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FoodWise: Geolocalised Food Wastes Tracking and Management

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Abstract

Food waste has a number of impacts, such as: economic, environmental and social. Recent efforts in human computer interaction research have examined methods with the goal of manage surplus food and food waste prevention. In addition, existing approaches have number of limitations related to the techniques used and food waste phase focused. In addition, to our knowledge, no approach provides an open access data for food waste (e.g., open API) to be used by any interested entities for data analysis.

In this paper, the effectiveness of a number of engineering approaches in the literature is investigated and an analytical comparison is demonstrated. The second step is highlighting the pros and cons of the proposed strategy. Finally, we propose "FoodWise", suitable tool for implementing the proposed strategy, by combining geo-localization, gamification, and crowdsourcing techniques. The contribution of this study might present a new opportunity for any interested stockholders to play a significant role in minimizing food waste problem.

1. Introduction

In Europe, there is about 88 million tonnes of food waste, with estimated cost of 143 billion euros. About 1/3 of the food that produced for human consumption is wasted, which is approximately about 1.3 billion of tonnes per year [1]. Food waste in developing countries is as high as in industrialised countries, with the difference in their distribution. However, in industrial

countries, over 40% of food waste occurs at consumer level. In developing countries, roughly similar amounts occur after the harvesting phase and also during processing phase. Food waste occurs at different levels, among which we mention, for instance, domestic food waste which occurs during the purchasing and at the home [2]. To decrease such cases, a number of regulation set to urge food suppliers and consumers to consider preventive actions to decrease the food waste. For example, France has apply taxes on the food wasted by supermarkets. Alternatively, Italy offers tax reduction to supermarkets who donates surplus food to charities.

However, food, sometimes, is often wasted due to lack of knowledge on: food planning and the regulations of donation. However, with the support of technology, it is possible to promote change and help make a difference in the food waste habits. Existing literature covers geolocation, gamification and crowdsourcing applications for food waste prevention and management (see Table 1). These studies highlights the different phases of waste generation, namely production, distribution, and consumption. The food production phase, for instance, farming, and manufacturing; distribution phase includes food marketing, and consumption phase includes, for instance, food consumption in restaurants and homes.

Applications in the literature focus on using one of the techniques (delocalization, gamification and crowdsourcing) to manage donations or report foods before their expiry date. Furthermore, they are focused on surplus food as a way to reduce food waste. However, our study focuses on analysing food wastes happening.

In this paper, an approach to collect data about food wastes is proposed. The approach aims to provide waste pattern in different regions based on a geolocalized application that harnesses the power of crowdsourcing to discover patterns of food waste. Furthermore, the approach employs gamification as a means to stimulate user engagement with the application.

Table 1 Food waste management approaches

Approaches	**Description**
Geolocation	The detection of physical location remotely [5].
Gamification	The concept of engaging and motivating people to achieve some goals using game mechanics and game design techniques [6].
Crowdsourcing	The practice of obtaining content (or service) as a contribution from online communities, apart from regular employees or service suppliers [7].

More specifically, the application motivates people to point out food waste type, quantity and locations. In some cases, the application can guess the phase at which the waste is generated based on user profile or location. The approach could offer empirical data on waste generation with a deeper level of analysis about the waste type, phase, and location. This could improve the academic

and industrial research in waste management.

2. Food Waste Management's Applications

In this section, we examines a number of existing food waste managements applications. In the following, we classified a number of applications based on geolocation, gamification, and crowdsourcing.

2.1. Geolocation

LELOCA [8] is a mobile application developed to reduce food waste at the consumer level, more specifically, to reduce the amount of fresh food wasted in restaurants, i.e., at consumption phase. The application uses geolocalization to promote dining discounts and tag them on a map. In this way, restaurants can promote their surplus food, which in turn would minimise the fresh food waste.

