Consumer preferences for the use of an innovative digital menu solution in public food service settings in four European countries

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Abstract: E-menu solution Consumer preference Public food services Digital technology Consumer preferences for the use of an innovative menu solution in public canteen services in the UK, Greece, France, and Denmark were investigated. Participants from both control and test groups were first introduced to the FoodSMART app through a video clip as well as verbal explanations. The control group filled a questionnaire evaluating their preferences for the use of a technical menu solution in public food services straight away, whereas the test group had the opportunity to experience the app adapted to a daily canteen menu in real-time before completing the questionnaire. The data collected was examined in both country-specific and collected manners. Participants in all four countries valued the canteen food quality the most, especially food hygiene, sustainability, safety, and freshness. Their preferences for other features such as app functions, information provision, and ethical issues varied in different countries. The knowledge gained from this study provides valuable lessons for the future design of a food-quality-focused digital menu solution in canteen services adapted to the specific country and population context to promote informed consumer food choices.

Keywords: E-menu solution, Consumer preference, Public food services, Digital technology.

1. Introduction

Cardiovascular diseases (CVDs), chronic respiratory diseases, cancer, and diabetes, make the greatest contributions to non-communicable diseases (NCDs)-related morbidity and mortality. Apart from the genetic factors, the leading risk factors for NCDs are behavioural; with unhealthy diet being one of the four primary behavioural risk factors for NCDs, especially for diabetes and CVDs. Unhealthy diets account for

241.4 million disability-adjusted life-years lost and 11.3 million deaths globally (Forouzanfar et al., 2015; World Health Organization, 2016). The fiscal cost of the growing diet-related NCDs burden is grim. By 2050, the accumulated cost of the aforementioned NCDs is expected to reach US $30.4 trillion worldwide, with CVDs and diabetes contributing approximately 57% of that value (Feigl, 2011). Therefore, the development of cost-effective interventions for dietary behaviour change is essential for improving population health and well-being.

2. Behaviour change in catering facilities

With increasing numbers of catering facilities these days, a large proportion of food consumption comes from food-away-from-home, which contains a higher number of calories and fat compared with home-cooked meals. This correlates to an increased incidence of obesity and CVDs (Bes-Rastrollo et al., 2010; Bhutani et al., 2018; Bohm & Quartuccio, 2008; Stewart et al., 2006). Therefore, catering facilities have become a targeted venue for the implementation of healthy eating behavioural strategies (Kahn-Marshall & Gallant, 2012). Three main types of behavioural interventions have been conducted to promote healthy eating in catering facilities in the past: information provision, social modelling, and size manipulation. Within these measures, menu information (e.g. calories and contextual information) and social modelling such as advertisements connected to the menu information, have shown the most promising effects (Bray et al., 2019; Price et al., 2016; Wright and Bragge, 2018). However, rolling out such behavioural interventions at a large scale can be tricky and expensive. The development of cheaper alternative solutions is essential for the future of dietary behaviour change while dining out.

2.1. Behaviour change through digital technologies

Since the introduction of the internet, coupled with the rapid increase in the presence of internet-enabled tablets and smartphones, there has been massive interest in the utilisation of this technology as an alternative, cost-effective solution for health-related behavioural interventions such as those targeting changes in dietary behaviours (Webb et al., 2010). Recent statistics have shown that close to 85% of the global population is covered by a commercial wireless signal and there are close to 5 billion mobile phone users worldwide (World Health Organization, 2011). Such extensive smartphone use

levels, particularly among the youth, as well as the potential for free, instant, and automated monitoring of behaviours compared with other expensive approaches, have made tablets and smartphones a conventional and useful means to provide behavioural interventions in the past few years. To a large extent, this technology can be considered experimental and has potential drawbacks and benefits (Murray, 2012). However, it appears that with the ongoing technological proliferation in the daily life of humans, smartphones and tablets will constitute an essential component of dietary behavioural interventions in the future, with the benefit of increased coverage and proven effectiveness as means to elicit changes in health-related behaviours (Muessig et al., 2015; Tomlinson et al., 2013; Lowe et al., 2013).

