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MOBILE APPLICATIONS AS A NEXT GENERATION SOLUTION TO PREVENT FOOD WASTE

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ABSTRACT

Current study addresses the role of mobile applications of platforms recently developed to prevent food waste. Sustainability consciousness have usually been handled in the field. By examining the role of mobile applications this study wants to make a unique contribution to the sustainability literature. To do this we developed a research model according to the relevant literature and tested it on 439 people whom we access through social media. The findings 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 behavior is mediated by attitude towards mobile applications. However, people might prioritize the health concerns as far as risky conditions about those foods concerned. Implications to the policymakers and practitioners are put forward.

Keywords: Sustainability, Sustainable Food Consumption, Food Waste, Mobile Applications.

JEL Classification Codes: M31, Q56, L66.

INTRODUCTION

Food is wasted at every food supply chain phase, from agricultural production to final consumption. An approximately 1.3 billion tons of food waste are produced annually by households and the food industry combined. (FAO, 2011). According to the "UN Environment Programme's Food Waste Index Report 2021, 931 million tons of food waste were generated in 2019, with 61 percent coming from households, 26% from food service, and 13% from retail" (United Nations, 2021, p. 21). These results show the need for avoiding global food waste to ensure sustainability. The Food and Agriculture Organisation (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, p. 1). Pre- and post-consumer food waste are classified as a result of this concept based on the phases of waste formation (Principato et al., 2021). While post-consumer trash is produced at the consumer level, pre-consumer waste is produced at the manufacturing level. Waste generated during storage, preparation, and production is classified as "pre-consumer waste," whereas leftovers and plate garbage are classified as "post-consumer waste." (Burton et al., 2016). Food waste mostly happens at the consumer level, which means that even though it is still safe for human eating, it gets thrown away, and that a wide variety of factors such as socio-demographic characteristics and consumption patterns play a role in wasting behavior (Di Talia et al., 2019).

With the help of information and communication technologies, mobile applications (apps) have recently been a significant part of business strategies for organizations to reach and interact with their customers (Stöckli et al., 2018). Computer software known as mobile applications are created specifically to operate on portable electronics like smartphones and tablets. Mobile apps usage by organizations and consumers has been unpredictable, especially since the Covid-19 pandemic (Ramos, 2022). Mobile apps offer new opportunities to businesses as mobile devices significantly impact customers' purchasing experience. Therefore, mobile apps are projected to play a critical role in transforming customers' purchasing habits, opening up the potential to contribute to environmental sustainability.

Digital information systems offer a range of apps that may affect sustainability (Apostolidis et al., 2021). By

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reducing food waste and improving the food industry's long-term viability, the development of digital solutions has been accelerated by this shift to digital technologies. In a larger sense, digital technologies have the potential to make a digital enterprise more sustainable by generating social and environmental value. For example, some food waste mobile apps in Turkey, such as Yenir, Oreka, Raf, Sifir, etc., have been created to help food services sell food that is on sale that would otherwise be discarded. Mobile apps to reduce food waste allow enterprises to provide surplus food to willing consumers while also making earnings. Thus, mobile apps show how technology can assist the food industry in providing an advantage for customers, businesses, the environment, and society.

Nonetheless, there is little research on how firms and consumers might utilize food waste reducing mobile apps to produce long-term sustainability. This study intends to determine the role of mobile app acceptance, which is influenced by consumers' social, personal, and psychological traits.

THEORETICAL BACKGROUND

Information technologies are thought to have three effects on sustainability: "automation, information, and transformation" (Chen etal., 2008). While automation is defined as replacing human labor with technology to create more efficient business processes, information is defined as feedback processes that can aid decision-making by giving users a greater grasp of the situation at hand. Transformation is defined as significant changes that will result in the emergence of new products, services, consumption experiences or business models as a result of automation and information (Chen et al., 2008). Mobile apps are expected to deliver the essential transformation for sustainability aims regarding simplicity of use and prevalence.

The public's understanding of sustainability might be the first driver of market opportunities for a new venture or a business model (Klein Woolthuis, 2010). According to the Multi-Level Perspective grounded on "evolutionary economics, sociology of innovation, and neo-institutional theory" (Geels, 2019), radical innovations have the potential to revolutionize the entire system (Geels, 2019). MLP as a multi-dimensional approach, consists of three interconnected layers: socio-technical landscapes, regimes, and niches (Geels, 2019). At the broadest scale, "the socio-technical landscape" symbolizes the exogenous background, which includes all slow-changing demographic trends, macroeconomic trends, and political beliefs; at the meso-level, the socio-technical regime is mainly composed of technological configurations, scientific understanding, industrial networks, and frameworks, formed customs and symbols, marketplaces and consumer behaviors, practices, and infrastructural facilities, and it coordinates and directs the actions of the system's related actors and social circles. (Geels, 2019). At the micro level, niches might be government-funded research initiatives or tiny market segments where consumers have particular demands and are willing to support novel concepts. Entrepreneurs, start-ups, and spinoffs are niche actors who focus on radical ideas that diverge from existing regimes.

