JOURNAL OF MODERN SCIENCE

2/56/2024

www.jomswsge.com

DOI: doi.org/10.13166/jms/188723

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THE IMPORTANCE OF MOBILE APPLICATIONS IN REDUCING FOOD WASTE – THE EXAMPLE OF THE TOOGOODTOGO APPLICATION

ZNACZENIE APLIKACJI MOBILNYCH W OGRANICZANIU MARNOWANIA ŻYWNOŚCI – PRZYKŁAD APLIKACJI TOOGOODTOGO

Abstract

Objectives: The main goal of the presented research is to recognize the role of the application in the process of reducing food waste. The specific goals are to identify the reasons for using the *food saving* application TooGoodToGo and to verify the level of respondents' satisfaction with using the most popular application of this type in Poland.

Material and methods: The analysis is based on a survey of Generation Z using an online survey questionnaire that was available in Q4 2021. The survey was opened by 477 respondents, of whom174 responded positively to the filter questions. They constituted the survey sample.

Results: The research showed that *food saving* applications may be important in creating pro-ecological behavior. To be effective, they must meet users' expectations in terms of, among others: safety and costs of use.

Conclusions: The analyzed TooGoodToGo application has great potential in reducing food waste. It is an example of the possibilities of mobile technology in solving social problems and shaping pro-environmental behavior. According to the study and in accordance with the first hypothesis, the use of the TooGoodToGo application is determined by economic factors and the need not to waste food. The latter reason is confirmed by research by many authors on responsible food consumption. For young users of mobile applications, their features are also important. According to our research, the most important are free use and payment security (H2). Functional aspects are important for changing consumer attitudes and behavior towards more sustainable food consumption. The effectiveness of the application is undoubtedly determined by the level of satisfaction of its users. It was assumed and confirmed that the TooGoogToGo application meets users' expectations, as evidenced by the satisfaction rate at a good level. Personal data security and identification, application design and emotional attachment are key factors positively influencing the satisfaction of application users. For satisfaction to be assessed at a good level, the application's design and operation should be simple and easy to use.

Keywords: *mobile applications, food waste, generation Z, TooGoodToGo*

Acknowledgment: Publication co-financed from the state budget under the program of the Minister of Education and Science in Poland called Science for Society project no. NdS/545437/2022/2022 amount of co-financing 1500zł total value of the project PLN 321,632.00

Introduction

There is a causal connection between existential threats to the biosphere and unsustainable consumption practices. Food waste occurs both at the stage of agricultural production and final consumption. According to the UN report on the food waste index from 2021, as many as 931 million tons of food waste were generated in 2019 alone, of which 61% came from households, 26% from catering services and 13% from retail trade" (United Nations, 2021, s. 21). These results clearly demonstrate the need to avoid global food waste to ensure sustainable development. The Food and Agriculture Organization of the FAO describes food waste as " the discarding or alternative (non-food) use of food that was fit for human consumption by choice or after the food has been left to spoil or expire as a result of negligence (FAO, 2015, s. 1). It is estimated that $2.6 trillion worth of food is wasted each year, 39% of which is in North America and 31% in Europe (Tarabini, 2021).

The response to changing economic and social conditions is to look for ways to reduce food waste, shape conscious consumption and responsible distribution of surpluses. This process should be supported by an efficient information system that meets consumer expectations and at the same time promotes sustainable consumption practices. An example are mobile applications that perform information, promotional and educational functions in the field of environmentally and socially sustainable behavior.

Therefore, the main goal of the presented research is to recognize the role of the application in the process of reducing food waste. The specific objectives are to identify the reasons for using the *food saving* application and the level of respondents' satisfaction with using the most popular application of this type in Poland (TooGoodToGo application). The research was carried out among representatives of Generation Z, which is justified by the fact that this generation uses new technologies, including applications, to a much greater extent than older ones. This is also a generation that consciously experiences the negative effects of climate change and manifests concern for the natural environment (e.g. Youth Climate Strike).

