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Development of Mobile-Accessible Nutritional System to Improve Healthy Food Choices

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Abstract: The aim of this study was to develop a Web-based mobile system providing useful nutritional advice to consumers. This system encourages healthier food habits for sufferers of hypertension or diabetes. In the modern day society, the issues of globalization, consumers' choice and other recently introduced phenomena such as the Internet and the mobile phone are becoming more prominent. Making a decision to buy a product, in the present, can be rather a challenge for many consumers. This can mean that consumers eat foods such as breads, breakfast cereals and biscuit products that they know little about. In this paper, the authors developed software aimed at helping hypertensive and diabetic patients to improve their overall wellbeing. The health of the sufferers of these ailments can usually be improved by healthy diets. After the development of the system, a usability experiment involving interviews with the participants was conducted. Based on the analysis of the feedback a number of relevant findings arose, such as some participants suggested that the system was useful for monitoring their diets. However, few participants were prepared to change their shopping behaviours due to some issues like lack of the relatively small number of consumer products in the nutritional database, which need to be addressed in the future work on the system.

Key words: Diabetes, hypertension, mobile access, nutritional database

INTRODUCTION

The modern society has been dramatically changing in the last few decades. The customary ways of living of the past are being replaced by new trends and habits, which are more adapted to the continual evolution of technology and science. At present, rapid developments in technology have created an environment where people are faced with many consumer choices and may find the amount of available products on the shelves of supermarkets as confusing. This may lead to over consumption of various kind of food which may have a detrimental effect on the health of the consumer.

Moreover, now consumers expect more personalisation of the products and services that they purchase. The world has become smaller due to the improvements in transportation and communication infrastructure. People can achieve more by doing less. This all has translated into lower levels of activity amongst the general population. Even though medical science has been also rapidly developing, the overall reduced activeness of people and, in some cases, confusing advertisement messages from the corporate world that promote snack food and unwholesome eating have meant that the health of many people has deteriorated in the last couple of decades.

In recent years, especially the last decade, almost every product on the market has a linear barcode, an optical machine-readable representation of the product number, referred to as a Global Trade Item Number (GTIN). This has been particularly convenient to obtain cost and additional information such as the country of origin, manufacturer code and other product data via a computer database with the product number as the lookup key. Within a few seconds, with the help of a linear barcode scanner product details are obtainable. At the same time, researchers have been achieving success in developing smarter and smaller devices such as mobile phones and PDAs (Personal Digital Assistants) (Chai and Hock, 2006). Owing to the increased integration of cameras and mobile devices into personal image capture devices, mobile phones can now be used as an additional means of user input and a source of context data (Rohs and Gfeller, 2004).

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Background: Currently numerous phone models with in-built cameras are being developed throughout the world each day. As a result of such a rapid expansion of the range of phone models, it is important to have a scan application that is flexible enough to be used on literally all of them. Furthermore, the database that contains all barcode information has to be increased simultaneously; otherwise people can face a problem where a particular linear barcode number is missing from the database. If this is the case, none of information such as nutritional information or useful recommendations such as how much to eat can be provided.

Whitworth and Chalmers (2004) define hypertension as "raised blood pressure" that enforces extra pressure and stress onto the coronary arteries as well as circulation in general. Diabetes is an abnormal state of health marked by insulin deficiency. Type 1 Diabetes, also known as Juvenile Diabetes, is a chronic disease that relies on daily medical management for optimal glycaemic control (Juvenile Diabetes Research Foundation International, 2009). Hypertension and diabetes have become two of the most common health problems within the Western population, where dietary and lifestyle factors have shown to be major contributors. Sacks *et al*. (2001) claim high consumption of processed food products that contain excessive amounts of sodium, saturated fat and energy has become part of the normal daily diet. Such a diet has been proven a major cause of these ailments (Diabetesmellitus-information.com, 2006).

Even though there are two types of diabetes, this paper will cover only Type 1 as it is more critical and diabetics with Type 1 have an absolute requirement for insulin, therefore it is very important to determine how much insulin to take according to the amount of carbohydrate that is consumed. Type 2 diabetics are more of a spectrum, where people have a reduced responsiveness to the insulin that they still make; therefore not all Type 2 diabetics need to inject insulin.This paper aims to demonstrate whether implementing dietary changes can have positive effects on health. The authors are particularly interested in the effectiveness of the DASH (Dietary Approaches to Stop Hypertension) Diet (Vollmer *et al.*, 2001) that can help reduce blood pressure, and assist a Type 1 diabetic patient to calculate their insulin needs with less anxiety and further health complications.

Goals of the paper: Therefore, the aim of this study is to analyse consumer's bread, breakfast cereal and biscuit product purchase and educate them on the level of sodium and saturated fat present in each product. The consumption of these products can be decreased through the use of mobile phone technology. It was impossible to cover every product on the market in this pilot study. Thus, only these product categories were chosen due to the high consumption and their general contribution to daily sodium intakeIt is expected that gradually people will become familiar with the sodium and saturated fat levels within these food groups, therefore become less reliant on the mobile phone technology to access nutritional data. This will help them begin to choose healthier products based on knowledge and learnt behaviour, which will have a long-term health benefit to people who use the system. This can be achieved by using a mobile system because consumers need to have access to the nutritional information at the time of purchase. The best way to achieve this result is to use a web-based database system in conjunction with a mobile device. The benefits of using the online database are its ability to be continuously enriched with new products and its accessibility on a multitude of mobile devices. Furthermore, due to their widespread use in the general population it was reasonable to use mobile phones as a part of this project.

At the present, camera phones can scan several types of barcodes. Only two barcodes, linear (1D) and quick response (2D) barcodes (Technoriver, 2004), are important as they are widespread throughout the marketplace and contain all necessary information consumers may require. So far, more emphasis has been placed onto the development of 2D barcode systems for accessing nutrition information.

The topic of this study outlines the significance of such an innovative area that will help to promote the importance of health benefits to many people, simply by making informed decisions when grocery shopping. Such essential recommendations endeavour to provide positive results such as improved health and overall wellbeing. This system will help to defend against such major community threats as diabetes and hypertension. The development of this system is unique as no researchers have addressed such a system. No web-based, mobile phone technology for hypertension and diabetes exists.

