

Sustainability in the Digital Age: Mobile Apps' Role in Food Waste Management

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Anotacija

Apžvalgos tikslas – supažindinti su naujausiais moksliniais tyrimais apie maisto švaistymą ir apibendrinti skaitmeninių technologijų ir mobiliųjų programėlių poveikį tvarumui ir kaip jas galima panaudoti siekiant sumažinti maisto švaistymą visą vartojimo etapą

Reikšminiai žodžiai: *Food waste, environmental consequences, mobile apps*

Abstract

The purpose of the review is to introduce to the latest scientific research about food waste arising and summarize digital technologies and mobile applications' (apps') impact on sustainability and how it can be used to minimize food waste throughout consumption stage.

Key words: *Food waste, environmental consequences, mobile apps*

Introduction

Consumer food waste is a serious issue that contributes to food loss and environmental pollution. An evident and disheartening contradiction exists between the growing quantity of edible food lost throughout the supply chain or intentionally discarded by consumers and the shortage of food resources for a significant portion of the world's population who continue to endure malnutrition (Alvarez *et al.*, 2020). Consumer food waste is an escalating worldwide issue, accounting for nearly one-third of the total food produced for human consumption, which equates to 1.3 billion tons annually that are lost or discarded. In the European Union, approximately 88 million tons of food waste is produced each year. This equates to: 174 kilograms per person, 143 billion Euros in economic value, 170,000,000 tons of CO² emissions (Lucifero, 2016). Food waste is a significant contributor to global greenhouse gas emissions and it is approximately 8% to 10% of global greenhouse gas emissions. The UN's Sustainable Development Goal 12.3 aims to reduce food waste at the retail and consumer levels and minimize food loss throughout supply chains (UN Annual Report, 2021).

The pressing issues of food waste create opportunities for technological innovations that are applicable across all stages of the food value chain. Technologies aimed at addressing food-waste prevention and reuse at the consumer level have diverse goals, which include: prolonging the shelf life of food products; decreasing the generation of excess food in retail, households, restaurants, enhancing and streamlining the redistribution of surplus food (Ciccullo *et al.*, 2021). Food-waste reduction technologies thus include food preservation technologies, food packaging and smart labeling, consumer-oriented smart devices or consumer and food-sharing apps (UNEP, 2021).

A significant portion of these technologies is still in the early stages of development, involving experimentation, prototyping or limited deployment. Research conducted by the World Business Council for Sustainable Development has revealed that companies in various sectors (e.g., food manufacturing, food retail, hospitality, and food service) save \$14 in operating costs for every \$1 invested in reducing food loss and waste. (World resources institute, 2017). Household savings could potentially be even more substantial. Such information about cost savings has the potential to bolster the business case for the adoption of digital technologies. Food waste, long seen as an economic loss, is now considered a hidden potential for value creation.



This paper conducts a systematic literature review of scholarly articles on the topic of mobile applications and food waste to reach research tasks:

1. Summarize digital technologies which enable food waste reduction;
2. Review the types of mobile apps and their uses.

Results

Digital Technologies Enabling Food Waste Reduction

The pressing issues of food waste create opportunities for technological innovations that are applicable across all stages of the food value chain. These innovations are gaining growing recognition. By embracing various technological solutions, it becomes possible to enhance cooperation between technology adopters and other stakeholders within the value chain, with the goal of reducing food waste. Technologies aimed at addressing food-waste prevention and reuse at the consumer level have diverse goals, which include: prolonging the shelf life of food products; decreasing the generation of excess food in retail, households, restaurants, and other settings; enhancing and streamlining the redistribution of surplus food (F. Ciccullo *et al.*, 2021). Food-waste reduction technologies thus include food preservation technologies, food packaging and smart labeling, consumer-oriented smart devices or consumer and food-sharing app (UNEP, 2021).

A significant portion of these technologies are still in the early stages of development, involving experimentation, prototyping, or limited deployment. The skills and essential technical knowledge required for adopting and integrating new technologies often reside outside the food supply chain. This necessitates novel forms of collaboration with technology providers and the creation or adaptation of business models to effectively implement these innovations. Furthermore, there is a lack of data regarding the economic, environmental and social advantages of embracing green and digital technologies concerning food waste (Ciccullo *et al.*, 2021).

