelines that define how an organisation operates, makes decisions, and manages resources. The framework should ensure accountability, transparency, and compliance with regulations as well as helping align organisational – in this case – project objectives with stakeholder interests, promote ethical conduct, and support risk management.

10.1 Governance Definition

Governance refers to the set of processes, practices, and structures through which an organisation or system is directed, controlled, and regulated. It requires policies, procedures, and decision-making process to ensure an entity operates efficiently, ethically, and in line with its objectives and stakeholder interests. The goal is to support accountability, transparency, and effective management of resources whilst also mitigating risks. Data governance defines policies, processes, and responsibilities for managing and ensuring the quality, availability, integrity, and security of data. The primary objectives are maintaining data accuracy, promoting data quality, compliance with regulations, and facilitating effective decision-making. Data governance frameworks typically address data stewardship and/or ownership, meta data management, access controls, and data lifecycles.

10.2 Importance of Governance in Data Management

Governance in data management is important in the context of handling and leveraging data to ensure quality, accuracy, and reliability, which are essential for making informed decisions and trust in conclusions derived from data analysis. Governance also helps organisations comply with data protection regulations, privacy laws, and industry standards, thereby reducing the risk of legal and regulatory issues. Finally, governance practices safeguard data against unauthorised access, ensuring confidentiality but also maintaining data integrity by preventing unauthorised modifications or deletions.

A well-governed data environment provides decision-makers with reliable, timely, and relevant information, improving the quality of decision-making processes. Similarly, governance structures streamline data-related processes, reducing redundancies and inefficiencies in data management practices, optimise resources by avoiding duplication of effort, minimise errors, and ensure that resources are allocated appropriately. Consequently, data-driven innovation becomes possible, built on experimentation, analysis, and development of solutions.

Data governance also establishes clear ownership and stewardship (provider) roles, ensuring accountability for the quality and management of data, which are vital for establishing standards and protocols, and enabling integration of systems and data sources. Governance should also oversee the data lifecycle, from collection to

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disposal, ensuring that data are handled appropriately at each stage and not left languishing where they might become vulnerable to misuse in the future.

Governance ensures that data management practices align with organisational objectives, supporting the strategic goals and mission of the organisation. In the case WASTELESS, these objectives are development and testing of innovative tools and methodologies for FLW measurement and monitoring, achieving a harmonised methodological framework for FLW quantification, and delivering a decision support toolbox targeting all food value chain stakeholders. In that respect, governance facilitates collaboration amongst actors by fostering shared understanding and (re)use of data. Effective governance also builds trust among stakeholders by promoting transparency in how data are handled, used, and protected.

Ultimately, governance frameworks should be adaptable, accommodating changes in technology, regulations, and business requirements, while maintaining data integrity and privacy, reducing costs by avoiding errors and data breaches, and optimising processes. WASTELESS data governance should support stakeholders to derive value from data assets while ensuring ethical, secure, and compliant practices.

10.3 Governance Structure

A governance structure refers to the framework, processes, and hierarchy that define how an organisation is directed, controlled, and managed, establishing rules, roles, and responsibilities to ensure effective decision-making, accountability, and alignment with organisational goals. Designing a governance structure for FLW data involves creating a framework that ensures responsible and effective management of data throughout the entire supply chain and beyond to user communities.

This means WASTELESS must tailored the following to address its unique challenges:

1. Executive oversight: establish a high-level board dedicated to overseeing WASTELESS FLW data governance comprised of beneficiaries, actors, and stakeholders, as well as experts in data management and sustainability.

Roles and responsibilities (see below): teams responsible for overseeing data quality, ensuring compliance with data policies, and promoting best practices.

Decision-making processes: establish a data governance committee responsible for making day-to-day decisions related to FLW data strategy, prioritising initiatives, and resolving conflicts.

Technology and innovation: evaluate, implement, and oversee technology solutions that support FLW data management and innovation.

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2. Data policies and standards: data governance policies that address the unique characteristics of WASTELESS WP3 FLW data but also recommend standards for FLW data collection, classification, sharing, and disposal in general.

Data quality assurance: deploy quality teams/individuals at stages in the data supply chain to monitor and ensure accuracy, completeness, and reliability.

Continuous improvement: establish feedback mechanisms to gather input from stakeholders including user communities and use this feedback to continually improve FLW data governance processes and adapt to evolving challenges.

Reporting and transparency: develop standards for reporting on FLW data ensuring stakeholders have access to accurate information.

3. Stakeholder engagement that includes representatives from different sectors/ food supply chains to ensure diverse perspectives and collaboration.

Collaborative platforms: participate – or recommend how actors and user communities participate – in or establish industry-wide collaborations and initiatives focused on FLW data governance, which could involve stakeholders to share best practices and standards.

Training and awareness: implement training to raise awareness and build capabilities amongst actors and stakeholders regarding the importance of proper FLW data management practices for reducing food loss and waste.