In order to achieve the desired system, the authors separated the project into two stages. Initially the authors developed the novel system and then undertook usability testing of it to determine the effectiveness of the system. Therefore, the research aims to determine if using a mobile phone device that scans a barcode to access nutritional information in breads, breakfast cereals and biscuit products will produce a behavioural change amongst people who are suffering from hypertension or diabetes. Furthermore, it is aimed to determine if a reduction in daily sodium and saturated fat consumption can be achieved via use of the mobile device. The portable nature of the technology is likely to allow the diabetic purchaser to try new products more easily. Mobile phones access, through the scanning of the product's barcode, a purpose built Internet database containing nutritional information related to that product to help guide the customer to make a healthier choice.Another distinguishing characteristic of the development of the mobile-accessed nutritional database is to collect as much data as possible. This includes gathering barcode numbers of current products available on the market. Without limitations, the database must contain almost all products of a similar nature such as cereals, breads and biscuits to name a few. Therefore, it is not enough just to develop software for this project. The gathering of barcode numbers is as vital a requirement and should be done in parallel in order for the project to work. Presently, the database for this project contains around 500 products from two leading supermarkets in Australia.

Presently, a process applying 1D barcodes and camera-phones has not fully been developed by other researches. The closest investigation to this research was done by GS1 (GS1 MobileCom, 2009).

Essential recommendations like how much to consume endeavour to provide positive results aimed at improving dietary habits of consumers. Moreover, the connection between developing new models of mobile phones and producing modern food products means the database should be continually expanded. The expansion of the database is an ongoing process and will continue while 1D barcodes are used in the marketplace. In the current and technologically progressive age, such systems will be applicable for decades to come.

This study benefits two groups of the population with the first of them aimed at people above forty-five years old, and in most cases unhealthy. People from other age groups who are interested in improving their health by making more appropriate food choices will also participate. However, the stakeholders of this project are not limited to consumers only; they can be divided into the following groups (GS1 MobileCom, 2009):

- **Brand owners:** will provide extra data about the products they manufacture.
- **Retailers:** will provide extra data about the products they sell.
- **Mobile Phone Operators such as Vodafone and Handset Manufacturers, for example, Nokia or Sony Ericsson:** will provide value added services to their consumer base (SMSs, MMSs, and GPRS).
- **Service and Solution providers (reader application developers and information aggregators):** will be a link between brand information and consumers' mobile devices and interoperable network.

The result of this system analysed in this paper is to develop software that can provide consumers with useful nutritional information and health advice about food products via the mobile phone; for example, the amount of a product one should consume. The results and advice can be different for each consumer, however, it is essential that most camera phones be able to retrieve and display them.

Hence, a system like ours should be able to do the following:

- Scan product barcodes (linear barcodes).
- Obtain supplementary data about products using camera-phone devices.
- Grant generic information about products as well as recommendations.
- Keep a scanning history of each consumer.

LITERATURE REVIEW

This review will discuss previous study, and display a comparison of different approaches in the quest to help sufferers of Type 1 diabetes and hypertension to improve their health and to lead a normal life. Additionally, it will show the significance of this project as well as highlight technological methods that have not attempted to achieve the goal of this paper.

Extended packaging: The development of mobile-accessed nutritional database, known as Extended Packaging (GS1 MobileCom, 2009), is one of the applications for mobile commerce. This has been identified as relevant for the Fast Moving Consumer Good (FMCG) supply; for instance, food products, self-hygiene products and some other products that have a short shelf life. Extended packaging means giving consumers access to additional information or services about products through their mobile phone. It is the ability to retrieve additional information about the product through mobile devices or in general to link a product with virtual information or services. Some examples are allergen information, language translations, recipes and usage instructions. Consumer needs are better met in this way since it is not feasible to print everything a consumer might want to know on a product's packaging or a store shelf.

Extended packaging provides a solution (GS1 MobileCom, 2009) to:

- Requirements of consumers for additional product information.
- Constrains of packaging to display much product information.
- Untailored information on packaging for the individual needs of consumers.
- Record consumers' preferences.

A system that considers 1D barcodes and camera-phones was attempted by GS1 and divided into four steps: packaging, consumer experience, and information exchange and information storage. The four steps are as follows:

- Packaging includes affixing barcodes on products. Barcodes have to be pre-registered in a system using Global Trade Item Number (GTIN is an identifier for trade items developed by GS1).
- Optimising consumer experience is the process of scanning barcodes using an application installed on mobile phones that is very simple and well-designed. The system automatically detects what barcode is being scanned and what phone is being used by consumers. After accessing a product database, the mobile phone will display all significant information about the scanned product and format the screen accordingly.
- Information exchange is a process of interaction with a server using standard protocols (sending and receiving information to and from the server). The mobile phone has to establish the connection to the server via the Internet in order to send request and receive incoming packets of information.
- Information storage involves use of a secure database which contains product information.

The extended packaging of GS1 is quite a well-designed system designed for both 1D and 2D barcodes. However, the far majority of products in the world are labelled with 1D barcodes, which makes it a more useful and widespread way of storing product information. Currently only a small number of Japanese companies use 2D barcodes. Regardless of the fact that the 2D barcode is able to contain so much more information, 2D barcode usage is still rare.

GossRSVP: Another investigation completed in 2008 by Goss International Inc., involved the development of a system which was aimed at scanning 2D barcodes in advertisements printed in magazines, and linking them to online resources (Goss International, 2009). The result of the development was GossRSVP™, a mobile phone technology designed to work with all types of print. This system provides a cost effective measurement tool that is affordable by even the smallest of advertisers.

GossRSVP™ allows advertisers to see in real time which print advertisements are more popular with the consumers exposed to them. The key benefits of the system according the developers are the following (Goss International, 2009):

- A gauge of interest in the advertisement.
- A digital medium for print marketing campaigns.
- A novel and interactive method to respond to printed advertisements.

The system utilises the advantages of an array of technologies including mobile phones, web browsing, text messaging, camera and barcode scanning. It is possible for readers to send a message about the advertisement to Goss International Inc., which relays back some additional information such as promotional rewards or marketing data (Goss International, 2009).

As the application provided by Goss International Inc. scans only 2D barcodes, it cannot provide any nutritional information, nor can it be ascribed to the nutrition extended packaging.

Mobile multi colour composite: The interest in new methods of product identification has been strong since the very first days of the mass production era. From inventory management in stores to automotive part tracking in assembly plants, barcodes are one of the most prevalent automatic identification and data capture technologies. Dr. H. Kato and Dr. K.T. Tan from Edith Cowan University (Perth, Australia) focused their research on recent developments in barcodes, including study of colour barcodes for mobile devices. In their work, the authors presented design details for a novel colour 2D barcode: the Mobile MultiColour Composite (MMCC) barcode. They concentrated their attention on inventing various algorithms for scanning barcodes faster, better and more accurately (Kato *et al.*, 2008).

