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INNOVATIVE STRATEGIES FOR FOOD WASTE REDUCTION AND THE USE OF MOBILE APPLICATIONS IN THE AGRI-FOOD SECTOR

Maria-Georgeta MOLDOVAN[1], Dan-Cristian DABIJA[2], Cristina Bianca POCOL[1]

[1]University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Department of Animal Production and Food Safety, 400372 Cluj-Napoca, Romania; E-mails: maria-georgeta.moldovan@student.usamvcluj.ro, cristina.pocol@usamvcluj.ro
[2]Babeș-Bolyai University Cluj-Napoca, Department of Marketing, 400591 Cluj-Napoca, Romania; E-mail: dan.dabija@ubbcluj.ro

Corresponding author: cristina.pocol@usamvcluj.ro

Abstract

The FLW phenomenon represents a challenge for all actors in the agri-food chain today, as one-third of the food produced globally is wasted at some point along its journey, with significant economic, social, and environmental consequences. Addressing this issue by finding solutions to minimize food loss and waste represents a priority for both researchers and socioeconomic experts. Based on the gap identified in the literature, the research aims to analyse the impact of using a mobile app in Romania that connects companies that have surplus food or food that is nearing the end of its warranty period with people who need that food and pay low prices for it. Statistical analysis of the data provided by this application reveals that the benefits of using it are multiple, for all actors involved, from redistributing food to segments of the population in need, to reducing the amount of food thrown away and educating and raising awareness of its users.

Key words**:** *FLW phenomenon, agri-food stakeholders, mobile applications, digitalisation, innovation*

INTRODUCTION

Within contemporary food systems, the issue of food waste and food loss poses significant difficulties [3, 6], undermining global sustainability initiatives [17, 25].
Approximately one-third of the food produced is either lost or wasted throughout different stages of the supply chain, leading to substantial environmental and socioeconomic impacts [35, 53]. These losses are due to a variety of factors, including inadequate storage and transportation, improper handling [29, 67], adverse weather conditions, consumer behaviour, lack of cold storage infrastructure, and rejection due to aesthetic standards [54, 58]. The impact of food waste is far-reaching. In addition to inefficient use of resources, it results in increased greenhouse gas emissions, greater pressure on water and land resources, reduced overall productivity, and negative impacts on local and global economies [16, 27, 31]. Addressing this challenge is critical not only to alleviate hunger [30, 26], but also to reduce the environmental footprint of food production, a high priority within the framework of the circular economy model [12, 41, 98]. Studies focusing on the creation of applications that serve as dual-purpose tools, functioning both as food waste trackers and educational resources to involve all stakeholders throughout the food supply chain, have yet to be identified [87]. Our analysis includes an in-depth examination of the factors influencing the quality of this pioneering mobile app in Romania, its implications, benefits, and user responsiveness, with a focus on the first and only digital application that links stakeholders within the local agri-food chains: Bonapp®.
Therefore, the paper aims to address the following research question:
How the first Romanian food loss and waste app is accepted by consumers
The implementation of the research question in the paper is based on the following research objectives:
1.Weekly and monthly variations of food waste: How do the quantities of orders, unique customers, and active locations fluctuate across different weeks and months? Are there seasonal patterns or trends in these

metrics? 2.Impact of transactions on performance: How does the number of deals affect the number of boxes sold and the number of new customers?
3.Dynamics of operational efficiency: How does the efficiency of the mobile application, measured by the ratio of food boxes to boxes sold, evolve over time? What factors contribute to variations in this efficiency?
4.Long-term growth assessment: How has the mobile application developed over the years in terms of order volume, unique customers and active locations?
5.Social and environmental impact assessment: How do sustainability and social responsibility initiatives manifest themselves in weekly and monthly statistics? What methods can be used to quantify this impact?
These research objectives explore operational dynamics and their direct impact on the promotion of food sustainability, including variations in orders, customer behaviour and the influence of transactions on performance metrics. By integrating findings from similar research into the Romanian context, this study pioneers the understanding of FLW management in emerging markets and contributes to global efforts towards sustainable food systems.
The paper's layout contains a theoretical background segment, offering insights into how app technology holds the potential to catalyse behavioural change. This part is followed by the methodology section, which presents the data used and its statistical analysis. The results section presents the outcomes of the usability evaluation and concludes with a discussion of the findings, managerial, practical, and societal implications, and an outlook on potential future research directions.

