

LOWINFOOD

**Multi-actor design of low-waste food value chains
through the demonstration of innovative solutions to
reduce food loss and waste**

GA No. 101000439

D5.7 – Report on Demonstration – Kitro

WP5 - Type of deliverable: other - Dissemination level: public - Due date: Dec 31st, 2023 (M38)

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LOWINFOOD has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000439.

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Table of contents

Summary	4
Introduction to the deliverable	4
Introduction to KITRO	5
Methodology	8
Scope of the demonstration	8
User of the demonstration	9
Food waste measurement	10
Surveys to assess the socio-economic and environmental effect	12
Implementation and usage of Kitro	13
Challenges of the baseline and demonstration phases	13
Outcomes of demonstration phase	14
Improvements made to the innovation	17
Learnings and recommendations for future applications	17
Conclusion	18
References	19



Summary

This deliverable reports on how the innovation Kitro, provided by the Swiss company KITRO SA, which aims at reducing food waste in the food service sector, was applied in the LOWINFOOD project. A Kitro device can weigh food waste when thrown out; it takes a picture of the waste, which is then analysed so that the waste can be categorised. This way, KITRO supports businesses by providing an automated food waste management solution. The businesses receive data insights and tips for food waste reduction from KITRO in iterative meetings. In LOWINFOOD the innovation was tested for seven to eleven months in three German and Swiss food services with the scientific support of ISUN, and in two Greek hotels with the scientific support of HUA.

KITRO's effect was assessed by carrying out a quantitative analysis on the food wasted and surveys of management and staff to understand its economic and social impact and to reveal user satisfaction with the innovation. This report describes the methodological approach applied for testing Kitro in LOWINFOOD. Moreover, results for user satisfaction are presented. Generally, all participating business managers described positive experiences with KITRO. Two users will continue to use the innovation after the end of the project and will install additional devices in other facilities of the hotel chain. The results presented in this report will be complemented by other LOWINFOOD deliverables due in October 2024.

Introduction to the deliverable

LOWINFOOD is a project committed to co-design, together with actors of the food chain, low-waste value chains by supporting the demonstration of a portfolio of innovations in a set of value chains particularly concerned by food loss and waste (fruits & vegetables, bakery products and fish), as well as in at-home and out-of-home consumption. Each of these value chains corresponds to a single Work Package (WP) of the project.

The innovations are selected among promising solutions that have already been developed and tested by some partners of the consortium, with the aim to provide the necessary demonstration and upscale to allow market replication.

The LOWINFOOD consortium comprises 28 entities, located in 12 different countries, and ranging from universities and research institutes to start-ups, foundations, associations, and companies working in the food sector. During the 52 months of the project, the partners are committed to complete 30 tasks and to deliver 60 outputs (deliverables).

This deliverable (D5.7) is part of WP5, which is dedicated to reducing food waste within household and foodservice consumption settings. Specifically, D5.7 is related to the innovation of task 5.1 (T5.1) which aims to reduce food waste in restaurants and canteens by automatising food waste measurements, allowing managers greater insights into their individual food waste situation and

potential room for improvement. This deliverable comprises a report on the methodological approach used in the task and presents the preliminary results of a management survey conducted to assess user satisfaction with the innovation and the changes to the working processes that have occurred as a result of using the innovation. In addition, it presents the improvements made to the innovation in the context of LOWINFOOD. KITRO's efficacy of reducing food waste is analysed in work package 1. This is where the data for the food waste measurements outlined in this report is analysed. Results will be presented in deliverable D1.6 of the LOWINFOOD project due in October 2024.

Introduction to KITRO

Founded in 2017, KITRO is a Swiss company embarking on a global challenge by harnessing the power of technology and using it for sustainable change. With artificial intelligence (AI) as the foundation, KITRO offers an automated food waste data collection and analysis solution that can be adopted by food and beverage outlets worldwide. By combining image processing and deep learning technologies with a hardware solution, relevant information on the food being thrown away is captured and analysed. Food services receive detailed insights into their food waste via an online dashboard, empowering them to make informed decisions and optimize work practices leading to a reduction in food waste, food cost and their negative environmental impact.