The motivation for this study stems from a need to address food waste and how mobile app innovations motivate consumers to target sustainability by using these apps. Mobile apps to reduce food waste develop technology solutions to link consumers with local food suppliers such as restaurants, grocery stores, motels, and bakeries, who may sell unsold extra food at a lower price instead of throwing it away. Besides, this new idea of mobile apps extends beyond using digital technologies for the food waste reduction at the retail level by providing information about sustainability to develop a sustainable vision for consumers. Recently, new ventures like Yenir, Oreka alike have also emerged in Turkey with an aim to save food, money, and the Earth (Alemdar, 2020; Tahirler, 2021). This research investigates whether mobile apps can aid in the food waste reduction and a societal change in the current food industry in Turkey by analyzing consumers' attitudes.

CONCEPTUAL FRAMEWORK AND HYPOTHESES DEVELOPMENT

Attitude towards sustainable food consumption

Due to their increased environmental and sustainability knowledge, consumers have a more favorable attitude toward their intake of sustainable foods (Principato et al., 2021). Food is commonly acknowledged as one of the most critical factors related to environmental sustainability. Sustainable food consumption implies the creation of more optimum consumption patterns, all while considering basic human needs and goals to act in the best interests of current and future generations (Gazdecki et al., 2021; Vermeir et al., 2020). According to Reisch et al. (2013), associated environmental problems with food waste include "climate change, water pollution, water scarcity, soil degradation, eutrophication of water bodies, and loss of habitats and biodiversity" are also challenges for future generations. Therefore, consumer

understanding of sustainable food consumption influences their attitude before making a purchase decision.

Studies investigating the attitudes towards sustainable food consumption (Gazdecki et al., 2021; Rana & Paul, 2017) analyze how consumer interest transforms into sustainable purchasing patterns and behavior, as well as the themes of organic versus conventional food, and customer perceptions of eating organic food. Misunderstanding the notion of sustainable food indicates customers' lack of awareness and obstructs its spread. Thus, consumer attitudes toward sustainable food consumption, as well as personal beliefs, perceived impediments, and knowledge, have an impact on their purchasing practices.

"$H_{1=}$There is a positive relationship between attitude towards sustainable food consumption and intention to purchase on food wasting (mobile) apps."

Attitude towards mobile apps

Individuals interested in new digital solutions react in several ways when they are offered. Therefore, it becomes critical to assess attitudes to determine whether or not a new technology will be accepted. Davis (1989) proposed the "Technology Acceptance Model (TAM)" to examine which factors impact the acceptance or rejection of information technology. TAM describes the factors that influence individuals' system acceptability by considering two dimensions (Davis et al., 1989); (1) perceived ease of use and (2) perceived usefulness. The positive or negative attitude of an individual toward achieving the desired action is referred to as attitude (Ajzen, 2001). While perceived ease of use refers to finding easy to use and learn a particular technology perceived usefulness refers to the idea that using a particular technology to perform specific activities while solving difficulties would improve their performance (Davis et al., 1989).

Scholars also argue that technological conveniences have a favorable attitude-altering impact (Veríssimo, 2018). The importance of retailers' mobile apps as a subsidiary of food waste reduction attracts the consumers' attention and consumers are increasingly using mobile apps for all types of eating behaviors, such as dining out and shopping for convenience (Mu et al., 2019). Despite the fact that they utilize use of the convenience of a mobile app, these apps are more similar to a sharing platform than a meal ordering app. In the case of sharing platforms for sustainability, it's critical to investigate the perspectives of the various participants in the purchasing phase. Therefore, this study aims to investigate whether the putative simplicity of mobile app usage can contribute to the sustainable action of reducing food waste by considering the consumers' perception towards sustainable food consumption.

"$H_{2=}$ Attitude towards food wasting (mobile) apps mediates the effect of attitude towards sustainable food consumption on intention to purchase on food wasting (mobile) apps."

"H_3=There is a positive relationship between attitude towards food wasting (mobile) apps and intention to purchase on food wasting (mobile) apps."