Literature Review

The Theoretical Framework

The paper extends previous literature by focusing on both stakeholder theory [9, 43, 100] and the Technology Acceptance Model (TAM) to address phenomena related to food waste. Stakeholder theory suggests that organisations should consider the interests and concerns of different stakeholders in their decision-making processes [48, 42]. For Bonapp®, the relevant stakeholders are the internal shareholders who provide the company with the necessary funding, as well as various farmers, food producers, retailers, consumers, government agencies, NGOs and other relevant entities interested in contributing to adecrease in food loss and waste. The TAM demonstrates to which extent the app users are ready to embrace and adopt a specific technological tool or system [2, 97]. Bonapp®is an application using modern communication methods to manage the over-quantities of food waste produced by this or that stakeholder within the agri-food chain and to enable them to sell those food items (saved from waste) to buyers looking for bargains and affordable prices.

Food Waste and Technological Advances

Green, digital and innovative technologies have emerged as powerful allies in the combat against waste and to substantially decrease food losses [1, 52]. There are several publications tackling efforts to reduce food waste and loss and improve food systems using advanced technologies. Initiatives that address the food system through technology are crucial for sustainability [57, 80]. as emerging technologies such as IoT, AI, and ML enable real-time optimisation through IoT sensors [72]. Circular economy models focus on waste reduction, complemented by Industry 4.0 technologies [33, 56]. Traceability systems, such as blockchain, implemented in the food supply sector, serve to uphold product quality standards and avoid risks associated to fraudulent activities [36, 50]. These technological innovations are increasingly being used not only to prevent losses, but also to recover and recycle food. Recent developments such as digital platforms and social networks [20, 73] have shown promise in reducing waste at source [101] and improving consumer behaviour through increased awareness and education. There has also been research into how food waste can be converted into valuable resources, including energy, biofuels and nutrients, with applications in the agricultural sector [60].
The literature review explored the ever-evolving field of technological advances, examining the pros and cons associated with

them in the context of the interaction between users on both sides of the applications (consumers and donors or vendors). This exploration concerns the potential to address the ongoing challenge of improving food security, which also underlies the promotion of sustainable manufacturing systems [64, 85].

The literature review highlights the swift evolution of artificial intelligence and the effective practice of social media tools and online groups [91, 68], all of which are part of day-to-day life and play an important role in preventing and monitoring various types of waste, including food. Considerable investment is being made in user-friendly techniques, especially for mobile applications. These techniques refer to design and development strategies that improve the overall usability and accessibility of the application for its target audience [83, 88]. Here, user-friendliness is crucial to ensure a positive experience: intuitive navigation, responsive design with layout and content adapted to different screen sizes and orientations, but also gesture control, in-app tutorials and real-time or offline/email assistance and user notifications (information on regular updates) or user experience feedback [75, 78]. These tools provide instant data, educational resources, and user engagement features that empower individuals to make informed decisions about food consumption, storage, and disposal [69, 86]. These applications serve a crucial role in promoting sustainable behaviours and instilling a sense of accountability among users by offering insights into the environmental and economic impacts of food waste [96]. Consequently, they greatly contribute to ongoing endeavours aimed at curbing food waste related adverse effects [77]. Moreover, these apps offer an avenue for collaboration between donors, NGOs, and users, facilitating the effective distribution of surplus food to vulnerable populations. By fostering a collective sense of responsibility, these applications advocate for a comprehensive approach to tackling food waste and addressing issues of hunger and food insecurity [30, 64].Besides information on ways to reduce food waste and avoid losses, real benefits exist for app users on both sides, in the form of experimental outcomes for consumers, such as games, quizzes, rewards for earning points, access to affordable good quality food through purchase discounts [37, 66]; on the other hand, producers, distributors, retailers, and donors report significant improvements in product quality and profit margins, inventory optimisation, increased client loyalty, efficient distribution, reduction of storage costs and risk of spoilage [74].