The hardware of the innovation comprises a scale that is placed underneath the waste bin in kitchens and an Internet of Things device with a camera on top (see Figure 1).



Figure 1: Hardware of the Kitro innovation

KITRO monitors all food waste in a business by installing the AI-based device. The camera automatically takes a picture whenever something is thrown in the bin. Combining deep learning technologies with image processing to analyse what has been wasted and combining this information with the weight registered by the scale, a detailed report on what and how much was wasted when can be produced with little daily effort by the businesses. As a result, the following information is produced and made accessible for management via an online dashboard: what food item was wasted in which quantities, at which time, as well as type of waste meaning serving waste, preparation waste or plate waste. KITRO detects if the waste is edible or not, therefore showing areas with most room for improvement. By comparing months, weeks or days, trends become visible. KITRO provides different graphs on the dashboard for customers (see Figure 2, Figure 3, and Figure 4). This eases comparison between waste being produced at different service times, from different sources or consisting of different food groups. In addition, it also provides information on the cost of food waste.

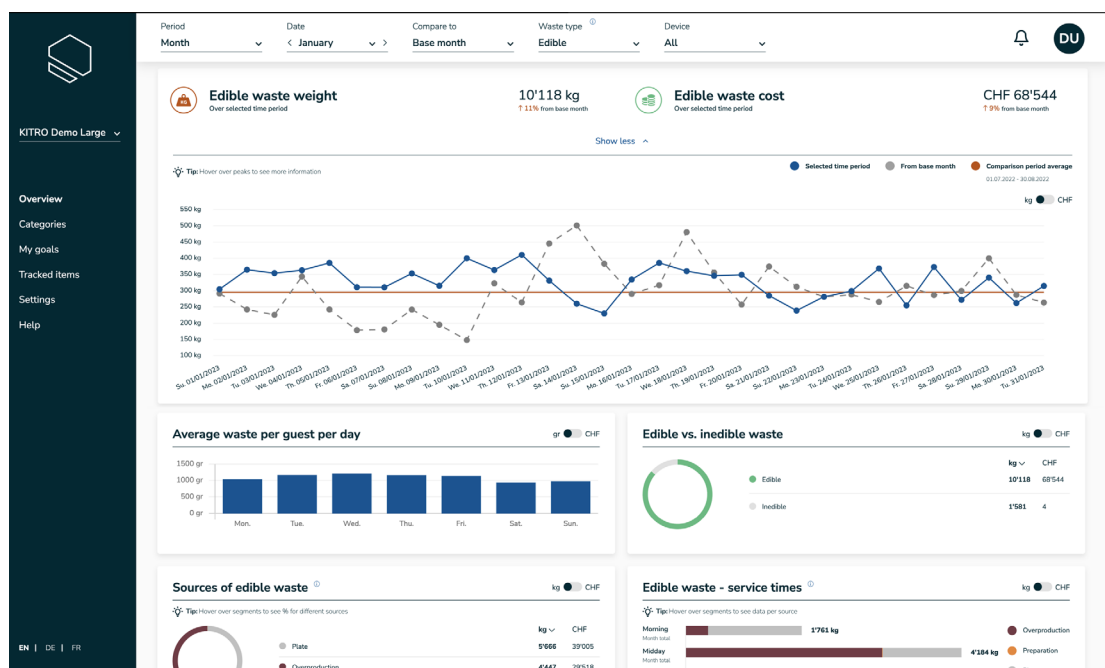


Figure 2: Kitro dashboard displaying different parameters (Edible waste weight and cost, Average waste per guest per day, Comparison of edible vs. inedible waste)



Figure 3: Kitro dashboard showing "All waste per category over time"