Perceived health risk

Food safety and food waste reduction are two opposing challenges. While environmental responsibility entails persuading people to throw less food away, foodborne disease prevention entails, in part, convincing people to do the exact opposite (Watson & Meah, 2012). According to the literature, people judge whether food is still fit for consumption in various ways. The most common methods for determining health risk perception include date labelling, and the usage of odor. This is most likely related to the fact that there are more opportunities to define something as waste. Most consumers are concerned that various foods carry different degrees of risk, for instance meat can be the most harmful, and vegetables can be the least damaging. Food waste is not something that most customers take lightly; in fact, many consumers are concerned about it. People don't want to become sick, therefore, they discard potentially edible food rather than risk it. Health concerns are strongly linked to food safety and nutrition. Therefore, consumers' perceived health risks of food should be given special consideration to reduce food waste.

"H_4=Perceived health risk moderates the effect of attitude towards sustainable food consumption on attitude towards food wasting (mobile) apps."

A conceptual model is built in accordance with the aforementioned evidence.

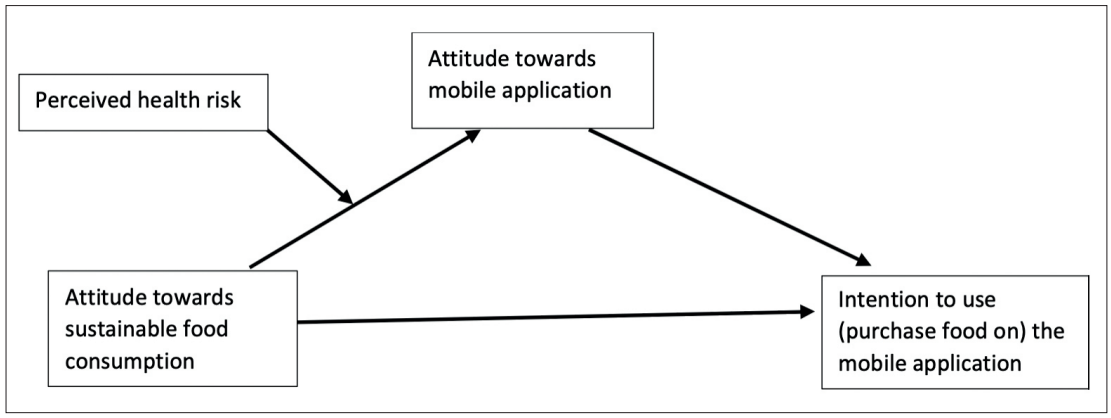

Figure 1. Conceptual Model

METHOD

Sampling

An online questionnaire tool was used to carry out the survey, Google forms, frequently used by academics and practitioners both. It was administered through social media between January 2022 and March 2022. Conveniently reached 443 Turkish respondents over the age of 18 returned the questionnaires. However, four of them were detected as careless respondents with preliminary analysis. The analyses were carried out over the total of 439 questionnaires. The following Table 1 displays the sample's demographic characteristics.

Procedure and Measures

The survey instrument consisted of items adapted from existing scales measured on a 5-point Likert type scale (1-Strongly disagree, 5-Strongly agree) and four parts: attitudes towards sustainable food consumption, the attitude towards the mobile app, intention to use the relevant mobile app, and four items on the perceived risk of consuming food near expiration date as well as the questions on demographics. Attitude towards sustainable food consumption scale by 13 items was adapted from Azzura et al. (2019). Attitude towards the mobile app mediator in the research model was operationalized from the scale of Kim et al. (2014) with five items, and intention to use the mobile

Table 1. Demographic Characteristics of Participants

	Characteristics	N	%
Gender	M(ale)	183	42
	F(emale)	256	58
Age	18-25	124	28
	26-35	164	37
	36-45	120	27
	46-55	23	5
	56-65	7	2
	66 and over	1	1
Education	High School and below	80	18
	Undergraduate school and below	184	42
	Graduate school	175	40

app was evaluated using Shiv et al.'s scale (1997) by three items. Perceived risk of consuming food near expiration date scale was obtained from Visschers et al.'s (2016) study.

We first examined the relevant mobile apps for product selection and created a list of the 15 commonly placed products. Afterwards, we introduced 25 participants the apps briefly and asked them to rank these products according to the risk they perceived when making a purchase. While the sandwich was expressed as the riskiest in the ranking, the banana was evaluated as the least risky product. During the main study, the respondents were allowed to see the two types of products, a packaged sandwich, and a banana to see whether the participant intent change depending on the product type: they were asked to indicate their intention to use such a mobile app when buying each product.