Despite numerous studies on the issue of food waste, there is a clear shortage of research related to the behavior of Generation Z consumers. What is more, the role of *food saving* applications has been treated incidentally

in scientific research (Zarifis & Fu, 2023; Balińska, 2023; Balińska, 2022; Jaska et al., 2022; Balińska et al., 2021, Balińska & Staśkiewicz, 2021; Balińska, et al., 2020). The presented research results therefore fit into the existing research gap. The authors hope that they will encourage other researchers to start a scientific discussion on the importance of mobile applications in reducing food waste and creating sustainable behavior of young consumers.

The remainder of the article is structured as follows. Part 2 reviews the literature on the use of new technologies in reducing food waste. This part constitutes a justification of the adopted research issues. The third part is the development of hypotheses. The fourth part presents the research methodology. The fifth part is the results of own survey research. The last, sixth part is a discussion and summary of the research results, as well as limitations and directions for the future.

Literature review

The use of new information technologies to reduce food waste

Food waste has become an important social, economic and scientific topic due to growing concerns about sustainability.

Haas et al. (2022) emphasize that EU Member States should reduce food waste per capita at retail and consumer levels by 50% by 2030 and reduce food losses in the food production and supply chain (Eu Action Against Food Waste, 2020). These activities are intended to lead to achieving sustainable development goal 12.3. It is estimated that over 50% of food waste in Europe comes from consumers (Stöckli et al., 2018). Therefore, consumer awareness activities are crucial to reduce food waste. The research of Boccia et al. (2018), Agudo-Valiente et al. (2015), Ellen et al. (2000), Igarová et al. (2023) show that, among others, entrepreneurs actively participating in activities aimed at reducing food waste are perceived positively by young consumers, which may result in long-term loyalty and shape future attitudes.

According to data from the project *Development of a system for monitoring food waste and an effective program for rationalizing losses and reducing food waste – PROM* financed by the National Center for Research and Development,

loss of freshness is the main reason for wasting the following categories of food products in retail stores: fruit and vegetables (78 .2% of cases), fresh meat, poultry and fish (unpacked) (46.0%), bread (including pastry) (65.3%). However, exceeding the use-by date was the clearest reason for throwing away the following categories of food products: fresh meat, poultry and fish (packed e.g. in a vacuum, MAP) (42.5%), refrigerated products with a very short expiry date (e.g. fresh milk, unpackaged meats) (58.6%), refrigerated products with a longer expiration date (51.7%), refrigerated ready-made products, delicatessen (48.3%), frozen products (33.3%), packaged and toasted bread (46 .0%), beverages (55.2%), dry products (51.7%) (Łaba, 2023). The same research shows that following products are thrown away every day in retail stores: fruit and vegetables (48.3% of stores), fresh, unpacked meat and poultry (37.9%), refrigerated products with a very short expiry date (e.g. fresh milk, unpacked meats) (34.5%), bread, including pastry (60.9%), packaged and toasted bread (29.9%). Shop activities to prevent waste by selling at a reduced price were used mainly in relation to fruit and vegetables (28.7% of shops). In the case of other products, the shop share ranged from 9.2% for unpackaged meat, poultry and fish to 18.4% for refrigerated products with a longer expiration date. Unfortunately, this study did not take into account sales using the application.

Such observed trends in food waste have inspired the development of new distribution techniques to minimize this phenomenon. The number of mobile applications aimed at reducing food waste has increased recently due to the opportunities provided by information and communication technologies and increasing awareness of sustainable nutrition (Doğan et al., 2023). Haider et al. (2022) note that sustainable consumption research has spread since 2015 (although it has been analyzed for over three decades) and lists the main schools of thought in sustainable consumption research, using three interdependent micro, meso, and macro levels of analysis in order to understand consumption practices. At the same time, they indicate future directions in the development of marketing using new technologies in popularizing this type of consumption practices.