Tailoring the governance structure to the unique characteristics of WASTELESS WP3 use case data will ensure that the framework is effective, practical, and aligned with the specific challenges and opportunities in the various environment (primary production, agri-food manufacturers, food retailers, and food services and consumers). However, WASTELESS should also make recommendations for wider FLW landscape, where it might be necessary review, update, and adapt the governance structure to changes in technology, regulations, and industry practices.

10.4 Roles and Responsibilities

In governance structures, roles and responsibilities define duties and accountabilities assigned to individuals or groups. These roles ensure effective and timely decision-making, accountability, and achievement of goals. Responsibilities include tasks related to decision-making, oversight, compliance, and strategic alignment. Establishing clear roles and responsibilities is fundamental for a well-functioning governance framework. In WASTELESS, the responsibilities might need to be assigned specifically but individuals or committees may have more than one role. Equally, a responsibility might be deemed unnecessary (with appropriate justification) or duplicated across use cases.

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Potential key roles and their associated responsibilities include:

1. Chief Data Officer:

Responsibilities: develop and implement WP3 use case data governance policies and strategies; define WASTELESS's wider FLW data governance framework; ensure compliance with data-related regulations; advocate for the value of data as a strategic asset; and oversee data stewardship and management initiatives.

2. Data Steward:

Responsibilities: define and enforce WP3 use case data quality standards; resolve WP3 use case data-related issues and discrepancies; ensure that WP3 use case data assets are properly classified and labelled; collaborate with WP3 use case data providers to establish data definitions and standards; and monitor and report on WP3 use case data quality metrics.

3. Data Provider:

Responsibilities: define and communicate WP3 use case data requirements; ensure that WP3 use case data assets are appropriately protected; establish WP3 use case data access controls and permissions; collaborate with WP3 use case data stewards to resolve data-related issues; and align data management practices with project and exploitation goals.

4. Data Custodian:

Responsibilities: implement and manage WP3 use case data security measures; maintain and protect WP3 use case data repositories (e.g., WASTELESS Zenodo Community); execute backup and recovery processes; collaborate with IT to implement data encryption and masking; and monitor WP3 use case data access and (re-)use.

5. Data Governance Manager:

Responsibilities: develop and manage the overall WP3 use case data governance programme; coordinate communication amongst different actors/stakeholders; track and report on key WP3 use case data governance metrics; conduct training and awareness programmes on data governance; and facilitate resolution of WP3 use case data-related issues.

6. Data Quality Analyst:

Responsibilities: monitor and assess WP3 use case data quality; implement WP3 use case data quality improvement initiatives; identify and rectify WP3 use case data anomalies and errors; collaborate with WP3 use case data stewards and providers to address WP3 use case data quality issues; and develop and maintain WP3 use case data quality metrics.

7. Data Architect:

Responsibilities: design and implement WP3 use case data models; define WP3 use case data structures and relationships; ensure alignment of WP3 use case

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data architecture with WASTELESS needs; collaborate with data stewards and providers to design WP3 use case data solutions; and provide expertise on WP3 use case data integration and storage.

8. Compliance Officer:

Responsibilities: ensure adherence to data-related regulations and policies; conduct audits to assess compliance with data governance standards; work with legal and regulatory bodies to understand and implement data requirements; and collaborate with the CDO to establish and enforce data governance policies.

9. Business (Open Science, IPR & Exploitation) Analyst:

Responsibilities: understand and document 'business' requirements for WP3 use case data; collaborate with data owners and stewards to ensure WP3 use case data meets business needs; translate business requirements into data governance policies; and participate in WP3 use case data governance committees and meetings.

10. IT Administrator:

Responsibilities: implement and manage WP3 use case data governance tools and technologies; ensure availability and reliability of WP3 use case data systems; collaborate with WP3 use case data custodians to implement security measures; and monitor and manage WP3 use case data storage and infrastructure.

10.5 Decision-Making Processes

Decision-making processes in data governance involve systematic approaches to agreeing informed choices about management, use, and protection of data. These processes involve defining how decisions are initiated, analysed, and -ultimately- approved or implemented. In the context of data governance, decision-making encompasses areas such as data quality standards, access controls, compliance measures, and strategic data initiatives. A well-defined decision-making process ensures that data-related choices align with goals, adhere to regulatory requirements, and contribute to the overall effectiveness of data management practices.

WASTELESS will need to identify and define decision, or critical decision points, including those related to data quality standards, access controls, data (re-)use policies, and strategic data initiatives for WP3 use case data but also FLW data more widely. Alongside convening governance bodies, WASTELESS will need to clearly articulate criteria used to evaluate/justify decisions such as data accuracy, regulatory compliance, impact, and alignment with project objectives. Importantly, whilst governance bodies can make recommendations and provide oversight, collaborative decision-making is essential to achieve collaboration and information-sharing at use case, task, WP, and project levels as well as amongst stakeholders. It

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also ensures that decision-making involves input from user communities and outputs are fit-for-purpose in the broader context.