MATERIALS AND METHODS

In today's society, the Internet plays a crucial role. It facilitates a myriad of activities ranging from videos and online shopping to academic research and remote working [8, 63]. At present, the Internet is faster than ever, particularly in developed nations, enabling seamless activities. According to the World Population Review [93, 99], Romania is one of those nations from this point of view, as its Internet connectivity ranks among the top 10 worldwide [47, 19, 89]. Therefore, the study of the Romanian FLW context holds significance as the conditions in Romania can serve as a prospective benchmark within the international literature related to food waste issues and online applications involving food chain stakeholders.

Efforts can be directed towards understanding and addressing the FLW concerns of each stakeholder group through the acceptance and use of technology, here in the specific form of a mobile app created and implemented in Romania. Bonapp® is the first Romanian food saving application that allows stakeholders, internet users, to successfully purchase online food products from farmers, transformers, restaurants, cafes, bakeries, groceries, and even hypermarkets with discounts ranging from 50% to 80%. It offers the same quality at half the price. The app is free, easy to download from the internet, and features a user-friendly interface. The path to tracking food waste starts with the installation of the Bonapp®application, facilitating users' access to a digital marketplace offering a daily

selection of food products. By creating personalised accounts, users engage with the application's interface, navigating through acurated selection of offers. After selecting desired items, users proceed to place orders according to their geographic location, with digital receipts automatically generated to streamline transaction processes. As designated pick-up times approach, users visit designated locations to collect their orders discretely.

On the main page, users can find food products listed by Bonapp® partners and the users can view partner discounts, the number of discounted portions available, and pick-up details directly in the app. Payments can also be made via the app. The latter enforces quality standards for its partners, ensuring that all listed food products are not out of date, altered, and have been stored in optimal conditions. None of the products listed are old or improperly stored. Surprise Boxes are packages listed by the app's partners, the contents of which are not revealed until the buyer receives them. While some may be curious, it's an exciting way to discover new food items.

The research material was represented by a monthly and weekly database provided by the Bonapp® application: number of orders, number of unique clients, number of active locations, number of signed and active leases (locations), number of offers, number of offered and sold boxes, amount of saved food (kg) and quantity of CO_2 saved (kg). The data sourced from the Bonapp® application, spanning from November 2021 to April 2023 and exclusively pertaining to the cities of Bucharest (capital of Romania) and Cluj-Napoca (the second city in terms of population after Bucharest) where the mobile app is accessible, offers diverse insights into understanding Romanian consumers. The analysis underlines their unique relationship with food, aiming to encourage active participation in combating FLW altogether.

To analyse the data collected through the Bonapp® application and to extract valuable information, descriptive statistics were used: the evolution of orders, the evolution of customers, the dynamics of locations versus orders, the evolution of offers versus sales, the ratio of orders to customers ratio and the impact of mobile apps on the environment. To investigate the relationships between the different variables in the dataset and to assess which variable is the best predictor of a particular outcome, the research applied a methodology involving regressions in SPSS (Statistical Package for the Social Sciences, version 20).

According to the nature of the data collected, the use of linear regression was adopted. Therefore, if a prediction had to be made on the price reduction as a function of different factors, such as time of day or type of product, linear regression was the most appropriate.

Linear regression was also run, by using Number of orders as the independent variable (X) and Number of unique customers as the dependent variable (Y).

The following formulas calculated the slope (m) and intercept (b) of the linear regression line:

$$\boldsymbol{m} = \left(\frac{N*\sum(x*y)-\sum x*\sum y}{N*\Sigma x^2-\Sigma x^2}\right)^2 \text{ ... ...} \textbf{(1)}$$

$$\boldsymbol{b} = \left(\frac{\sum y-m*\sum x}{N}\right)^2 \text{ ... ...} \textbf{(2)}$$

where: Σ is the sum, N is the Number of data pairs, x is the Number of orders, and y is the Number of unique customers.