3. FoodSMART, a digital solution for behaviour change in catering facilities

Nowadays, there are hundreds of mobile applications devoted to nutrition education and dietary habits based on various behavioural change theories (Hingle & Patrick, 2016). However, very few of them focus on dining out situations and none of them look at consumers' preferences on such digital applications to provide more evidence for the design of more effective mobile/tablet-based intervention strategies for behaviour change while eating out. Considering the abovementioned challenge, the present study was performed within the frame of the FoodSMART project https://microsites.bournemouth.ac.uk/foodsmart/ . The aim of this project was to promote informed consumers' food choices through a technical menu solution while eating out, especially in public catering service locations. Within this project, the consumers' criteria for information quality while dining out was first identified (Price et al., 2016). Afterwards, a flexible, customizable, and accessible information and communications technology (ICT) menu prototype was developed, which was followed by a prototype validation. A video demonstration of the app functions and interface is available online at https://youtu.be/roLlNbLvJMA.

3.1. Study objectives

The objective of this study was to investigate consumer preferences for the application of an E-menu solution in public catering services through the existing prototype by testing it in the field in the UK, Greece, France, and Denmark. The results from the study indicate consumer food selection through related analytical/measured

approaches and data mining approaches across countries alongside attribute benchmarks for a consumer appreciated E-menu solution in public sector food services, which provide stepping stones for the next step of further improvement of the app to enable a longitudinal study to capture behaviour change in real life as well as potential commercial application. Consumers' preferences while eating out are the keys to unlocking out-of-home food choices and dietary behaviours, which could be the beginning point of directing consumers towards more sustainable and healthier food choices within canteens through the use of mobile technologies.

4. Material and methods

4.1. Participant recruitment

Healthy adults aged 18 years and above were recruited in the UK, Greece, France, and Denmark. All participants provided either digital or written informed consent to participate in the study, and the nationalities of the respondents were confined to the four countries to decrease bias from various cultural backgrounds. The recruitment took place at on-campus canteens at Bournemouth University (U.K.), University of Copenhagen (Denmark), and University of Macedonia (Greece) and the staff canteen at Institut Paul Bocuse (France). Only those individuals who had used the selected canteens were included. A total number of 1,031 participants were recruited for the study, with 305 participants in Denmark, 284 participants in the UK, 99 participants in France, and 343 participants in Greece.

4.2. Study procedure

The present study was undertaken to explore consumers' preferences via the FoodSMART app and assess the possible introduction of the application into the public domain. Prior to the field testing, a questionnaire was created to capture the responses of consumers in test and control cohorts. Furthermore, all partner canteens supplied dish information to be included into the interface of the app, including dish allergy information, nutritional information, names, and pictures. A standard protocol was used on the collected data within testing sites with few modifications to adapt to actual situations.

On the day of testing, the app was initially introduced to participants within the control group through a video and verbal explanations, followed by the completion of a

questionnaire. The test group participants had the opportunity to try out the app adapted to the daily menu at the selected canteen before filling out the questionnaire. Further verbal explanations were provided when participants have questions. Data was collected at four canteens in four FoodSMART partner countries. The canteens were selected based on based on a previously established partnership agreement.

Afterwards, data obtained from the survey was analysed using the appropriate analytical/measured and data mining approaches. Ethical approval was obtained through the appropriate channels in all the FoodSMART partner countries. Digital consent was obtained from all participants before participating the study. Confidentiality and anonymity were assured at all times.

4.3. Questionnaire instrument

Initially, the questionnaire was developed based on past research findings regarding consumers' decision making, information needs, and preferences in canteen scenarios (Price et al., 2016). Afterwards, some adjustments were made based on experts' opinions and in-depth interviews with consumers to create core questions and structures for assessing the study objectives. Then, it was subjected to a pre-testing phase to assess its reliability and validity. Lastly, the questionnaire was formalised to examine consumers' behaviors using the questions below to target particular consumers' insights (Appendix A):

a) Information regarding the participants' demographic characteristics such as dietary preference, health status, education level, age, and gender.

b) Frequency of canteen visits for various purposes, including the purchase of water, pastries, hot meals, breakfast, and other beverages.

c) The consumers' preferences regarding food-related ethical concerns, information provision, app interface and functions, and food quality at the canteen.