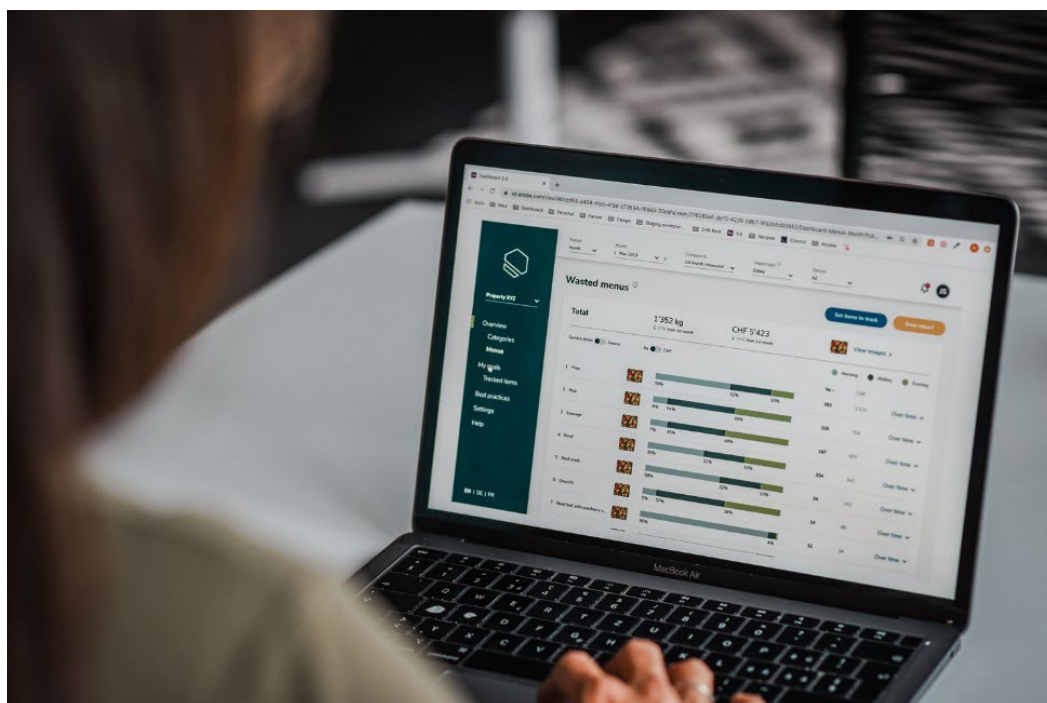


Figure 4: Kitro dashboard showing "Wasted menus" (per service time: morning, midday, evening)

During iterative meetings with KITRO staff, reduction measures fitted to the individual food service business are discussed. KITRO allows a business to develop reduction measures against food waste that are custom to their facility and situation, therefore saving food and money. The measures are based on the findings revealed by KITRO. Depending on the findings, individual food waste reduction measures can include, for example, optimising buffet stocking, reducing portions or changing side dishes on menus. KITRO's goal is to change the way that food waste is handled and bring back the value of food, so it is appreciated and not wasted.

KITRO offers a subscription-based service with the option to rent the device monthly. Depending on the length of contract, the size of the property and the number of units required different discounts apply. KITRO also offers various service packages. The amount of the monthly subscription fee depends on how detailed the analysis of the food waste is and how often an expert consultation is requested by the customer. In addition a fee for setting up and shipping the devices applies. Interested companies can request a customised offer from KITRO. The users that tested KITRO as part of LOWINFOOD received the services offered free of charge.

Methodology

Scope of the demonstration

As part of the LOWINFOOD project, Kitro was tested in five German, Swiss and Greek food service businesses. Testing comprises the implementation and usage of Kitro in the businesses, determining its efficacy to reduce food waste and assessing the socio-economic and environmental effect of its use. The data collection for the evaluation is carried out through waste measurements and user surveys. Figure 5 shows the procedure for testing Kitro as part of the LOWINFOOD project and for collecting the necessary data.