Furthermore, the Pearson correlation coefficient was calculated between the two data sets (“Number of boxes sold” and “Amount of food saved”) using the following formula:

$$\boldsymbol{r} = \frac{\sum(X-X\_mean)(Y-Y\_mean)}{\sqrt{\sum(X-X\_mean)^2*\sum(Y-Y\_mean)^2}} \text{ ... ...} \textbf{(3)}$$

where:

X stands for "Number of boxes sold".

Y represents "Amount of food saved (kg)".

The X_mean and Y_mean are the means of X and Y, respectively.

RESULTS AND DISCUSSIONS

The data analysis reveals that there was a consistent upward trend in the number of orders over time, indicating an average overall growth of 1.19 times in the service provided. Furthermore, there was clear evidence of seasonal variations, with a notable increase in orders from September 2022 to March 2023 (2,28 times), possibly linked to various social and/or cultural events or the Christmas/New Year/Valentine sales seasons (Fig. 1).

Fig. 1.Evolution of orders
Source: own processing using data provided by Bonapp® [11].

The most significant month-on-month increase occurred between October and November 2022, when orders rose from 4,466 to 5,006 (12% increase). Finally, March 2023 recorded the highest number of orders, at 6,954 (55.7% increase compared to October 2022), with an average monthly number of orders of approximately 2,934 (Fig. 1). Similarly, there was a positive trend in the number of unique clients (check Fig. 2).

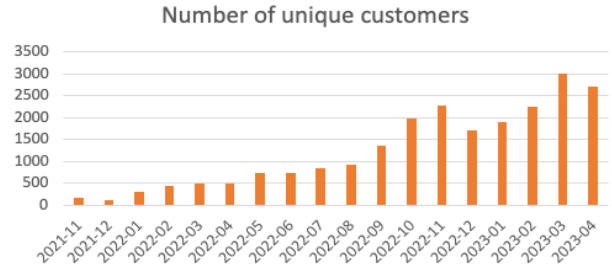

Fig. 2. Customer evolution
Source:own processing using data provided by Bonapp® [11].

This indicates positive growth as it implies an expanding customer base correlating with the rise in orders, which bodes well for the business' prospects. Taking a closer look, one can see engagement through the order-per-customer ratio, representing the average number of orders made by each customer within a month. For instance, in November 2021, this ratio stood at approximately 1.78, reflecting a meaningful level of customer activity. A close correlation was recorded between the growth in orders and the growth in unique customers. This suggests that the increase in order volume was due to the acquisition of new customers. Of notable significance was the period of heightened activity, particularly in September 2022, when both the number of orders and the number of unique customers increased significantly. This could potentially represent the effectiveness of a marketing campaign or the impact of a particular event that drew a high influx of clients.A locations-orders connexion was visible and calculating the ratio of the number of orders to the number of active locations allowed us to see how many orders each active location generated on average in a month. For example, in November 2021, each active location generated an average of 283/27 ≈ 10.48 orders. However, seasonal or monthly variations in data could occur, such as an increase in the number of orders in certain months due to seasonal demand or marketing campaigns (an increase in December 2022 in the number of active locations could be most certainly related to the holiday season). On the other hand, in March 2023, although the number of active locations decreased slightly compared to February 2023 (Fig. 3), the number of orders and unique customers increased significantly (Figs. 1 and 2), suggesting a possible improvement in location efficiency or a focus on the quality of the service.

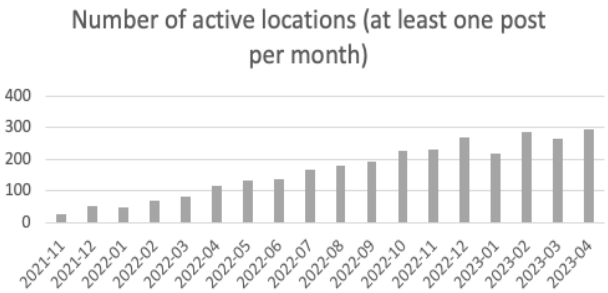

Fig. 3.Dynamics of active locations (before signing of lease).
Source: own processing using data provided by Bonapp® [11].

The connection between offers and orders was obvious (Fig. 4).

