LIFE Project Number

LIFE15 ENV/GR/000257

LIFE PROJECT NAME or Acronym

LIFE-F4F (Food for Feed)

Action:	B1: Development of the Source Separated Food Waste Collection System
Partner:	HUA
Deliverable:	B1.3. Selected hotels source separation system qualitatively and quantitatively survey

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ABSTRACT

Hotels, or more broadly the hospitality sector represents one of the most important subsectors of the travel and tourism industry. Many of the services provided to hotel guests are highly resource intensive, whether it concerns energy, water or raw materials. Therefore, hotels have been found to have the highest negative impact on the environment of all commercial buildings, apart from hospitals.

This report is a deliverable of the Action B1 of the project “Food for Feed: An Innovative Process for Transforming Hotel’s Food Wastes into Animal Feed – LIFE F4F” (LIFE15 ENV/GR/257) and contains the results (analysis) of the questionnaires and semi-structured interviews regarding the existing food waste management practices within the hospitality sector in the area that was used to formulate an effective source separated food waste collection system.

The primary goal of this deliverable is to develop a representative, statistically defensible estimation of the waste composition and also, to identify the various characteristics for the hotels situated in the general area of Heraklion. A survey was conducted by the HUA, for the purpose of identifying waste composition (including microbiological characterisation). The sampling plan consisted of seasonal one-week sampling periods of the hotels participating in the programme.
The e-mail-based survey aimed to evaluate the waste management system of the hotels in the study area and record their operational characteristics, their waste management practices, the municipal waste collection system as well as to gather the information about the environmental policy already taking place within the tourist industry in the area.

The waste management system and waste characteristics of 24 hotels in the Heraklion and Hersonissos area of Crete (Greece) are presented.

This report is just a preliminary evaluation of the results. Further, more detailed evaluations will be performed and published in the future.

1 INTRODUCTION

The objective of this deliverable (sub-action) is the evaluation of, (i) the existing source separation system of the organic waste, (ii) the storage conditions of these waste, (iii) the deployed tools (bags, bins etc), (iv) the quality and quantity of the separated wastes (composition analysis), and (v) the existing municipal waste collection system.

The island of Crete is one of the greatest tourist resorts in Greece (Table 1-1) and numbers more than six hundred thousand residents (623,065, ELSTAT 2011). Furthermore, Crete is a combination of urban, mountainous, rural, and purely tourist regions. Heraklion, geographically located in the centre of Crete with nearly 150,000 residents, is the metropolis of Crete. Chania and Rethymnon lie in the west and Aghios Nikolaos in the east. Regions with high seasonal variability in population due to tourism are Hersonissos and Malia, located east of Heraklion and west of Aghios Nikolaos. Ierapetra, located south of Aghios Nikolaos, qualifies as rural mainly because of the numerous greenhouses located there.

Hotels, or more broadly the hospitality sector represents one of the most important subsectors of the travel and tourism industry.

Table 1-1: Main characteristics of the study area

	Population(1)	Hotel beds(2)	Hotel rooms(2)
Rethymnon	85,609	31,509	16,530
Heraklion	305,490	68,838	35,722
Lassithi	75,381	24,646	12,647
Chania	156,585	43,689	23,715
Crete	623,065	168,682 (2015)	88,614 (2015)
Greece	10,850,000	788,553	407,146

Source: (1) ELSTAT, 2011 National Census, http://www.statistics.gr/en/2011-census-pop-hous
(2) Hellenic Chamber of Hotels, http://www.grhotels.gr/EN/Pages/default.aspx

The primary goal of this deliverable is to develop a representative, statistically defensible estimation of the waste composition and also, to identify the various characteristics for the hotels situated in the general area of Heraklion. A survey was conducted by the HUA, for the purpose of identifying waste composition (including microbiological characterisation). The sampling plan consisted of seasonal one-week sampling periods of the hotels participating in the programme.

It is estimated that there are more than 150 hospitality facilities compatible with F4F requirements, within the area of interest. One hundred (100) four (4*) and five (5*) star hotels of various sizes situated in the north coast around the City of Heraklion (25 km radius). Regarding hotels, is estimated that more than 10,000 rooms in 5-star and 4-star hotels are available. That made easy to locate the required 4 hotels, which they are participating in the programme and operate reliable source separation scheme.

Four hotels were selected for participating in the project. The hotels were selected based on their rating, their food wastes system (separated collection) and the total number of beds that should be about 2,000. On a daily basis, these hotels will generate up to 1.0-1.5 t of source separated food wastes.

Figure 1-1. The area of the targeted 4 and 5-star hotels.

Sampling was carried out at the participating hotels around Heraklion and Hersonissos in Crete, according to international standard ASTM D5231-92(2008) [1] and RCRA regulation [2].

2 THE ANALYSIS OF FOOD WASTE AND RELATED ATTRIBUTES OF HOTELS

2.1 INTRODUCTION

The determination of the related attributes of source segregated food residues (i.e. hotels' food waste) was an important stage of the evolutionary stages of solar drying/ pasteurisation, since the rate at which materials are processed as well as the quality of the final material (feed) are largely dependent on the initial properties of the feedstock material. A complete physicochemical analysis of sorted food residues was performed in order to be able to evaluate the solar drying/ pasteurisation process and the resulting end product considering that the input material determines a priori the physical, chemical and biological conditions involved in solar drying/ pasteurisation.

To this end, a coherent protocol was developed aiming to effectively depict (a) the parameters that need to be quantified for the characterisation of food waste, (b) the collection frequency of representative samples and (c) the selection of appropriate standard methods of analysis for each parameter.

The document was developed through consultation among the LIFE-F4F beneficiaries, previous background experience of the HUA working group on composting and solid waste sampling and analysis and information from the literature review and peer review articles on biowaste management. Overall 25 batches of source segregated food waste were analysed, whereas various parameters were quantified in order to characterise effectively the sorted organic material. The HUA working team developed a state-of-the-art methodology for conducting the compositional analysis of segregated biowaste for the hotels. The methodology was based on different technical reports, standards and scientific papers given that an international standard methodology has not been established up until now, while a variety of categorisation systems has been developed due to the different focus and objectives of each study.

2.2 QUESTIONNAIRE-BASED SURVEY

The questionnaires have been sent via e-mail to the targeted hotel representatives in the area throughout the months of March to May 2017, while the collection of the completed questionnaires that are included in this report was completed and collected via appointments with the hotel representatives during June 2017.

Surveys, especially those conducted via e-mail have a general drawback of very low response rate. Such a situation can be attributed to the form of e-mail correspondence, lacking personal contact and thus believed to be less obligatory. However, the response rate achieved allows for the formulation of some general statements.

In certain cases, the questionnaire was completed and collected during the interviews with the hotel representatives. The questionnaires were being sent to hotels, which did not respond previously, periodically approximately every 1 or 2 weeks. The questionnaire consisted of four sections (i.e. basic information, operational characteristics, environmental policy, and waste management). A copy of the questionnaire is attached to Appendix 1.

The e-mail based survey aimed to evaluate the waste management system of the hotels in the study area and record their operational characteristics, their waste management practices, the municipal waste collection system as well as to gather the information about the environmental policy already taking place within the tourist industry in the area.

The characteristics of 24 hotels (out of 28 approached) were identified and their different waste management activities were recorded (a detailed summary of the survey's results is presented in Appendix 1), through questionnaires and semi-structured interviews with hotel representatives. For the no responded hotels, some basic information (i.e. the number of rooms, number of beds etc.) was collected from the National Tourist Organisation and ESDAK.

Four (4) hotels of these were selected to participate in the pilot program and cooperate with the LIFE-F4F project, in order to ensure the required quantity of 1.0-1.5tn of food residues per day. The three of the selected hotels operate all year round (city hotels), while the fourth (Creta Maris) operates for about 70% of the year.

The questionnaire consisted of 17 questions and the most important findings, related to the project, are summarised below. Although there are some differences in certain issues, the situation looks relatively similar for all hotels under investigation. Generally, it can be concluded that the majority of hoteliers perceive the environment as an important factor in the development and well-being of both the tourism and hotel industry, at least in terms of intentions.

- A significant number of hotels had no knowledge of the waste (and food waste in particular) generation rate. It was feasible, only for the seventeen (17) hotels, out of the 24 hotels responded, to estimate directly or indirectly the food waste generation from the information given.
- Food waste is not being collected separately from other waste, although almost all hotels (~90%) are collecting separately the packaging waste. This was advantageous for the setup of a system for separate collection of food waste.
- Temporary storage of waste is not always done at a low temperature. The hotels in the city of Heraklion do not have "cold rooms".
- Collection: bins and bags
- The management of the hotels had no knowledge of waste management costs.
- Method of management: Waste is transferred to the municipal landfill.
- A significant number of hotels declared an interest on their environmental footprint, even if in most cases was not formulated in a specific policy or just remained in the level of intentions.

Generally, the high response rate (24 out of 28 hotels) from the representatives of hotel management (hotel managers or the food and beverages managers) allows the conclusion, that the survey was treated seriously and that the answers obtained are representative for the Cretan hotel industry.

2.3 QUANTIFICATION OF FOOD WASTE GENERATED

In order to operate the pilot plant and transforming food waste to animal feed, an understanding of the quantities and quality of food waste is necessary. The food waste generation rate, for the 17 hotels that was possible to obtain direct or indirect information about the quantity of food residues (waste) generated, was estimated. The cornerstone of successful planning for a waste management program is the availability of reliable information about the quantity and the type of material being generated.

2.3.1 Estimation of food waste generation from hotels

As a result of everything we were able to learn until this point about food waste in the hospitality sector, via all of the interviews conducted and data collected from the participating hotels, the following formulae are proposed as indicators that can be used to evaluate hospitality sector's food waste generation (at least for 4* and 5* hotels).

$$\text{Food waste generation } \left(\frac{kg}{\text{day}}\right) = 0.50\left(\frac{bed}{\text{day}}\right) \times [N\ of\ beds] \times [Occupancy\ (\%)]$$

The next equation developed relates the food waste generated to the number of employees at the hotel though it is the guests who are the ones who generate the waste.

The equation relates the food waste amount to the total number of employees and not just the kitchen staff (as may be considered a natural consequence of the significant proportion of preparation food waste).

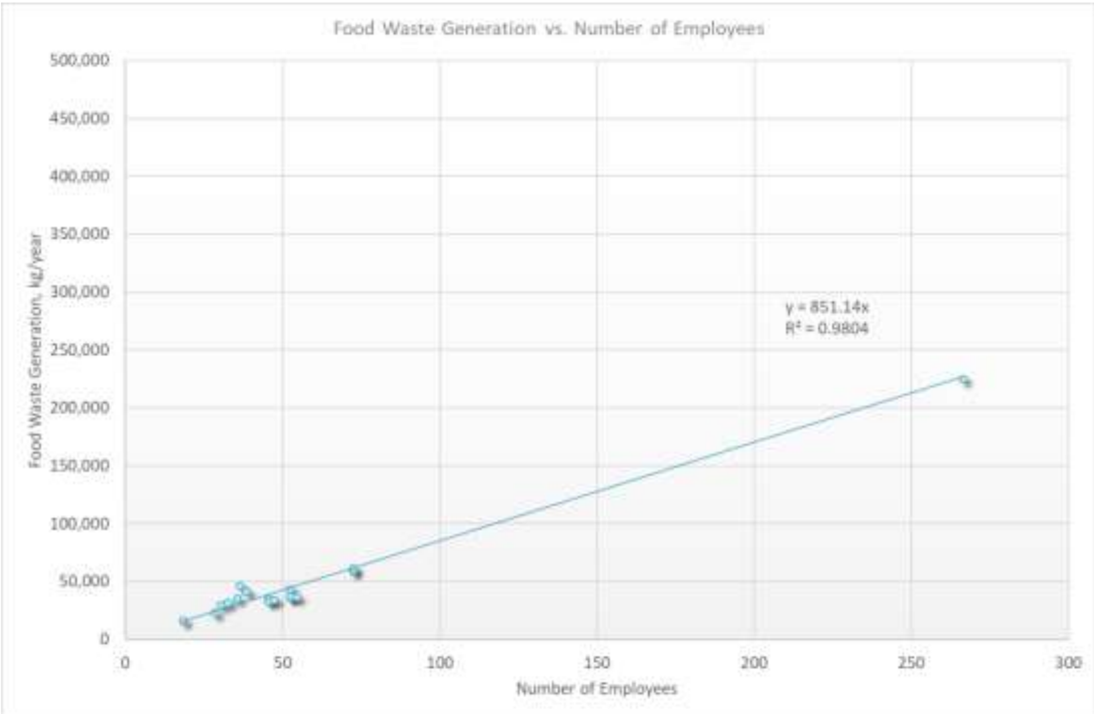

Figure 2-1. Correlation of hotels' food waste generation with the number of their employees.