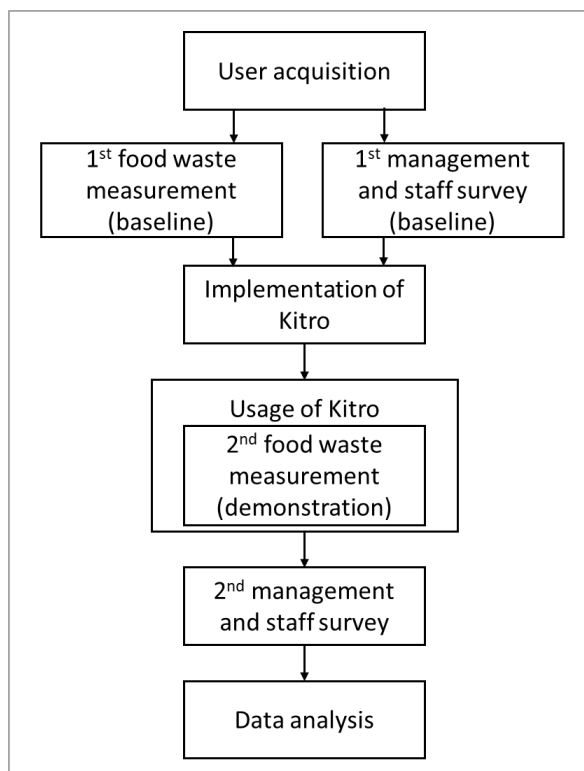


Figure 5: Approach of testing the Kitro innovation in LOWINFOOD

User of the demonstration

The innovation was used by two German and one Swiss restaurants. Kitro was also tested in two Greek hotels belonging to the LOWINFOOD partners THA and BLU.

The first German user, DE1, was a restaurant located in a vacation parc. Patrons there are mostly people who rent a vacation home in the parc or other guests in the area. The restaurant serves a breakfast buffet and lunch and dinner *à la carte*. During an average day of the demonstration phase around 130 guests are served in the location. Two Kitro devices were installed: one in the kitchen, measuring mostly preparation waste and waste from overproduction. A second device in the dishwashing area measured mostly plate waste. A definition of the different waste types is provided in the section "food waste measurement".

The second German user, DE2, was a business caterer. This business caterer works on behalf of a company and is located in this company's office building. From Monday to Thursday, customers can buy lunch and choose between five different menu lines, a salad or pasta bar, desserts and snacks (two lines on Fridays). Before the pandemic, around 800 people ate in the canteen every day. During the winter of 2021/2022, the guest number was reduced to around 150 guests per day. As measurements began in May 2022, the average guest number was around 330, but varied a lot with each weekday. The business caterer also serves any conferences or other meetings held in the office building. People not associated with the office the canteen is located in are not served.

Two Kitro devices were installed: one in the kitchen for preparation and serving waste, and one in the dish washing area, measuring plate waste.

The third user, DE3, is located in Switzerland. It is a restaurant located in a hotel. Patrons can visit a buffet for breakfast or order *à la carte* for lunch and dinner. While the breakfast is usually attended by hotel guests only, the restaurant is frequented by other guests for dinner. For this user, only one Kitro device was installed, measuring all food waste. This includes waste from the oriental-style hotel restaurant and the hotel bar, serving cocktails and snacks. During an average day, about 300 guests are served here.

The first Greek user, GR1, is an “all inclusive” hotel unit located in the island of Kos. Five KITRO devices were installed in the: i. Central kitchen, ii. Cold kitchen (where “cold” dishes are being prepared, iii. The Restaurant, iv. The Terrace L, and v. the Terrace R. The KITRO innovations was implemented for two consecutive seasons (2022 and 2023).

The second Greek user, GR2, is an *à la carte* restaurant, and is located in the island of Santorini. Five KITRO devices were installed in the: i. Pastry, ii. Close to the bench for the preparation of vegetables, iii. Close to the benches for the preparation of meat/fish, iv. The culinarium, and v. The main restaurant. The latter was measuring plate waste. The KITRO innovation was implemented for two consecutive seasons (2022 and 2023).

Food waste measurement

As described above, KITRO measures food waste automatically and without hindering staff in their daily business routines. Depending on where the KITRO device is located in the food service facilities different types of waste are measured. The most commonly included processes are the preparation of food, serving, and consumption (Malefors et al., 2019). The associated waste types include preparation waste, safety margin waste, serving waste, and plate waste. If required by the customer, storage or receiving waste can also be recorded. The definitions of the waste types are provided in Table 1. All waste types may contain edible or inedible parts. Inedible waste comprises parts of food that is usually not consumed such as peel or bones.

Kitro differentiates the waste measured into edible or inedible waste. The type of waste measured can be identified based on where the device is located in the food service facility. For instance, plate waste is measured in the dishwashing area or preparation waste in the kitchen. Although this categorisation does not apply in general. One device can also capture the waste from several processes. The number of devices used in a company depends on the agreement between the customer and Kitro. KITRO also records the service time (morning, midday, and evening) at which the waste is generated.