> "The MMCC is a colour two dimensional barcode designed for storing high capacity data on printed media and displays, tailor made for camera mobile phone applications" (Calvo, 2009).

By using the mobile phone, various kinds of information can be accessed by scanning the MMCC barcode including videos, music and text. The decoding of the barcode happens in the mobile itself regardless of whether it is connected to the Internet or a mobile network at the time. This means that this system can be used in areas where the Internet is unavailable.

This technology has been found by the cattle and meat industry as a possible database tag which can store information about the breeding, veterinary and slaughterhouse history of meat products in a supermarket.

The authors believe that this technology has some potential in the retail markets as a source of useful information for consumers. However, the drawback of the MMCC barcode at the moment is its limited penetration into the marketplace (Calvo, 2009).

Context-aware mobile services: Another comparable project involving mobile devices was developed by a number of researchers from Cambridge University (Toye *et al.*, 2004). Their work aimed at investigating ways to utilise camera-phones to access web pages, by photographing "machine-readable visual tags" representing URLs. The main goal of this project was to create an interaction technique that allows users to use their camera-phones and visual tags. Visual tags represent specifically developed circular barcodes which contain information resulting either in information being displayed or in an action being performed.

Toye *et al.* (2004) claim that in order to use a visual tag, a user needs to activate the Mobile Service Explorer software on the phone. This enables the embedded camera in the mobile phone to continuously capture video in real-time until a tag is clearly visible. There are a number of limitations that users face when using the mobile phone. This approach overcomes some of them by utilising the following methods:

- Visual tags and public information displays instead of small screens and keypads.
- Personal information stored on the mobile phone to drive context-aware services that activate user-specific actions.

Although this approach addresses a number of important shortcomings of using mobile devices, it does not fully solve them due to the experimental nature of the project (Toye *et al.*, 2004).

Web-based diabetes applications: Web-based application is an online web application (Ironman, 2009) created very recently to help people who suffer from diabetes. People that require medical advice pertaining to the amount of units of insulin per dosage are able to determine this in detail via the portal. The web application is quite simple and easy-to-use. The prototype interface helps people to count the amount of insulin without the user calculating the amount themselves. All calculations are done automatically once a user has typed the information such as carbohydrate intake and activity level.

Ironman (2009) states that the prototype interface aims for diabetics to understand that this is a proof-of-concept of how it is possible to create an online application for calculating insulin dosage levels that would be accessible from a number of devices. These devices include any Internet-access capable devices from PCs to game consoles, to mobile phones, to electronic readers, and to many others. Despite its ease of use, there are several different factors that are used to determine insulin dosage factors, which this proof-of-concept tool may not cover. For instance, the "default" unit insulin dose reduces blood sugar by 55 points in this diabetes calculator, whereas other types of insulin dosages may affect blood sugar levels by a higher or lower amount. Besides, there is an entire review process that this tool will need to pass through before it might be considered to be an appropriate method of calculating an individual's correct insulin dosage level.

Another important tool in the area of the web is the weblog. Sufferers around the world with any type of diabetes are called to share their own experience of what they have been facing with diabetes and how they have dealt with it. By posting messages, people not only provide information for further research but also help others who need proper advice (Weblogs Inc, 2010).

These systems cannot scan barcodes and provide the necessary information regarding products on the market. Eventually, the system cannot be acknowledged as a portable system unless it deals with mobile devices.

Functionality of nutritional database system: Before consumers can go through the process of purchasing products and using them with the system, they have to be registered in the system. For these purposes the registration page was created. Necessary information such as date of birth, gender, weight, height and many others are entered during registration and used during subsequent calculations. This information is kept in the database and it is easy for consumers to change some details like weight at any time.

When consumers have registered in the system they are able to get information about products as well as recommendations. For these purposes the main pages were developed; thereby, the main pages are the web pages that reflect the whole information on the screen of mobile phones. However, before consumers can see any information, they must input the username and password first. It is very important to log in because the system should know what user details are necessary to obtain from the database. In addition, the system should know for what health condition it is necessary to provide results: hypertension or diabetes.

Consumers need to click the "Target" button to obtain recommendations for the selected product. There is the information calculated according to the personal health conditions. Author 3 and author 4 provided Basal Metabolic Rate (BMR) and Basal Energy Expenditure (BEE) formulae. As it is crucial to exclude any types of errors these formulae were checked and proven. The system also provides the recommended daily saturated fats and sodium intake per day. Besides, it shows the percentage of the user's daily recommended intake that the scanned product contributes in one serve. To make it more obvious for consumers a traffic light reading was developed.

Traffic lights represent three different colours:

- The green colour means that the product contains a low amount of the harmful nutrients (e.g., saturated

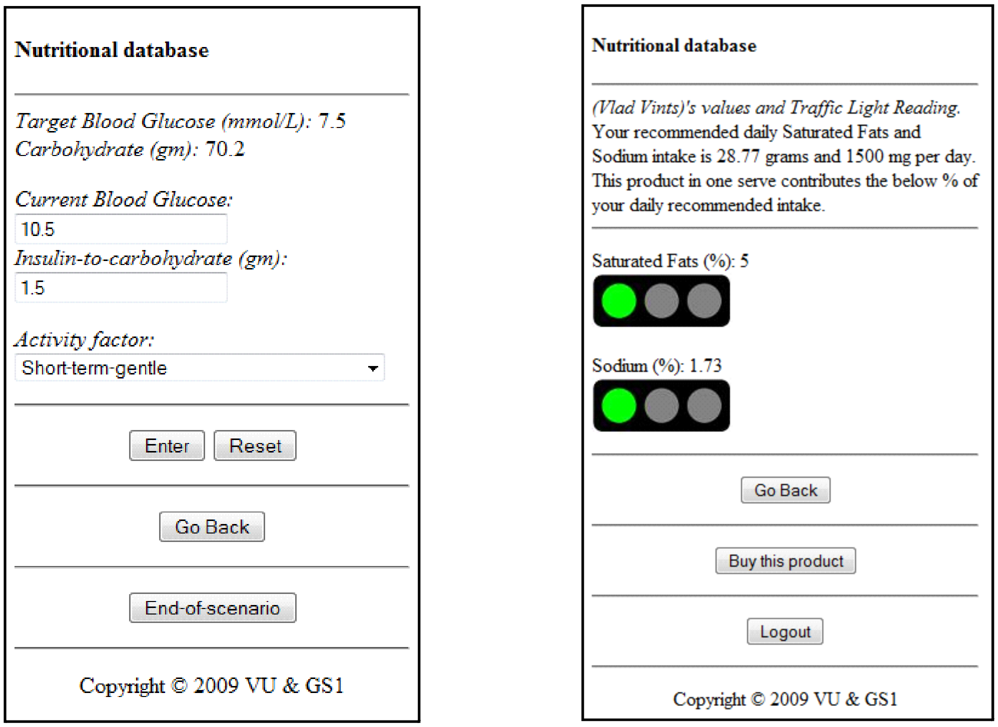

Fig. 1: Diabetes and hypertension pages

fats) and the consumer may eat the product without any problems.