Today, many food systems are unsustainable because they cause significant resource depletion and unacceptable environmental impacts. According to Holden et al. (2018) this problem is becoming so important that food can

be identified with fossil resources. Researchers emphasize that new information technologies based on the Internet platform create opportunities for the transition from fossil food to sustainable food systems. To achieve the goals of sustainable production and consumption (12 Sustainable Development Goal), traditional consumer education is becoming insufficient for the young generation. Calafell et al. (2019) as part of a research project on young people's consumption, focused on the acquisition, purchase and use of new technologies. According to the research, young people did not take into account sustainability criteria in the use or purchase of technological devices, especially mobile phones (the replacement rate of mobile phones was very high and amounted to 1, 2 or 3 years), and the most important purchase criteria were price, technical features and brand. This result is undoubtedly a prerequisite for developing new methods of consumer education and is a challenge for young people to think about and adopt sustainable consumption patterns. Hingle, et al. (2013) attempted to answer the research question about how mobile technologies enable the recording of behaviors related to the eating habits of young people and whether they are an effective tool for health promotion. In order to identify the eating behaviors of the young generation, the popular social media Twitter (X) was used and its usefulness in this regard was verified. Research on the use of social media makes it possible to identify relationships between food consumption style and behavioral factors. Baragwanath (2021) also writes about the importance of digital technologies in improving consumer health and the sustainable development of food systems. These tools can be used to promote food produced through sustainable farming practices, although the need for them to be carefully designed to maximize effectiveness is emphasized. Sapienza (2018), in turn, writes about the use of smartphones and mobile applications to collect consumption data, although at the same time he analyzes the legal and ethical concerns arising from the adoption of such a crowdsourcing data collection method. Barska & Wojciechowska-Solis (2020) identified, as part of their study, the behavior of Polish consumers purchasing local food products on the Internet. Although Polish food e-commerce is still relatively undeveloped, online food sales are the fastest growing category of online sales among consumers aged 30-40. According to experts, by 2026 almost 40% of all products worldwide will be sold online.

Cane & Parra (2020) highlights the Too Good To Go application, which allows users to discover a new responsible and economical way of consumption. Up to now, over 11 million Magic Boxes have been purchased in Europe, helping the environment avoid emissions of over 23 million tons of CO2. Consumers are primarily looking for convenience and are increasingly migrating between available channels and forms of shopping, avoiding simple classification and assignment to one category. *They become conscious buyers who value their time, but also shopping experiences, moving towards a profile called a hybrid consumer* (Gregor et al., 2017, p.119). They share information efficiently, which means that the process of innovation diffusion (the term innovation can be applied to applications) is fast, although not free from disruptions.

The use of technology in the form of smartphone applications is a possible alternative to information campaigns and is increasingly recognized as an important means of supporting the reduction of food waste(Schanes et al., 2018).). As Thaler and Sunstein (2023) claim, information can be a surprisingly strong motivator. Applications, according to their interpretation, are the *green default option* and can be treated not only as an element of education but also as impulses that remind people about the environment cyclically and without any effort on the part of the user. A similar approach is presented by Mruk and Jankowska-Kaczmarek (2017), emphasizing that people make decisions more easily when they have limited choices, and such solutions are provided by applications, filters and personalization included in them. Barboza and Filho (2019) point out that mobile eco-applications offer society new opportunities and alternatives in the field of green consumption, i.e. lifestyle changes. As Kuo and Horona (2017) emphasize, despite numerous studies, knowledge on this subject is still insufficiently recognized. Essiz et al. (2023) even foregrounds that due to consumers' difficulties in changing their consumption style to an ecological one, a new area of research called the *green gap* has arisen.