The consumers' preferences items were measured on a five-point Likert scale, with 1 indicating strongly agree, 2 indicating disagree, 3 denoting neither disagree nor agree, 4 denoting agree, and 5 representing strongly agree, thus allowing more accurate identification of consumer insights with continuous constructs. The questionnaire constructs were similar in the control and experimental situations, enabling the groups to be compared.

4.4. Data analysis

A principal component analysis (PCA) was conducted to examine the antecedents of using an ICT menu alternative within the canteens in the four countries. SPSS 20.0 was utilised for the analysis of the eight datasets, which included four test groups and four control groups. All 34 questions regarding consumers' preferences were analysed to identify the factors influencing consumers' preferences (each question addressed a different factor). Afterwards, the cumulative variance contribution rate that denotes the initial dataset interpretation level was obtained. The weight of the 34 factors was calculated by dividing each factor variance contribution rate by the cumulative variance contribution rate. Notably, a higher weight indicates a stronger influence of the variable on the corresponding population, to explain the preference differences across countries and groups (OECD, 2008).

To provide a holistic illustration of the preference variations across the four countries, the questions on consumers' preferences were divided into four dimensions, with the first dimension representing the interface and general functions of the app, the second dimension denoting the canteen food quality and properties, the third dimension describing the information presented on canteen food, and the fourth dimension describing the ethical concerns associated with food. The degree of agreement for each question (individual DoA) was measured by calculating the average weight of the question derived from past PCA times the acceptance level of questions within the dimension. The greater the value, the greater the importance it presents for consumers' preferences.

5. Results

5.1. Participants' characteristics

A total of 1,031 consumers with average age of 23.1 (range 18 to 61) were surveyed across the four countries. The health status and sociodemographic characteristics of the sampled population are summarized in Table 1. The percentage of females within the countries was overall higher than that of males. In the UK, Greece, and Denmark, the participants' average age was approximately 21 years as most of the respondents were university students. The average age in France was higher (38.4 years) as the survey was completed by the canteen staff. The level of education in all countries was usually university or secondary level and the majority of the respondents regarded themselves

as having good or very good health status. A large portion of the respondents were omnivores; the highest number of non-omnivores (flexitarian, pescatarian, vegan, or vegetarian) participants was in Denmark. Additionally, the population of vegetarians was considerably higher in the UK and Denmark than in Greece and France.

The canteen use frequency was captured within the survey on a scale from 1 (lowest use) to 5 (highest use). Within the study, the frequency with which participants ordered hot meals and breakfasts was determined based on the working week, on a scale with values of 1 denoting one day or less each week and 2-5 denoting an increasing frequency of use from 2 days to 5 days each week. The frequency with which participants ordered pastries and different beverages was determined daily, with a value of 1 denoting never or rarely and values of 2-5 denoting an increasing frequency from once a day to four times daily. The results, as shown in Table 2, indicated that most respondents ordered one to two hot meals or breakfasts at the canteen per working week, and the frequency with which pastries and beverages were purchased was also low (one to two per day).

Table 1
Sociodemographic information and dietary preferences of participants in the study across countries.

	Denmark (n = 305)	France (n = 99)	Greece (n = 343)	United Kingdom (n = 284)
Gender (%)	Female-63.6 Male-36.4	Female-58.6 Male-41.4	Female-58.9 Male-41.1	Female-61.3 Male-38.7
Age (years)	23.49 (SD = 0.32) (Range 18-55)	38.4 (SD = 1.38) (Range 20-61)	20.47 (SD = 0.13) (Range 18-36)	20.36 (SD = 0.21) (Range 18-46)
Education Level (%)	Secondary-40.3 University-59.7	Elementary-11.1 Secondary-43.4 University-	Elementary-0.9 Secondary-88.0 University-	Secondary-60.2 University-39.8

		45.5	11.1	
Health Status (%)	Poor-2.6 Fair-15.1 Good-53.1 Very good-29.2	Poor-5.1 Fair-23.8 Good-45.5 Very good-21.2	Poor-1.7 Fair-12.0 Good-54.5 Very good-31.8	Poor-4.2 Fair-19.4 Good-52.5 Very good-23.9
Dietary preference (%)	Omnivore-77.4 Vegetarian-6.6 Vegan-2.9 Pescetarian-4.9 Flexitarian-8.2	Omnivore-87.9 Vegetarian-1.0 Vegan-2.0 Pescetarian-0.0 Flexitarian-9.1	Omnivore-87.8 Vegetarian-1.6 Vegan-0.0 Pescetarian-1.1 Flexitarian-9.6	Omnivore-83.1 Vegetarian-5.6 Vegan-2.5 Pescetarian-4.9 Flexitarian-3.9

Table 2

Mean canteen usage frequency across the four countries.