- The amber colour means that the product contains a medium amount of the harmful nutrients which means the consumer needs to refrain from consuming the product.
- The red colour means that the product contains a relatively high amount of the harmful nutrients (e.g., sodium) that the consumer is recommended to minimise consumption of the product.

One of the main goals of this development was to produce software which would provide useful advice on healthy food choices thus helping consumers to improve their well-being. In order to cater for a variety of possible consumers the system has a simple and user-friendly interface, which allows anyone using a mobile phone to cope with web portals. The developed pages pass through the process of getting the information from start to finish by guiding the consumer through them.

Consumers, in order to use the system to obtain valuable nutritional advice, first of all, need to register themselves in the system. Then, after logging in, they can review the nutritional information about a scanned product and obtain useful advice via the use of the nutritional information pages or the insulin information pages. This entire process is quite straightforward and requires little time and effort from the consumer. Thus, from the consumer's point of view, the nutritional database system presents a powerful and easy-to-use tool in their quest to improve health.

The authors believe that there is a consumer market for mobile phone delivered information, where consumers use the barcode-accessed nutrition advice platform with personalised web pages for calculating carbohydrate-to-insulin requirements and accessing the nutrition information. Also, the author thinks that these web pages are potentially practical to use and can increase confidence levels when calculating insulin needs and providing healthy food advice, allowing the diabetic and hypertensive patient to widen food choices.

The implementation of the project required the use of different algorithms and approaches. For all programming purposes and storing information in a database, the Java language, Apache Tomcat and MySQL were used accordingly. The development of the software was undertaken in such a way as to comply with the requirements set out at the beginning of paper. All information including registration details and nutrition information is kept in the database. As any data is confidential, it was very important to use various secure methods to prevent any disclosure of sensitive information. To achieve a satisfactory level of security algorithms such as Data Encryption Standard (DES) and Message-Digest 5 (MD5) were used in this project.

In order to achieve the main objective of this project, i.e. improvement of consumers' healthy food choices, a number of formulae were used to provide recommendations. These formulae take necessary values from the database and count how much a product (per serve) contributes to the recommended daily sodium intake for a particular consumer. For hypertensive patients such information is useful as it assists them to improve their health and overall wellbeing. The traffic light reading was developed to establish what products can be eaten without detrimental affects to the health. For some people visual demonstration is much easier to comprehend than countered results (Fig. 1).

For the purposes of developing the database for this project, the author utilised MySQL 5.1 with the JDBC connectivity driver. This querying language was chosen for this database because of a number of reasons, such as, its availability, ease of use and versatility. All tables, relationships between them and data were created by means of submitting queries to MySQL. The information about the consumer products was provided as excel spreadsheets by the biomedical collaborators of this project. Then this data was uploaded into the database for further use.

For the purposes of transferring any confidential information through different pages the DES algorithm (Next Wave Software, 2008) was used.

It used strong encryption and a faster algorithm for protecting sensitive commercial and unclassified data. DES is a 64-bit algorithm that performs only two operations: bit shifting, and bit substitution. In areas such as banking, people try to use more secure algorithms such as Triple-DES (3DES), Advanced Encryption Standard (AES) or Ron's Code (RC2). However, the level of security provided by the DES algorithm was found adequate for the purposes of this project.

DATA ANALYSIS

Analyzing the scope and needs of this project, one applicable usability method has been selected. There are three different types of questions which were used. The first type is the closed-ended question with 'Yes' or 'No' answers. The next type of question is the Likert scale used for measuring opinions, attitudes and beliefs as well as for evaluating satisfaction with systems. Lastly, the open-ended question is where the participants have to provide their own comments. Sometimes This type is also called 'free' questions allowing participants to write anything they like, usually not limiting them. There are several reasons for selecting the questionnaire-based method.

First, organization of questionnaire-based interviews (Appendix A) does not involve big financial outlays. Second, since participants have only to answer specific questions, a more straightforward collection of data is possible. Third, the uniformity of questions means easier data analysis. Taking into account the fact that only 15 participants were available for this analysis, the authors thought that questionnaire-type interviews would be the most appropriate.

By collecting and analysing data from a number of interviews with participants, the authors highlighted some useful information. The results of the analysis shed some light on the perception of the concept by the participants. It has allowed the authors to derive a number of interesting ideas about the nutritional database system and has helped to identify several areas for improvement. This section explains the work carried out by the authors in relation to collection and analysis of data obtained from the participants.

Having completed the interviewing process, the data obtained from the questionnaires was processed and analysed to evaluate the usefulness and usability of the system. All data was summarised into tables and input into an Excel spreadsheet to represent the results of the interviews graphically. Individual answers were summarised, put into a table and then used to make graphs. Due to the similar nature of some questions, the author grouped them into 14 sections represented by graphs.

The graph for the first group of questions shows that the majority of the participants were quite satisfied with the scanning process (Fig. 2). These three questions were meant to evaluate the participants' views on the usability of the scanning module. The questions were grouped together because they ask the same questions from different points of view and, thus, reinforce each other. Question 2 and 3 ask how easy it is to operate the mobile phone camera to obtain scans of barcodes. The difference between these questions lies in their wording. Thus, the reason for using both of them is that their answers confirm the validity of the participants' feedback