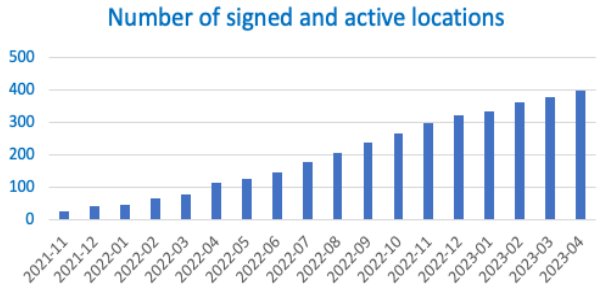

Fig. 4. Situation of signed active locations
Source: own processing using data provided by Bonapp® [11].

Thus, more offers tend to draw in more customers and, in turn, generate more orders. Over the analysed period, to check the effectiveness of online bids, a ratio was calculated between the number of orders and offers. In November 2021, the bidding effectiveness stood at approximately 0.69 orders per bid. Special periods, such as holidays or events, may see an uptick in offers aimed at attracting more customers (Fig. 5).

Fig. 5. Evolution of offers.
Source:own processing using data provided by Bonapp® [11].

This could be a contributing factor to increased orders during certain months or periods of a month. Furthermore, a calculation of the ratio between the number of boxes sold (Fig. 6) and the number of posted boxes gave us an idea of sales efficiency. When the value of this ratio was high (Fig. 7), it meant that a high proportion of post boxes were sold. For example, in November 2021, the sales efficiency was 327/686 ≈ 0.48. In addition, an increase in the number of offers could be correlated with an increase in the number of boxes sold if the offers were attractive to customers. In July and September 2022, significant increases in the number of posted boxes were seen (Fig. 6), accompanied by increases in the number of sold boxes, suggesting either that there was an increase in demand during those months, or/and that the marketing strategies were more effective.

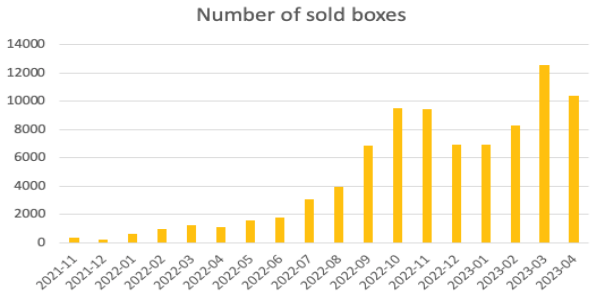

Fig. 6. Evolution of sales
Source: own processing using data provided by Bonapp® [11].

Whilst examining the correlation between customers, orders, and sold boxes, it was noticed that the number of sold boxes was growing faster than the number of unique customers, suggesting an increase in purchases by existing customers.

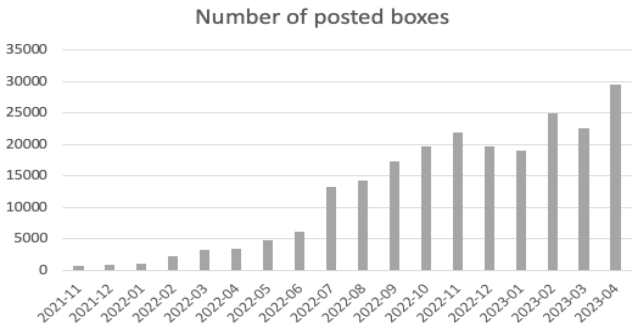

Fig. 7. Analysis of the orders
Source: own processing using data provided by Bonapp® [11].

By saving food and reducing CO_2 emissions, sustainable practices are encouraged. In Fig. 8 and Table 1 below, the 'Amount of food saved' and the 'Amount of CO_2 saved' show the positive climate impact of the application. The amount of food saved as well as the amount of CO_2 saved are correlated with the number of boxes sold. If the relationship is strong, this can be used to predict environmental impact based on sales performance and give a real picture of how efficiently resources are being used to have a positive impact on the environment.

Fig. 8. Analysis of the environmental impact
Source: own processing using data provided by Bonapp® [11].

The result of the calculated Pearson correlation (approximately 0.994) indicated a very strong positive linear relationship between the number of sold boxes and the amount of saved food (an increase in the number of sold boxes translated into an increase in the amount of saved food) (Table 1).