From the above graph a formula that relates the number of hotel employees and the food waste generation rate is determined.

$$\text{Food waste generation } \left(\frac{kg}{\text{year}}\right) = [N\ of\ employees]\ \times \left(851.14\frac{kg}{\text{employee} \times \text{year}}\right)$$

It can be inferred in such a situation that the use of the number of employees as a variable provides more reliability to the formula since this is a number which is more stable in the sense that it does not change from one meal to another, while the number of guests at each meal does. Moreover, since the quantity being calculated is being estimated over an extended period of time (i.e. on a yearly basis), considering a variable such as the number of employees helps make the calculations less complex (if the number of guests was being used instead, the average number of guests during the year may need to be calculated first, etc.).

The implications of the previous assessment are that the food waste generation from that the hospitality and food service sectors in Crete amounts to **0.08** kg/ca/day (**29.0** kg/ca/year) or 18,050 tonnes annually, of which 14,950 tonnes are generated from hotels (**0.065** kg/ca/day or **24,0** kg/ca/year).

2.3.2 Quantities of food residues collected

The quantities of food residues collected that have been collected and delivered to the Solar drying/ Pasteurisation Pilot Unit, from the operation start-up unit until the end of October, are presented in the following Table 2-1.

Table 2-1. Food residues delivered to the Solar drying/ Pasteurisation Pilot Unit (7th May – 31st October 2018).

Month	Average daily average quantity collected, kg d^{-1}	Total food residues collected, kg
May	768	17,665
June	907	27,200
July	829	25,700
August	917	28,430
September	876	26,290
October	780	24,180
May-October	**849**	**149,465**

The total weight of the collected food wastes for this period amounts to **149.5** metric tonnes. The data of the previous table are summarised in the diagram below (Figure 2-2).

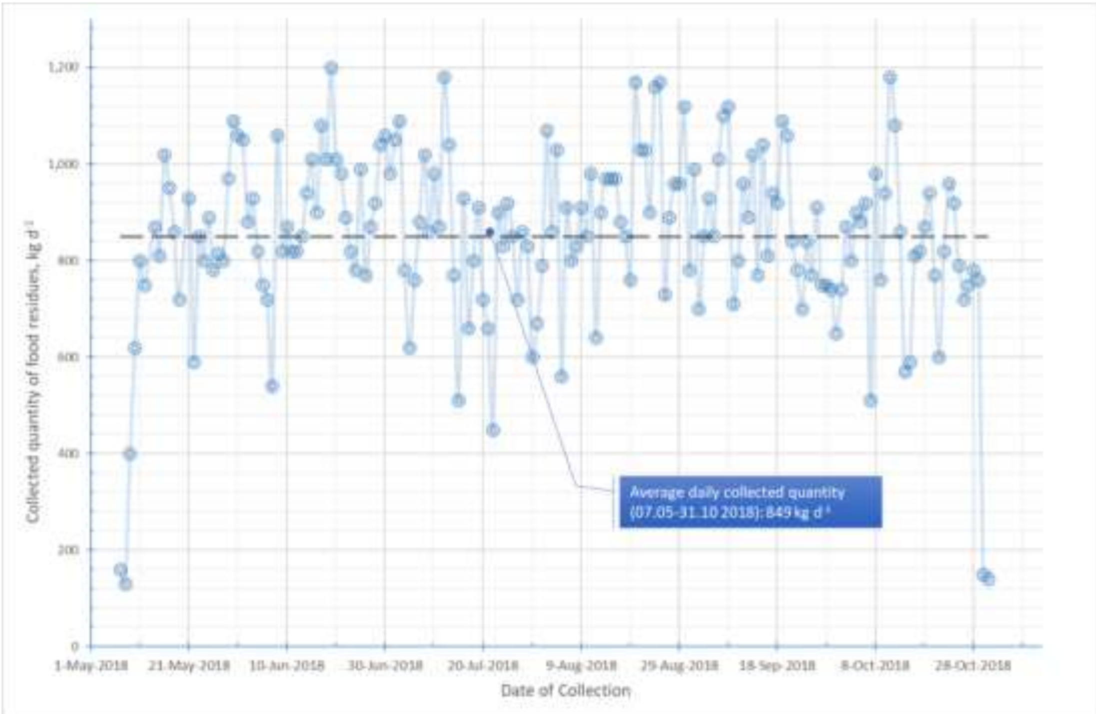

Figure 2-2. Quantity of food residues collected from the participated hotels (7th May – 31st October 2018).

The total collected quantity of food waste represents a daily average of 850 kg per day.

The correlation of the measured and estimated quantity for the participating hotels is very high and thus the developed formulae give an indication of the measure of food waste generated in the hospitality sector in Crete.

2.4 COMPOSITIONAL ANALYSIS OF THE HOTELS' FOOD WASTE (RESIDUES)

2.4.1 Introduction

Waste composition information has widespread applications and can be used for activities such as solid waste planning, designing waste management facilities, and establishing a reference waste composition for use as a baseline standard in both facility contracts and acceptance test plans.

In recent years there is a tendency towards quantifying and recording food waste characteristics due to the increasing efforts to optimise food waste management conditions at local, regional and/or national level. Therefore, information on food waste characterisation is of great interest to a range of stakeholders, such as national and local authorities, waste management companies, researchers and the public in order to: (a) define the current situation of waste composition, (b) prioritise waste management and treatment needs, (c) determine preventive measures and benchmarking the progress towards their implementation, (d) determine the degree and nature of the presence of impurities in source separation, (e) inform food waste reduction activities and (f) plan and optimise waste collection and treatment services [1]. Moreover, as in any waste treatment process, feedstock characteristics are of considerable significance and importance in order to define the design and operational parameters of the F4F process [2].

Despite the increasing demand for food waste composition analyses, there is not yet an approved international standard methodology. Additionally, authoritative data on food waste quantities and composition is fragmentary, whereas systematic and comparable data is missing [3, 4]. This is also evident by the different methods applied to obtain data on food waste composition including Waste Analysis Campaigns (WAC) undertaken by a third party, kitchen diaries kept by the consumers, estimations from statistical data on food supply, nutrition and questionnaire surveys etc. [1]. Each method has advantages and disadvantages, as presented by Lebersorger and Schneider [1], whereas the selection of a method is strongly related to the specific objectives of the study (i.e. breakdown of potential contamination in source segregated collection systems, requirements of material to feed anaerobic digestion (AD) units, insight into the behaviour of participants in source segregated domestic waste collection schemes etc.) and whether the measurement point is performed by consumers or by third parties [5].

Considering the above, this study aims at presenting the developed methodology for conducting food waste compositional analysis with the use of a state of the art WAC methodology. Furthermore, it is in the scope of the present work to illustrate the results of food waste composition and physicochemical analyses on samples from study area of the targeted hotels (Heraklion and Hersonissos in the Region of Crete). The increased need for food waste diversion from landfill and the existing policy which promotes its separate collection and treatment necessitates the in-depth characterisation of food waste in order to fill information gaps and uncertainties towards food waste management improvements and aid the development of the F4F process management.

2.4.2 The basis for the recommended food waste characterisation process

The physical composition of the municipal solid waste stream will vary from region to region based on several factors including, among other things, the waste generation practices of a municipality's population and businesses, the extent of recovery programs that divert solid waste components before collection, and the effect of the informal sector in recovering materials of value from collection containers prior to collection. Generally, waste composition assessments are important in determining the extent of recoverable materials within the waste stream so as determine the technical and economic viability of recovery and recycling programs. Assessments can also help to determine the extent of biodegradable material that must be treated prior to disposal.

Given the typical variability of a municipal solid waste stream, the extent of sampling and sorting required in any locale to generate reliable waste characterisation data is a function of the required confidence level of the assessment results. For example, the investigation of a major investment in recycling infrastructure may justify a need for a high confidence level in characterisation data. A moderate confidence level may be justified to properly assess the recycling and recovery opportunities that may exist in a certain region based on existing market opportunities for recoverable materials.

Although several countries, at EU and international level, have performed studies seeking more information on municipal food waste characterisation, other countries such as Greece, have almost a complete knowledge gap on the compositional and physicochemical characteristics of food waste despite the fact that it represents the single biggest fraction of Municipal Solid Waste (MSW) accounting for approximately 35% w/w [6]. Providing relevant information to waste management stakeholders is considered of paramount importance towards coherent decision making and planning for biowaste management. The latter is also highlighted by the recent policy developments in Greece which impose mandatory targets of 40% w/w by 2020 for biowaste separate collection and treatment (Greek Law 4042/2012) aiming to reduce landfilling and enhance resource efficiency [7].

The following describes a basic process by which a food waste characterization could be conducted.

2.4.3 Methodology

For characterisation purposes, representative sampling is an established practice for accurately determining waste quantities and waste characteristics for planning purposes. The basis for the waste characterisation criteria for the participating hotels around Heraklion and Hersonissos in Crete presented below are in ASTM D5231-92(2008) standard [8], RCRA regulation [9], and UNEP/IETC [10]. A general overview of the quantification and characterisation process is presented in Gawaikar and Deshpande [11].

The proposed approach is intended to accomplish a reasonable level of food waste characterisation knowledge in a structured approach, produce accurate and reliable results, and be repeatable in the hospitality and food sectors and/ or multiple locations within the country. The selected method is based on the collection and manual sorting of a number of samples of food waste over a period of seven (7) days in each season i.e. from Wednesday to Tuesday in the target location.

The HUA team developed the state-of-the-art methodology for conducting the compositional analysis of the source separated food waste (residues) from the hotels. The methodology was based on different technical reports, standards, and scientific papers, as an international standard methodology has not been established yet, while a variety of waste classification systems have been proposed due to the different focus and objectives of each study. The methodology includes procedures for the collection of a representative sample of unprocessed food waste from the waste collection vehicle, manual sorting of the waste into individual waste components, data recording and reporting of the results.

A recommended sample weight of approximately 100 kg is proposed for the study since it has been established, through various studies that measurements made on this sample size do not vary significantly from measurements made on far larger samples taken from the same waste sources.

Fifteen (15) major waste categories could be selected for sampling. The Fifteen (15) waste characterisation categories include the following (Table 2-2).

Table 2-2. Food waste component categories for compositional analysis in food waste

No.	Food residue component category
1	Drinks (coffee and tea bags)
2	Fresh vegetables and salads
3	Bread and Bakery
4	Fresh fruit
5	Meat and fish
6	Cooked meals and snacks
7	Dairy (excluding milk) and eggs
8	Dried foods
9	Condiments, sauces, herbs and spices
10	Processed vegetables and salads
11	Desserts
12	Confectionery and snacks
13	Processed fruit
14	Other (organic material which does not fit into another category because (a) it is not possible to be integrated into a category and/or (b) has a size less than 15 mm)
15	Impurities (i.e. plastics, metals, glass, plastic bags etc.)

The selection of the specific waste components considers the effectiveness and practicability of the categorisation analysis, the usefulness of the information obtained and the compatibility and transferability of the outputs with data from existing and future related studies.

This test method describes procedures for measuring the composition of unprocessed food waste by employing manual sorting and it was adopted to measure the composition of untreated source separated food waste. This test method applies to the determination of the mean composition of food waste based on the collection and manual sorting of several samples of waste over a selected time period covering a minimum of one week. The method has been modified and adapted for the determination of the mean composition of food waste.

This test method includes procedures for the collection of a representative sorting sample of unprocessed food waste, manual sorting of the waste into individual waste components, data reduction, and reporting of the results.

The HUA team developed the state-of-the-art methodology for conducting the compositional analysis of the source separated food waste (residues) from the hotels. The methodology was based on different technical reports, standards, and scientific papers, as an international standard methodology has not been established yet, while a variety of waste classification systems have been proposed due to the different focus and objectives of each study. The methodology includes procedures for the collection of a representative sample of unprocessed food waste from the waste collection vehicle, manual sorting of the waste into individual waste components, data recording and reporting of the results.

The compositional analysis was executed through Waste Analysis Campaigns (WACs) prior to solar drying/ pasteurisation. The first waste collection and analysis campaign (compositional analysis and microbiological investigation) of the project took place during Autumn 2017 (11-19.11) and another one followed in Spring/ Summer 2018 (30.05-05.06 2018). In July/ August 2018 (27.07-02.08), the third waste analysis campaign took place. The fourth and last waste analysis campaign (WAC) took place on the last week of September 2018 (25.09-01.10). During this period food residues from Galaxy Hotel, Aquila Atlantis Hotel, Olive-Green Hotel and Creta Maris Resort Hotel were collected and the seasonal composition of the food residues was determined.

The equipment and the collection services provided for source segregated food waste are illustrated in Figure 2-3.

Figure 2-3.Illustration of food waste source separation scheme applied in F4F project (door to door system).