Researcher from the University of Twente in the Netherland have developed CHEETAH [9], an application that tries to reduce crops waste, which is used in West Africa, by exchanging traffic data between stakeholders: namely: transporters, growers and traders. This would minimise the risk of food spoilage by late delivery. For instance, in West Africa, a large amount of crops spoiled during transportation when the food transporters face a number of time consuming checkpoints. Therefore, the application helps them to exchange best route information.

BREADING [10] was developed to minimize the leftover bread at bakeries. This application helps bakers to donate any leftover breads, and also manage its collection process by other people. The donations are geolocalized on a map, so the nearby collectors get notified. In a similar way, BRINGTHEFOOD [11] manages food donations. However, it manages all donation types and at any phase.

RATATOUILLE [12] was developed to work at personal consumption level, by which people can donate food from home fridge. The application uses geolocation to display nearest fridge and gives an expiry date for each food donation. In addition, the application used by some hostels and student lodgings who are accustomed to share leftover food.

2.2. Gamification

Maintaining a specific behaviour over time has proven difficult [13], [14], [15]. However, Blevis et al. (2007) [16] discusses the effect of gamification, on maintaining a user behaviour over time. Blevis argues that research must consider engagement integration into technology to stimulate the behaviour change process of someone.

Many applications gained a large initial interest by users to stimulate behavioural changes, but they failed to sustain. Many applications successfully stimulated user motivation towards behaviour change, however, this motivation was not sustainable. An example of such difficulty is the POLAR BEAR application [17] that is designed to reduce energy consumption. This application uses a virtual polar bear that changes its emotion based on user adherence to energy savings. However, participants provided that the bear would be ignored after some time because of activity repetition. However, few food waste management applications applied gamification technique to motivate users. For instance, MINTSCRAPS [18], a platform that empowers restaurants to monitor waste generation patterns. More specifically, to track and understand what type of food is wasted, its quantity and at which mealtime. To get precise waste generation pattern data, the user has to interact with the platform and continuously insert their daily food leftovers. The platform employs gamification rewards to increase user's engagement and awareness in sustainable waste management practices.

2.3. Crowdsourcing

There are some applications that try to minimize food waste by providing people with some food recipes based on leftover in the kitchen, and give adviceses on how to reduce it. For instance, the LOVE FOOD HATE WASTE [19], and SMART SAVING [20]. These applications provide users with a search functionality based on leftover ingredients. This would reduce domestic food waste. However, the database in these applications is limited to a fixed data set, and might be upgraded once in a while by the developer.

On the other hand, some applications use the crowd to update the database with different recipes from different people around the world. To illustrate, food recipes and photos are shared by the crowd using the GOJEE [21]. In this case, the database is continuously updated with new recipes, which is an important factor for people to keep using the application. Similarly, S-CAMBIA CIBO [22], SHARECITY [23], BRINGTHEFOOD [11], FOOD COWBOY [24], are other applications that rely on the crowd (specifically, at home, in restaurants, and in supermarkets) to share food with others, such as products approaching expiry date. In addition, charities can use such applications to collect the food as intermediary entity and then provide it to people in need. The applications provide real-time notification, a simply way of message communication, and report tracking capabilities about surplus food.

SPOILER ALERT [25] which is an application developed by a group of MIT students who work in similar way. This application targets, also, the organic waste on which farms, supply chains and non-profits can create a value from it.

3. Limitations of current approaches

In this study, The applications has been analysed based on three main properties, namely: technique (geolocation, gamification, and crowdsourcing), phase (production, distribution, and consumption), and food management (surplus food, and food wastes). In addition, we have investigated if any application analyses or collects data about food waste generation. In Table 2, we list each application with their features. The (X) mark indicates the existence of that property in the application, while the (-) indicates the opposite.