Table 1. Number of sold boxes and amount of saved food

Month	Number of sold boxes	Amount of saved food (kg)
2021-11	327	163.5
2021-12	224	112
2022-01	618	309
2022-02	983	491.5
2022-03	1,193	596.5
2022-04	1,102	551
2022-05	1,596	798
2022-06	1,760	880
2022-07	3,066	1,533
2022-08	3,967	1,983.5
2022-09	6,860	3,430
2022-10	9,467	4,733.5
2022-11	9,405	4,702.5
2022-12	6,897	3,448.5
2023-01	6,923	3,461.5
2023-02	8,284	4,142
2023-03	12,574	6,287
2023-04	10,381	5,190.5

Source: own processing using data provided by Bonapp® [11].

Examining the weekly data and considering all the key metrics, including orders, customers, locations, leases, promotions, boxes, and the quantity of saved food, interesting insights related to the calculated averages could be uncovered. The average number of orders per week is around 742 (check Fig. 9).

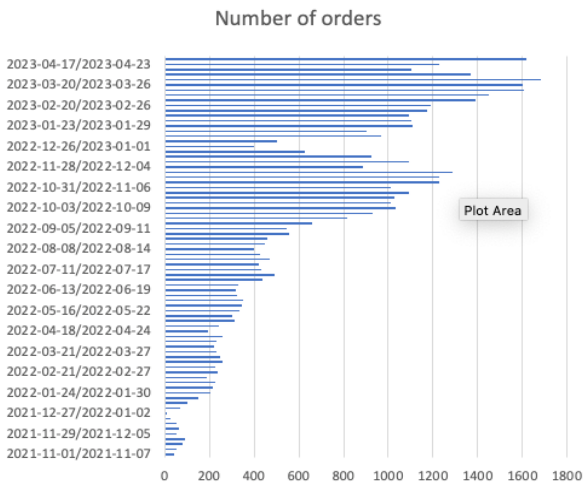

Fig. 9. The average of the weekly number of orders.
Source:own processing using data provided by Bonapp® [11].

Comparably, the average number of unique customers/week (519), the average number of active locations/week (94), the average number of signed and active locations/week (105), the average number of offers/week (1,633),the average number of boxes posted/week (3,829), the average number of boxes sold/week (1,342), the average amount of food saved/week (671 kg) and the average amount of CO_2 saved/week (1,678 kg) were calculated. The results of the linear regression show that, on average, for each unit increase in the Number of Orders, the Number of Unique Customers can be expected to increase by approximately 0.6699 (Fig. 10).

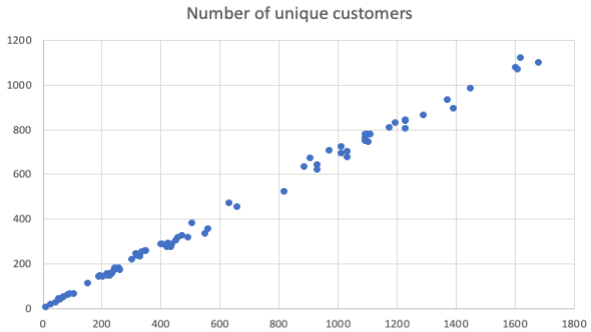

Fig. 10. Customer vs. order regression
Source: own processing using data provided by Bonapp® [11].

At the beginning of the reviewed period, there were 16 active locations in Week 1, and this number increased significantly to 245 in Week 2 of April 2023.

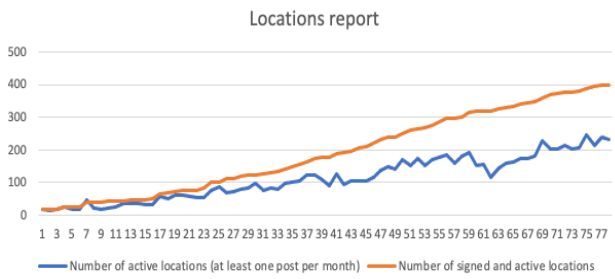

Fig. 11. Dynamics of the number of locations
Source: own processing using data provided by Bonapp® [11].