Table 1: Definitions used in the food-waste quantification process (Source: Malefors et al., 2019)

Waste	Definitions
Receiving waste	Waste that occurs from goods delivered to the kitchen, but never stored or used. Also known as reclamation waste in other sectors, such as retail.
Storage waste	Stored goods that become waste for whatever reason.
Preparation waste	Waste from the preparation and/or trimming of food, such as peel, bones, and fat.
Safety margin waste	Waste from food produced which did not leave the kitchen for consumption and was not saved for another meal.
Serving waste	Food served that did not reach the plates of guests.
Plate waste	All waste from the plates of guests. May contain napkins and/or bones.

In order to assess KITRO's efficacy to reduce food waste, a food waste baseline was determined first. This baseline was measured using KITRO for four to six weeks. During this period, users did not have access to the KITRO dashboard, meaning that the results could not be viewed. Therefore, this was a "blind" food waste measurement. Data on guest counts were also documented.

KITRO's efficacy to reduce food waste will be analysed by comparing baseline and demonstration data, i.e. the average waste per guest per day resulting from the respective phases. Data on food waste will be analysed in work package 1. Results will be presented in deliverable D1.6 of the LOWINFOOD project due in October 2024.

Timeline of baseline measurement

The time frame for the baseline measurement for all users can be found in Table 2.

Table 2: Time frame of baseline food waste measurements for all five users

Facility	Description	Start baseline	End baseline	Number of days
DE 1	Restaurant in vacation parc	Dec 01 st , 2021	Dec 31 st , 2021	28
DE 2	Business canteen	May 16 th , 2022	Jun 30 th , 2022	33
DE 3	Hotel restaurant	Feb 01 st , 2022	Feb 28 th , 2022	28
GR 1	Greek hotel	May 04 th , 2022	Jun 02 nd , 2022	30
GR 2	Greek hotel	May 01 st , 2022	May 30 th , 2022	30

Demonstration phase

The time frame for the demonstration phase is presented in Table 3 for each user.

Table 3: Time frame of the demonstration phase for all five users

Facility	Description	Start demonstration	End demonstration	Number of days
DE 1	Restaurant in vacation parc	Jan 01 st , 2022	Nov 01 st , 2022	276
DE 2	Business canteen	Jul 01 st , 2022	May 12 th , 2023	228
DE 3	Hotel restaurant	Mar 01 st , 2022	Jan 01 st , 2023	304
GR 1	Greek hotel	Jun 03 rd , 2022	Oct 25 th , 2022	320 (145 + 175)
		May 06 th , 2023	Oct 28 th , 2023	
GR 2	Greek hotel	May 31 st , 2022	Oct 25 th , 2022	309 (148+161)
		May 02 nd , 2023	Oct 10 th , 2023	

Surveys to assess the socio-economic and environmental effect

Besides assessing KITRO's efficacy to reduce food waste, it's social and economic impact is assessed by the means of surveys of management and staff (see protocols for collection - LOWINFOOD Deliverables 1.2-1.4). Results on the social and economic impact will be presented in deliverable D1.7 of the LOWINFOOD project due in October 2024. The management survey also included a part on the user satisfaction with the innovation as well as on the changes made to the working processes. This data was collected through a personal interview with the management of the respective user after the demonstration of the innovation had ended and results will be presented in the "Outcomes" section of this deliverable. The following questions were included in the survey:

Kitro's influence on working processes and offer

1. Are there specific menus / components for which you have **changed the production quantity, the serving sizes or the availability on the menu** due to the use of Kitro? If yes, please indicate what has been changed. (free text/open question)
2. Did you change the **cooking / preparation process or was the disposal process affected** by the use of Kitro? If yes, please indicate what you have changed. (free text/open question)

User satisfaction with Kitro and perceived usefulness

3. Did you have to train staff on how to use Kitro? (free text/open question)
4. How difficult was it to start using Kitro (1 – very difficult; 5 - very easy)?
5. How satisfied are you with the following features of Kitro (scale 1-5: 1 hardly satisfied, 5 very satisfied)?
 - Dashboard of the innovation
 - Functionality / features of the innovation
 - Ease of use for managers
 - Ease of use for kitchen staff
 - Quality of service
6. Do you think Kitro helped you reduce food waste? (free text/open question)
7. Would you recommend Kitro to others? (free text/open question)
8. Will you continue using Kitro (even) after the project ended? (free text/open question)