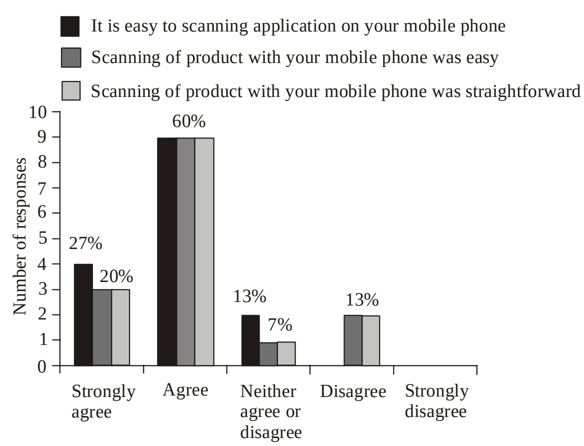

Fig. 2: The scanning module

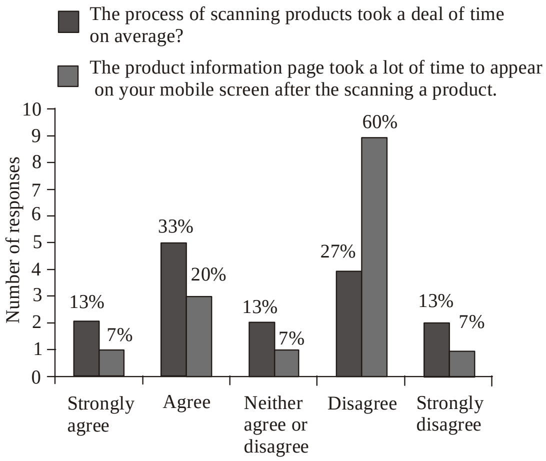

Fig. 3: Time requirements

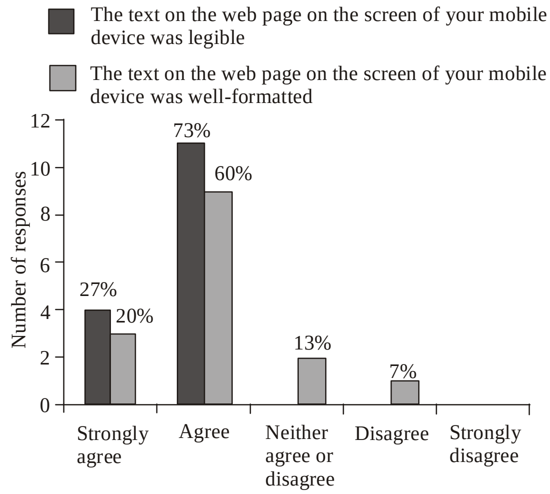

Fig. 4: Text legibility

regarding the scanning process. The answers to these questions show a uniform distribution where the majority of the participants agreed or strongly agreed with them. This means that more than 80% of all participants had few issues with the scanning process and thought that it was easy and straightforward to use the mobile camera to scan barcodes. The rest of the participants had some constructive comments and suggestions towards improving it. For example, participant 12 wrote: 'Sometimes hard to focus on the barcode', and participant 2 commented: 'Trying to position product + camera in busy supermarket was not easy'. This indicates that even though the scanning module, in general, satisfies the requirements of the majority of the participants, there could be a few improvements aimed at solving the issues with wrinkled and stained barcodes as well as dark coloured backgrounds.The next set of questions asked the participants to rate their satisfaction with the responsiveness of the scanning unit (Fig. 3). These two questions deal with the issue of how long it takes to complete a single scan and display the appropriate web page. They approach the issue of the quickness of the system from two different angles. Question 4 implies that the scanning process is slow and asks participants to provide their thoughts regarding this statement. Additionally, Question 5 narrows the statement down by asking participants to evaluate the time taken for the page to load after the scan. In answering Question 4, 46% participants agreed with the statement that scanning a product took a good deal of time on average. However, there was a pronounced disagreement with Question 5, which asked that it was time-consuming to open product information pages. Almost 70% of the participants disagreed with Question 5. The feedback received on these questions shows that even though many participants judged the scanning process as slow, only 27% of all participants thought that the process of retrieving nutritional information from the database was unsatisfactory. This means that the scanning unit should still be improved and made faster. The reason for agreement with Question 5 by 27% of the participants is attributed to poor reception of mobile phones when scanning occurred.

The questions displayed in the next graph (Fig. 4) deal with text legibility on the mobile phone screen. They were grouped due to their similarity and the fact that they specify each other. Even though one participant thought that the text in the web pages was ill-formatted, overall majority of the respondents agreed with the statements. Based on the analysis of these questions it is clear that this part of the system requires insignificant improvements if any.

In relation to scrolling the pages, the views of the participants differed (Fig. 5). Almost half of them felt that the pages were too big and thus they had to scroll them too often. Nevertheless, there were those who disagreed with the statement and thought that it was expected to scroll pages often when using the mobile phone. For instance, participant 12 indicated: 'Did have to scroll but this didn't phase me'. Most current mobile phones have relatively small screens and thus people are used to scrolling when browsing the Internet on their mobile devices. Future technology may alleviate the problem, however, it cannot be solved at the moment without compromising the formatting of the web page content.

The results of the questions dealing with the web page appearance evidence that the overwhelming majority of the participants were satisfied or very satisfied with the screen design on their mobile phones (Fig. 6). Even though several participants chose 'Neither agree nor disagree' as their answer, their comments indicate that, in general, they were satisfied with the visual representation