For instance, BRING THE FOOD uses geolocalization to map food donations. It also relies on the crowd to contribute in publishing their donations. However, the current version does not use any gamification technique. This application manages donations at any phase. For instance, a donation could come from the farm, the supermarket or even from home fridge. BRING THE FOOD focuses on

surplus food donation as a way to minimise possible waste, and it does not target food waste already generated. Moreover, this application does not collect data about food wasted, since it focuses on food donation and waste reduction. A number of conclusions have been drafted from Table 2. Generally, out of thirteen applications, gamification was used by only one application (MINTSCRAPS). Moreover, most of the applications target surplus food management, rather than food wastes. Furthermore, few applications have covered all phases, most of them are focused on distribution and consumption phases only, and none of the applications have considered collecting data about food waste generation patterns.

Based on the mentioned observations, we are motivated to design ICT tool that we call FOODWISE, that provides an open access geolocalised data about food waste. This might help to minimise the food waste, as stated in a study by Geremy et al. [2] that a lack of food supply and location knowledge factors can contributing to domestic food waste practices.

Our tool targets food waste management in all of the three phases. Furthermore, we will try to get the advantages of the three available techniques, geolocation, gamification, and crowdsourcing. In the following section, we will discuss the design of FOODWISE application.

Table (2) Features of food waste management applications.

Applications	Techniques			Phases			Target Data		Analysis
	Geolocation	Gamification	Crowdsourcing	Production	Distribution	Consumption	Surplus	Waste	
LELOCA	X	-	-	-	X	X	X	-	-
CHEETAH	X	-	-	X	-	-	-	X	-
BREADING	X	-	-	-	-	X	X	-	-
BRINGTHEFOOD	X	-	X	X	X	X	X	-	-
RATATOUILLE	X	-	-	-	-	X	X	-	-
MINTSCRAPS	-	X	-	-	-	X	X	-	-
LOVE FOOD HATE WAST	-	-	X	-	-	X	X	-	-
SMART SAVING	-	-	X	-	-	X	X	-	-
GOJEE	-	-	X	-	-	X	X	-	-
S-CAMBIA CIBO, FOOD COWBOY, SHARECITY	-	-	X	-	X	X	X	-	-
SPOILER ALERT	-	-	X	X	X	-	X	X	-

4. FoodWise Application

The main goal of the tool is to build a food waste map and collect data about the generated waste. Specifically, by designing a mobile application to geolocate food waste photos from different part. The waste is reported by the users of the application, similar to the way food data are collected by OpenFoodFacts [26]. This may improve the use of interventions targeting raised awareness of food supply and location knowledge. The integration of gamification into technology to serve a targeted purpose has been adamantly explored in the literature. To overcome the challenge of how to motivate users to contribute by using the tool, we investigate the use of gamification technique. Furthermore, user interface simplicity is another important factor that we intend to study.

The collected data by FOODWISE include: wastes photo, and geolocation coordinates as mandatory data. Furthermore, waste type, phase and weight might also be included. These additional data are either provided, optionally, by user or learned by the application through location and user profile information.

The software architecture, as shown in Figure 1, has five main components, namely: report manager, geolocation map, rewards manager, feedback manager, and database access API. A user can publish a waste report using the report manager interface. The collected data by the report manager will be shown on the geolocation map in terms of tags. Clicking on a specific tag triggers a pop-up window with photos, and other details of the waste, as reported by the user. Furthermore, the collected data could be used by any interested entities, either by accessing the geolocation map or through a web API, this is similar to the API provided by OpenFoodFacts [26]. The system rewards the user with bonus points on their achievement, each time a waste reported. Also, the user can contribute by providing feedback about reports published by others. This is managed by feedback management component. However, from the general system description, we can conclude the main stakeholders of the application, namely: waste reporter, data collector, and feedback reporter. More details about stakeholders roles are provides

in the following section.