The analysis considers a single waste route which is associated with waste ending up in the food waste collection bin provided by the project services. The compositional analysis was executed through WACs to the Solar drying/ Pasteurisation pilot unit prior to solar drying by appropriately trained personnel. In certain cases, the compositional analysis performed for each hotel separately. Due to the fermentable nature of the material, it was decided to maintain the interval between food waste generation, transportation, sampling and sorting to a minimum (between 12 and 24 hours), depending mainly on the weather conditions, in order to preserve the freshness of the samples and avoid food spoiling. The food residues were collected and transported with to the pilot unit with a refrigeration truck. Prior to the collection were stored in a cold room. In total, four WACs were implemented for each hotel in a year period.

2.4.4 Application of sampling

For the sampling of the required quantity of waste on every occasion required to be available at the Solar drying/ Pasteurisation Pilot Unit:

- 2 workers for manual sorting
- 1 ~1m^3 bucket for selecting the appropriate amount of sample
- 1 scale for weighing fractions,
- fractions analysis containers
- tools (shovel, rake, broom)
- clean, covered area (shelter) for manual sorting and protection from adverse weather conditions.

Sampling was performed in the early hours after the waste collection from the hotels by the F4F project's collection vehicle. The provision for the *manual sorting area*[1] that includes part of the necessary equipment shown in Figure 2-4.

1 *Selected daily load of bin vehicle for manual sorting/ analysis,*
2 *Selected quantity of 1m^3 of the bin vehicle load,*
3 *bins for waste fraction selection,*
4 *Balance for weighing of the manually selected waste fractions,*
5 *containers for collection of the total quantities of the daily manual sorting waste fractions and*
6 *Containers for emptying liquids from bottles/ containers.*

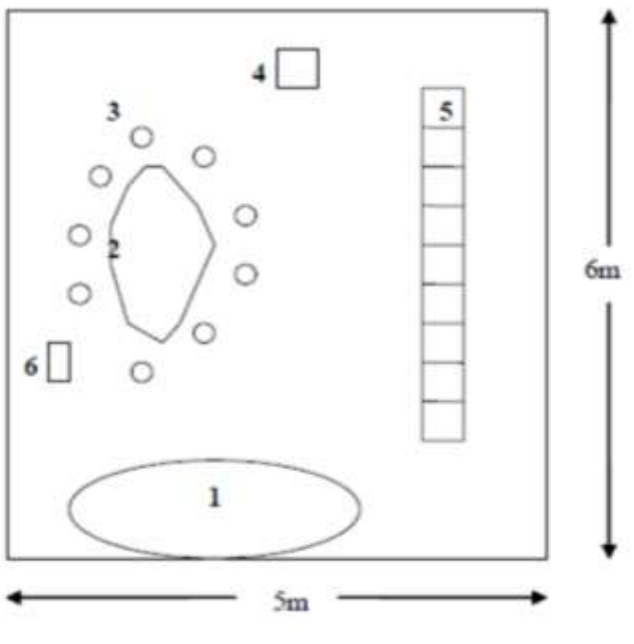

Figure 2-4. Overview of the area for the analysis of waste composition

Vehicle loads of food waste were designated for sampling, and a sorting sample was collected from the discharged vehicle load. The sample was sorted manually into food waste components. The weight fraction of each component in the sorting sample was calculated by

[1] Notes:
1. Calculated surface area ~30m^2,
2. The area under and next to the pile (2) is covered with a plastic cover ~10m^2,
3. Temporary housing of the manual sorting area for the protection from extreme weather conditions (sun, rain, etc.).

the weights of the components. The mean waste composition was calculated using the results of the composition of each of the sorting samples.

According to ASTM D5231-92, the number of sorting samples (that is, vehicle loads (n) required to achieve the desired level of measurement precision) is a function of the component(s) under consideration and the confidence level. The governing equation for n is as follows:

$$n = \left(\frac{t^* \times s}{e \times \bar{x}}\right)^2 \qquad (1)$$

where t* is the student t statistic corresponding to the desired level of confidence, s the estimated standard deviation, e the desired level of precision, and $\bar{x}$ is the estimated mean.

Suggested values of s and $\bar{x}$ for waste, components are listed in Table 6. Values of t* are given in statistical tables (Appendix II, Table 4-4). The results of one-week sampling at Pera Galinoi landfill, Heraklion Crete (2003), performed, prior to the main sampling period on a previous study[2] are presented in Table 2-4.

Table 2-3. Values of Mean ($\bar{x}$) and Standard Deviation (s) for within-week sampling to Determine MSW Component Composition

Component	**Standard deviation (s)**	**Mean value ($\bar{x}$)**
Inert (stones, ground, construction and demolition wastes)	0.0046	0.0193
Metals (all kinds except aluminium)	**0.0179**	**0.0444**
Aluminium (all kinds)	0.0066	0.0301
Glass (all kinds and colours)	0.0052	0.0458
LWTR (leather, wood, textiles, rubber)	0.0122	0.0360
Paper (all kinds, magazines, newspapers, books, packaging materials, cardboard)	0.0674	0.1971
Putrescibles (food waste, yard waste, leaves)	0.0196	0.3545
Plastics (PVC, PET, HDPE, LDPE, others)	0.0561	0.2249
Miscellaneous (nappies, sanitary napkins, materials that do not fit in any of the above categories)	**0.0133**	**0.0479**
		1.0000

Table 2-4 (columns 2, 3 and 4) is shown statistical data (standard deviation, mean and CV) for the period 15/9 - 31/10/2003 for the Pera Galinoi landfill (Heraklion, Crete). The calculation of the number of samples under the procedure described above is in columns 5 and 6. An accuracy (precision) of 10% is desired (0.1) and a confidence level of 90% is selected. More details about the calculation in Appendix II.

Table 2-4. Values of Mean ($\bar{x}$)and Standard Deviation(s) for Pera Galinoi landfill (Heraklion, Crete, 2003) and calculation of the required number of samples (n) for the determination of hotel waste composition.

[2] E. Gidarakos, G. Havas, P. Ntzamilis (2006): Municipal solid waste composition determination supporting the integrated solid waste management system in the island of Crete. Waste Management, **6**(6), pp 668–679.

Component	**Standard Deviation (s)**	**Mean** $(\bar{x})$	**CV** $\left(\frac{s}{\bar{x}}\right)$	n' *for t*=1.645*	n' *for t*=1.681*
Inert (stones, ground, construction and demolition wastes)	0.0046	0.0193	0.24	15	
Metals (all kinds except aluminium)	0.0179	0.0444	0.40	44	
Aluminium (all kinds)	0.0066	0.0301	0.22	13	
Glass (all kinds and colours)	0.0052	0.0458	0.11	3	
LWTR (leather, wood, textiles, rubber)	0.0122	0.0360	0.34	31	
Paper (all kinds, magazines, newspapers, books, packaging materials, cardboard)	0.0674	0.1971	0.34	32	
Putrescibles (food waste, yard waste, leaves)	0.0196	0.3545	0.06	1	
Plastics (PVC, PET, HDPE, LDPE, others)	0.0561	0.2249	0.25	17	
Miscellaneous (nappies, sanitary napkins, materials that do not fit in any of the above categories)	0.0133	0.0479	0.28	21 = n_o	**23 = n**

It is apparent, from Table 2-4, that as the frequency of occurrence of a waste component material decreases then the minimum required number of samples is increasing. The frequency of appearance of a material is inversely related to the ratio s/x, which is defined as the coefficient of variance (CV).

The determination of the mean composition of food waste was based on the collection and manual sorting of several samples of waste over a selected time period covering one week.

According to ASTM D5231-92, for a weekly sampling period of k days, the number of vehicles sampled each day should be approximately n/k, where n is the total number of vehicle loads to be selected for the determination of waste composition. A weekly period is defined as 7 days.

Therefore, to determine the hotels' waste composition, 23 samples are required between 100 to 150 Kg. The sampling will take place during the period of a week (7 days) and so the required number of samples to be collected daily is **23÷7 = 3.3**. Then, for a sample size of 100kg, at least **330 kg** (= 3.3×100) of hotel food residues should be collected daily.

2.5 Component Composition

The component composition of solid waste is reported on the basis of the mass fraction (expressed as a decimal) or percent of waste component *i* in the solid waste mixture. The reporting is based on wet weight, that is, the weight of materials immediately after sorting.

After sorting, weighing of the sorted material into categories was employed. Each weighting was executed twice, and the resulting values were recorded. Finally, the load discharge area, the sorting site and the sorting table of all waste materials were cleaned.

The mass fraction of component *i*, mf_i, is defined and computed as follows:

$$mf_i = \frac{w_i}{\sum_{i=1}^{j} w_i} \quad (2)$$

Where:

w_i = weight of component i and

j = number of waste components.

In those cases in which a container is used to store and weigh the materials,

$$w_i = gross\ weight - tare\ weight\ of\ container \quad (3)$$

The percent of component *i*, P_i, is defined and computed as follows:

$$P_i = mf_i \times 100 \quad (4)$$

For the data analysis to be correct, the denominator of (Eq. 2) must be unity, and

$$\sum_{i=1}^{j} P_i = 100 \quad (5)$$

The mean component composition for the one-week period is calculated using the component composition results from each of the analysis samples. The mean mass fraction of component *i*, $\overline{mf_i}$, is calculated as follows:

$$\overline{mf_i} = \frac{1}{n} \sum_{k=1}^{n} (mf_i)_k \quad (6)$$

and the mean percent of component *i*, P_i, is calculated as follows:

$$\overline{P_i} = \frac{1}{n} \sum_{k=1}^{n} (P_i)_k \quad (7)$$

where:

n = number of samples.

2.5.1 Reduction of sample size

The sample should be reduced to a more manageable size as the actual classification of materials will be carried out by hand. The ideal sample size for characterisation is between

100-150 kg (minimum 100 kg) and the size reduction is achieved by a *coning and quartering technique*.

Coning and quartering is a method used to reduce the sample size without creating a systematic bias. The technique involves pouring the sample so that it takes on a conical shape, and then flattening it out into a cake. The cake is then divided into quarters; the two quarters which sit opposite one another are discarded, while the other two are combined and constitute the reduced sample. The same process is continued until an appropriate sample size remains. Analyses are made with respect to the sample left behind (Figure 2-5).

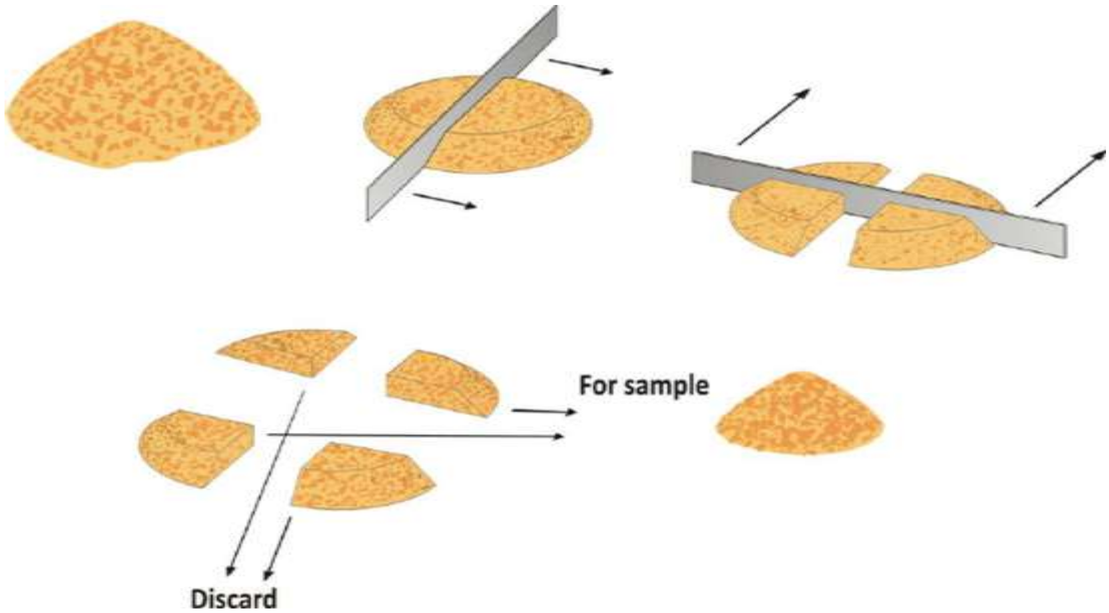

Figure 2-5. Coning and quartering procedure for selecting representative unprocessed waste samples

The method involves the following in detail:

- The sample is placed on the floor and thoroughly mixed by mechanical shovel.
- The sample is then placed in a uniform pile of approximately 0.8 m high.
- The pile is divided into four quarters using straight lines perpendicular to each other.
- Either pair of opposite corners is removed to leave half the original sample.
- The process is repeated until the desired sample size i.e. 100-150 kg is obtained.
- The surplus ‘two-quarters’ from the last size reduction should be retained for analysis of moisture content and bulk density (see paragraph 2.6).

Care was exercised to avoid selection of larger sized particles to reduce sample bias.

Since unprocessed food waste is a highly heterogeneous material, care was taken to obtain representative samples, eliminating or minimising of the sample bias. After appropriate mixing, about 5 kg of representative sample was collected and stored for further laboratory analyses to be performed. The remaining mixture was weighed and transferred to the sorting table where the compositional analysis was conducted (Figure 2-6).