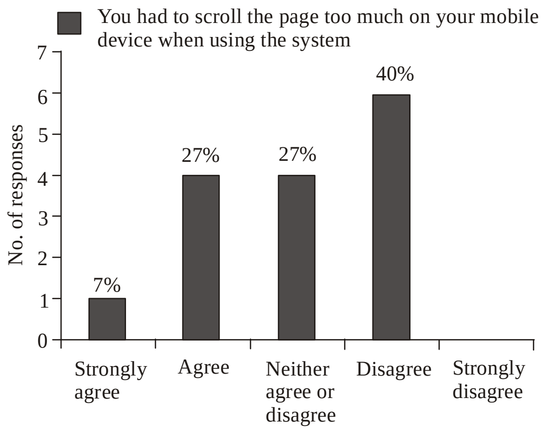

Fig. 5: Web page size

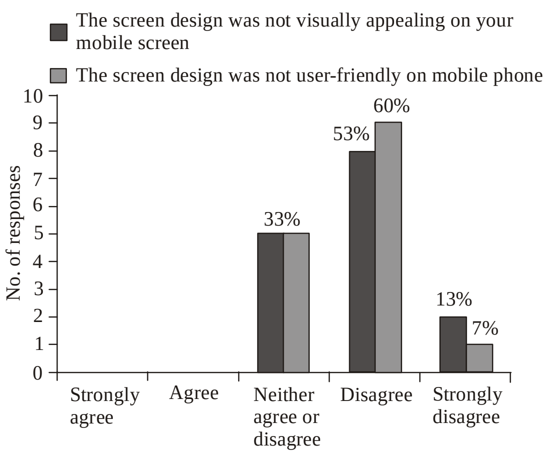

Fig. 6: Web page appearance

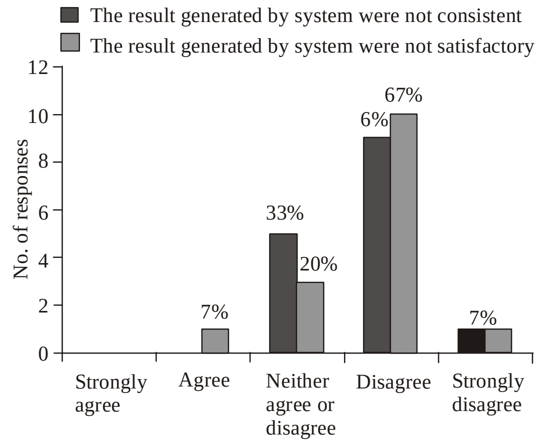

Fig. 7: Web page navigation

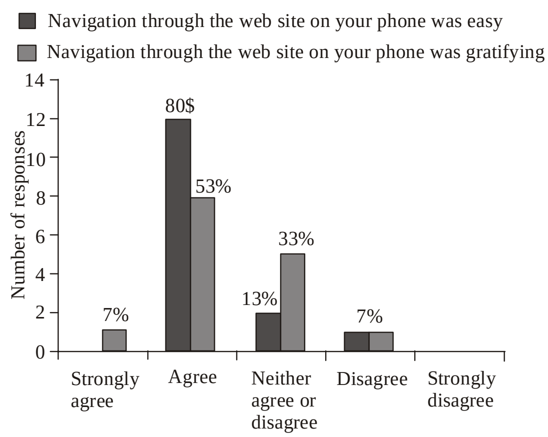

Fig. 8: Result generation

of web pages. The results show that there is no urgent need to change the visual design of the system, however, due to the 33% undecided participants there is still room for improvement. For example, according to the comment provided by participant 1: 'Non-registered products should have come up with a simple message to advise - to avoid wasting time in retrying and navigating through screens', the screen design can be improved by implementing simpler error messages. It should be understood that due to the constant release of new consumer products it may difficult to maintain a complete database of the products. Since the link between GS1 and nutritional database for the purpose of the trial had not been fully established, the nutritional database currently needs to be manually updated.

In answering Questions 11 and 12, the participants indicated that navigating the web pages was easy in most cases. 80 and 60% of all participants agreed with Question 11 and 12 respectively. Only one respondent stated that it was hard to navigate the system due to ambiguous warning messages and the size of the mobile screen. Despite the fact that these questions read very similarly, they have a slightly different meaning. On the emotional level, the participants thought that navigation of the web pages was less satisfying than it was easy.

For instance, participant 9 noted: 'With use it became easier' (Fig. 7). It appears that the more the participants used the system the more accustomed they became with navigating it. The results of these questions indicate that although this system has quite a steep learning curve, the participants had to spend some time using it to adapt to it emotionally.

With regard to the group asking questions about the results generated by the system, the participants indicated overall satisfaction writing responses like: 'The use of traffic lights were brilliant' and 'depended upon products scanned, but were consistent to product specs' (Fig. 8). Only one participant thought that the advice generating part of the system could be improved. However, the rest of the respondents indicated that the results provided by the system were consistent with their expectations. This

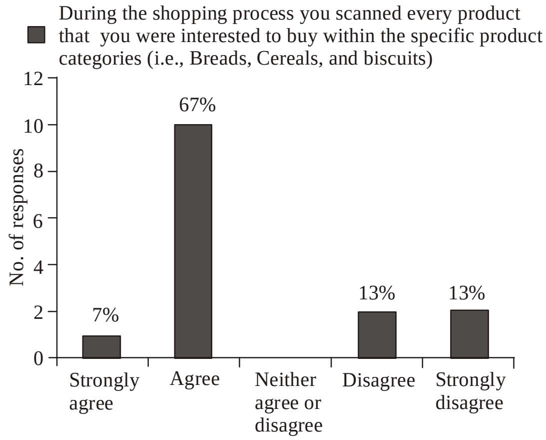

Fig. 9: Frequency of scanning

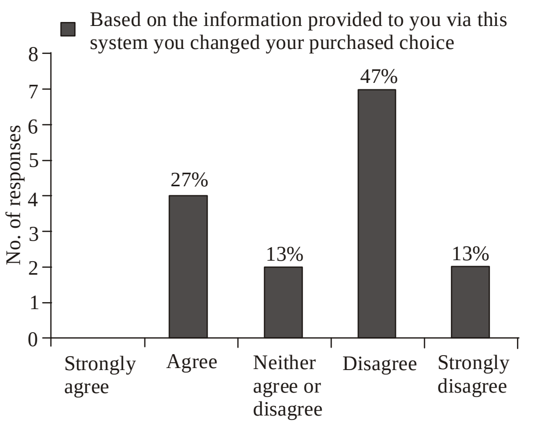

Fig. 10: Shopping behavior

means that the system could be considered for an update as new nutritional formulae become available. However, at present the system does not require any improvements in this area.

The analysis of Question 15 reveals that 74% of all participants scanned the products in which they were interested. That means that the system generated interest in the participants. Only a few participants disagreed with this statement and wrote: 'Did not take the phone shopping' (Fig. 9).

The graph of Question 17 (Fig. 10) shows that 60% of all respondents clearly stated that they did not change their shopping behaviour as the result of using the nutritional database system. Another 13% of the participants stayed undecided about changing their shopping behaviour. For example, participant 20 commented: 'My purchase choice has not changed, however, my awareness of how much intake per day is permissible has allowed me to re-think what I should be eating'. The other 27% agreed with the statement indicating their willingness to change their shopping

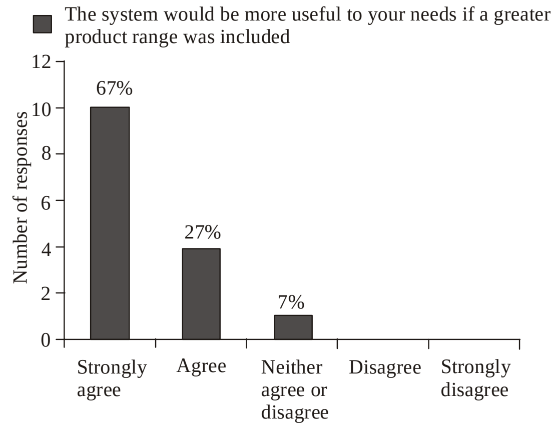

Fig. 11: Product range

preferences. The analysis of this question indicates that the participants are not prepared to completely change their shopping behaviour when using the system. However, there was also some feedback showing that they would continue to buy the product for their family, but reduce personal consumption of it due t o becoming educated through the use of the system. Moreover, some participants are not ready to do that mainly because of the lack of products in the database and the problems with the scanning unit. Such problems include but not limited to occasional issues with focusing on the linear barcodes and dealing with uneven surfaces of products' packages. As the product range in the database becomes expanded, it is expected that more and more consumers may be prepared to adjust their product preferences in line with the system recommendations. Besides what has been said above in relation to this limits of the product database, in answering the other questions the participants indicated their strong support for this system. Thus, the author thinks that with additional updates the system may have a bright and successful future.