	Denmark (n = 305)	France (n = 99)	Greece (n = 343)	United Kingdom (n = 284)
Breakfast	1.30 (SD = 0.04)	1.65 (SD = 0.12)	1.16 (SD = 0.04)	1.30 (SD = 0.04)
Hot meals	1.76 (SD = 0.06)	1.16 (SD = 0.06)	1.96 (SD = 0.10)	1.62 (SD = 0.52)
Coffee and pastry	1.71 (SD = 0.05)	1.00 (SD = 0.00)	1.37 (SD = 0.05)	1.79 (SD = 0.05)
Sugary beverages	1.34	1.62	1.10	1.51

	(SD = 0.04)	(SD = 0.07)	(SD = 0.03)	(SD = 0.05)
Water and fresh juice	1.57 (SD = 0.05)	1.71 (SD = 0.07)	1.60 (SD = 0.07)	1.8 (SD = 0.06)

5.2. Preferences across countries - Individual factors

Concerning the results indicating the effect of individual factors on the consumers' decision making, it can be inferred that the greater the question weighing, the greater the rank, and the stronger the effect on the consumers' behaviour. For instance, individual factor ranked 1 (in red colour), appears to have the greatest influence and weighting out of all the variables. The weightings are summarized in Appendix A.

In Denmark, many top individual aspects in both groups were linked to food qualities and properties, such as canteen food sustainability, hygiene, freshness, and safety. Ethical concerns associated with food also had a significant influence on Danish consumers. Questions with information such as healthy eating, sustainability, water shortage as well as human and animal rights were ranked first within the testing group and second within the control group. The subtle variation in ranking can be attributed to environmental change. Nevertheless, based on the results, it can be inferred that ethical concerns are generally important for Danish consumers. In contrast, information concerning allergens, training on app use, and confidence constituted the least essential factors.

In France, there was an interesting change in the most essential factors (rank 1) from the function of the app within the control group to the qualities and properties of the canteen food within the test group, which could be explained by different potential causes. Questions concerning integrated functions, that is, the functions of the app and the interface such as consistency, easy to learn/use, and a simple system were highly ranked within the control group, but were ranked second within the test group. Meanwhile, questions concerning the properties and qualities of canteen food including personal preferences, freshness, hygiene, sustainability, taste, and healthiness were ranked first within the test group, but second to fourth within the control group. However, the ranks for other groups remained relatively consistent, particularly concerning the

interface and app functions. The factors that French consumers were the least concerned with included app use training, personalised information, and scientific accuracy. The information given concerning canteen food was generally characterized by less influence on consumers compared with other factors.

Similar to the results obtained for Denmark, the factors that presented a concern to participants from Greece were mainly related to the properties and qualities of canteen food, particularly the freshness, sustainability, hygiene, taste, and healthiness. Additionally, information that was easily understandable concerning canteen food was highly ranked by the test and control groups. There were certain differences between the two groups. For instance, the test group focused on personalised information and accuracy alongside personalised canteen food and variety (rank 1) more than the control group (rank 4-6). The factors that had the least effects differed for both groups as well. App learning, discount, and recommendation of the chef had the least effect on the control group whereas integrated functions of the app, the availability of a plant-oriented dish, and chef recommendations had the least effect on the testing group.

The top factors for the UK participants were significantly consistent between the two groups, including food variety, sustainability, taste, and safety. The only variation occurred in the ratings on easily understandable information (ranked first within the control group and second within the test group). Nevertheless, the participants from the testing group had more understanding of the eco-friendly elements of the food (ranked first) than the participants in the control group (ranked sixth). The lack of confidence in utilising the app constituted an important factor in both groups, whereas healthy eating behaviours and food healthiness were the least important aspects for the control group, and global warming alongside locally produced food were least important for the test group.