Development of hypotheses

Research conducted by Wang et al. (2023) shows that the choice of an application and loyalty to it are influenced more by the use value (including financial benefits) than by the social value. In turn, activities in the field of *food saving* are motivated by both economic factors and a sense of responsibility for the environment (Aschemann-Witzel, et al., 2018) and the usefulness of the application (Bolton &Alba, 2012). The economic aspect in the context of reducing food waste was omitted in the studies of Clark and Manning (2018) and Viccaro et al.(2023), which is surprising because the food crisis caused by climate change and intensified by Russia's aggression against Ukraine affects consumers in many countries. The research considerations of the authors mentioned above led the authors of this paper to put forward the following hypothesis:

H1. *The use of the TooGoodToGo application is determined by economic factors and the need not to waste food.*

The use of some applications involves fees for users, which makes them dissatisfied (Kim& Lee, 2023; Lee &Cho, 2017). When using mobile applications, users' sense of security in terms of protecting sensitive data and payments is also important (Preibusch et al.,2016; McKnight, et al.,2011; Zhu, et al., 2023; Kim, et al., 2004; Hu et al., 2014; Yoo &Kim, 2014; Zarifis, et al., 2023). In the case of the analyzed application, what is important is the sense of security resulting from its usefulness, as well as the quality of the food offered by the seller, similarly to the case of group purchases (Zang & Gu, 2015). The discussion in scientific publications was the basis for formulating the second hypothesis:

H2. *The most important features of the application for respondents are free use and payment security.*

The intensive development of new media and high competition mean that individual application dimensions quickly lose their attractiveness, which makes it difficult to maintain user satisfaction at a very high level (Alamer et al., 2023). This problem, with emphasis on Generation Z, is also addressed by Cao et al. (2023).

Food saving applications respond to the needs of young users (Auer&Rogers, 2022), and their satisfaction results in loyalty not only to the application, but also to food product providers (Dirsehan &Cankat, 2021). Research by Ng et al. (2023) shows that, apart from saving time, the most important factor

influencing customer satisfaction is a diversified product range and the usability of applications. It is therefore justified to formulate the following hypothesis:

H3. *The TooGoogToGo application meets users' expectations, as evidenced by the satisfaction rate at a good level*

Materials and methodology

The selection of the application for analysis was carried out in several stages. First, those applications whose use allows for reducing food waste were selected from the database of available ones. Then, an in-depth group interview was conducted with a group of Polish students (treated as preliminary research), which allowed for the selection of the most recognizable applications (knowledge of application logos was also verified). In parallel, the applications' range was analyzed. The TooGoodToGo application had the widest reach and was the most recognized in the pilot studies and was included at a later stage of the research process.

It was food waste and all the environmental consequences associated with it that inspired the creation of the TooGoodToGo application. The idea itself was born in Denmark but quickly gained supporters in European countries and the United States. It is an application with the largest reach operating in the B2C scheme and *food saving*, i.e. allowing for the distribution of surplus food. On August 17, 2023, the application's website stated that 250 million meals were saved from being wasted. This is the result of the involvement of over 81 million registered users and 134,000 partners in 17 countries. The partners include both large chains (e.g. Carrefour, Aldi, Biedronka, Starbucks, Costa and others), but also local restaurants, bakeries and shops. Apart from the platform, the company also carries out educational campaigns, e.g. *OFTEN GOOD LONGER*, in which special labels on products with the message: *Check before you throw away: LOOK, SMELL, TASTE*, attract consumers' attention in order not to throw away food without checking. In 2022, such labels could be found on 465 products in 13 countries. Another example is the Mon École Anti Gaspi Initiative (*My Anti-Waste School*), which aims to teach children how to handle food so as not to waste it. Application users also receive notifications

about the availability of food to be saved and information, for example, on greenhouse gases or the carbon footprint generated by thrown away food.

Questionnaire design and data collection

The survey questionnaire was prepared on the Google.com platform. It consisted of 16 questions, including closed single-choice questions, closed multiple-choice questions, questions on a scale of 1-5 and open questions. People were asked, among others, about: assessment of their own behavior in the field of sustainable behavior, including, for example, the purchase of food products with a short shelf life (question with a scale); using the TooGoodToGo application; reasons for using it and the assessment of individual attributes of this application. The adopted research issues were reflected in the structure of the questionnaire and in the process of conducting survey research. The use of the CSI method discussed below required the inclusion of questions in the survey questionnaire that allowed obtaining information on the importance of individual parameters of the mobile application at a general level and the assessment of these parameters in the TooGoodToGo application. According to the research topic, the sample was to include only people who belong to Generation Z and use the TooGoodToGo application. To implement this assumption, filtering questions were introduced. Convenience sampling of respondents was used (Etikan, 2016). The questionnaire was distributed via social media on a snowball basis(Jabłońska&Sobieraj, 2013). Every effort was made to reach the widest possible group of respondents by asking them to share the link to the survey on their own social media accounts and groups. It should be emphasized that one respondent had the opportunity to complete the survey once. The survey was available in the fourth quarter of 2021. It was opened by 477 respondents. 174 people responded positively to the filtering questions and they constitute the research sample. Cronbach's Alpha indicator was used in the reliability analysis (a value of 0.823 indicates that the test is reliable)