As expected by the authors, the participants indicated that the system would be more useful if the nutritional database contained a wider range of products (Fig. 11). The results of this question provide support for the explanation to the previous question (Question 17).

According to the analysis of Question 16, it can be seen that 79% of the participants did not experience any trouble with connecting to the Internet (Fig. 12). The fact that the majority of the participants could use the system without any connectivity trouble acts as proof of the viability of this concept. Despite the fact that 21% of the participants experienced issues with the connectivity to the Internet, this is an external problem and can be only addressed by mobile phone manufacturers and Internet Service Providers (ISP).

The graph for the question asking the participants about the overall satisfaction with the system shows that

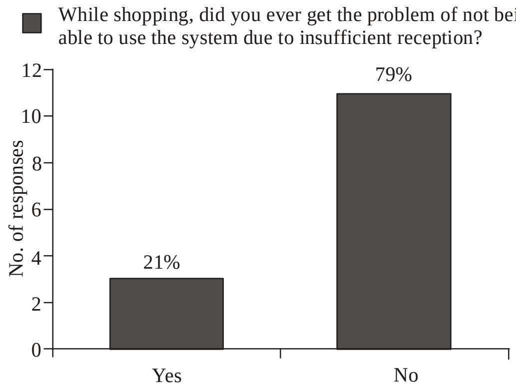

Fig. 12: Reception

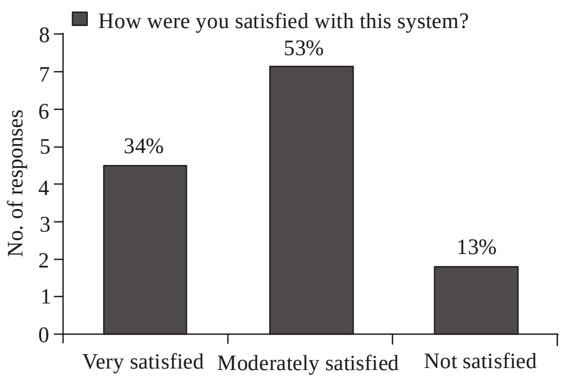

Fig. 13: Satisfaction

only 13% were unsatisfied (Fig. 13). Whereas 87% of the participants were either moderately or very satisfied. This is a good indication that the software satisfied the majority of the requirements, which consumers could expect from this kind of system.

The future work on the system will most likely reduce the number of unsatisfied consumers. To strengthen the previous finding, the analysis of Question 20 states that 73% of the participants would like to continue using this system in the future. Participant 10 said: 'Would love a phone that you scan everything in the supermarket' (Fig. 14).

It turns out that the participants felt that they were limited by the number of the products available in the database. Finally, the last question in the questionnaire asked the participants to write how many times they would consider scanning products per shopping session. Two groups of participants of 31% each equally answered that they would scan between 4 and 7 or between 8 and 11 products per shopping session respectively. Whereas other two groups of 15% each remarked that they would like to scan 12 to 15 or 15 and more products. Only 8% decided that they would consider scanning between nil and three products every time they go shopping as it is shown in

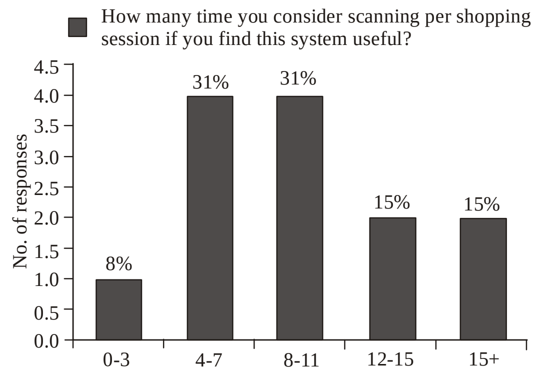

Fig. 14: Future usage

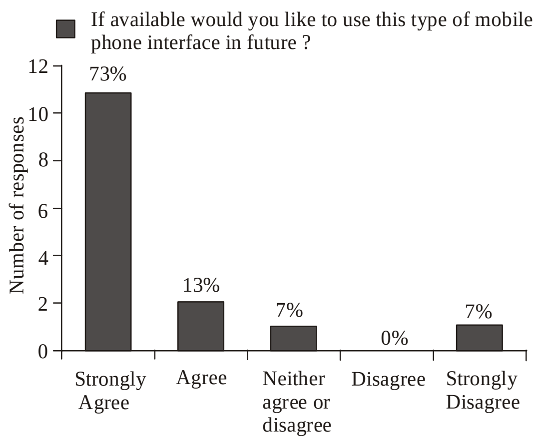

Fig. 15: Quantity of scanned products

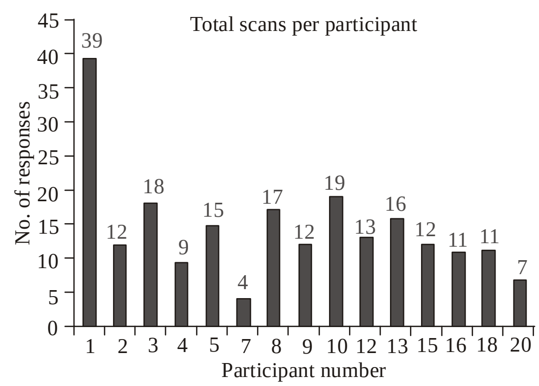

Fig. 16: Participants' scans

Fig. 15. These results come as evidence that the participants would frequently use the system if all the above stated concerns were removed.

After analyzing the data on the frequency of scanning, it is apparent that all the participants were quite active with each accumulating on average 15 scans at the end of the trial period (Fig. 16). This shows that the

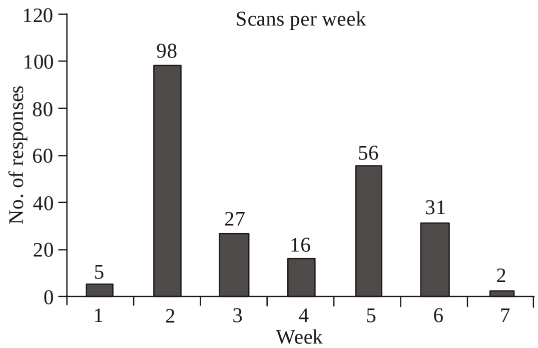

Fig. 17: Weekly scans

participants were quite interested in using the nutritional database with only one participant accruing only 4 scans. On the other hand, participant 1 was extremely active with using the system and managed to have done 39 scans by the end of the trial.