5.3. Preferences across countries - Dimensional factors

The degree of agreement of each dimension (dimension DoA) was determined by the average of the weight of each question multiplied by the degree of agreement for individual questions (Individual DoA) in that dimension (see section 2.4). The higher the value of dimension DoA, the more important that dimension to the consumers as a whole. The highest dimension DoA was marked in yellow colour for each group of each country, representing the highest weighting relative to other dimensions and potentially

the biggest impact on the subsequent behaviours of the consumers. The individual country results presented in Appendix B were coherent with the previous results on the importance of individual factors.

In Denmark, the highest dimension DoA for the test and control groups, with values of 86.17 and 76.46, respectively, was the second dimension, which implied that the Danish consumers mostly valued the quality and properties of the canteen food. The next highest dimension DoA was the fourth dimension, which represented understanding of ethical concerns associated with food. The information about the canteen food ranked third within the control group and fourth within the test group, whereas the first dimension, the interface and app functions, ranked fourth within the control cohort and third within the test cohort.

With regards to France, the greatest dimension DoA was the second dimension in the test cohort and the first dimension for the control cohort, whereas the fourth and second dimension had the highest dimension DoA. The first dimension, which had the third-highest dimension DoA within the test cohort, had an identical DoA as the fourth dimension, with values of 42.05 and 45.03, respectively. The third-highest dimension DoA for the control cohort was within the fourth dimension. The third dimension that provides a description of information on canteen food had the lowest dimension DoA in both the test and control groups.

In the Greek groups, the second dimension had the largest dimension DoA, that is, 73.30 and 76.77 for the test and control groups, respectively. The DoA of the other dimensions in the control group were identical (first dimension: 52.44, third dimension: 54.40, and fourth dimension: 59.28) and considerably lower than that of the second dimension DoA. The first, fourth, and third dimensions of the test group in Greece had the second, third, and fourth highest dimension DoA, respectively.

The rankings of the dimension DoA were the same in both the control and test groups in the United Kingdom. Similar to the results in Denmark and Greece, the highest DoA was in dimension two for both groups in the UK. The second highest DoA was in dimension three, whereas the third highest DoA was found in dimension one. Finally, dimension four had the lowest dimension DoA in both UK groups.

6. Discussion

In recent years, more and more restaurants and canteens have started a digital transformation by adopting technological alternatives such as e-menus and e-payment

methods, primarily motivated by cost reduction and service improvement (Beldona et al., 2014). However, few of these alternatives are specifically designed to help consumers make better food choices and change dietary habits. With the high population coverage of internet-enabled smartphones/tablets, countless digital interventions have been conducted by various national governments as a cost-effective method for health-related behavioural changes (Webb et al., 2010). One of the targeted behaviours is food choice. Many studies have shown strong links between eating out and weight gain, which ultimately increases the risk for obesity, diabetes, and CVDs (Ayala et al., 2008; Bezerra et al., 2012; Naska et al., 2011). Therefore, catering facilities should be a targeted venue for delivering large-scale digital dietary behavioural interventions.

In a catering service setting, individuals tend to use more elaborate thinking to make decisions compared with the more heuristic, automatic decision making that takes place in food retail settings (Feldman et al., 2015). Consumers appreciate tailored information according to their needs and values, which allow them to navigate the menu more easily and effectively (Rasberry et al., 2007). Therefore, food information provided digitally should also be adapted to the consumers' preferences to elicit more informed food choices. In this study, we investigated for the first time consumers' preferences regarding an e-menu alternative in the FoodSMART app in public catering facilities in both atomistic (individual country) and holistic (all four countries) manners. We identified the factors that consumers value the most in four European countries. The majority of the participants valued the quality and properties of the canteen food (dimension 2) the most, especially the individual factors in that dimension such as canteen food hygiene, sustainability, safety, and freshness. An older survey of over 10,000 participants in 15 countries also revealed that food quality was the top factor influencing food choice in non-digital settings (Lappalainen et al., 1998). That is, in both digital and non-digital settings, food quality is a top influencer for consumers' food choices. Therefore, information related to food quality should be highlighted in e-menu alternatives in the future, providing consumers with the information they require to make informed decisions.