Documentation is central to the quality of data and must record decisions including rationale, criteria considered, and outcomes as well as any disagreement. It underpins transparency, accountability, and provides a historical record that can be valuable for future reference, such why decisions were made. Similarly, communication plans to inform stakeholders about decisions, decision-making processes, and outcomes help build understanding and support for data governance initiatives and achieve impact. That said, before making decisions, WASTELESS will also need to conduct a thorough assessment of how decisions will impact actors/stakeholders including WP3, processes, and systems, considering potential risks, benefits, and dependencies.

For decisions related to standards and practices, impacts on FLW data quality generally and WP3 use case data specifically, as well as interoperability with other systems (e.g., JRC Model) will need to be considered. Decisions must align with efforts to maintain and improve accuracy, completeness, and consistency of FLW data globally as well as within and between WP3 use cases. Likewise, decisions must be in line with existing governance policies and procedures to maintain coherence.

Regularly monitoring the impact/ outcomes of decisions and a willingness to adjust strategies, based on evolving circumstances, technological advancements, and changes in organisational priorities, is highly desirable. This can be achieved through feedback and improvement mechanisms capturing insights gained from experiences and perspectives of those involved.

10.6 Data Security and Privacy

Governance for data security and privacy is critical for safeguarding personal and sensitive information, ensuring compliance with regulations, building trust with stakeholders, but also simply preserving valuable information. Components in establishing governance for data security and privacy include comprehensive data security and privacy policies that clearly outline a commitment to protecting data. In WASTELESS, these policies should cover WP3 use cases data handling practices, access controls, encryption, and guidelines for secure data management.

Generally, data should be categorised based on sensitivity and importance, which will help determine appropriate security measures for different types of information alongside feedback mechanisms for review and continuous improvement. Robust access controls, user authentication and authorisation, must be implemented to ensure only authorised individuals can access specific data (e.g., personal, sensitive, commercially sensitive/confidential data). Encryption can protect data, both in transit over networks and at rest to prevent unauthorised access. Regardless, WASTELESS must establish a plan to address and respond to data security incidents with steps for identifying, containing, eradicating, recovering, and learning from data breaches. Data privacy impact assessments can help evaluate potential risks and impacts of

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processing activities on individual privacy as well as shaping mitigation, including procedures for reporting breaches to regulatory authorities and affected individuals.

Following the principle of 'least privilege' will ensure that individuals only have access to data necessary for their roles and responsibilities and minimise unnecessary data collection. Training and awareness will also remind individuals of their responsibilities to protect personal and sensitive information as well as thinking about whether data are necessary (i.e., date of birth can be replaced in most cases by age ranges [e.g., 30-35] or year of birth). Executive oversight (see above) will help ensure compliance with security and privacy policies, and support risk assessment. However, WASTELESS must also consider third-party risk management, i.e., security practices of third-party providers and partners to ensure they meet the project's standards. It might be necessary to conduct audits to monitor compliance with data security and privacy, although implementing "privacy by design", will ensure that privacy is built into systems, applications, and processes from the outset.

It is essential that WP3 use cases specifically and the project in general stay abreast of evolving data protections and regulatory frameworks at national and European levels.

10.7 Compliance with Regulations

Ensuring compliance with regulations is a fundamental aspect of data governance. An effective governance framework helps organisations adhere to laws and industry standards, mitigating legal risks and fostering trust.

Key considerations for compliance with regulations within data governance are the **regulatory landscape**, identifying and analysing the regulatory landscape relevant to FLW and geographical location (including Regulation (EU) 2016/679 [General Data Protection Regulation]) and mapping regulatory requirements to specific data management processes to ensure compliance measures and privacy are fully integrated; ensuring that **data governance policies** explicitly address regulatory and legal requirements in respect of data collection, storage, processing, sharing, and disposal; establishing **data retention and deletion** policies; **classifying data** based on sensitivity and regulatory requirements, so that appropriate controls and safeguards can be applied to meet compliance standards; implementing robust **access controls and authentication** mechanisms to restrict access to data; utilising **audit trails** and logs to track data access and modifications; having a well-defined **data breach response**; conduct regular **training** sessions to educate users about regulations, legal obligations, and consequences of non-compliance for the project; addressing cross-border/**non-EU data transfers**; establish mechanisms to stay informed about **changes in regulations**; appointing a **data protection officer**, and/ or data controller and data processors, responsible for overseeing data protection efforts and ensuring compliance with relevant regulations.

Finally, as with other aspects of governance, clearly communicating data processing practices to individuals and organisation as well as obtaining necessary consents is essential to meet stakeholders' expectations.

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11. Data Collection, Interoperability, and Governance Plan

The Data Collection, Interoperability, and Governance Plan for WASTELESS is a strategic framework designed to enhance management, interoperability, and responsible (re-)use of data throughout the project but specifically the WP3 use cases.

This plan addresses the unique challenges associated with minimising FLW in each environment (primary production, agri-food manufacturers, food retailers, and food services and consumers), based on conclusions drawn from data generated by WP2 solutions for the various food commodities and products, by establishing guidelines for systematic data collection, promoting FAIR principles, and implementing measures to ensure data integrity, security, and legal and regulatory compliance.