Suggestions for further improvement of Kitro

9. Which features or design elements would you change or add to Kitro? (free text/open question)

Implementation and usage of Kitro

After the baseline period, the demonstration phase began seamlessly. During this phase, KITRO gave the users login information to view their food waste data. The usage phase lasted between seven and eleven months. During this time, food waste was measured continuously. Users discussed results with KITRO and implemented measures to reduce food waste. During the implementation and usage periods meetings were held with the users for installation, introduction, goal setting and data reviews. The businesses involved held a total of four to 15 meetings each of which three to ten were dedicated to goal setting and data review. The necessary frequency of these meetings depended on the needs of the respective user. Users entered guest numbers used to calculate food waste per guest per day. This unit of measurement helps with comparing data from busy and less frequented days. KITRO held iterative meetings with each user to discuss the results and help developing measures to reduce food waste.

Challenges of the baseline and demonstration phases

ISUN encountered some difficulties with scheduling the baseline measurement phase due to the COVID19 pandemic. In general, the baseline period should be representative of a usual business month, ensuring that any food waste reductions are largely due to KITRO and not due to other changes within the facility or their guest flow. Because of the pandemic, it was difficult to

determine if the guest flows of the baseline period were representative for the business. In case of DE2, the beginning of the measurements was pushed back twice due to orders to work from home that caused guest numbers in this business canteen to be significantly lower. For the user DE1, baseline measurements took place in December 2021. Since the end of the pandemic and lifting of guest restrictions could not be foreseen, it was decided to start the measurements at this time. It is unclear if the chosen time frames will affect the representativeness of the baseline data. A statement on this can be made once the waste measurement data has been analysed.

Another challenge was related to connecting Kitro to the local wi-fi which was necessary for KITRO to receive the pictures taken and weight registered. The business caterer is located in the office building of its client and uses the client's IT infrastructure. Because the client has strict data and privacy protection, connecting the Kitro device to the client's wi-fi was not possible. The user (business canteen) had to purchase a wi-fi dongle extension which operates on a data plan independent from the company wi-fi.

HUA did not encounter difficulties due to the COVID19 pandemic, as both the baseline and the demonstration phases took place in 2022 and 2023. Minor difficulties regarding the connection of two KITRO devices with the local wi-fi were faced and largely addressed.

At the beginning of the baseline phase, the bin in one of the devices installed on the terrace of GR1 was damaged by drunk customers, but it was immediately replaced. This was an isolated incident.

Outcomes of demonstration phase

The analysis of the food waste amounts will be carried out in LOWINFOOD task 1.2 "Evaluation of the efficacy of innovations". Results will be included in Deliverable 1.6 "FLW evaluation of innovations" (due in Oct 2024). In this deliverable, results of the management survey related to changes made to the working processes or the food services' menu, user satisfaction, and suggestions for further improvements of KITRO are presented. As part of this survey, the responsible managers in the companies were interviewed. For four of the five users, the interview partners were one general manager per user, who were also responsible for the introduction of Kitro. For one user (DE1), two managers (a kitchen manager and a general manager) answered the interview questions together.

Further it should be noted that GR2 won the TUI Blue Innovation Award in the 2023 "TUI Global Hotel Awards", with KITRO implementation being a component of its application. This created awareness about and interest for in the entire TUI Group of hotels.