Methods

The collected material was subjected to quantitative and qualitative analysis. Speraman's rank correlation coefficient, Mann-Whitnay U test, Kruskal-Wallis test (statistically significant results at $p<0.05$) and Customer Satisfaction Index (CSI) were used.

CSI allows to indicate customer satisfaction in numerical terms. The indicator methodology requires first to establish satisfaction criteria – the attributes of the product or service that will be assessed (exploratory phase). At this stage, secondary data, expert opinions, panel methods or pilot studies may be used. In the main survey, the criteria are assessed by respondents according to their importance and degree of fulfillment. Based on the importance ratings, the weights of individual criteria are determined, and the CSI index itself is a weighted sum of the designated weights and criteria ratings.

The CSI index is calculated from the formula (Frąś, 2014):

$$CSI = \sum_{i-1}^{N} W_i \cdot C_i$$

where:
CSI – customer satisfaction result,
i – consecutive number of the tested requirement,
N – number of requirements specified in the analysis,
W_i –factor of the importance of the ith requirement,
Ci – assessment of customer satisfaction with the ith requirement.

The obtained results can be analyzed in absolute values (Gajewska, 2015), which makes it difficult to compare results when scales with different ranges are used. Another method used in the literature (Wolniak&Skotnicka-Zasadzień,2008; Woźniak&Zimon, 2016) is to express them in percentage values, which is done in this text using the following scale: 0-40% very bad (extremely dissatisfied); 40–60% bad - (dissatisfied); 60–75% – average (there are some problems with user satisfaction); 75–90% – good (there are minor problems with user satisfaction); 90–100% – very good (highly satisfied) (Frąś, 2014, Woźniak & Zimon , 2016).

The customer satisfaction index is quite often used in scientific studies, including: by S. Skowron (2010), Pukas (2015) or Przybytniowski (2019) , German & Cabacungan (2021).

Research results

The majority of respondents were women (75.9%), which is typical for survey questionnaire (Mulder & de Bruijne, 2019). According to the adopted criterion, all respondents were aged 18-25. Most lived in large cities, i.e. over 500,000 inhabitants (50.6%). In small towns up to 50 thousand inhabitants lived 16.7% of respondents, the same number in medium-sized cities (16.7%) and slightly less in rural areas, 16.1%. The number of people in the household varied. The smallest share was represented by the largest households (5 or more people) – 8.6%. Four-person households accounted for 27%, three-person households 28.7%, two-person households 20.1% and one-person households 15.5%.

The amount of income (net) in respondents' households also varied. Most people (44.8%) indicated the amount of PLN 1,500-3,000 (EUR 334 – 669) for one month per person. An amount above PLN 3,000 (EUR 669) was indicated by 36.2% of respondents, and the remaining (20%) indicated an of up to PLN 1,500 (EUR 334 – At the exchange rate of October 25, 2023 (PLN 4.48).

The frequency of application use varied quite a bit. The fewest number of respondents indicated that they use it every day (4%), 12.1% indicated that they use it several times a week. Such a low frequency can be explained by the relatively large (on average) size of packages (number of food items), which justifies this frequency even in the case of consumers who highly value the application. These two groups were called *loyal* for the purposes of the research and treated together in further analysis. 29.3% of respondents who were called *interested* indicated using it several times a month. The largest group of respondents (54.6%) used the application once every few months. They were called *curious*.