Figure 2-6. Conducting an analysis of the waste composition

The methodology employed manual sorting of the mixture into specified components until the maximum particle size of remaining waste particles was less than 15 mm.

After sorting, weighing of the sorted material into categories was employed. Each weighting was executed twice, and the resulting values were recorded. Finally, the load discharge area, the sorting site and the sorting table of all waste materials were cleaned.

An outline of the methodology is illustrated in Figure 2-7.

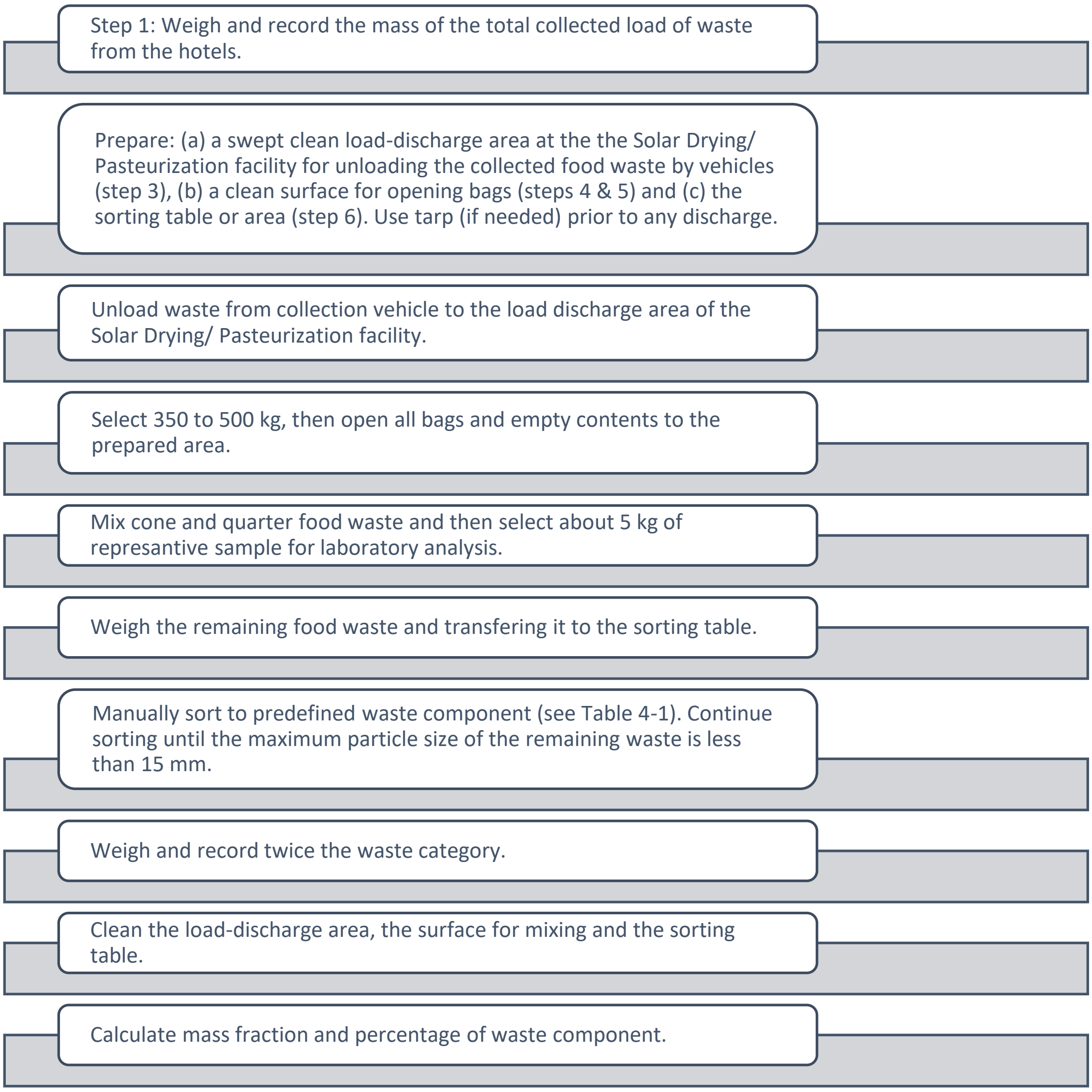

Figure 2-7. Outline of the methodology used for conducting analysis of the composition of the hospitality sector food waste.

Table 2-5 presents the results of the compositional analysis from four WACs together with the

Extensive work has been performed concerning complete physicochemical analysis of samples from pre-sorted food waste. Moreover, compositional analyses were carried out in order to gather additional data, throughout the duration of the activity. Such analyses are considered of high importance since they provide feedback about the characteristics of the input material in the Solar drying/ Pasteurisation Pilot Unit and are strongly connected with the quality of the end-product (feed).

Table 2-5. Compositional analysis (% w/w) for sorted food residues for hotels, Heraklion, Crete (Greece), 2017-2018.

Component category	1st WAC (autumn 2017)	2nd WAC (spring 2018)	3rd WAC (summer 2018)	4th WAC (autumn 2018)	Average (±SEM)
Drinks	0,00%	0,00%	0,00%	0,00%	-
Fresh vegetables and salads	17,52%	15,64%	9,58%	12,94%	**13.92%** (±1.72)
Bread and Bakery	11,08%	4,90%	3,48%	3,36%	**5.71%** (±1.82)
Fresh fruit	39,71%	41,21%	45,28%	51,26%	**44.37%** (±2.58)
Meat and fish	19,26%	30,67%	32,42%	19,32%	**4.90%** (±1.38)
Cooked meals and snacks	8,96%	4,25%	3,11%	3,29%	**25.42%** (±3.56)
Dairy (excluding milk) and eggs	0,81%	0,51%	0,11%	1,72%	**0.79%** (±0.34)
Dried foods	0,00%	0,00%	0,00%	0,00%	-
Condiments, sauces, herbs, and spices	0,00%	0,47%	0,90%	0,00%	**0.34%** (±0.22)
Processed vegetables and salads	0,00%	0,00%	0,00%	0,00%	-
Desserts	0,48%	0,34%	0,00%	0,06%	**0.22%** (±0.12)
Confectionery and snacks	0,35%	0,00%	0,00%	0,00%	**0.09%** (±0.09)
Processed fruit	0,11%	0,00%	0,00%	0,00%	**0.03%** (±0.03)
Other	1,38%	1,49%	4,43%	6,64%	**3.48%** (±1.26)
Impurities	0,32%	0,52%	0,69%	1,42%	**0.74%** (±0.24)
	100,0%	100,0%	100,0%	100,0%	

In

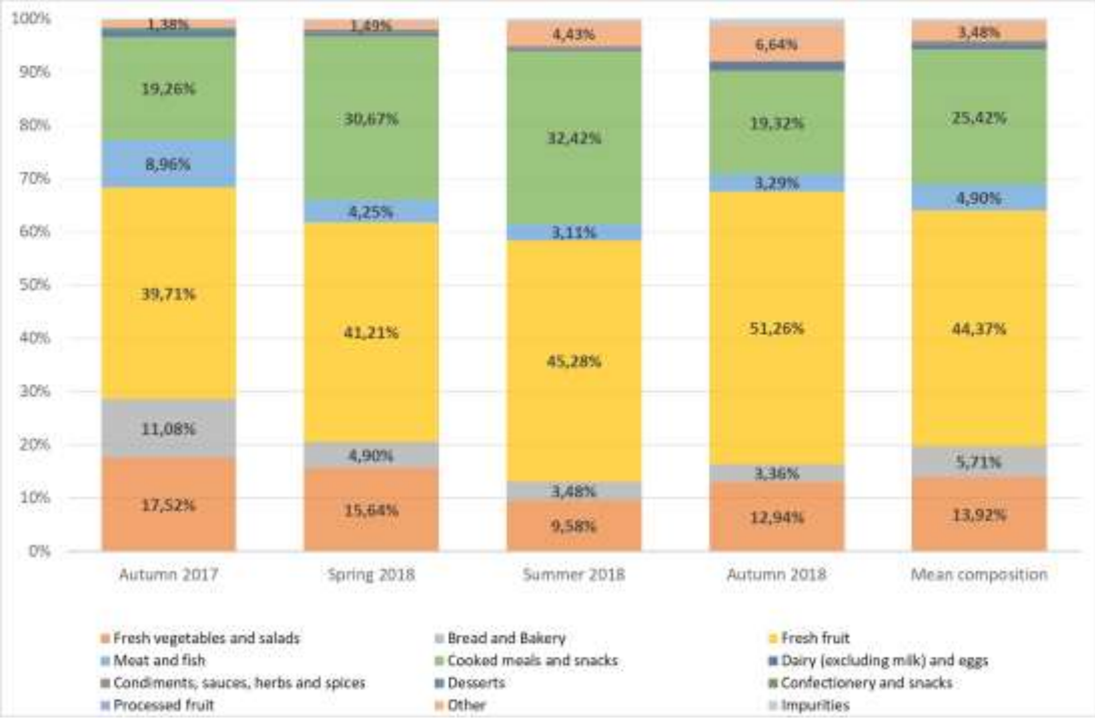

Figure **2-8**, the composition determined in all WACs, together with the average composition of all the WACs is presented.

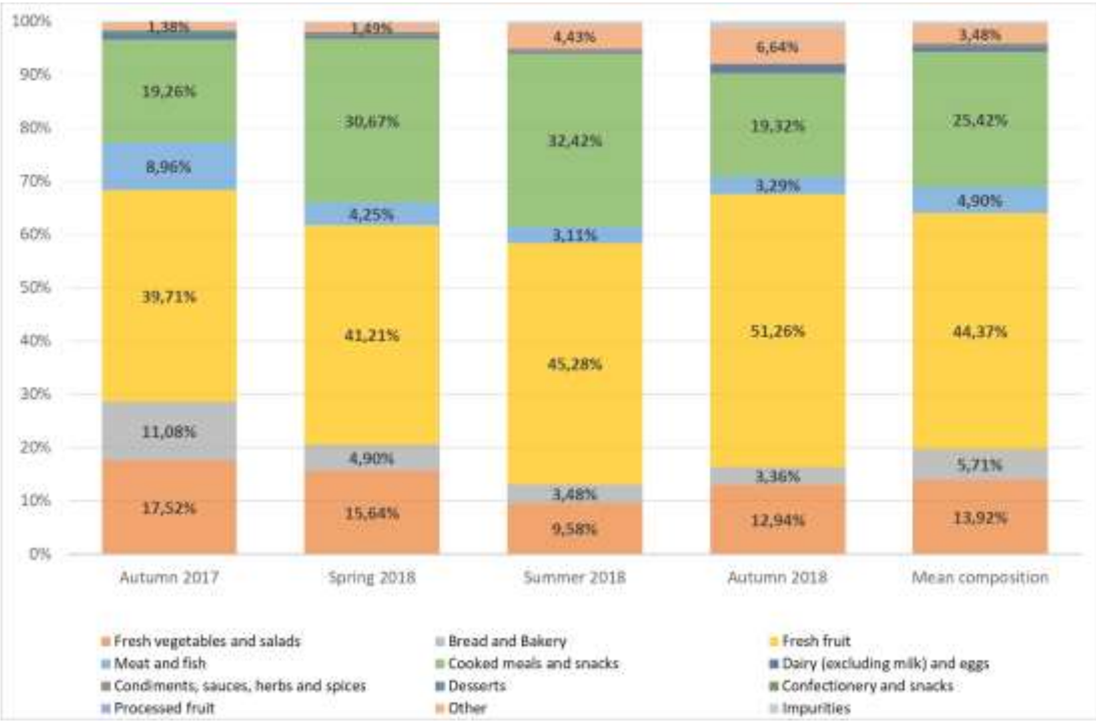

Figure 2-8. Average composition of hotels' food residues from the four WACs.

The analyses throughout the initialisation phase of the food waste source separation revealed the principal food waste categories found in collected food waste per season. The average values are:

- Cooked meals: **25.4%**
- Bread and bakery products: **5.7%**

- Meat and fish: **4.9%**
- Fresh Fruit and fresh Vegetables & salads waste: **58,3%**

The 'Fresh Fruits' and 'Fresh Vegetable and Salads' represented the greatest proportions in each WAC for the four hotels. A certain degree of variability is observed though due to seasonal variation.

Source separation is of significant importance, especially for the sensitive food waste, since separately collected organics exhibit high purity levels so as to facilitate any further treatment and thus the products received (feed) have better quality and greater value. The recorded low impurities content **(0.7 %**) demonstrate that the participating hotels practice effectively the source separation of the generated food waste.