Smartphone Apps Enabling Food-waste Prevention in Households

Food-waste behavior is influenced by consumers' motivations, resources and opportunities, and the ability to control and change of behavior. Mobile apps have been developed to guide such behavior in a more sustainable direction, covering the phases of food planning, food acquisition and food storage. In their examination of specific consumer applications focused on reducing food waste, Vogels *et al.* (2018) found that offering incentives for positive actions and enhancing everyday utility were key elements for the success of these apps. However, they also noted that many consumers interviewed lacked a natural drive to use the apps, perceiving the costs in terms of time, energy and effort to be greater than the benefits. A significant finding was that these consumers did not believe they wasted significant amounts of food. This perception aligns with previous research indicating that consumers tend to consistently underestimate their food wastage (Elimelech *et al.*, 2019). Another research on Italian consumers showed that the main factors contributing to the willingness to use these apps are the perceived utility and the perceived ease of use. Alternatively, the perceived risks related to the privacy were found to negatively affect the willingness to use these apps (Nastasi&Fraccascia, 2023). The findings from study from Turkey indicate that people who care about sustainability also care about food waste and convert their attitude into sustainable purchase behavior over mobile applications selling food available to prevent waste. This outcome behavior is mediated by attitude towards mobile applications. (Doğan *et al.*, 2023).

Many consumer apps in app stores, often developed by tech-savvy individuals, are noted for their limited functionality, infrequent updates, incomplete information from unreliable sources, and subpar usability (Vogels *et al.*, 2018). Notable exceptions are apps created by or for commercial entities like supermarkets and food-sharing platforms, which offer broader functionality, regular maintenance, and higher user adoption rates. To achieve the best results, Rizzo *et al.* (2023) in their study suggest marketers and managers operating in the food and beverage sector how to design effective strategies to incentivize sustainable behavior through the use of new technologies, by



leveraging consumers' individual differences, and specifically on their desire to be recognized as sustainable consumers.

The current market offers a variety of apps aimed at reducing food waste, including reminder and food storage apps, as well as applications that combine food planning, shopping, storage, and recipes in various ways, as elaborated below in table 1.

Table 1. Variety of most popular apps aimed at reducing food waste. Source: <https://play.google.com>

Reminder and food storage apps' & Integrated consumer apps		Distribution	Number of downloads
Fridgely	Food Expiration Date Tracker. Suggests recipes for the food which is in the fridge, and creates a shopping list of the food.	Only available on iPhone, worldwide	No data
No Waste	Food Expiration Date Tracker. Suggests recipes for the food which is in the fridge, and creates a shopping list of the food.	Denmark	10k
Nosh	Food Expiration Date Tracker. Suggests recipes for the food which is in the fridge.	UK	10 k
Best Before Food Tracker	Food Expiration Date Tracker.	Worldwide	50k
BEEP – Expiry Date Tracking	Food Expiration Date Tracker.	Worldwide	100k
No Waste	Food Expiration Date Tracker.	Worldwide	10k
My Kura	Food Expiration Date Tracker.	Worldwide	50k
Smartphone apps enabling food-sharing and redistribution			
Olio	Sharing the surplus of food and non-food items.	Worldwide	5 millions
Share Waste	Designed to connect with the people in neighborhood that wish to recycle their kitchen scraps.	Worldwide	10 k
Too Good To Go	Local restaurants joining in listing their surplus food at discount prices. Teaming up with businesses, schools, households and public affairs to change society positively and create a more sustainable lifestyle for everyone.	Most of the EU and US	Over 10 millions
Imperfect foods	Imperfect foods from local farmers are delivered via a subscription to customers home.	US	50 k
Flashfood App	App shows nearby grocery stores with up to 50% discounts on regular-priced food nearing its best date.	US and Canada	1 million
Phenix	Find merchants, caterers and grocery stores nearby that offer anti-waste baskets made up of their daily surplus that would otherwise go to landfill.	France, Belgium, Spain and Portugal	1 million
Karma	Restaurants, bakeries, grocery stores and cafes suggest a discounted takeaway meal, snack in the app.	UK and Sweden	500 k
Resq Club	App helps delicious food that would otherwise go to waste from quality restaurants, cafés, and bakeries find a new home and the business is making an extra income.	Finland, Sweden, Estonia, Germany	500k

From the apps' downloads shown in the table 1, it can be seen that smartphone apps enabling food-sharing and redistribution are preferred by consumers because they generally require less effort and are more attractive to use. One of the most popular app in the EU and whole World is "Too Good To Go". It started its activity in Denmark saving its first meal in Copenhagen. The company "Too Good To Go" has now saved 29 million meals and avoided the equivalent of more than 72,000 tons of greenhouse gas emissions, the equivalent of 15,000 vehicles driven for one year. Through a community of 18 million users called "waste warriors" and 38,000 restaurants, supermarkets and cafes in 14 countries, the company is managing to save one meal per second and is continuing to expand year after year (<https://www.toogoodtogo.com/>). Meanwhile, reminder and food storage apps are less frequently downloaded because they require more user involvement and work and are less attractive.