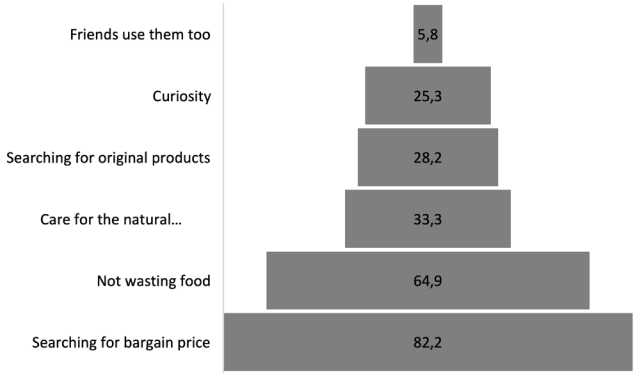
Verification with the Mann-Whitney U test did not show a statistically significant difference in the frequency of using the application between women and men (p=0.682). In turn, verification with the Kruskal-Wallis test showed

no difference in the frequency of use depending on the place of residence (p=0.352) and the level of income per person in the household (p=0.541).

There was no relationship between the frequency of using the application and the number of people in the respondents' household (R=-0.024, p=0.0792).

In accordance with the adopted hypothesis H1, respondents were asked to indicate the reasons for using the application (Figure 1)

Figure 1. *Reasons for using the TooGoodToGo application [%]**



*Respondents could select more than one answer

Source: own research (N=174)

The most important reason encouraging respondents to use the TooGoodToGo application was economic. For 2/3 of respondents, not wasting food was also important. This is also reflected in respondents' assessment of their own behavior in areas related to responsible food consumption. Thus, respondents who declared using the TooGoodToGo application rated their willingness to buy organic food as 2.8 (on a scale of 1-5), the purchase of food with the FAIRTRADE mark as 2.0, and the choice of food products with a short shelf life (on *zero waste* shelves or sections) to 2.6 and these were values similar to those achieved by respondents who do not use this application, i.e. those whose sustainable attitudes are not of interest in the presented research. The first hypothesis was positively verified. It should be emphasized that the influence of friends was the least important here. Verification of hypothesis 2 (H2: The most important features

of the application for respondents are free use and payment security) required a diagnosis of the importance of individual application parameters (Table 1)

Table 1. *Assessment of individual parameters of the TooGoodToGo application (on a scale of 1-5, with 5 being the highest)*

	M	Me	Q1	Q3	SD
Free of charge application	4.8	5	5	5	0.6
Secure payment	4.6	5	4	5	0.7
Ease of use	4.5	5	4	5	0.8
Possibility to use the location	4.5	5	4	5	0.8
Intuitive use	4.3	5	4	5	0.9
Information security/personal data protection	4.3	4.5	4	5	0.9
Buyer protection	4.2	4	3	5	0.9
Compatibility with various systems	4.1	4	3	5	1.0
Wide range of products	4.0	4	3	5	1.0
Possibility to add recommendations	3.8	4	3	5	1.1
Advertisements (ad frequency)	3.6	4	3	5	1.3
Frequent updates, novelties	3.5	3	3	4	1.1
Possibility to choose the delivery method	3.1	3	2	5	1.5

Source: own research. M – mean, Me-median, Q1 – lower quartile, Q3 – upper quartile, SD – standard deviation

Respondents rated the lack of fees for using the application and payment security as the highest, i.e. H2 was positively verified. Ease of use and the ability to use the location were also rated quite highly. The lowest rating was given to the possibility of choosing the delivery method, which results from the specificity of the products. The vast majority of entrepreneurs offer collection at their own facilities, in a few cases they are parking lots in city centers or shopping centers.

Using the Mann-Whitney U test, the difference in the assessment of individual elements of the application was verified depending on the gender of the respondents. Women rated the following parameters of the TooGoodToGo application significantly higher than men: ease of use ($p=0.004$), free of charge

(p= 0.0003) and the possibility of using the location (p=0.032), but they rated lower than men the wide range of products (p=0.032).