Finally, by aligning data practices with sustainability goals and leveraging interoperability standards, the plan aims to improve decision-making, optimise resource allocation, and contribute to FLW reduction within the broader context of a sustainable and efficient food system.

11.1 Integration of Data Collection, Interoperability, and Governance

Integration of data collection, FAIR principles, and governance represents a comprehensive approach to managing FLW information within WASTELESS and beyond amongst stakeholders. It will harmonise systematic gathering of WP3 use cases data, inter/exchange of information across diverse systems, and establish a robust governance structure to ensure data quality, security, and compliance. By aligning these components, WASTELSS can create an efficient ecosystem for managing data, enabling better decision-making, fostering collaboration, and promoting responsible and sustainable practices. This integrated approach is crucial in food supply chains, where optimising data processes can lead to improved efficiency and contribute to addressing challenges such as FLW but also more sustainable food system(s).

11.2 Key Goals and Objectives

The key goals and objectives in the integration of data collection, FAIR principles, and governance for FLW data aim to creating a robust and efficient data ecosystem.

More specifically this includes:

Goal 1. Enhance FLW data collection, i.e., improve systematic collection of FLW data from WP2 (tools/technical) solutions, as related to WP3 use cases.

> **Objectives:** implement standardised data collection methodologies and enhance accuracy and granularity of data through advanced technologies.

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Goal 2. Promote FAIR principles including interoperability specifically to achieve seamless data exchange and collaboration amongst actors in WP3 use cases.

> **Objectives:** adopt common data standards and formats; promote use of interoperable APIs for data sharing; and establish protocols for consistent data representation.

Goal 3. Create data governance structures to oversee and regulate data practices, ensuring integrity, security, and compliance.

> **Objectives:** develop and implement data governance policies for each WP3 use case including audit trails and define roles and responsibilities for data stewardship.

Goal 4. Optimise decision-making by empowering providers and users with actionable insights derived from comprehensive and high-quality data.

> **Objectives:** enable data-driven decision-making at every stage of the WP use cases.

Goal 5. Mitigate FLW through informed decision-making and process optimisation.

> **Objectives:** support WP3 use cases to enable data analysis, dynamic supply chain adjustments based on data insights, novel FLW reduction strategies.

Goal 6. Safeguard data security and privacy to protect personal and sensitive data.

> **Objectives:** identify vulnerabilities, unnecessary data collection, and enforce GDPR.

Goal 7. Promote sustainability practices in data management to support environmentally responsible decision-making.

> **Objectives:** encourage adoption of FAIR principle and open science.

Goal 8. Facilitate cross-sector collaboration among stakeholders, technology providers, and regulatory bodies.

> **Objectives:** participate in initiatives and standards development efforts, foster partnerships for data sharing and research, and align with regulatory requirements.

Goal 9. Ensure regulatory compliance through adhere with relevant regulations and standards governing FLW and data management.

> **Objectives:** stay informed about evolving regulatory landscapes, implement processes to ensure compliance with data protection laws, conduct regular reviews.

Goal 10. Drive innovation by leveraging emerging technologies and data insights.

> **Objectives:** support adoption of new technologies for data collection and analysis, as demonstrated in WP3 use cases and share outcomes with stakeholders.

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11.3 Draft Implementation Timeline

Creating an implementation timeline means breaking down this plan into actionable phases and setting specific milestones. Given the immaturity of the WP3 use cases, only a generalised outline for the implementation timeline from January 2024 to December 2025 is possible at this stage:

1. January 2024 - March 2024:
    - Develop a detailed plan and timeline for each WP3 use case
    - Identify Key Performance Indicators (KPIs)
2. April 2024 - June 2024: Data collection
    - Review current data collection practices for each WP3 use case
    - Establish data quality assurance protocols
3. July 2024 - September 2024: Interoperability framework implementation
    - Identify appropriate standards and standardised/harmonised data formats
    - Develop protocols for consistent data representation
    - Test interoperability
    - Engage stakeholders in the implementation process
4. October 2024 - December 2024: Data governance framework setup
    - Develop and implement data governance policies
    - Define roles and responsibilities for data stewardship
    - Establish data governance council
    - Conduct training on governance policies and practices
    - Begin regular audits to ensure policy adherence
5. January 2025 - March 2025: Decision-Making Optimisation
    - Monitor and optimise decision-making processes
6. April 2025 - June 2025: FLW reduction initiatives
    - Monitor and evaluate the impact of initiatives
    - Adjust strategies based on performance
7. July 2025 - September 2025: Data security and privacy measures
    - Develop and enforce data privacy policies
    - Conduct regular security audits and assessments
    - Facilitate training on security practices
    - Review and update security measures as needed

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8. October 2025 - December 2025: Sustainability integration and continuous improvement

- Track and report on sustainability metrics
- Evaluate and implement data feed to JRC Model
- Conduct comprehensive year-end review and planning for 2026

NB: This timeline is a general outline, and the actual timelines will vary based on WP3 use cases planning, resources, and unforeseen challenges. Regular reviews and adjustments will be made throughout the implementation period to ensure alignment with project goals generally and WP3 use cases specifically.