2.6 Determination of other parameters

Further characterisation of the source separated food waste was performed by measuring a wide variety of parameters, as the moisture content, pH and bulk density. The water content (moisture) of the collected food waste was determined after drying the collected samples at 105 °C for 24hrs. The weight difference was calculated before and after dehydration to determine the moisture content using:

Moisture content (%) = Wet sample Wet sample − Dry sample × 100

The pH was measured according to EPA Method 9045D using a pH-meter. The value of each parameter is presented as an average of a triplicate measurement, whereas analyses of source separated food waste were carried out for each WAC performed for the four participating hotels (i.e. three representative samples from each hotel).

2.6.1 Calculation of bulk density (specific gravity)

The calculation of the bulk density is performed using a container of a known volume (V1 = 0.120 m^3 or 120 l). The sample weight is calculated by weighing the individual fractions after the manual sorting. For weighing fractions used portable scale precision hundredth of a kilogram to display three decimal places.

A sample of each consignment of waste is poured into the container until it overflows. The contents of the container were then settled by dropping it three times onto the measuring table from an approximate height of 10 cm. The container was then topped up with additional waste from the selected sample. The container was then weighed again and the weigh recorded (W2).

The bulk density was then calculated using the following equation: W2–W1/ V1

The calculation of specific gravity is directly related to the degree of compaction of food waste or else their density. The density of food waste easily changed and always mention when the measurement results of specific weight must clarify what state food waste talking and analytically describe the measurement procedure.

Food waste weighed in this study is the food waste into bags and bins with no compression, collected daily from the participated hotels.

Therefore, the specific weight recorded and displayed in the results refers to the food waste after their removal from the bins.

2.7 Analysis of Microbiological Parameters

Harokopio University of Athens (HUA), during the Waste Analysis Campaigns, collected food residues samples and in certain cases dried feed samples that it had been produced at the pilot unit. The samples were analysed for the microorganisms that have been determined for microbiological analysis (total coliforms, E Coli, Salmonella spp.).

At the same time, HUA investigated the existing legislation and performed an extensive literature survey to assess the possible addition of more microorganisms than the initially determined ones (total coliforms, E Coli, Salmonella spp.) that needed to be determined in order to evaluate the possible microbiological load of the food residues more effectively.

The microbiological load (total coliforms, E Coli, Salmonella spp., etc.) was routinely analysed in all food residues and dried product samples collected during Waste Analysis Campaigns (WACs). The collected food residues were also analysed for additional microbiological parameters (e.g. Staphylococcus spp., Clostridium spp., yeast, Listeria monocytogenes).

2.7.1 Microbial population enumeration

In order to evaluate the feed safety of the raw material and the processed food waste, a series of microbiological analyses were conducted, by taking into consideration the European Food Safety Authority Journal (EFSA, 2008) [12], the European Feed Manufacturers' Guide (EFMC)[13] and Directive 2002/32/EC [14]. Indicators of Total Coliforms, *Escherichia Coli*, *Salmonella* spp., *Clostridium* spp., *Staphylococcus aureus*, *Listeria* spp. *and Listeria monocytogenes*, and Yeast were evaluated.

The samples were prepared for analysis as specified in ISO 6887 [15].

Total Coliforms and *Escherichia Coli* were counted on Chromocult@ Coliform Agar plates (Merck KGaA Darmstadt, Germany) according to Manafi&Kneifel (1989) [16]. Each sample was inoculated to nine plates which were incubated for 24h at 37^{o}C. The violet colonies were counted as *Escherichia Coli*, whereas the total (violet and red colonies) counted as total coliforms bacteria.

The detection and the enumeration of the pathogenic bacterium *Salmonella spp*. was done according to the method 1682 (U.S. EPA 2006) [17] and completed in three stages: Pre-enrichment, Enrichment, Isolation and Observation in Xylose-Lysine-Decarboxylase agar (XLD, LabM) plates.

Clostridium perfingens was enumerated on Perfingens Agar (LabM) in accordance to Harmon, Kautter, & Peeler(1971) [18] after 24h anaerobic incubation at 37^{o}C.

Typical colonies of *Staphylococcus aureus* were counted on Baird Parker Medium ISO agar (LabM) according to ISO 6888 [19] after 48h incubation at 37^{o}C.

The identification and enumeration of *Listeria monocytogenes* and *Listeria* spp. involved culture methods based on selective enrichments as determined by ISO 11290 [20].

Colonies of yeast were counted on Sabouraud Dextrose Agar’s plates (LabM) according to Sabouraud, R. (1910) [21] after incubation at 37^{o} C for 48h.

Each microbial population was characterised on the basis of colony appearance, Gram’s stain, catalase reaction, and cell morphology. Colony counts were obtained and expressed as log_{10} of the Colony Forming Units (CFU/g DW sample).

Table 2-6 presents the results of the microbiological analyses and the results of the determination of other parameters from four WACs together with the results for moisture content. pH and bulk density of the food waste of the participating hotels.

Table 2-6. Microbiological Analysis of food residues

Parameter		1st WAC (16.11 – 19.11 2017)	2nd WAC (30.5 – 6.6 2018)	3rd WAC (27.7 – 2.8 2018)		4th WAC (25.9 – 1.10 2018)	
		Input food residues (as received)	Input food residues (as received)	Input food residues (as received)	Input food residues after grinding	Input food residues (as received)	Dried product
pH	-	4.85 (±0.55)			-	4.85 (±0.55)	5.25 (±0.30)
Bulk density	Kg m^{-3}	569.3 (±66.2)			-	569.3 (±66.2)	-
Dry Matter (DM)	%	22.15 (±4.15)			-	22.15 (±4.15)	89.88 (±2.76)
Total Coliforms	CFU[a]/g dw	$2.46X10^6$ ($\pm 5.93X10^5$)	$5.22X10^6$ ($\pm 5.98X10^5$)	$1.63X10^6$ ($\pm 7.27X10^5$)	$1.56X10^6$ ($\pm 9.66X10^5$)	$9.57X10^6$ ($\pm 1.42X10^6$)	$2.95X10^6$ ($\pm 3.14X10^6$) [d]
E. Coli	CFU/g dw	$2.90X10^3$ ($\pm 1.85X10^3$)	$5.74X10^3$ ($\pm 1.37X10^3$)	$9.56X10^4$ ($\pm 6.74X10^4$)	$8.43X10^5$ ($\pm 8.30X10^5$)	$1.09X10^4$ ($\pm 2.73X10^3$)	$3.04X10^2$ ($\pm 1.90X10^2$)
Salmonella spp.	MPN[b]/100ml	N.D.[c]	N.D.	N.D.	N.D.	N.D.	N.D.
Clostridium perfingens	CFU/g dw	-	$2.29X10^4$ ($\pm 2.55X10^3$)	-	-	$7.00X10^2$ ($\pm 3.50X10^4$) [d]	N.D.
Staphylococcus spp.	CFU/g dw	-	-	$2.17X10^3$ ($\pm 1.57X10^3$)	$6.76 X10^2$ ($\pm 6.15X10^2$)	N.D.	$6.27X10^5$ ($\pm 5.65X10^5$)
Listeria monocytogenes	CFU/g dw	-	-	D[e]	D	N.D.	N.D.
Listeria spp.	CFU/g dw	-	-	D	D	N.D.	$1.65X10^4$ ($\pm 2.85X10^3$)
Yeast	CFU/g dw	-	-	$5.83X10^6$ ($\pm 4.40X10^6$)	$1.14X10^7$ ($\pm 6.24X10^6$)	$1.42X10^7$ ($\pm 3.64X10^5$)	$7.25X10^6$ ($\pm 6.77X10^6$)

Note: (a) Colony Forming Units per gram dry weight (dw); (b) Most Probable Number; (c) Not Detected; (d) Below the detection limits of the method; (e) Detected

2.8 CONCLUSIONS

Overall, the microbiological load of the collected raw food waste appears to be low and presents similar findings compare to other studies [22-24].

The absence of the pathogenic bacteria *Salmonella spp., Staphylococcus aureus,* and *Campylobacter (see also Annex 2_Sub-Annex 2.3. Drying and microbiological tests by TEIC)* should be emphasised, probably as a result of HACCP application in the hotels' kitchens. *Salmonella spp. Staphylococcus aureus* and *Campylobacter* were absent in any of the finished feed samples collected from the pilot unit.

Shigella spp. and *Clostridium perfingens* were detected in the food residues but they were absent in any of the finished feed samples collected from the pilot unit.

The erratic appearance of *Listeria monocytogene*s could be a result of probable failure of the temporary storage or/and transportation system from hotels to the pilot unit. However, its presence was not confirmed by biochemical methods (API Listeria) and therefore reservations are maintained. It must be noted that on the last sampling period (Sept. – October 2018), of the initial operational period, when the system of separation, temporary storage, and transportation of the hotels' food residues was in a mature operational state, Listeria *monocytogene*s was not detected, consequently its presence in the food residues is undecided.

However, it is important to minimise contamination of animal feeds through hygienic production and appropriate storage conditions. This can help to minimise contamination of food residues and final product. Good housekeeping should be ensured, proper sanitation procedures should be carried out in the pilot unit to ensure that all feed is of good microbiological quality and the recontamination of the pilot unit is avoided.

Feed hygiene is usually managed by using technologies including heat treatments (pasteurisation/ hygienisation) or/and the use of feed additives containing organic acids (i.e. propionic acid) and formaldehyde or a combination of formaldehyde and propionic acid. It may be worthwhile to investigate these two technologies and their effect on feed safety and quality. The possibility of further pasteurisation/ hygienisation (heat treatment) and the use of feed additives will be investigated and evaluated in the next operational period (April – October 2019).

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4 APPENDICES

APPENDIX I: SURVEY RESULTS - SUMMARY OF HOTEL RESPONSES

APPENDIX II: TEST METHOD FOR DETERMINATION OF THE COMPOSITION OF UNPROCESSED MUNICIPAL SOLID WASTE

4.1 APPENDIX I: SURVEY RESULTS - RECORDING OF HOTEL RESPONSES

Table 4-1. Targeted hotels' characteristics - Survey results

BASIC INFORMATION

A/A	Hotel	Category	Address
1	AGAPI BEACH HOTEL	4*	Gazi, Ammoudaras, Heraklion, Crete
2	AKS MINOA PALACE HOTEL	4*	Amnissos , Heraklion, Crete
3	Aldemar Knossos Royal Villas	5*	Limenas Hersonissou, 70014 Heraklion, Crete
4	Aldemar Royal Mare & Thalasso	5*	Anissaras Hersonissos, 70014, Crete
5	Aldemar Royal Suites	5*	Limenas Hersonissou
6	Annabelle Village	5*	Anissaras Hersonissou, 70014
7	APOLLONIA BEACH HOTEL	4*	Gazi 71414, Heraklion, Crete
8	AQUILA ATLANTIS HOTEL	5*	2, Igias str., Heraklion, Crete
9	Aquis Bella Beach Hotel	5*	Anissaras Hersonissos, 70014, Crete
10	Arina Beach Hotel & Bungalows	4*	Kokkini Hani, Heraklion, Crete
11	ASTORIA CAPSIS HOTEL	4*	Pl. Eleftherias, Heraklion, Crete
12	Atlantica Caldera Palace	5*	Analispis, 70014, Hersonissos
13	CANDIA MARIS	5*	72, A. Papandreou str., Gazi, Ammoudaras, Heraklion, Crete
14	CRETA BEACH	4*	74, A. Papandreou str., Gazi, Ammoudaras, Heraklion, Crete
15	CRETA MARIS Convention & Golf Resort	5*	Hersonissos, 70014, Crete
16	GALAXY HOTEL IRAKLIO	5*	75, Dimokratias Ave., Heraklion, Crete
17	GDM MEGARON HOTEL	L'CLASS	9, Mpofor Ave., 71202, Heraklion, Crete
18	Grecotel Amirandes	5*	Gouves 71110 Heraklion, Crete
19	Imperial Royal Belvedere	4*	Limenas Hersonissou
20	KNOSSOS BEACH HOTEL& BUNGALOWS	4*	Kokkini Hani, Heraklion, Crete
21	LATO BOUTIQUE HOTEL	4*	15, Epimenidou str., 71202 Heraklion, Crete
22	Mitsis Laguna Resort & Spa	5*	Anissaras, 70014 Hersonissos, Crete
23	Mitsis Rinela Beach Resort & Spa	5*	Kokkini Hani, Heraklion, Crete
24	Mitsis Serita Beach Hotel	5*	Anissaras Hersonissou, 70014, Crete
25	OLIVE GREEN HOTEL	4*	Meramvellou & Idomeneos 22, 71202 Heraklion, Crete
26	SANTA MARINA	4*	106, Papandreou str., Gazi, Ammoudaras, Heraklion, Crete
27	St. Constantin	5*	Kato Gouves
28	THE VILLAGE HEIGHTS GOLF RESORT	5*	Ano Hersonissos