Results for KITRO's influence on working processes / menu

Table 4: Changes on various aspects of business

	Question 1	Question 2
Change of:	production quantity / serving size for specific menus / components / change of availability on the menu	cooking / preparation / disposal process
DE1	Side dish salad formerly was automatically served with main dishes but often thrown away untouched → menu was changed and salad needs to be ordered separately.	
DE2	Buffets for special occasions are now planned differently.	As only two Kitro devices were available, staff had longer ways to reach bins - this affected the disposal process during the preparation of meals and in the dishwashing area. Planning of pasta counter (self-service) has changed: Pasta is produced as needed, less is produced ahead of time.
DE3	Side dishes changed or eliminated. Smaller bowls on breakfast buffet which are refilled more frequently.	Two rice cookers to cook less rice on shorter notice to avoid overproduction.
GR1	Changes in the presentation of the food items in the buffet and partially in the composition of some recipes.	
GR2	Some changes have been done in the composition of the dishes (i.e. some ingredients which were usually discarded have been substituted).	The way the kitchen staff was handling food ingredients was changed, i.e. in the first season KITRO revealed that some of kitchen staff members used to waste edible parts of vegetables when they cleaned the vegetables from the inedible parts. Also wasting of a lot of whipped cream was detected, because a member of staff often "forgot" the whipping cream on the bench (outside of the fridge) after preparing pastries, resulting to the remaining whipping cream to be discarded.

Survey results on user satisfaction with KITRO

Questions 3 and 4 refer to the phase of implementing Kitro. The first question asks for the required effort necessary to train the staff that uses the device. All five German, Swiss and Greek users consistently stated that no training was required. The second question delivers information regarding the perceived level of difficulty to implement Kitro. Here, too, all users agreed that it was very easy to start using the innovation (see Figure 6).

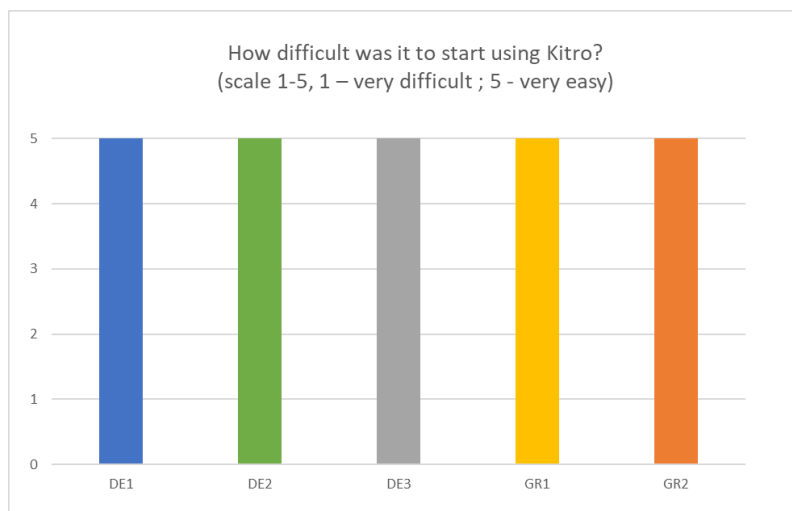


Figure 6: Level of difficulty to implement Kitro innovation

Question 5 studies the users' satisfaction with different features of the innovation. All five users indicated to be very satisfied with Kitro's ease of use for managers and kitchen staff (see Figure 7). The three items, the dashboard, the functionality / features of the innovation, and the quality of Kitro's service also received high ratings with a 5 by three users and a 4 by two users.



Figure 7: User satisfaction with various features of KITRO

The answer to question 6, if KITRO helped the facilities to reduce food waste was uniquely answered by all five participants with "Yes". Question 7 asked if whether or not the users would recommend KITRO to others. While four of the respondents answered with "Yes", one stated "No". Two of respondents added that Kitro fits small restaurants to a limited extent only, as the

innovation would be more useful in larger facilities. One Greek and one of the German / Swiss facility will continue to use the innovation while three answered “No” to question 8 on whether or not they will continue to use Kitro after the project end. GR1 described the cost of KITRO as one reason for not continuing the use, and the fact, that they need to have member of staff in charge of Kitro which is not always feasible. DE1 stated that the innovation is useful for one year as the waste situation is analysed, changes are made, and KITRO has already served its purpose by then.

Results for suggestions to further improve KITRO

Asked about the features or design elements they would change or add to KITRO (question 9) the users suggested the following aspects:

- Make successes more visible (e.g., put a tablet in the kitchen so staff can see how much is wasted in real time to increase awareness).
- Improve taxonomising of food items, e.g. there were high weight recordings for bread, although, most of the times this was due to sauces or the olives that the bread had absorbed, not because of the bread itself.
- Make Kitro adaptable to bins with lids and foot pedal for quality assurance reasons (HACCP requirements).