11.4 Resource Requirements

Implementing a comprehensive Data Collection, Interoperability, and Governance Plan for WASTELESS requires careful consideration of various resources.

Key resource requirements include (1) **Personnel** (i.e., data scientists/analysts, data stewards, and IT specialists, project managers); (2) **Technology** (i.e., WP2 data collection tools, interoperability solutions, data governance software, analytics platforms); (3) **Training** and education; (4) Consultants/**Experts** in each environment willing to work with WASTELESS to adopt recommendations regarding data FAIRification; (5) **Infrastructure** (i.e., servers, storage systems, and networking equipment, cloud services); (6) **Financial resources** for technology investments, training programmes, consultancy, and contingencies; (7) Data **security** measures (i.e., software and IT specialists); (8) Legal and **compliance** expertise; (9) **Collaboration** platforms (e.g., Zenodo, WASTELESS knowledge hub); (10) **Documentation** and reporting; (11) Continuous **improvement** initiatives and auditing; (12) **Sustainability** integration including environmental impact assessment; (13) Project **management** tools; and (14) Stakeholder **engagement**.

It will be important to conduct a thorough assessment of specific needs for each WP3 use case to tailor these resource requirements accordingly. Regular monitoring and adjustments to resource allocation will be necessary throughout implementation.

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12. Risk Management

Risk management for the WASTELESS Data Collection, Interoperability, and Governance Plan involves identifying, assessing, and mitigating potential challenges and uncertainties that may arise during implementation of each WP3 use case and, subsequently, sharing of FLW data. Risk management aims to minimise the impact(s) of unforeseen events on data processes, FAIRifcation, and governance practices within the context of WASTELESS. Key elements include proactive planning, continuous monitoring, and the development of contingency measures to ensure resilience.

Not all of these will be relevant to WASTELESS generally or WP3 use cases specifically.

12.1 Identification of Risks and Mitigation Strategies

Contingency planning involves pre-defined actions and procedures to minimise impact(s) of risks if/when they occur. Regular risk assessments, ongoing monitoring, and a flexible approach to adapt to changing circumstances are crucial. Regardless, likely risks associated with WP3 use case data, with mitigation strategies, are:

1. Data Security and Privacy Risks:

Risk: Unauthorised access, data breaches, or privacy violations

Mitigation:

- Implement robust encryption and access controls
- Conduct regular security audits and assessments
- Provide comprehensive training on data security and privacy

2. Interoperability Challenges:

Risk: Difficulty in achieving data exchange among diverse systems

Mitigation:

- Adopt standardised data formats and protocols
- Implement interoperable APIs and middleware
- Engage in regular testing and validation of interoperability

3. Data Quality Issues:

Risk: Inaccurate or incomplete data impacting decision-making

Mitigation:

- Implement data quality assurance protocols
- Conduct regular audits of data sources
- Provide training on accurate data collection and entry

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4. Lack of Actor/Stakeholder Collaboration:

Risk: Resistance or lack of cooperation from actors/ stakeholders

Mitigation:

- Establish clear communication channels and engagement strategies
- Conduct workshops and training to build awareness and engagement
- Highlight benefits of collaboration and data sharing

5. Technological Challenges:

Risk: Technical issues, system failures, or outdated technology

Mitigation:

- Regular update(s) and maintain technology infrastructure(s)
- Have contingency plans for system failures or redundancies
- Invest in scalable and adaptable technologies

6. Regulatory Compliance Risks:

Risk: Non-compliance with data protection and privacy regulations

Mitigation:

- Stay informed about evolving regulatory requirements
- Appoint a Data Protection Officer to oversee compliance
- Conduct regular compliance audits and implement recommendations

7. Resistance to Change:

Risk: Resistance to new data collection and governance practices

Mitigation:

- Develop comprehensive training programmes, e.g., e-learning
- Communicate benefits of the new practices, e.g., time-saving
- Involve actors/stakeholders in the planning and decision-making process

8. Insufficient Training and Skill Gaps:

Risk: Inadequate skills to manage and utilise data effectively

Mitigation:

- Provide ongoing training programmes for actors/stakeholders, and researchers
- Identify and address skill gaps through targeted education

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9. Unforeseen External Factors:

Risk: External events such as natural disasters, pandemics, or geopolitical issues

Mitigation:

- Develop a continuity and disaster recovery plan(s)
- Diversify data storage and processing locations on and offline
- Stay informed about external factors and adapt plans accordingly

10. Lack of Scalability:

Risk: Inability of systems to handle increasing data volumes

Mitigation:

- Design systems with scalability in mind
- Regularly assess and upgrade infrastructure(s) to accommodate growth
- Monitor data usage patterns and plan for future scalability

12.3 Contingency Planning

Contingency planning is also a crucial aspect of risk management, providing a structured approach to respond effectively if unforeseen events or risks materialise. Contingency planning measures in relation to the identified risks and their mitigations for WASTELESS and WP3 use case more specifically are:

1. Data Security and Privacy Risks:

Contingency Plan:

- Activate an incident response team in the event of a data breach
- Establish a communication plan for informing affected parties promptly
- Have backup systems and data recovery procedures in place

2. Interoperability Challenges:

Contingency Plan:

- Maintain rollback plan(s) to revert to previous system if disrupted
- Establish alternative data exchange methods if primary mechanisms fail
- Engage technical support promptly to address critical issues

3. Data Quality Issues:

Contingency Plan:

- Implement data validation checks to identify and correct inaccuracies
- Have a rapid response team to address urgent data quality issues
- Establish protocols for data correction and revalidation

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4. Lack of Actor/Stakeholder Collaboration:

Contingency Plan:

- Develop alternative communication channels in case of disengagement
- Identify key influencers to address resistance and promote collaboration
- Implement strategies to regain trust and commitment

5. Technological Challenges:

Contingency Plan:

- Maintain a redundant technology infrastructure for critical systems
- Establish relationships with technology providers (WP2) for rapid response
- Have a backup data centre or cloud-based solution for continuity

6. Regulatory Compliance Risks:

Contingency Plan:

- Keep WP1 and WP2 involved to provide responses regarding compliance
- Regularly update policies and procedures to align with evolving regulations
- Establish a regulatory compliance task group for quick decision-making

7. Resistance to Change:

Contingency Plan:

- Develop change strategies to address resistance, e.g., explain benefits
- Provide additional training and support for teams facing challenges
- Adjust implementation timelines and milestones as needed

8. Insufficient Training and Skill Gaps:

Contingency Plan:

- Develop a training to address immediate skill gaps
- Utilise resources or experts for quick upskilling
- Establish mentorship for ongoing skill development

9. Unforeseen External Factors:

Contingency Plan:

- Develop a continuity plan that includes scenarios for external disruptions
- Establish alternative data provision routes and communication methods
- Monitor global events and adjust plans in response to emerging external risks

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10. Lack of Scalability:

Contingency Plan:

- Assess system performance and scalability to predict potential issues
- Develop a rapid scalability plan to address sudden increases in data volume
- Engage with technology partners to explore scalable solutions.

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13. Monitoring and Evaluation

Monitoring and evaluation are essential components of the WASTELSS Data Collection, Interoperability, and Governance Plan, providing a systematic approach to assessing effectiveness, identifying areas for improvement, and ensuring alignment with project goals. More specifically, monitoring involves tracking and surveillance of key performance indicators (KPIs), milestones, and processes. These aim to provide insights into progress, helping the WASTELESS consortium, WP3 use cases specifically, and FLW actors and stakeholders generally to understand whether activities are on track and if objectives are being achieved. Regular monitoring activities might include data quality assessments, system performance checks, and compliance audits. Information gathered during monitoring enables timely decision-making and adjustments to ensure activities remains aligned with outcomes and timescales.

Evaluation requires comprehensive assessment of overall impact(s), effectiveness, and efficiency of the Data Collection, Interoperability, and Governance Plan. Typically, it would be conducted at predefined milestones or following implementation. Evaluation activities delve into outcomes and impacts of the plan and related activities, examining how well objectives have been met and progressed project or WP3 use cases goals. This process might involve surveys, interviews, data analytics, and performance reviews. Insights gained from evaluation inform future planning, helping refine strategies and approaches for ongoing improvement.

Key components for monitoring and evaluation include:

1. Performance Metrics: specific metrics related to data collection accuracy, interoperability effectiveness, governance policy adherence, and other relevant KPIs.

2. Data Quality Checks: quality and integrity of collected data to ensure accuracy.

3. Compliance Audits: adherence to data governance policies, privacy regulations, and other standards.

4. User Feedback: feedback from actors/stakeholders, including end-users and decision-makers, to understand their experiences.

5. Impact Assessment: impact on WASTELESS goals and FLW reduction.

6. Process Efficiency: efficiency of data collection, interoperability mechanisms, and governance processes to identify areas for streamlining.

7. Strategic Alignment: alignment with project strategies and objectives.

Benefits of monitoring and evaluation are informed decision-making, timely insights and responses to challenges or opportunities for improvement or refinement of data collection strategies and approaches. An important outcome of EU-funded projects is demonstrating impact, and evaluation will showcase effectiveness and impact(s). By combining monitoring and evaluation, WASTELESS can ensure that the Data Collection, Interoperability, and Governance Plan remains dynamic, responsive, and aligned with project and WP3 use cases needs as well as broader FLW objectives.

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13.1 Key Performance Indicators (KPIs)

Key Performance Indicators (KPIs) can have a role in measuring success and effectiveness of activities by tracking track progress, identify areas for improvement, and demonstrating impact(s) of WP3 use cases on FLW reduction.

KPIs that might be relevant for WASTELESS generally or WP3 use cases specifically are:

1. Data Collection:

Data Accuracy: percentage of collected data that are accurate and free from errors.

Data Entry Error: percentage of data entries that contain errors or inconsistencies.