OPERATIONAL CHARECTERISTICS

A/A	No of rooms	No of beds	Average		Days of operation	No of emplyees		Meals offered					
								April-June		July-August		Sept.-October	
			Rooms	Beds		Winter	Summer	Breakfast	Meal/ Buffet	Breakfast	Meal/ Buffet	Breakfast	Meal/ Buffet
1	318	614	80,0%	82,0%	210		52						
2	127	240	76,0%	77,0%	210		38						
3	322	610	80,0%	80,0%	240		58						
4	413	840	75,0%	75,0%	210		72						
5	435	914	80,0%	80,0%	240		54						
6	265	534	75,0%	78,0%	240		42						
7	313	643	75,0%	75,0%	240		52						
8	163	291	67,0%	68,4%	365	26	57	16.000	4.040	15.000	7.009	15.000	5.200
9	163	356	N.A.	N.A.	270		N.A.						
10	233	452	78,0%	80,0%	210		38						
11	131	253	67,5%	69,0%	365	24	32						
12	345	803	75,0%	77,0%	210		56						
13	287	664	75,0%	77,0%	240		45						
14	150	265	N.A.	N.A.	210		N.A.						
15	547	1078	75,0%	77,0%	210		266						
16	127	234	64,0%	65,0%	365		30						
17	58	138	72,0%	74,0%	365		18						
18	212	513	75,0%	77,0%	210		35						
19	341	670	70,0%	72,0%	210		57						
20	105	206	77,0%	78,0%	210		47						
21	59	102	66,0%	67,0%	365		19						
22	226	467	78,0%	80,0%	365		45						
23	440	865	78,0%	80,0%	210		72						
24	276	559	78,0%	80,0%	210		58						
25	48	100	62,0%	65,0%	365		28						
26	208	398	N.A.	N.A.	240		N.A.						
27	118	224	N.A.	N.A.	365		N.A.						
28	416	662	75,0%	76,0%	240		67						

ENVIROMENTAL POLICY / WASTE MANAGEMENT

A/A	Policy for of Environmental footprint	Sustainable Development Action Plan	Quality Management System	HACCP	Waste generation (kg/day)	Means of collection	Collection Frequency	Cold Room	Separate collection: food residues	Separate collection: waste packaging	Management method of residues	Cost of waste management
1	N	N	N	N	N.A.	Bags/ bins	Daily	X	N	Y	Disposal at the Municipality's Landfill	N.A.
2	N	N	N	N	135	Bags/ bins	Daily	✓	N	Y		N.A.
3	Y	N	Y	Y	93	Bags/ bins	Daily	✓	Y	Y		N.A.
4	Y	N	Y	Y	123	Bags/ bins	Daily	✓	Y	Y		N.A.
5	Y	N	Y	Y	172	Bags/ bins	Daily	✓	Y	Y		N.A.
6	N	N	Y	N	N.A.	Bags/ bins	Daily	✓	N	Y		N.A.
7	N	N	N	N	105	Bags/ bins	Daily	X	N	Y		N.A.
8	Y	Y	Y	Y	130	Bags/ bins	Daily	X	Y	Y		N.A.
9	N	N	Y	Y	N.A.	Bags/ bins	Daily	N.A.	N.A.	N.A.		N.A.
10	N	N	Y	Y	116	Bags/ bins	Daily	✓	N	Y		N.A.
11	Y	N	Y	Y	90	Bags/ bins	Daily	X	N	Y		N.A.
12	N	N	N	N	N.A.	Bags/ bins	Daily	X	N	Y		N.A.
13	N	N	N	N	N.A.	Bags/ bins	Daily	X	N	Y		N.A.
14	N	N	N	N	N.A.	Bags/ bins	Daily	N.A.	N	Y		N.A.
15	Y	N	Y	Y	620	Bags/ bins	Daily	✓	Y	Y		N.A.
16	Y	N	Y	Y	84	Bags/ bins	Daily	X	N	Y		N.A.
17	Y	N	Y	Y	46	Bags/ bins	Daily	N	N	Y		N.A.
18	N	N	N	N	100	Bags/ bins	Daily	✓	N	Y		N.A.
19	N	N	N	N	N.A.	Bags/ bins	Daily	✓	Y	Y		N.A.
20	N	N	N	N	97	Bags/ bins	Daily	Y	Y	Y		N.A.
21	Y	N	Y	N	N.A.	Bags/ bins	Daily	X	N	Y		N.A.
22	N	N	N	N	N.A.	Bags/ bins	Daily	✓	Y	Y		N.A.
23	N	N	N	N	164	Bags/ bins	Daily	✓	Y	Y		N.A.
24	N	N	N	N	103	Bags/ bins	Daily	✓	Y	Y		N.A.
25	Y	N	Y	Y	65	Bags/ bins	Daily	X	Y	Y		N.A.
26	N	N	N	N	N.A.	Bags/ bins	Daily	N.A.	N.A.	N.A.		N.A.
27	N	N	N	N	N.A.	Bags/ bins	Daily	N.A.	N.A.	N.A.		N.A.
28	N	N	Y	Y	142	Bags/ bins	Daily	✓	Y	Y		N.A.

(green) Participating to F4F hotel; (blue) No response
✓ available; X not available

ΧΑΡΟΚΟΠΕΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ

ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ ΔΙΑΓΝΩΣΤΙΚΗΣ ΕΡΕΥΝΑΣ

LIFE15 ENV/GR/000257
LIFE-F4F (Food for Feed)

Το ερωτηματολόγιο που ακολουθεί, εκπονήθηκε στο πλαίσιο του ευρωπαϊκού προγράμματος LIFE: «**Food for Feed: An Innovative Process for Transforming Hotels' Food Wastes into Animal Feed**». (Καινοτόμος Διεργασία για τη Μετατροπή των Ξενοδοχειακών Αποβλήτων Τροφών σε Ζωοτροφή, LIFE-F4F), LIFE15 ENV/GR/000257.

Στο πρόγραμμα αυτό συμμετέχουν ο Ενιαίος Σύνδεσμος Διαχείρισης Απορριμμάτων Κρήτης (Ε.Σ.Δ.Α.Κ.), το Γεωπονικό Πανεπιστήμιο Αθηνών, το Χαροκόπειο Πανεπιστήμιο, το Freie Universität Berlin (Ελεύθερο Πανεπιστήμιο του Βερολίνου) και το Τεχνολογικό Εκπαιδευτικό Ίδρυμα (ΤΕΙ) Κρήτης.

Ο κύριος στόχος του έργου LIFE-F4F είναι να αξιολογήσει, σε πιλοτική κλίμακα, μια καινοτόμο, τεχνολογικά απλή και με χαμηλές εκπομπές ρύπων διαδικασία, που επιτρέπει την ασφαλή μετατροπή των διαχωρισμένων στην πηγή απόβλητων τροφών, κυρίως από ξενοδοχεία (και γενικότερα από επιχειρήσεις εστίασης και διασκέδασης), σε ζωοτροφή, αξιοποιώντας μια τροποποιημένη διαδικασία ηλιακής ξήρανσης/ παστερίωσης.

Το έργο συμπεριλαμβάνει το σχεδιασμό, τη λειτουργία και την αξιολόγηση του συστήματος χωριστής συλλογής για τα απόβλητα τροφών των ξενοδοχείων σε τουριστική περιοχή της Κρήτης, αξιοποιώντας το υφιστάμενο σύστημα διαχωρισμού στην πηγή που εφαρμόζεται λόγω των κανονισμών ISO και HACCP.

Η διαγνωστική έρευνα πραγματοποιείται με στόχο να συγκεντρωθούν ουσιαστικά και ρεαλιστικά δεδομένα που θα επιτρέψουν την ανάπτυξη της πιλοτικής μονάδας σε βιομηχανική κλίμακα. Η έρευνα θα περιλαμβάνει τουλάχιστον 20 ξενοδοχεία και έχει ως στόχο να αξιολογήσει: α) το υφιστάμενο σύστημα διαλογής στην πηγή των αποβλήτων τροφών, β) τις συνθήκες προσωρινής αποθήκευσης των αποβλήτων αυτών, γ) τα μέσα συλλογής (κάδοι, πλαστικές σακούλες κλπ.), δ) την ποιότητα και η ποσότητα του διαχωρισμένου στην πηγή κλάσματος των απορριμμάτων, και ε) το υφιστάμενο δημοτικό σύστημα συλλογής αστικών αποβλήτων.

Η έρευνα αυτή δεν είναι δυνατή χωρίς τη δική σας συμβολή, που συνίσταται στη συμπλήρωση του παρόντος ερωτηματολογίου. Η βοήθειά σας κρίνεται σημαντική και καθοριστική για τα αποτελέσματά της συγκεκριμένης διερεύνησης.

Παρακαλούμε συμπληρώστε πλήρως όλα τα πεδία με όσο το δυνατόν μεγαλύτερη σαφήνεια και ακρίβεια. Όταν δεν είναι δυνατόν να απαντήσετε σε κάποια ερώτηση θα εκτιμούσαμε μια σύντομη αιτιολόγηση π.χ. «έλλειψη στοιχείων».

Το ερωτηματολόγιο θα χρησιμοποιηθεί αποκλειστικά για τους σκοπούς του έργου LIFE-F4F. Όλες οι παρεχόμενες πληροφορίες είναι αυστηρά εμπιστευτικές και θα χρησιμοποιηθούν με αποκλειστικό σκοπό την επεξεργασία τους για την εξαγωγή στατιστικών δεδομένων για το έργο.

Σας ευχαριστούμε εκ των προτέρων για τη συνεργασία σας σε αυτό το πολύ σημαντικό ευρωπαϊκό έργο που θα επιτρέψει την αξιολόγηση και σύγκριση των παραμέτρων λειτουργία της προτεινόμενης διαδικασίας με βάση πραγματικά δεδομένα.

Τα συμπληρωμένα ερωτηματολόγια θα πρέπει να αποσταλούν σε ηλεκτρονική μορφή στη ηλεκτρονική διεύθυνση, eterzis@hua.gr ή με φαξ στο 210 9514759 ή εναλλακτικά ταχυδρομικά:

Υπόψη: κ. Κωνσταντία Αικατερίνη Λαζαρίδη
Χαροκόπειο Πανεπιστήμιο
Τμήμα Γεωγραφίας
Ελευθερίου Βενιζέλου 70
Καλλιθέα
17671 Αθήνα

Παρακαλούμε επικοινωνήστε με τον Δρ. Ευάγγελο Τερζή (Τηλ.: 210 9549294/ 6973805968, email: eterzis@hua.gr), εάν έχετε οποιαδήποτε ερώτηση σχετικά με αυτό το ερωτηματολόγιο.

Έχω ενημερωθεί για τους σκοπούς της παρούσας έρευνας, η οποία διεξάγεται στο πλαίσιο του έργου «Food for Feed: An Innovative Process for Transforming Hotels' Food Wastes into Animal Feed», και συμμετέχω ☐ εθελοντικά.

1. Βασικές πληροφορίες

Όνομα Ξενοδοχείου: …………………………………………………………………………………… Κατηγορία: …………..

Όνομα εταιρείας: ………

Οδός: …………………………. Αριθμός: ….. Πόλη: ……………………………. Νομός: ……………………. ΤΚ: ………….

Όνομα Διευθυντού Ξενοδοχείου/ Εταιρείας: …………………………………………………………………………………….

Όνομα και θέση αυτού που συμπληρώνει το ερωτηματολόγιο: ……………………………………………………….

Τηλέφωνο: ………………… Φαξ: ………………… Ηλεκτρονική διεύθυνση (email): ……………………………………..

2. Λειτουργικά χαρακτηριστικά

(i) Αριθμός δωματίων: …………

(ii) Αριθμός κλινών: …………

(iii) Ημέρες λειτουργίας: …………

(iv) Μέση πληρότητα δωματίων: ……. %

(v) Μέση πληρότητα ατόμων: ……. %

(vi) Μέση διάρκεια παραμονής: ………. ημέρες

(vii) Το ξενοδοχείο προσφέρει γεύματα;

ΝΑΙ ☐

ΟΧΙ ☐

Αν ναι, μπορείτε να εκτιμήσετε τον αριθμό των μερίδων που προσφέρονται κατά τις περιόδους Απρίλιο-Ιούνιο, Ιούλιο-Αύγουστο και Σεπτέμβριο-Οκτώβριο;

Είδος γεύματος	**Αριθμός μερίδων**		
	Απρίλιος -Ιούνιος	*Ιούλιος-Αύγουστος*	*Σεπτέμβριος-Οκτώβριος*

α) Πρωινό			
β) Μεσημεριανό			
γ) Δείπνο			
δ) Buffet			
ε) Room service			
ε) Άλλο			

3. Προσωπικό

(i) Αριθμός μόνιμου προσωπικού: ☐

(ii) Εποχικό προσωπικό (σε περιόδους αιχμής): ☐

4. Διαχείριση αποβλήτων

[1] Έχει το ξενοδοχείο ως πολιτική του τη δέσμευση να μειώσει την επίδραση στο περιβάλλον;

ΝΑΙ ☐

ΟΧΙ ☐

[2] Έχει το ξενοδοχείο αναπτύξει σχέδιο δράσης για την αειφόρο ανάπτυξη;

ΝΑΙ ☐

ΟΧΙ ☐

[3] Το ξενοδοχείο εφαρμόζει κάποιο σύστημα διαχείρισης ποιότητας (π.χ. ISO 9001);

ΝΑΙ ☐

ΟΧΙ ☐

Αν ναι, ποιο είναι; ………………………………..