This indicates an expansion of the network of locations, which contributes to an increase in orders. The number of signed and active leases also increased from 18 to 400 until the end (Fig. 11), showing an increase in partnerships or new contracts with locations. Some seasonal variations were also recorded. In this respect, it was noted that there were weekly variations in the number of orders and unique customers. For instance, a decrease in the number of orders during the Christmas week (19-25 December) and the New Year week (26 December - 1 January) potentially show that customers are less likely to order during holiday times. Moreover, the number of orders was growing at a faster rate than the number of unique customers. This could suggest that existing customers were ordering more frequently or that there was an increase in the average order size. In general, there was a direct relation between the increase in the number of active locations and of orders. Nevertheless, there were weeks where despite the growth in active locations, the number of orders declined. This indicates that factors beyond just location expansion were at play, such as promotions, special events, or other marketing campaigns, influencing order volumes. The widespread appeal of these digital applications is obvious in their ability to address the pressing issue of domestic food waste [4, 14], while also accommodating the changing needs and preferences [24, 32, 38]. As a result, the collaborative efforts of researchers and developers have led to the growing popularity of anti-FLW mobile applications which have become, in various ways, personal assistants for fridge and pantry systematic storage improvement (i.e. Fridge Pal, EatChaFood, LeftoverSwap or AppX [15, 5, 13]).

In line with these results achieved, other researchers have also identified a positive trend in the use of mobile apps to reduce food waste [18, 7], despite the perceived risks related to the users' willingness to download apps, [22, 34, 39], such as: required access to sensitive personal information like the routes visited (geolocalisation permission) [44, 40], pictures taken (required access to the photo gallery) [45, 61], favourite locations (monitoring the main aspects of the user's behaviour and his/her emotional engagement) [46, 28], introduction of bank details for online payment of takeaway orders [55, 51, 65]. Other researchers have also reported that several factors typically influence the adoption of these user-friendly tools, such as seasonality and marketing campaigns that revolve around specific times of the year: Easter, Christmas, Valentine's Day, Thanksgiving, and so on [62, 21].

When comparing these results with those of older studies, it is important to note that some benefits of mobile applications to counter the FLW issue are to be found at every level, for every party concerned, even though the highest financial investment is on the companies' side and not the consumers' one. As tech related investment cost is not always easy to anticipate, some companies may be reluctant to tackle food waste (FW) for commercial reasons: the cost of reducing waste may outweigh the financial benefits with longer payback period. First movers (early adopters) may suffer from lack of ready market for surplus produce (high cost of new market outlets) and maintenance cost, allowing others to learn at their expense [71, 76, 84]. The compensation for all these risks comes from the fact that apps highlight the locations (supermarkets, food stores, etc.), serving as an advertisement that inherently provides a favourable return on investment in the long run [79]. On the consumer side, advantages at purchase, like discounts, vouchers (end-of- day boxes – the advantage of the surprise factor) and the possibility of discovering new tastes through orders are obvious, even though risks (seen by

companies) should not be underestimated: reluctance to change and adoption of new habits, fear of reduced quality for food nearing its end-date, new waste-to-value food (neophobia) [31, 94, 90], risks associated to non-compliance with the full GDPR regulation [92, 70].

All in all, the Bonapp.eco application is a promoter of sustainable production and consumption, offering numerous managerial, practical, and social implications. From a managerial perspective, companies can optimise their anti-food waste policies, leading to substantial budget savings by managing food surplus, as opposed to the more costly waste management methods. This offers economic, social, ethical, and environmental advantages, aligning with the companies' Corporate Social Responsibility (CSR) goals. Also, broadband internet and internet connectivity provide excellent prospects for the development of offline businesses, which can seamlessly transition online and naturally flourish. Simultaneously, online businesses can strengthen their market presence by integrating social platforms within their operations.

Integrating mobile apps into food waste management has several noteworthy implications for businesses. First and foremost, it increases visibility and marketing opportunities by showcasing a company's commitment to reducing food waste, attracting environmentally conscious consumers, and bolstering the brand's image. In addition, mobile apps and other technological tools contribute to operational efficiency through real-time inventory management, demand forecasting, and supply chain optimisation, minimising overstocking and reducing waste across various industries [95, 81]. These apps also engage consumers in the fight against food waste by providing information on sustainable practices, offering discounts on surplus items, and encouraging responsible consumption habits. This not only leads to cost savings in the supply chain management, but also creates new revenue streams by selling surplus food at discounted prices – all of these being principles of circular economy [82, 23].