Data Completeness: percentage of required data fields that are populated.

Timeliness: average time taken to collect and input or share data.

2. Interoperability:

System Integration Success: percentage of systems successfully integrated.

Data Exchange Efficiency: time taken for data to be exchanged between systems.

Errors in Data Exchange: percentage of errors or failures in data exchange processes.

Data Formats and Standards: number and compliance with data formats and standards supported.

3. Governance:

Adherence to Data Governance Policies: percentage of data-related activities that comply with established governance policies.

Incident Response Time: average time taken to respond to and address data incidents.

Completion of Data Privacy Impact Assessments: percentage of data processing activities evaluated.

Governance Policy Violations: number and nature of violations.

4. Decision-Making and Analytics:

Time to Generate Reports: average time taken to generate analytical reports.

User Satisfaction with Analytical Tools: Feedback from user communities regarding the effectiveness and user-friendliness of WP2 analytical tools or WP3 use cases.

Number of Data-Driven Decisions: frequency with which decisions are made based on data insights.

Impact on FLW Reduction: quantifiable reduction in FLW attributed to data-driven initiatives, based on WP2 and WP3 activities.

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5. Actor/ Stakeholder Engagement:

Stakeholder Satisfaction: Feedback from actors/ stakeholders.

Level of Collaboration: extent to which actors/ stakeholders actively participate in data sharing and collaboration.

Number of Training Sessions: frequency of training conducted to enhance actor/ stakeholder understanding and cooperation.

6. Security and Privacy:

Number of Security Incidents: frequency and nature of security incidents, breaches, or unauthorised accesses.

Data Encryption Effectiveness: effectiveness of data encryption measures.

Privacy Compliance Adherence: degree to which WASTELESS complies with relevant data privacy regulations.

Number of Compliance Audits Passed: results of internal and external audits.

7. Sustainability:

Environmental Impact Assessment: environmental impact of data-related activities.

Sustainability Metrics Tracking: e.g., carbon footprint reduction.

Alignment with Sustainable Practices: e.g., evidenced sustainable practices.

13.2 Monitoring Mechanisms

Equally, monitoring mechanisms are essential for tracking KPIs effectively. These should be integrated into overall data management to ensure that data-related activities are tracked and assessed continuously. Automated tools, reporting dashboards, and periodic reviews are helpful as part of an effective monitoring framework. However, regular communication with and feedback from actors/stakeholders are also useful in assessing success. Not all of these will be relevant to WP3 use cases or WASTELESS:

1. Data Collection:

Monitoring Mechanisms:

Data Validation: check data accuracy and completeness.

Regular Data Audits: verify the accuracy and completeness of collected data.

Timeliness Tracking: track the time it takes for data to be collected and entered.

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2. Interoperability:

Monitoring Mechanisms:

Interoperability Testing: testing to ensure seamless integration between systems.

Performance Monitoring: monitor the efficiency of data exchange processes.

Error Logging and Alerts: log errors and send alerts for interoperability issues.

3. Governance:

Monitoring Mechanisms:

Policy Compliance: monitor and enforce adherence to governance policies.

Automated Incident Response: detect and respond to policy violations.

Regular Compliance Audits: ensure compliance with established policies.

4. Decision-Making and Analytics:

Monitoring Mechanisms:

Dashboard and Reporting: provide timely insights into analytical processes.

User Feedback: effectiveness and user-friendliness of analytical tools.

Tracking Data-Driven Decisions: track when/where decisions are data-based.

5. Stakeholder Engagement:

Monitoring Mechanisms:

Feedback: channels for actors/ stakeholders to provide ongoing feedback.

Collaboration: frequency and nature of collaboration.

Attendance: track attendance and participation in training or events.

6. Security and Privacy:

Monitoring Mechanisms:

Security Management: monitor security events.

Regular Security Audits: periodic security audits to identify vulnerabilities.

Access Logs: review access logs to identify unauthorised or suspicious activities.

7. Sustainability:

Monitoring Mechanisms:

Environmental Impact Assessment: assessment of environmental impact.

Sustainability Metrics Tracking: track and report on sustainability metrics.

Alignment Checkpoints: assess alignment of data activities with sustainability.

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8. Continuous Improvement:

Monitoring Mechanisms:

Performance Reviews: regularly reviews of KPI performance against targets.

Root Cause Analysis: investigate causes of deviations from expected KPIs goals.

Innovation and Technology: monitor emerging technologies and best practices.

9. Compliance with Regulations:

Monitoring Mechanisms:

Regulatory Compliance: monitor changes in regulations and assess compliance.

Regular Checks: scheduled checks to ensure adherence with data protection.

Legal Checks: engage WP1 and WP2 to stay informed about regulatory landscapes.

13.3 Evaluation Criteria

Evaluation criteria provide benchmarks and targets against which success and impact can be measured. Regular evaluations should be conducted to identify achievements, areas for improvement, and opportunities for further optimisation. The criteria should be flexible enough to adapt to changing priorities and industry trends. Again, not all of these will be relevant to WASTELESS generally or WP3 use cases and should be refined in response to more concrete information about WP3 use cases.