[4] Το ξενοδοχείο εφαρμόζει σύστημα HACCP (ISO 22000);

ΝΑΙ ☐

ΟΧΙ ☐

[5] Υπάρχει αρμόδιος στο ξενοδοχείο για τη διαχείριση των απορριμμάτων; Αν ναι ποιος είναι;

……

[6] Ποια είναι η *εβδομαδιαία* ή *μηνιαία* παραγωγή απορριμμάτων του ξενοδοχείου; (Προσδιορίστε εάν οι ποσότητες που θα αναγράψετε, προέρχονται από υφιστάμενα ζυγολόγια ή εκτιμήσεις)

……

……

[7] Παρατηρείται εποχική διακύμανση στις ποσότητες των απορριμμάτων και αν ναι, ποια η παραγόμενη ποσότητα απορριμμάτων για τις περιόδους Απρίλιο -Ιούνιο, Ιούλιο-Αύγουστο και Σεπτέμβριο-Οκτώβριο;

……
……

	Απρίλιος - Ιούνιος	Ιούλιος-Αύγουστος	Σεπτέμβριος-Οκτώβριος
	Μονάδα καταγραφής [τόννοι/ μήνα] ή [τόννοι/ εβδομάδα]*		
Ποσότητα αποβλήτων			

**επιλέξτε ανάλογα*

[8] Τι μέσα προσωρινής αποθήκευσης χρησιμοποιεί το ξενοδοχείο για τις διάφορες κατηγορίες αποβλήτων;

Ρεύμα αποβλήτων	Κάδος	Σακούλα	Άλλο*
α) Απόβλητα τροφών			
β) Συσκευασίες			
γ) Άλλα ανακυκλώσιμα			
δ) Απόβλητα κήπου (π.χ. κλαδιά)			
ε) Υπόλοιπα			

**προσδιορίστε*

[9] Πραγματοποιείται χωριστή συλλογή συγκεκριμένων ρευμάτων αποβλήτων;

ΝΑΙ ☐

ΟΧΙ ☐

Αν ναι, για ποια ρεύματα; Σημειώστε στον παρακάτω πίνακα

Ρεύμα αποβλήτων	[ΝΑΙ]	[ΟΧΙ]
α) Απόβλητα τροφών		

β) Συσκευασίες		
γ) Άλλα ανακυκλώσιμα		
δ) Απόβλητα κήπου (π.χ. κλαδιά)		
ε) Υπόλοιπα		

[10] Τι μέγεθος κάδων, συμπιεστών ή απορριμματοκιβωτίων διαθέτει το ξενοδοχείο για τα σύμμεικτα απορρίμματα ή για προδιαλεγμένο ρεύμα απορριμμάτων;

………
………
………
………

[11] Πώς γίνεται η συλλογή και η μεταφορά των απορριμμάτων του ξενοδοχείου και από ποιον (δήμος, Ιδιώτης);

………
………

[12] Ποια η συχνότητα συλλογής των απορριμμάτων του ξενοδοχείου σας κατά τις περιόδους Απρίλιο-Ιούνιο, Ιούλιο-Αύγουστο και Σεπτέμβριο-Οκτώβριο;

	Απρίλιος - Ιούνιος	Ιούλιος-Αύγουστος	Σεπτέμβριος-Οκτώβριος
α) Κάθε ημέρα (όλες τις ημέρες της εβδομάδας)			
β) Έξι φορές την εβδομάδα			
γ) Κάθε ημέρα, εκτός σαββατοκύριακου			
δ) Τρεις φορές την εβδομάδα			
ε) Δύο φορές την εβδομάδα			
στ) Άλλο (Αναφέρετε πότε)			
ζ) Δε γνωρίζω			

[13] Σημειώστε τις ποσότητες για τις κατηγορίες των αποβλήτων του παρακάτω πίνακα που απορρίπτονται κατά μέσο όρο ημερησίως στις ημέρες λειτουργίας του ξενοδοχείου.

Κατηγορία	Μονάδα καταγραφής κιλά/ λίτρα*
α) Απόβλητα τροφών	
β) Συσκευασίες	
γ) Άλλα ανακυκλώσιμα	
δ) Απόβλητα κήπου (π.χ. κλαδιά)	
ε) Υπόλοιπα	

**επιλέξτε ανάλογα*

[14] Τα απόβλητα τροφών και τροφίμων διακρίνονται σε δύο κατηγορίες: τα **αναπόφευκτα** και εκείνα που μπορούν να αποφευχθούν (**αποφευκτέα**). Στην πρώτη κατηγορία ανήκουν τα υπολείμματα τροφών και τροφίμων που δεν θα μπορούσαν να αποφευχθούν, όπως η φλούδα της μπανάνας, τα κουκούτσια των φρούτων ή τα τσόφλια των αυγών. Στη δεύτερη κατηγορία περιλαμβάνονται τρόφιμα που απορρίφθηκαν είτε γιατί δεν χρησιμοποιήθηκαν καθόλου (πριν τη λήξη τους), είτε γιατί χρησιμοποιήθηκαν εν μέρει κατά την παρασκευή και κατανάλωση γευμάτων. Επιπλέον, περιλαμβάνει τις ποσότητες φρέσκων φρούτων και λαχανικών που απορρίφθηκαν.
Είναι δυνατόν να εκτιμήσετε το ποσοστό των **αναπόφευκτων** αποβλήτων τροφών στο σύνολο των παραγόμενων αποβλήτων τροφών;

ΝΑΙ ☐

ΟΧΙ ☐

Αν ναι, σημειώστε το ποσοστό [%] βάσει της εμπειρία σας.

Τοποθετείστε τις κατηγορίες των αποβλήτων τροφών του παρακάτω πίνακα σε σειρά κατάταξης, ανάλογα με την ποια θεωρείτε ως σημαντικότερη, κυκλώνοντας ένα αριθμό για κάθε κατηγορία (1 = πιο σημαντική, 2 = λιγότερο σημαντική κλπ.). Αν είναι δυνατόν να εκτιμήσετε, βάσει της εμπειρίας σας, το ποσοστό των **αναπόφευκτων** αποβλήτων για κάθε κατηγορία, συμπληρώστε τη τελευταία στήλη.

Κατηγορία				***% αναπόφευκτων αποβλήτων***
Προετοιμασία και παρασκευή γευμάτων	1	2	3	
Υπολείμματα τροφών κατά την κατανάλωση γευμάτων από τους πελάτες	1	2	3	
Υπολείμματα τροφών Buffet	1	2	3	

[15] Το ξενοδοχείο διαθέτει ψυκτικό χώρο για την προσωρινή αποθήκευση των οργανικών αποβλήτων (υπολείμματα τροφών, απόβλητα κουζίνας κλπ.);

ΝΑΙ ☐
ΟΧΙ ☐

Αν ναι, τι χωρητικότητας; ☐ (σε κυβικά μέτρα)

[16] Ο οικείος Δήμος χρησιμοποιεί Σταθμό Μεταφόρτωσης Απορριμμάτων (ΣΜΑ);

ΝΑΙ ☐

ΟΧΙ ☐

ΔΕΝ ΓΝΩΡΙΖΩ ☐

Αν ναι, ποιος είναι; ……………………………………………………………………………………….

Χρησιμοποιείται για τα απορρίμματα του ξενοδοχείου;

ΝΑΙ ☐

ΟΧΙ ☐

Ποιο το ετήσιο ή μηνιαίο κόστος συλλογής και μεταφοράς των απορριμμάτων του ξενοδοχείου; Σημειώστε τυχόν άλλο επιπρόσθετο κόστος για τη διαχείριση των απορριμμάτων του ξενοδοχείου.

………

[17] Θα σας ενδιέφερε η συμμετοχή του ξενοδοχείου σας*, στην περίπτωση που αξιολογηθεί ως κατάλληλο και συμβατό, στο πρόγραμμα **LIFE-F4F**;

ΝΑΙ ☐

ΟΧΙ ☐

ΙΣΩΣ ☐

* [*Η συμμετοχή αφορά τη δωρεάν διάθεση των αποβλήτων τροφών του ξενοδοχείου στο πρόγραμμα LIFE-F4F, για τις περιόδους Μάιος-Οκτώβριος 2018 και Μάιος-Οκτώβριος 2019.*]

Σας ευχαριστούμε για τον χρόνο που διαθέσατε!!!

4.2 APPENDIX II: Test Method for Determination of the COMPOSITION OF UNPROCESSED MUNICIPAL SOLID WASTE[3]

1. SCOPE

This test method describes procedures for measuring the composition of unprocessed municipal solid waste (MSW) by employing manual sorting. This test method applies to determination of the mean composition of MSW based on the collection and manual sorting of a number of samples of waste over a selected time period covering a minimum of one week.

The test method includes procedures for the collection of a representative sorting sample of unprocessed waste, manual sorting of the waste into individual waste components, data reduction, and reporting of the results.

The test method may be applied at landfill sites, waste processing and conversion facilities, and transfer stations.

The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. For specific hazard statements, see Section 6.

2. TERMINOLOGY

Definitions:

(i) *composite item* - an object in the waste composed of multiple waste components or dissimilar materials, such as disposable diapers, bi-metal beverage containers, electrical conductors composed of metallic wire encased in plastic insulation, etc.
(ii) *solid waste composition or waste composition* - the characterization of solid waste as represented by a breakdown of the mixture into specified waste components on the basis of mass fraction or of weight percent.
(iii) *sorting sample* - a 200 to 300-lb (100 to 150 kg) portion deemed to represent the characteristics of a vehicle load of MSW.
(iv) unprocessed municipal solid waste - solid waste in its discarded form, that is, waste that has not been size reduced or otherwise processed.
(v) waste component - a category of solid waste, composed of materials of similar physical properties and chemical composition, which is used to define the composition of solid waste, for example, ferrous, glass, newsprint, yard waste, aluminium, etc.

[3] Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste» D5231 – 92 (Reapproved 2008). This test method is under the jurisdiction of ASTM Committee D34 on Waste Disposal and is the direct responsibility of Subcommittee D34.01.06 on Analytical Methods. Current edition approved July 31, 1992. Published September 1992.

3. Summary of Test Method

The number of samples to be sorted is calculated based on statistical criteria selected by the investigators.

Vehicle loads of waste are designated for sampling, and a sorting sample is collected from the discharged vehicle load. The sample is sorted manually into waste components. The weight fraction of each component in the sorting sample is calculated from the weights of the components.

The mean waste composition is calculated using the results of the composition of each of the sorting samples.

4. Procedure

Secure a flat and level area for discharge of the vehicle load. The surface should be swept clean or covered with a clean, durable tarp prior to discharge of the load.

Position the scale on a clean, flat, level surface and adjust the level of the scale if necessary. Determine the accuracy and operation of the scale with a known (that is, reference) weight.

Weigh all empty storage containers and record the tare weights.

Determine the number of samples to be sorted. The determination is a function of the waste components to be sorted and the desired precision as applied to each component. Weights of 200 to 300 lb (91 to 136 kg) for sorting samples of unprocessed solid waste are recommended. The number of samples is determined using the calculation method described in 9.1.

A comprehensive list of waste components for sorting is given in Table *4-2*. A description of some of the waste component categories is given in Table *4-3*. Other waste components can be defined and sorted, depending on the purpose of the waste composition determination. The list in Table *4-2* is comprised of those components most commonly used to define and report the composition of solid waste. It is recommended that, at a minimum, the complement of left-justified categories in Table *4-2* be sorted. Similar breakdowns of solid waste composition are therefore available for purposes of comparison, if desired. Label the storage containers accordingly.

Table 4-2: List of Waste Component Categories

Mixed paper	Other organics
High-grade paper	Ferrous
Computer printout	Cans
Other office paper	Other ferrous
Newsprint	Aluminum
Corrugated	Cans
Plastic	Foil
PET bottles	Other aluminum
HDPE bottles	Glass
Film	Clear
Other plastic	Brown
Yard waste	Green

Food waste	Other inorganics
Wood	

Table 4-3: Descriptions of Some Waste Component Categories

Category	Description
Mixed paper	Office paper, computer paper, magazines, glossy paper, waxed paper, and other paper not fitting the categories of newsprint and corrugated
Newsprint	Newspaper
Corrugated	Corrugated medium, corrugated boxes or cartons, and brown (Kraft) paper (that is, corrugated) bags
Plastic	All plastics
Yard waste	Branches, twigs, leaves, grass, and other plant material
Food waste	All food waste except bones
Wood	Lumber, wood products, pallets, and furniture
Other organics/ combustibles	Textiles, rubber, leather, and other primarily burnable materials not included in the above component categories
Ferrous	Iron, steel, tin cans, and bi-metal cans
Aluminum	Aluminum, aluminum cans, and aluminum foil
Glass	All glass
Other inorganics/ non-combustibles	Rock, sand, dirt, ceramics, plaster, non-ferrous non-aluminum metals (copper, brass, etc.), and bones

Vehicles for sampling shall be selected at random during each day of the one-week sampling period, or so as to be representative of the waste stream as agreed upon by the affected parties. With respect to the random selection of vehicles, any method is acceptable that does not introduce a bias into the selection. An acceptable method is the use of a random number generator. For a weekly sampling period of k days, the number of vehicles sampled each day shall be approximately n/k, where n is the total number of vehicle loads to be selected for the determination of waste composition. A weekly period is defined as 5 to 7 days.