4.1. A System Use Case Scenario

Let’s consider an agrarian society that is interested in apples. The society is interested to know how much apples are wasted in the farm during the harvesting season. For example, to evaluate procedures for minimising apple wastes. In this case, the society is the data collector entity. However, the society asks farmers to report any in-field apple wastes. A farmer in this case is considered as the waste reporter. Moreover, an important factor to motivate farmers on using the tool are rewards. More specifically, a farmer gets points each time he/she reports a waste, such points could be converted to society bonus. The main interface of the application has two options, fast report and detailed report. The fast report allows the farmer to take a photo of any waste by one click and publish the photo by another one. The application, in this case, will store the photo with waste geolocation data, type, date and waste phase. The application gets data, apart from the photo, automatically from user profile. For instance, in our example, the waste type (apple) and phase (production) are filled automatically, since the user registered as an apple farmer.

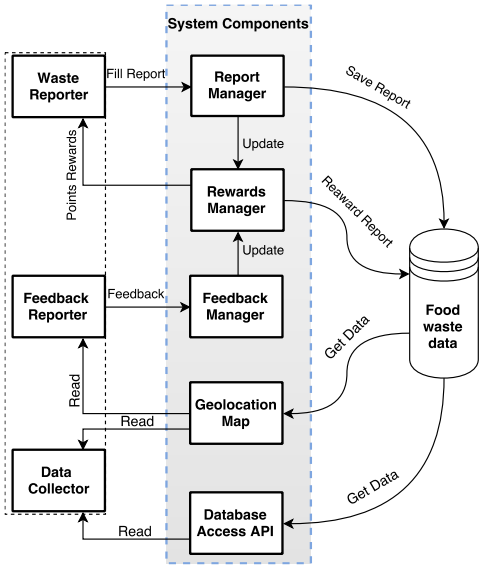

Figure 1 General architecture of FoodWise.

On the other hand, the detailed report interface allows the farmer to fill more details in a manual manner. This includes, for example, the waste weight, reason, and also the waste type and phase, if they

are not the default ones. Note that, providing more details by a farmer means more bonus points.

Finally, other farmers, or any interested user, might contribute in providing feedback about the published reports. For instance, imagine that a farmer published, by mistake, a photo of good quality apple as a waste. Other users can contribute with feedback about such mistake. Moreover, feedback providers can get bonuses for their successful feedback. However, the tool requires simple steps to publish a report. A farmer needs only three clicks to publish a fast report, which are: a click to select fast report, to press camera snap, and finally to publish the report. Such simplicity is important to increase the usability of the tool.

5. Discussion

Mapping the location of food wastes would support both academic and industrial sectors. Among the possible advantages we mention the possibility to improve waste minimisation and recycling process. More specifically, regarding the minimisation, linking waste with location in specific area for a specific food type would raise an alert that helps interested entities (e.g., farmers, factories, markets, and societies) to re-evaluate their policies and procedures against food waste. For instance, a high rate of expired cheese in a specific city would motivate to regulate cheese production in the city, which would help to minimise the waste. Recycling could be supported also by expanding the knowledge circle. For example, considering our apple farm example, factories who can use damaged apples are interested to know where they could find it. Providing information (could be real-time) about the location of damaged apple in a specific city could be an opportunity for both of the farmer and the factory to make a deal. Beside the mentioned expected advantages, the map of food wastes could be useful, for sure, for research activities, both academic and industrial.

6. Conclusion and Future Work

Food wastage has a significant environmental, social, and economic impacts. The complexity of such problem has been considered by several research efforts. However, most applications were limited with their focus on a single phase (either Production, distribution, or consumption), or single technique

(either geolocation, gamification, or crowdsourcing) to mostly manage surplus foods to minimize possible waste. Moreover, there has been little research on the patterns and drivers of food waste generation, especially on the global level. In addition, to our knowledge, no approach provides an open access data for food waste (e.g., open API) to use for data analysis.

However, FOODWISE can help to identify the patterns of food wastes generation. This is by providing wastes geolocalized data. Developing countries suffer more food losses during agricultural production, while in middle- and high-income regions, food waste at the retail and consumer level tends to be higher.

As a future work, to further validate our tool, an experimentation phase will be conducted through a case study of food waste generation. The emerging data from the case study will be one contribution of this work and further validate our assumptions.

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