Reminder and Food-storage Apps

Apps designed for reminders and food storage serve to alert users about product expiration dates and assist in managing stored food items within households (Vogels *et al.*, 2018). Vogels *et al.* (2018) highlight 13 of these apps, with some requiring manual product identification from a list while others utilize barcode scanning by the user. An illustrative instance of the latter, supported by documentation, is the FoodTrek app, which notifies consumers about the expiration dates of food products in their possession (Phiri & Trevorrow, 2019).

The FoodTrek App is a prototype mobile app that alerts consumers of the end dates of food items in their home (Phiri & Trevorrow, 2019). By scanning product names and expiry dates with a smartphone camera, the app stores this data in the phone's calendar. Users receive notifications three days before and daily leading up to the expiry date. The app also tracks weight and price information to monitor spending and food waste costs. In a pilot test with 30 participants over four weeks, there was a 10% reduction in food waste, with users crediting the timely reminders for their improved food usage. While 75% of participants found the app user-friendly, challenges arose in households with differing views on food disposal based on expiry dates and meal preferences. Some users experienced heightened anxiety from alerts, leading to premature food disposal.

Integrated Consumer Apps

Integrated food planning, shopping and recipe apps have emerged in recent years that provide consumers with important information, which they can use to reduce the amount of leftover or spoiled food in the household, thus reducing food waste (Vogel *et al.*, 2018). These apps often include details on nutrition and occasionally the environmental impact of food items, promoting healthier and more sustainable eating habits. Among the most popular downloads in this category are the 'supermarket apps' (Vogels *et al.*, 2018) offered by major retail chains, such as the Albert Heijn app (featuring recipe-based shopping lists, recipes and special deals) from the Dutch retailer Albert Heijn, and the OptUP app (emphasizing nutrition) from the US supermarket giant Kroger. However, few of these apps prioritize food waste reduction as their primary goal. Independent developers have created numerous comprehensive apps with a stronger emphasis on food waste and sustainability compared to those from retailers. Examples include Evocco from Ireland (which calculates shopping carbon footprints with offset options) (UNEP, 2021), AnyList from the US (offering shopping lists, meal plans, and recipes), Magic Fridge from France (providing recipes based on available ingredients, nutritional information, and shopping lists), Empty the Fridge from Belgium (offering recipes and tips for using leftovers) and NoWaste from Denmark (enabling tracking of stored food, meal planning, and shopping lists) (UNEP, 2021). It is worth noting that independent evaluations or reviews of these apps are very rare.

One common drawback of numerous reminder apps is the absence of comprehensive product databases or connections to producers and retailers, hindering access to crucial details like product origin, history, and remaining shelf life (Vogels *et al.*, 2018). Users frequently need to input information manually, significantly reducing user-friendliness. Independent evaluations or reviews of such apps are infrequent.

Smartphone Apps Enabling Food-sharing and Redistribution

Various food-sharing apps and web platforms facilitate the growing trend of food-sharing and redistribution efforts aimed at reusing surplus food from households, restaurants, and retail establishments (Michelini *et al.*, 2018). These initiatives can be viewed as an evolution of traditional food banks found in North America, where charitable organizations gather surplus food from various sources and distribute it to those in need (Michelini *et al.*, 2018). Three distinct food-sharing models were outlined: *Sharing for money*, *sharing for charity* and *sharing for the community* (Bozhinova, 2021).

The business to consumer for-profit model of *sharing for money* aims to reduce waste and generate revenue, primarily focusing on preventing food waste at the retail level. Too Good To Go



is a prominent example, operating across multiple European countries, where consumers can purchase surplus food from restaurants and bakeries. Similarly, apps like Imperfect Foods in the US facilitate access to 'sub-standard' food, while the NoFoodWasted app in the Netherlands notifies supermarket customers about products nearing their expiration date (UNEP, 2021).