One way to improve the Bonapp.eco application could be a future bartering policy for leftover foods, offering a simple solution to minimise waste: companies can list their surplus items and connect with other companies interested in exchanging food, as suggested in the literature [59, 10].

Finally, there are certain limitations to this study: the Bonapp.eco business management team must comply to all current GDPR regulations, which prevented us from obtaining demographic data on the application's users to correlate it with purchasing behaviour. Additionally, the supplier database lacks detailed company profiles.

CONCLUSIONS

The research provided valuable experience and findings that can serve as a guide for future app development projects, with the goal of fostering a more sustainable lifestyle among consumers. It also shows the extent to which such applications (beyond their lucrative goal) are beneficial to all agri-food chain parties concerned and enforce the participation of several of the shareholders and stakeholders within the agri-food chain.

The research indicates that by leveraging educational tools, such as a mobile app, and employing modern theoretical models such as the stakeholder theory and the TAM model, the food system can achieve sustainability. The data-driven insights generated by mobile apps into consumer behaviour and preferences can inform waste reduction strategies and targeted marketing efforts. Embracing mobile apps aligns companies with evolving regulations and consumer expectations for food waste reduction, providing a competitive advantage. Ultimately, this approach fosters brand loyalty, as consumers are more likely to support companies that demonstrate a commitment to sustainability.

For users, there are economic, social, and environmental benefits. The app enhances access to high quality, sometimes niche, products that users might not otherwise be able to afford. It helps educate all actors of the agri-food chainin order to keep food waste

figures down and foster a culture of waste prevention. The use of mobile apps in food waste issues offers the access to cost-saving opportunities, such as discounts and special deals on surplus or near-expiry food items, enhancing their purchasing power. These apps contribute to raise awareness by educating users and encouraging responsible consumption habits.

The convenience of browsing and purchasing food items through the app reduces barriers to accessing surplus or discounted products. Personalised recommendations based on user preferences enhance the shopping experience and minimise over-buying. Apps also facilitate community-driven initiatives and the provision of data-driven insights, transparent supply chain information, and community building features further empower users to make informed, ethical, and sustainable choices, creating a sense of belonging to a like-minded community of active stakeholders.

Stakeholder theory disrupts conventional analytical frameworks by proposing that the needs of stakeholders should take precedence at the outset of any action, much as the contemporary philosophical perspectives bring forward the civil society and interactions among individuals.

Bonapp.eco is relevant to all players in the agri-food chain and addresses farmers, processors, distributors and end customers. Bonapp enables the redistribution of food boxes that cannot be consumed/sold at a given moment and, through this mediation, find a recipient. Without this innovative application, significant quantities of food would be wasted. Bonapp.eco is living proof that the needs of users can be met with the help of technology (TAM) and the involvement of other stakeholders. The research shows that there is an acceptance of the use of this application and, implicitly, of the technology on which it is based. During the analysed period, customer growth was approximately 17 times, from 159 unique customers to 2708 unique customers. Based on co-communication and information processing technology, the Bonapp application is still easy to use for the stakeholders, and the number of users has increased in a relatively short period of time.

Based on the results obtained, further research could focus on studying the correlations between the number of active locations and the amount of saved food and CO_2 saved. Such studies require detailed data collection and modern methods to ensure the accuracy and representativeness of the collected data, such as data related to the amount of food saved and CO_2 emissions from each active location over time. Another example would be the regression analysis which could show whether an increase in the number of active locations leads to a proportional increase in the amount of food saved and a visible reduction in CO_2 emissions.

Regarding other potential future research directions, investigating the long-term effects of using the application in both business and consumer settings could provide valuable information. Understanding how this technology can be integrated into broader sustainability initiatives and its scalability across different industries would be essential. Furthermore, exploring the impact of food waste reduction apps on greater environmental issues is a path worth taking for future investigations.

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