Direct the designated vehicle containing the load of waste to the area secured for discharge of the load and collection of the sorting sample.

Collect any required information from the vehicle operator before the vehicle leaves the discharge area. Direct the vehicle operator to discharge the load onto the clean surface in one contiguous pile, that is, to avoid gaps in the discharged load in order to facilitate collection of the samples.

Using a front-end loader with at least a 1-yd^3 (0.765-m^3) bucket, remove the material longitudinally along one entire side of the discharged load in order to obtain a representative cross-section of the material. The mass of material shall be sufficient to form a mass of material which, on a visual basis, is at least four times the desired weight of the sorting sample (that is, approximately 1000 lb (454 kg)). Mix, cone, and quarter the material, and select one quarter to be the sorting sample, using a random method of selection or a sequence agreed by all affected parties, for the purpose of eliminating or minimizing biasing of the sample. If an oversize item (for example, water heater) composes a large weight percent of the sorting sample, add a notation on the data sheet and weigh it, if possible. Unprocessed solid waste is a heterogeneous mixture of materials. Care must thus be taken during application of the procedures for sample collection in order to obtain a representative sample.

One sorting sample is selected from each collection vehicle load designated for sampling. All handling and manipulation of the discharged load and longitudinal and sorting samples shall be conducted on previously cleaned surfaces. If necessary, remove the sorting sample to a secured manual sorting area. The sorting sample may be placed on a clean table for sorting for the convenience of the sorting personnel. The sorting area shall be a previously cleaned, flat, level surface.

Position the storage containers around the sorting sample. Empty all containers from the sorting sample, such as capped jars, paper bags, and plastic bags of their contents. Segregate each waste item and place it in the appropriate storage container.

In the case of composite items found in the waste, separate the individual materials where practical, and place the individual materials into the appropriate storage containers. Where impractical, segregate the composite items for classification by the crew chief according to the following order:

If there are many identical composite items (for example, plastic-sheathed aluminum electrical conductor), place them into the waste component containers corresponding to the materials present in the item, and in the approximate proportions according to the estimated mass fraction of each material in the item.

If there are only a few of the identical composite item, place them in the storage container corresponding to the material that comprises, on a weight basis, the majority of the item (for example, place bi-metal beverage cans in the ferrous container).

If composite items represent substantial weight percent of the sorting sample, a separate category should be established, for example, composite roofing shingles.

If none of the above procedures is appropriate, place the item(s) (or proportion it (them)) in the storage container labelled “other non-combustible” or “other combustible,” as appropriate.

Sorting continues until the maximum particle size of the remaining waste particles is approximately 0.5 in. (12.7 mm). At this point, apportion the remaining particles into the storage containers corresponding to the waste components represented in the remaining mixture. The apportionment shall be accomplished by making a visual estimate of the mass fraction of waste components represented in the remaining mixture.

Record the gross weights of the storage containers and of any waste items sorted but not stored in containers. The data sheet shown in Fig. 1 can be used to record both gross and tare weights.

After recording the gross weights, empty the storage containers and weigh them again, if appropriate. Re-weighing is important and necessary if the containers become moisture-laden, for example, from wet waste.

Clean the sorting site, as well as the load discharge area, of all waste materials.

Due to lack of sufficient number of comparable statistical data composition of MSW in previous years for the region of Crete data used by field measurements carried out within the research project "Qualitative/ Quantitative Crete region Waste Analysis" in the period 15/9 - 31/10 the 2003. the implementation of the above calculation method was the Pera Galinoi landfill of Heraklion provided as shown in the following table (table 7-3) that receives the bulk of waste of the region of Crete (Figure 7-2) and is only corresponding to a population> 100,000 inhabitants.

Calculation the required number of samples

A key element of any sampling is the selection of the correct size and number of samples (n) using a suitable statistical method. The international standard ASTM D5231-92 (2008) - "Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste", was used.

According to the standard it is recommended to researchers taking sample sizes 91-136 kg (200-300lb). The number of samples (n) is calculated using the calculation method described below. Here it should be noted that this method is based and tested on sample applications to US landfills in which a sufficient number of statistical data on waste composition are available. Also, the method referred to large landfills (population> 100,000) as in the US there are no landfills in small cities.

The number of samples needed to provide the required degree of accuracy (precision = 10%) is a function of the components (fractions) considered the level of confidence (90%) where we want to go. The equation used for the extraction of (n) is as follows:

5. CALCULATION

Samples: Number of 100 to 150 kg (200 to 300 lb)

The number of sorting samples (that is, vehicle loads) (n) required to achieve a desired level of measurement precision is a function of the component(s) under consideration and the confidence level. The governing equation for n is as follows:

$$n = \left(\frac{t^* \times s}{e \times \bar{x}}\right)^2 \qquad (1)$$

Where:

t* = student t statistic corresponding to the desired level of confidence,

s = estimated standard deviation,

e = desired level of precision, and $\bar{x} =$ estimated mean.

All numerical values for the symbols are in decimal notation. For example, a precision value (e) of 20% is represented as 0.2.

One sorting sample is chosen per vehicle load.

Suggested values of s and of $\bar{x}$ for waste components are listed in Table 4-4. and Table 4-5.

Table 4-4. Values of Mean $(\bar{x})$ and Standard Deviation(s) for Within-Week Sampling to Determine MSW Component Composition[4]

Component	Standard Deviation (s)	Mean $(\bar{x})$
Newsprint	0.07	0.10
Corrugated	0.06	0.14
Plastic	0.03	0.09
Yard waste	0.14	0.04
Food waste	0.03	0.10
Wood	0.06	0.06
Other organics	0.06	0.05
Ferrous	0.03	0.05
Aluminium	0.004	0.01
Glass	0.05	0.08
Other inorganics	0.03	0.06
		1.00

[4] The tabulated mean values and standard deviations are estimates based on field test data reported for MSW sampled during weekly sampling periods at several locations around the United States.

Table 4-5. Values of Mean ($\bar{x}$) and Standard Deviation(s) for for within-week sampling to determine MSW component composition (Pera Galinoi landfill, Heraklion, Crete, 2003)[5]

Component	Standard Deviation (s)	Mean ($\bar{x}$)
Inert	0.46	1.93
Metals	1.79	4.44
Aluminum	0.66	3.01
Glass	0.52	4.58
LWTR	1.22	3.60
Paper	6.74	19.71
Putrescibles	1.96	35.45
Plastics	5.61	22.49
Misc.	1.33	4.79
		1.00

Values of t* are given in Table 4-6 for 90% and 95% levels of confidence, respectively.

Table 4-6. Values of t Statistics (t*) as a Function of Number of Samples and Confidence Interval

Number of Samples, n	90%	95%
2	6.314	12.706
3	2.920	4.303
4	2.353	3.182
5	2.132	2.776
6	2.015	2.571
7	1.943	2.447
8	1.895	2.365
9	1.860	2.306
10	1.833	2.262
11	1.812	2.228
12	1.796	2.201
13	1.782	2.179
14	1.771	2.160
15	1.761	2.145
16	1.753	2.131
17	1.746	2.120
18	1.740	2.110
19	1.734	2.101
20	1.729	2.093
21	1.725	2.086
22	1.721	2.080
23	1.717	2.074
24	1.714	2.069
25	1.711	2.064

[5] Gidarakos E., Havas G., Ntzamilis P. (2006): Municipal solid waste composition determination supporting the integrated solid waste management system in the island of Crete. Waste Management, 6(6), pp 668–679.

26	1.708	2.060
27	1.706	2.056
28	1.703	2.052
29	1.701	2.048
30	1.699	2.045
31	1.697	2.042
36	1.690	2.030
41	1.684	2.021
46	1.679	2.014
51	1.676	2.009
61	1.671	2.000
71	1.667	1.994
81	1.664	1.990
91	1.662	1.987
101	1.660	1.984
121	1.658	1.980
141	1.656	1.977
161	1.654	1.975
189	1.653	1.973
201	1.653	1.972
∞	1.645	1.960

6. EXAMPLE CALCULATION OF THE NUMBER OF SAMPLES FOR ANALYSIS

Step 1: Estimate the number of samples (n') for the selected conditions (that is, precision and level of confidence) and components using (Eq. 1). For the purposes of estimation, select from Table 4-6 the t* value for $n = \infty$ for the selected level of confidence. Since the required number of samples will vary among the components for a given set of conditions, a compromise will be required in terms of selecting a sample size, that is, the number of samples that will be sorted. The component that is chosen to govern the precision of the composition measurement (and therefore the number of samples required for sorting) is termed the "governing component" for the purposes of this method.

Step 2: After determining the governing component and its corresponding number of samples (n_o), return to Table 4-6 and select the student t statistic (t_o^*) corresponding to n_o. Recalculate the number of samples, that is, n', using t_o^*.

Step 3: Compare n_o to the new estimate of *n*, that is, n', which was calculated for the governing component. If the values differ by more than 10%, repeat the calculations given in *steps 1 and 2*.

Step 4: If the values are within 10%, select the larger value as the number of samples to be sorted.

The number of sorting samples (that is, vehicle loads) (n) required to achieve a desired level of measurement precision is a function of the component(s) under consideration and the confidence level. The following calculations illustrate the use of the method.

Assumptions:

Metals (all kinds except aluminium) is selected as the governing component.

A 90% confidence level is selected. A precision of 10% is desired.

Therefore:

s = 0.0179 (from **Table *4-4***),

$\bar{x}$ = 0.0444 (from **Table *4-4***),

e = 0.10, and

t* (n = ∞) = 1.645 (from **Table *4-6***).

Using (Eq. 1):

$$n = \left(\frac{t^* \times s}{e \times \bar{x}}\right)^2 = \left(\frac{1.645 \times 0.0179}{0.10 \times 0.0444}\right)^2 = 43.9 \cong 44 = n_o$$

Referring again to **Table *4-6***, for n = 44,

t^*_{90} (n = 21) = 1.681

And, $n = \left(\frac{t^* \times s}{e \times \bar{x}}\right)^2 = \left(\frac{1.681 \times 0.0179}{0.10 \times 0.0444}\right)^2 = 45.93 \cong 46 = n'$

Since 46 (that is, n_o) is within 10% of 44 (that is, n_o), consequently **46 samples** should be selected for analysis.

Table 4-7. Καταγραφικό έντυπο (Recording form for selected food waste component categories for analysis of composition in food waste)

Ημερομηνία/ Ώρα:	**Είδος Α/Φ:**	**30 m^3**	**12 m^3**	**8 m^3**
Ξενοδοχείο:	Διαδρομή:			
Κλιματικές συνθήκες:				
Κατηγορία υλικού	**Βάρος σε kg**			**% του συνόλου**
	Απόβαρο	Μικτό	Καθαρό	
Ποτά [Drinks]				
Φρέσκα Λαχανικά & σαλάτες [Vegetables and salads]				
Αρτοπαρασκευάσματα [Bread and bakery]				
Φρέσκα φρούτα [Fresh fruit]				
Μαγειρεμένο φαγητό [Cooked meals]				
Κρέας, ψάρι, θαλασσινά [Meat and fish]				
Γαλακτομικά (εκτός γάλατος) και αυγά [Dairy and eggs]				
Ξηρά τρόφιμα [Dried food]				
Καρυκεύματα, σάλτσες, βότανα [Condiments, sauces, herbs]				
Επεξεργασμένα λαχανικά [Processed vegetables]				
Επιδόρπιο [Desert]				
Μικρογεύματα και ζαχαρώδη [Cake, desserts and confectionery]				
Επεξεργασμένα φρούτα				
Άλλα (υλικά τα οποία δεν είναι δυνατόν να υπαχθούν σε κάποια κατηγορία, ή/ και έχουν μέγεθος >15 mm) [Other: organic material which does not fit into another category because (a) it is not possible to be integrated in a category and/or (b) has a size less than 15 mm]				
Προσμίξεις (πλαστικό, μέταλλα, γυαλί, πλαστική σακούλα) [Impurities]				
ΣΥΝΟΛΟ				
ΣΗΜΕΙΩΣΕΙΣ:				
ΕΙΔΙΚΟ ΒΑΡΟΣ:				