In the *sharing for charity* or 'food bank' model, surplus food is gathered from various outlets, including consumers, and donated to non-profit organizations for redistribution. For instance, FoodCloud in Ireland operates a retail solution app/platform connecting retailers with excess food to local charities. In India, the No Food Waste charity collects untouched surplus food from events to feed the hungry, addressing both food waste and hunger. Another variation is the social supermarket, where surplus food is obtained from retailers and sold at discounted rates to those in need. (UNEP, 2021).

The sharing for the community model is a or peer-to-peer model in which food is shared among consumers. Several such apps are available, some focusing only on sharing, while others include consumer-to consumer among other forms of exchange. One of the most widely used apps of the second type, the OLIO food-sharing platform (Michellini, 2018; UNEP, 2021).

Conclusions

With a growing global population and food production set to be affected by progressing global warming, household food waste is a big issue to be tackled at the systemic level and the individual level. Smartphone apps enabling food-waste prevention in households should be investigated, which might help us have more knowledge about efficacious solutions to transform the food system in to sustainable food production and consumption. Although there is a lack of evidence on the economic, environmental and social benefits of green and digital technologies related to food waste, this review proposes the use of apps as they are likely to improve awareness among retailers and consumers, and thus contribute to sustainability. Instead, applied in the right way, they can work as a powerful enabler and accelerator to support initiatives and instruments led by different stakeholders and partnerships.

Future research should investigate the share of users effectively changing their food waste behavior due to mobile app usage. This could be done either in the form of experimental studies by testing the influence of app usage on the amount of food wastage or by benchmarking the effect of app usage against conventional information campaigns.

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Tvarumas skaitmeniniame amžiuje: mobiliųjų programėlių vaidmuo tvarkant maisto atliekas

(Gauta 2024 m. kovo mėn.; atiduota spaudai 2024 m. balandžio mėn.; prieiga internete nuo 2024 m. gegužės 10 d.)

Summary

Straipsnyje apžvelgiami naujausi moksliniai tyrimai apie vartotojų ir maisto tiekėjų keliamą maisto švaistymo problemą, jos poveikį tvarumui ir tai, kaip išmaniųjų telefonų mobiliosiomis programėlėmis galima sumažinti maisto švaistymą visą vartojimo etapą. Didėjant pasaulio gyventojų skaičiui ir maisto gamybai, kurią paveiks vis labiau šylantis klimatas, maisto švaistymas namų ūkiuose yra didelė problema, kurią reikia spręsti tiek sisteminiu, tiek individualiu lygmeniu. Vien tik technologijos maisto atliekų problemos neišspręs. Maisto švaistymo elgsenai įtakos turi ir vartotojų motyvacija, išteklių ir galimybių bei gebėjimas kontroliuoti ir keisti elgseną. Sukurtos mobiliosios programėlės, skirtos nukreipti tokią elgseną tvaresne linkme, apimančios maisto planavimo, maisto įsigijimo ir laikymo etapus. Nors trūksta įrodymų apie ekologiškų ir skaitmeninių technologijų, susijusių su maisto švaistymu, ekonominę, aplinkosauginę ir socialinę naudą, šioje apžvalgoje siūloma naudoti programėles, nes jos gali pagerinti mažmenininkų ir vartotojų informuotumą ir taip prisidėti prie tvarumo. Dabartinėje rinkoje yra įvairių programėlių, skirtų maisto švaistymui mažinti, įskaitant priminimų ir maisto saugojimo programėles, taip pat programėles, kuriose įvairiais būdais derinamas maisto planavimas, apsipirkimas, saugojimas ir receptai. Tinkamai pritaikytos, jos gali tapti galinga priemone ir akceleratoriumi remiant įvairių suinteresuotųjų šalių ir partnerysčių iniciatyvas ir priemones. Ateities tyrimuose reikėtų iširti, kokia dalis vartotojų dėl mobiliųjų programėlių naudojimo veiksmingai keičia savo elgesį maisto švaistymo srityje. Tai būtų galima padaryti atliekant eksperimentinius tyrimus, tikrinant programėlių naudojimo įtaką maisto švaistymo kiekiui, arba lyginant programėlių naudojimo poveikį su įprastinėmis informavimo kampanijomis.