Improvements made to the innovation

During the project, KITRO has improved its innovation by changing the graphs visible on the dashboard. This has made viewing and comparing data easier for users. A default for daily guest numbers can be set by users. This helps with quality of data when users may not enter guest numbers for every day. The device itself has been upgraded in embedded systems and hardware. A higher quality scale is now used. The top unit of the KITRO device, where the camera is located, is now coated on the inside with copper to reduce electromagnetic radiation and immunity. Other improvements have been made in regard to customer service, now offering an EU-based shipping station, and the logic with which labels are assigned to food waste, improving data quality. Consequently, the AI algorithm that drive KITRO's food waste detection increased accuracy and data annotation responsibility percentage.

Learnings and recommendations for future applications

In LOWINFOOD Kitro was tested in five food service facilities in Germany, Switzerland, and Greece. The results of the management survey suggest that KITRO has the potential to reduce the amount of food waste in both small and large facilities. However, regarding the costs three German and Greek managers stated they would recommend Kitro for rather larger facilities (DE2 recommends

it for >600 meals per day). To meet this finding KITRO launched a Report or light model solution for smaller properties that allows them to measuring using the KITRO solution at a lower price with less services and detection.

Handling of the Kitro devices was assessed very user-friendly by all users. This includes both the simplicity of implementation process as well as handling of device and dashboard during operation. One aspect to consider is the number of devices to be installed. If the aim is to measure all food waste in a facility, it is advisable to install sufficient equipment to avoid additional walking distances.

Asked about the features or design elements they would change or add to Kitro only one user answered that they would make successes more visible for kitchen staff. He suggested to put a tablet in the kitchen so staff can see how much is wasted in real time to increase awareness. Kitro could use this recommendation that staff should share in the short-term successes to further develop their concept.

A quite interesting point of design improvement was indicated by the Quality Assurance Consultant of GR2. More specifically, he indicated that the KITRO innovation could be improved by making it adaptable to bins with lids and foot pedal, as these bins are needed in the kitchen to comply with an HACCP certification. This was an issue for GR2 during inspections by the relevant authorities, but they did not get a penalty for the open bins because that was part of a research project.

As indicated by GR1, KITRO can contribute to the reduction of food waste given that (at least) one of the staff member will be in charge of analysing the feedback and developing food waste prevention/reduction measures. One lesson the scientific partners ISUN and HUA have learnt from their collaboration with the business partners is how important it is to create a basis of trust for cooperation. The personal contact of the researchers proved to be crucial in keeping contact and receiving correct data on time. One learning is therefore the importance of regular, personal contact and a good understanding of each facility to ease the data transfer and increase trust by users.

Conclusion

The innovation was successfully implemented in the participating food service facilities. The main challenge was to cope with the situation caused by the COVID-19 pandemic. The methodological approach required a baseline measurement of the users involved, which is representative of their regular operations. Due to the restrictions, both guest numbers and food waste quantities can deviate from normal events. Defining a representative baseline period therefore proved to be a challenge. For the first phase of the task (the Greek partners were not particularly affected by the COVID-19 restrictions, as the pilot implementation of KITRO took place in summer 2022 and 2023). The evaluation of the waste volumes, which will take place in Deliverable 1.6 of work package 1, will provide some further insights on the impact of the pandemic. The part of the

management survey that analysed user satisfaction with the innovation and the changes to work processes was the focus of this report. The analysis revealed:

- user-friendliness of Kitro during implementation and operation daily business was assessed positively by all users of the LOWINFOOD project,
- all users certified Kitro's suitability for the purpose of food waste reduction and consider KITRO a useful tool to discover the individual food waste situation and areas for improvement for the respective kitchens.

KITRO will be able to use the experience and insights gained during the project to further improve the innovation. Because of the project, several hotel networks have become aware of KITRO as they could observe the success in food waste reduction in one of their facilities. In addition, GR2 was awarded the 2023 TUI Blue Innovation Award to which the use of KITRO has made an important contribution. The aim is to use those new contacts to further expand the business and implement KITRO in more of their facilities.

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