The size of the place of residence, the number of people in the household and the amount of net income per person in the household did not differentiate the assessments of individual application parameters.

Using Spearman's rank correlation coefficient, a relationship between the frequency of use and the assessment of individual application parameters was sought. The analysis showed that the more often the respondents used the analyzed application, the higher they rated the following parameters: ease of use (R=0.1836, p=0.015), secure payment (R=0.1543, p=0.042), information security, i.e. personal data protection (R=0.175, p=0.021) and the possibility of adding recommendations (R=0.262, p=0.0005). It should be emphasized that R values ranging from 0 to 0.3 indicate a rather weak connection. In order to perform a more detailed analysis of the relationship, the Kruskal-Wallis Test was used, which showed a statistically significant difference (p=0.003) only in the case of the *possibility to add a recommendation* parameter between respondents who use it most frequently (*loyal*) and least frequently (*curious*), i.e. *Loyal* respondents rated this parameter significantly higher than *curious* ones.

The relationship between the assessment of parameters and the reasons that prompted respondents to use the application was also verified. Verification with the Mann-Whitney U test showed that there are the following statistically significant differences:

1. Respondents who indicated *looking for price bargains* as the reason for using the application rated the ease of use of the application higher than respondents who did not indicate this reason (p=0.0126). They also rated the ease of opening an account higher (p=0.003)
2. Respondents who indicated that the application was free of charge as a reason for using it rated the following application parameters higher than those who did not indicate it: ease of use (p=0.002), secure payment (p=0.002) and intuitive use (p=0.005).
3. Respondents who indicated *looking for original products* as the reason for use the application rated the following parameters lower than those who did not indicate this reason: ease of use (p=0.049), payment

security (p=0.011), buyer protection (p=0.026) , the possibility of using the location (p=0.048), and higher, a wide range of products (p=0.023).

4. Respondents who indicated *concern for the natural environment* as a reason rated buyer protection (p=0.048) and information security/personal data protection (p=0.023) higher than those who did not indicate this reason.
5. Respondents who indicated *curiosity* as a reason rated the wide range of products lower than those who did not indicate it (p=0.022).

To verify hypothesis 3 (*The TooGoogToGo application meets users' expectations, as evidenced by the satisfaction index at a good level*), the CSI index was used.

The importance of individual application parameters, the assessment of these parameters in the TooGoodToGo application and the calculation of the CSI index are presented in Table 2.

Table 2. *CSI of the customer satisfaction index*

	Importance of the parameter	Weight	Evaluation of the parameter	Weighted value
Free of charge application	4.8	8.9	4.8	0.4
Secure payment	4.8	8.8	4.6	0.4
Ease of use	4.5	8.3	4.5	0.4
Possibility to use the location	3.5	6.5	4.5	0.3
Intuitive use	4.2	7.7	4.3	0.3
Information security/personal data protection	4.5	8.3	4.3	0.4
Buyer protection	4.6	8.5	4.2	0.4
Compatibility with various systems	3.8	6.9	4.1	0.3
Wide range of products	4.4	8.1	4.0	0.3
Possibility to add recommendations	3.9	7.1	3.8	0.3
Advertisements (ad frequency)	3.9	7.2	3.6	0.3
Frequent updates, new products	2.9	5.4	3.5	0.2
Possibility to choose the delivery method	4.4	8.2	3.1	0.3
Total	54.3	100.0	53.2	4.1
CSI value				**82.3**

Source: own research

The CSI value indicates that respondents were on average *rather satisfied* with the use of the analyzed application. The value of this indicator prompted the authors to analyze the share of respondents with different levels of satisfaction in the study sample, and the results are presented in Table 3.

Table 3. *Share of respondents in each CSI range*

Ranges (%)	Interpretation	Share of respondents (%)
0 – 40.0	Very bad – definitely dissatisfied	0
40.1 – 60.0	Bad – rather dissatisfied	4.6
60.1 – 75.0	Average – neither satisfied nor dissatisfied	17.2
75.1 – 90.0	Good – rather satisfied	51.7
90.1 – 100	Very good – very satisfied	26.4

Source: own research

No respondent was in the first group, and every fourth respondent was very satisfied with the use of the analyzed application.