Before delivering to the participants, the items were first translated from their original English form into Turkish and translated back into English to ensure that they kept their meaning. Four marketing academics evaluated the final version of the scales and we finalized it in line with their recommendations.

Data Analysis and Findings

A series of preliminary analyzes of validity and reliability were performed prior to hypothesis testing. Running Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) respectively, we first assessed the construct validity. Subsequent to CFA, the EFA was conducted, and each procedure shows that the scales provide construct validity with existing items. However, the item "I believe that the risk of becoming ill as a result of eating food past its use-by date is high" was omitted since its factor loading value does not meet the threshold of 0.60 or above in EFA and the criteria that the factor loading for every item should be 0.6 or higher in CFA (Awang, 2014) ($\chi 2/df=2,390$, AGFI=.92, CFI=.95, NFI=.92, IFI=.95, TLI= .95, RMSEA= .056).

Findings also indicate that the research model has a convergent validity (scales' Average Variance Extracted (AVE) value ranging between 0.50 and 0.78) and discriminant validity (AVE values exceeding squared correlations for each respective scale) (Fornell and Larcker, 1981). The measure of internal consistency in scale items, the composite reliability values also exceed the threshold of .80 recommended by Netemeyer et al. (2003) (Table 2).

Table 2. Descriptive statistics, validity, reliability, and correlations

	ATSFC	ATM	$MU_{sandwich}$	MU_{banana}	PHR
Attitude towards sustainable food consumption	1	,274**	,121*	,236**	,012
Attitude towards mobile app	,274**	1	,312**	,290**	,211**
(Mobile app usage) $_{sandwich}$	,121*	,312**	1	,441**	,083
(Mobile app usage) $_{banana}$	,236**	,290**	,441**	1	,143**
Perceived Health Risk	,012	,211**	,083	,143**	1
Mean	4,10.	4,49	3,55.	3,85	3,28
Std.Dev.	0,71	0,64	1,02	0,94	0,98
Composite Reliability	.92	.92	.90	.90	.81
AVE	.50	.69	. 75	.78	.62

**p<0.01; *p<0.05
Attitude towards sustainable food consumption: ATSFC; Attitude towards mobile app: ATM; Mobile App Usage: MU; Perceived Health Risk: PHR)

Table 3. Model Coefficients (Sandwich)

	Consequent					
	M (Attitude towards mobile app)			Y (Mobile App Usage Intent)$_{sandwich}$		
Antecedent	Coeff.	SE	p	Coeff.	SE	p
X (Attitude towards sustainable food consumption)	.826	.149	<.001	.054	.067	.420
M (Attitude towards mobile app)	-.870	-.183	-<.001	.479	.075	<.001
W (Perceived Health Risk)				-	-	-
X x W	-.175	.043	<.001	-	-	-
Constant	0.601	0.633	.343	1.169	.377	.002
	R^2=0.149			R^2=0.098		
	F(3,435)=25.564 , p < .001			F(2,436)=23.851 , p < .001		

Prior to mediation analysis, we tested whether the participant's intention to use a mobile app when buying each product (a packaged sandwich or banana) differs and conducted one-sample t-test. The results indicate that there is a significant difference between the intention to use the mobile app for each product ($M_{sandwich=3.55,}$ M_{banana}=3.85, p<.05), and so we tested the relevant hypotheses for each product respectively.

Findings indicate that sustainable food consumption is positively related to purchasing over the mobile apps aiming at preventing food waste depending on the food type. Thus, H1 is partially accepted (direct effect is significant for the banana and not significant for the sandwich)

In accordance with Preacher and Hayes' (2008) methodology, we used SPSS macro to evaluate the moderation and mediation hypotheses. Tables 3 and 4 report the regression coefficients for the paths through the mediator, moderator (attitude towards sustainability x perceived risk), and the direct effect of the independent variable on the dependent variable.

The results of the mediation analyses with intention to use the mobile app for sandwich as the dependent variable (Table 3) support the H2= attitude towards the mobile application mediates the effects of attitude towards sustainable food consumption on intention to use the mobile application conferring perfect mediation: the indirect effect is significant, direct path is not significant (path coeff.=.054, p=.420>.05). However, the relevant finding on the banana indicates that the intention to use the mobile app for banana is partially mediated. The indirect effect and the direct path are significant (path coeff.=.224, p<.05), in support of partial mediation (Table 4). H3 proposing that there is a positive relationship between the attitude towards mobile app and intention to use it is also supported for the two products both.

The moderation analyses support the H4= the risk perceived related to the product (sandwich or banana) sold on the application moderates the effect of attitude towards sustainability on attitude towards the mobile application (Table 3). That is, the consumer perceives buying the product (sandwich or banana) risky in terms of health, then s/he will develop negative attitude towards the app with a suppressing effect (path coeff.= -.175, p<.05).