As the next graph shows the distribution of the scans follows a distinguishable pattern (Fig. 17). The majority of the scans occurred in the first week of the trial. As expected, the participants were interested in testing the system and thus were scanning many products. In the next two weeks the number of scanned products significantly dropped. This happened due to the fact that the participants became used to the system and were less likely to use it as frequently as in the first week of the trial period. In the week when the majority of the mobile phones were collected from the participants, there was another spike in the number of scans. It can be explained by the desire of the participants to check the nutritional information of the remaining products in which they were interested.

Results from this 8-week study intervention showed the successful development of a database that provides nutritional information after scanning the barcode of breads, breakfast cereals and biscuit products. Even though no significant changes in diet consumption and food purchases within the participants were observed between weeks 1-4 compared to weeks 5-8, the concept of the device and usability were given positive feedback. Participants noted that while they continued to buy the product for their families, they themselves tended to restrict their consumption of a product that had higher levels of sodium and/or saturated fat.

In regards to the nutrients analysed, no statistical significant findings ($p>0.05$) were found. The variability of dietary intakes of each participant as well as their overall perception of using the mobile phone device affected the clarity and consistency of the results.

CONCLUSION

It is speculated that in the last decade the use of computers and the Internet has become widespread and the majority of people at least in Australia now carry a mobile phone. The new generation 3G phone allows access to the Internet whilst on the move. The rapid development in worldwide technology is leading to major changes in the way medicine and health care are being delivered. New technology is allowing active involvement by patients to receive immediate feedback from medical professionals. Technology, such as the Internet and mobile phones, holds some great potential for providing quick and easily accessible information in many areas of healthcare. This study showed that mobile phone technology could be applied to read barcode labels on food products and to access nutritional information. This technology assists patients in making personalised informed health decisions based on their dietary condition before purchasing the product.

The usability experiment conducted after the development of the nutritional database system provided insight into the usefulness and relevance of the system. The data obtained from the questionnaires indicate that there is an overall support of the system amongst the test participants with minor concerns about the scanning part of the project. The majority of the test participants responded that they were either moderately or very satisfied with the system. Even though the shopping behaviour of the participants did not changed significantly as the result of the test, it became clear that many of the participants thought that it was very useful to use the system to identify healthy food products and to keep track of the sodium and fat intake.

Health delivery practices are shifting towards self-care to manage chronic conditions. This has implications for health delivery costs, the availability of healthcare services and increasing the quality of life. Mobile phone technology allows the user to access nutritional information of food products by using the camera as a scanner to identify the product. The application then connects the user via the Internet to a database and provides calculations on web pages. This database provides the user with information tailored to the individual user's requirements, thereby aiding the user to manage their chronic condition.

The aim of this research was to investigate if a mobile technology can deliver a service aimed at reducing blood pressure in hypertension sufferers. It evaluated the capacity of the technology to assist in increasing levels of confidence of consumers when calculating insulin requirements and performing dietary modifications. It also assessed the user experience of the technology.

It is speculated that this project may have an exciting future. It only started exploring the possibilities of mobile phone technology, however, it is quite important to keep updating the model range of supported mobile phones as well as increasing the product database. To ensure wider penetration of the market, it is crucial not to limit people by the amount of supported products and phone models.

It is also important to make sure that the correct barcode numbers of products are maintained in the system. As the understanding of management of chronic conditions such as hypertension and obesity increases, new ideas and formulae will be devised. For this software, it means that as new formulae become available it will be important to incorporate them promptly to reflect better understanding of the medical conditions.

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Appendix A:

It was easy to start the scanning application on your mobile phone.
• Strongly agree • Agree • Neither agree or disagree
• Disagree • Strongly disagree

Scanning of products with your mobile phone was easy.
• Strongly agree • Agree • Neither agree or disagree
• Disagree • Strongly disagree

Scanning of products with your mobile phone was straightforward.
• Strongly agree • Agree • Neither agree or disagree
• Disagree • Strongly disagree

The process of scanning products took a good deal of time on average
• Strongly agree • Agree • Neither agree or disagree
• Disagree • Strongly disagree

The product information page took a lot of time to appear on your mobile screen after the scanning a product.
• Strongly agree • Agree • Neither agree or disagree
• Disagree • Strongly disagree

The text in the web page on the screen of your mobile device was legible.
• Strongly agree • Agree • Neither agree or disagree
• Disagree • Strongly disagree

The text in the web page on the screen of your mobile device was well-formatted.
• Strongly agree • Agree • Neither agree or disagree
• Disagree • Strongly disagree

You had to scroll the page too much on your mobile device when using the system.
• Strongly agree • Agree • Neither agree or disagree
• Disagree • Strongly disagree

The screen design was not visually appealing on your mobile screen.
• Strongly agree • Agree • Neither agree or disagree
• Disagree • Strongly disagree

The screen design was not user-friendly on your mobile screen.
• Strongly agree • Agree • Neither agree or disagree
• Disagree • Strongly disagree

Navigation through the web site on your phone was easy
• Strongly agree • Agree • Neither agree or disagree
• Disagree • Strongly disagree

Navigation through the web site on your phone was gratifying
• Strongly agree • Agree • Neither agree or disagree
• Disagree • Strongly disagree

The results generated by the system were not consistent.
• Strongly agree • Agree • Neither agree or disagree
• Disagree • Strongly disagree

The results generated by the system were not satisfactory.
• Strongly agree • Agree • Neither agree or disagree
• Disagree • Strongly disagree

During the shopping process you scanned every product that you were interested to buy within the specified product categories (i.e. Breads, Cereals and Biscuits).
• Strongly agree • Agree • Neither agree or disagree
• Disagree • Strongly disagree

While shopping, did you ever get the problem of not being able to use the system due to insufficient reception?
• Yes • No

Based on the information provided to you via this system you changed your purchase choice.
• Strongly agree • Agree • Neither agree or disagree
• Disagree • Strongly disagree

How were you satisfied with this system?
• Very satisfied • Moderately satisfied
• Not satisfied

The system would be more useful to your needs if a greater product range was included.
• Strongly agree • Agree • Neither agree or disagree
• Disagree • Strongly disagree

If available would you like to use this type of mobile phone interface in the future?

• Yes • Maybe • Undecided
• Unlikely • No

How many times would you consider scanning per shopping session if you find this system useful?

• 0-3 • 4-7 • 8-11
• 12-15 • 15+

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