In the case of women, the CSI value was 82.9 and men 82.1, but this difference was not statistically significant, as verified by the Mann-Whitney U test ($p = 0.797$). There was also no statistically significant difference in relation to other socio-demographic variables. The obtained CSI value for the entire sample and the distribution presented in Table 5 allow to conclude that the third hypothesis was positively verified.

Discussion and conclusions

Mobile applications help connect food suppliers and consumers. They contribute to reducing waste at points of sale, increase social awareness and promote a sustainable approach to food. As a result, they contribute to reducing food waste and reducing its negative impact on the natural environment. The analyzed TooGoodToGo application has great potential in reducing food waste. It is an example of the possibilities of mobile technology in solving social problems and shaping pro-environmental behavior. Research results can be

a valuable source of information for application developers. According to the study and in accordance with the first hypothesis, the use of the TooGoodToGo application is determined by economic factors and the need not to waste food. 82.2% of respondents indicated looking for price bargains, and 64.9% indicated the need not to waste food. Similarly, the application users in Italy place greater emphasis on saving money and food quality is more important than combating food waste (Fragapane & Mortara, 2022). However, it is reasonable to assume that the growing number of users of the TooGoodToGo application in Italy may also result in attitudes combating food waste in the future. The latter reason is confirmed by research by many authors on responsible food consumption. Research by Bravi et al. (2020) shows that it is important for young consumers not to throw away food. At the same time, they point out that this is a complex problem that requires a broad analytical approach that takes into account several factors at the same time. Also the research of Aschemann-Witzel et al. (2018) shows that price and value are important (the idea of *food saving*), but the appearance of the product as well.

For young users of mobile applications, their features are also important. According to our research, the most important are free use (4,8 on a scale of 1-5) and payment security (4,6 on a scale of 1-5)(H2). Users' reactions to the mobile application were also analyzed by Haas et al.(2022). Functional aspects are important for changing consumer attitudes and behavior towards more sustainable food consumption.

The effectiveness of the application is undoubtedly determined by the level of satisfaction of its users. It was assumed and confirmed that the TooGoogToGo application meets users' (H3) expectations, as evidenced by the satisfaction rate at a good level . For women, the CSI value was 82.9 and for men 82.1. Personal data security and identification, application design and emotional attachment are key factors positively influencing the satisfaction of application users, as confirmed in their study by Niros et al. (2022). For satisfaction to be assessed at a good level, the application's design and operation should be simple and easy to use, which is confirmed by the results of research conducted, among others, by Parasuraman et al. (2005), Pikkarainen et al. (2006) and Olubusola (2019).

The research is pioneering in nature due to the lack of correlation in previous studies between the demographic characteristics of users and the parameters of a useful mobile application that plays an important role in creating environmentally responsible attitudes. In the authors' opinion, the study can therefore provide guidelines for future mobile application developers to prevent food waste.

Limitations and recommendations

The authors are also aware of the limitations of the presented study:

- the research was conducted only among Polish representatives of the Z generation.
- the size of the sample and its non-random selection do not give the right to formulate general conclusions.
- It is therefore reasonable to indicate directions for future research:
- expanding research among other generational groups,
- conducting research in EU countries where the TooGoodToGo application is present,
- conducting interdisciplinary research on the usability of mobile applications so that they become a tool for reducing food waste and an effective information and promotion tool;
- identifying behaviors in the field of *food saving* undertaken by respondents at their place of residence, work and study, as well as in public places.
- conducting long-term research that could help identify permanent effects of using the application and identify areas requiring improvement to better meet user needs. They could also provide data on the lastingness of changes in habits, which would be valuable information for application creators and users.

The presented research results therefore fit into the existing research gap. The authors hope that they will inspire a scientific discussion on the role of mobile applications in reducing food waste and creating sustainable behavior among young consumers.

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