1. Data Collection:

Evaluation Criteria:

Data Accuracy: achieve a target accuracy rate of 95% or higher.

Assessment: regular audits and comparison against established benchmarks.

Data Completeness:

Criteria: maintain completeness of 98% or higher for required data fields.

Assessment: periodic evaluations comparing completeness with established targets.

2. Interoperability:

Evaluation Criteria:

System Integration Success: achieve successful integration for 95% or higher.

Assessment: regular interoperability testing and tracking of integration success.

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Data Exchange Efficiency:

Criteria: maintain an average data exchange time within predefined benchmarks.

Assessment: regular monitoring of data exchange efficiency.

3. Governance:

Evaluation Criteria:

Adherence to Data Governance Policies: maintain at 98% or higher.

Assessment: regular compliance audits and policy adherence tracking.

Incident Response Time:

Criteria: achieve incident response times within defined timeframes.

Assessment: periodic evaluations of incident response times.

4. Decision-Making and Analytics:

Evaluation Criteria:

Time to Generate Reports: maintain an average within limits (to be defined)

Assessment: periodic evaluations for each WP3 use case or with user communities.

User Satisfaction with Analytical Tools:

Criteria: achieve a user satisfaction score of 80% or higher.

Assessment: regular user feedback surveys and usability assessments.

5. Stakeholder Engagement:

Evaluation Criteria:

Stakeholder Satisfaction: maintain a satisfaction score of 85% or higher.

Assessment: ongoing collection and analysis of feedback.

Level of Collaboration:

Criteria: increase frequency and depth of collaboration over time.

Assessment: tracking collaboration metrics and participation rates.

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6. Security and Privacy:

Evaluation Criteria:

Number of Security Incidents: reduce the number of security incidents by 20% compared to the previous period, or maintain number below limits (to be defined)

Assessment: analysis of security incident reports and incident response effectiveness.

Data Encryption Effectiveness:

Criteria: maintain an encryption effectiveness rate of 98% or higher.

Assessment: evaluation of encrypted data and encryption protocols.

7. Sustainability:

Evaluation Criteria:

Environmental Impact Assessment Results: achieve positive outcomes.

Assessment: reviews of reports and sustainability metric tracking.

Alignment with Sustainable Practices:

Criteria: align data activities with sustainable practices.

Assessment: reviews of alignment checkpoints and sustainability goals.

8. Continuous Improvement:

Evaluation Criteria:

Performance Reviews: achieve performance targets for each KPI.

Assessment: analysis of actual performance against targets (to be defined)

Root Cause Analysis:

Criteria: address root causes of deviations from expected KPI levels.

Assessment: implement corrective actions.

9. Compliance with Regulations:

Evaluation Criteria:

Regulatory Compliance Tracking: maintain awareness and promote compliance with evolving regulatory requirements.

Assessment: review of compliance tracking systems and legal requirements.

Regular Compliance Checks:

Criteria: pass all compliance checks with no major issues.

Assessment: periodic evaluations of compliance against regulatory requirements.

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14. Conclusion

In conclusion, development and implementation of a comprehensive food loss and waste data collection, interoperability, and governance plan is imperative for the success of WASTELESS generally, and the sustainability WP3 use case data specifically, in an increasingly open data-driven landscape. Through meticulous planning and strategic execution, WP4 Task 4.1 aim to foster data exchange, enhance FAIRification especially interoperability amongst systems and user communities, and establish robust governance framework(s). These will not only ensure reliability and accuracy of WP3 use case data, and FLW data in the future, but also promote informed decision-making at every level in a range of diverse food environments (primary production, agri-food manufacturers, food retailers, and food services and consumers) based on FLW data generated by different technical solutions. By prioritising data integrity, security, and accessibility, this plan lays the foundation for an agile and adaptive ecosystem. Continuous monitoring, evaluation, and refinement will be essential to align with evolving technological landscapes and regulatory changes, enabling our WASTELESS to stay at the forefront of innovation while maintaining the highest standards of data governance. However, it must be recognised that WP3 case studies are immature at this stage of the project (M12). There is ambiguity around not only the nature of the case studies in each environment but also data likely to be generated by WP2 (tools/technical) solutions for the various food commodities. Until the nature of the case studies in each environment and data generated by WP2 solutions have been elaborated, meta data (data about data), characteristics of the FLW data cannot be elaborated (e.g., descriptive, administrative, technical, structural, contextual, provenance, accessibility, interoperability, preservation, security, re-use). This lack of details has posed a significant challenge in developing this data collection, interoperability, and governance plan, especially in respect of strategies for data collection, processing, governance, security, and FAIRification as well as user community needs (e.g., develop a protocol for populating the JRC model, Task 4.4). Consequently, aspects for consideration and subsequent definition and decision-making have been identified and described and will be updated in parallel with WP3 use case development, progress, and execution to achieve a data collection, interoperability, and governance plan for each scenario and inform sharing with JRC.

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