Furthermore, app manageability, food freshness, food sustainability, calorie information, chef recommendations, and global warming/sustainability issues were the top influencers with respect to their corresponding dimensions (i.e. app functions, food

quality, information provision, and food-related ethical issues, respectively) in the combined data from the four countries. This provided more information for attribute prioritisation when addressing specific issues in relation to the aforementioned four dimension themes and more common understandings of consumers' food choices as a whole (across the four countries).

Consumers' preferences in other dimensions such as food information, app functions, and ethical issues varied from country to country. For instance, the Danish consumers were generally more concerned about food-related ethical issues than consumers in the other three European Union (EU) countries (Table 1), possibly owing to the higher percentage of non-omnivore population compared with the other countries. Research has shown that ethical and environmental concerns are one of the prime motives for plant-based diets (Janssen et al., 2016; Rosenfeld & Burrow, 2017). Similarly, the French participants placed higher value on app functionality than participants from the other three countries. This phenomenon could be possibly explained by age differences; because the field test in France was conducted in a workplace canteen, the average age (38.4, SD = 1.38) was almost double the average age of the rest of the participants. These participants were generally less tech-savvy than the rest of the participants, who were mainly Millennials and Generation Z university students (Chaney et al., 2017). Therefore, an app interface that is easier to navigate was essential for individuals in the more advanced age group. The two cases above show that preferences varied by dietary and age groups across the four countries. Therefore, featured app designs that target different population groups should be implemented accordingly. For examples, specific app features that address food-related ethical issues such as environmental impact and animal welfare can be added to the app interface for the Danish version app, while a simplified app interface should be used in catering settings for older consumers.

Apart from the main findings, some limitations of the study should also be addressed. Because of logistic issues, an exploratory study could not be performed prior to the field test to bring additional information into the questionnaire design. Moreover, there were two potential reasons for the inconsistencies observed in the French participants' results among the four countries and between the French control and test groups. The first reason is the language barrier. During the field test, some French participants reported troubles in understanding the app introduction video used

owing to language barriers, which might have caused difficulties in understanding the app functions and interface. Compared to the control group, the test group participants used the app after watching the introduction video. These different experiences might explain why one group focused on the app while the other one focused on the canteen food. However, the results from the opposite groups were relatively consistent (e.g. the questions ranked 1 in the control group were all ranked 2 in the test group). This is possible given that even after using the app in real-life, the language barrier still existed as the app interface was in English. Participants in the French test group still experienced difficulties in navigating the app in English. Participants from the other three countries did not have any difficulties in understanding English. The second reason is the sample size in France (N = 99, control group N = 30, test group N = 69) was much lower than the target 200 sample size, which reduced the statistical power of the results (Mundfrom et al., 2005). This makes it difficult to determine the real reasons behind the change in attitudes. This could also explain the ranking DoA of dimension 2 in the French control group, as it was the second highest instead of the highest, as in every other group. Further investigations (e.g. using a larger sample) are needed to answer these
questions. Another limitation of the study is the electronic devices used during the field tests, which was tablets only, and thus may not truly reflect consumers' responses using other devices (e.g. smartphones). The aforementioned limitations provide valuable lessons to improve experimental designs in future studies with a similar multi-country context.

For future directions, the benchmarked general and specific attributes revealed in this study could be used for designing better e-menu alternatives for catering services in public settings with the goal of eliciting consumers' informed food choices. More specifically, the e- menu alternative in public food services should focus on providing information and designs related to food quality, especially food hygiene, sustainability, safety, and freshness. Factors related to the app design such as app functions, information provision, and ethical issues should be adjusted according to country and population context to achieve effective outcomes. Once such an app becomes commercialised, further data mining can be conducted to investigate behavioural change, and feedback solutions can be incorporated to constantly adapt the interface according to the consumers' behaviour and needs to ultimately guide consumers into

healthier and more informed food choices in public food services.

7. Conclusions

This study provides valuable insights into consumers' preferences regarding an innovative e-menu alternative in public catering facilities. Four dimensions of preferences in app functions, food quality, information provision, and food-related ethical issues were measured. The results showed that consumers in the UK, Denmark, France, and Greece value food quality, particularly food hygiene, sustainability, safety, and freshness the most. Future digital menu solutions should be developed based on this study's findings: with an app design focused on emphasizing food quality and adapted to the specific country and population context to promote informed food choice in public food settings.

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