DISCUSSION and CONCLUSION

Recently, food waste has become an important social, economic, and scientific topic with increasing environmental sustainability concerns. Such environmental concerns have prompted the development of novel distribution techniques designed to minimize food waste and enhance social impact. The number of mobile applications to decrease food waste created by new businesses has lately increased due to opportunities provided by information and communication technology and the growing awareness of eating sustainably.

Table 4. Model Coefficients (Banana)

	Consequent					
	M (Attitude towards mobile app)			Y (Mobile App Usage Intent)$_{banana}$		
Antecedent	Coeff.	SE	p	Coeff.	SE	p
X (Attitude towards sustainable food consumption)	.826	.149	<.001	.224	.062	<.001
M (Attitude towards mobile app)	-	-	-	.359	.069	<.001
W (Perceived Health Risk)	.870	.183	<.001	-	-	-
X x W	-.175	.043	<.001	-	-	-
Constant	0.601	0.633	.343	1.316	.347	<.001
	R^2=0.149			R^2=0.110		
	F(3,435)=25.564 , p < .001			F(2,436)=27.128 , p < .001		

This research broadens our understanding of sustainable food consumption in general., and especially demonstrates why customers may favor food waste reduction smartphone apps. The results obtained in this study have verified that mobile apps can be seen as an incentive or a problem solver for food waste reduction and a societal change in the current food industry. To show that by two different product types (sandwich and banana), we tested a research model which focused on the relationship between the attitude towards the mobile application, attitude towards sustainability, intention to use the mobile application, and perceived health risk. We have verified two main results by this model. First, attitude towards the mobile application is a mediator in the relationship between attitude towards sustainability and intention to use the mobile application. That is, consumers' intention to use the sustainable food application depends on their attitude towards the mobile app. Second, the risk perceived related to the product (sandwich and banana) sold on the application is a moderator in the relationship between attitude towards sustainability and attitudes towards the mobile application. That is, if a product is perceived as risky in terms of health, users develop a negative attitude toward the application.

This research extends existing literature on sustainable food consumption and food waste by making unique contributions. That is, people concerned about sustainability might be motivated to do more for sustainability by preventing food waste by means of mobile applications. As indicated in the existing literature, current study findings also indicate that sustainably conscious people might convert their attitude into sustainably conscious behaviour (Rana & Paul, 2017). However, Vermeir et al. (2020) stated that people might develop positive attitude and favorable opinions towards environmental sustainability while not consuming in line with these attitudes and opinions.

In addition to this, the importance of new technologies in this behavioral effect has also been revealed. The introduction of the attitude towards mobile applications preventing food waste as a mediating variable between sustainable food consumption and consuming food on these platforms is a considerable contribution and there hasn't been any study on how successful mobile applications are in reducing food waste. As stated in the literature that consumers' positive attitudes towards a mobile commerce application have a beneficial impact on customer loyalty, this can affect the continuous usage of these mobile applications over time and in turn reduce food waste.

Another contribution of the current study is related to the health concerns. As in the existing literature findings, it is also revealed in this study that reducing danger and maintaining food safety, takes precedence over avoiding food waste. People might be cautious about sustainable concerns and behave accordingly. However, things might change as far as risky conditions related to health concerned and they might precede health over their sustainable consciousness.

We also develop implications for the stakeholders including practitioners and policy makers. It is proved that practitioners need to focus on marketing communication activities to increase awareness of the app and engage positive feelings and attitudes towards the app if they want to get the attention of consumers who already tends to consume sustainable products. Therefore, there is a need to focus on the perceived health of the products sold on the application. It's essential to bear in mind that if the application provides reliable and detailed information about the product's past, it will be possible to achieve more effective results in a shorter amount of time to reduce food waste. The policy makers might also benefit from such platforms to make the individuals care about sustainability by attracting their attention to the relevant applications. They might urge companies to make such developments on their value propositions by using monetary incentives. They might also communicate to the audience emphasizing merely on sustainability over food waste and how people might prevent it. All over the world people spend most of their time on their smart phones online. Thus, it is the best way to communicate the people fast and effectively.

This study is also confined by a few limitations. Mobile applications aiming at food waste reduction such as Yenir, Oreka, Raf, Sifir etc. are relatively new. Thus, participants are not so familiar with such types of applications. However, current research findings might be considered as a preliminary step to provide foresight for future studies. We recommend future research adopting multiple sorts of food as well as applications with more advanced designs**.**

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