Assessment of Public Perception toward Mobile Tagging System for Retrieving Information of Genetically Modified Food

Tan Shiang-Yen, Long Yoon Foo, and Rosnah Idrus

***Abstract*—** the purpose of this paper is to assess the public's perception and acceptance toward the proposed mobile tagging system, which can be used by consumers to retrieve product information of Genetically Modified Food (GMF) in the market. In the proposed mobile tagging system, consumers can use the camera on their mobile phone to capture the image of the Quick Response (QR) codes on the product packaging and send to the server for decoding. Subsequently, the server sends back the details of the GMF product in the form of Multimedia Message Service (MMS). Findings of this study indicate that albert not much the public is currently using mobile tagging service, but they possess positive attitude to find out more and to try the mobile tagging services. Most importantly, acceptance of the proposed mobile tagging service for retrieving product information of genetically modified food is considerably high. Additionally, the finding suggests that marketing campaign is vital to increase awareness among the consumers, and customer education is important to improve the acceptance level toward the mobile tagging service. This study is one of the pioneer studies in mobile tagging system. It provides the feasibility analysis of applying mobile tagging system in genetically modified food area and assesses the marketability of the system.

***Keywords*—** 2D Codes, Genetically Modified Food, Mobile Tagging, Quick Response (QR) Code

I. Introduction

IN the recent years, mobile phones with integrated digital cameras and capability to send data through General Packet Radio Service (GPRS) are prevalent and available to the wide range of users. In relevant to this, mobile tagging technologies have subject to ever increasing growth. Generally speaking, mobile tagging is the process of scanning or capturing the tag or barcode with the camera of a mobile device, subsequently decoding, interpreting, and use the content embedded in the barcode or tag. Due to the convenience, user friendliness, multiple fields of application, customer-driven information provided by mobile tagging, it has become the key technology for mobile surfing [1]. The primary usage of mobile tagging is to use 2D codes to embed URL and works as a hyperlink to request further or relevant information.

At the same time, genetically modified food (GMF) has attracted much attention in the past decade as well. The terms GMF applies to foods, which contain genetically modified ingredients or to food additives or processing aids produced using genetic technology. Genetic technology uses recombinant DNA techniques to alter the heritable genetic material of living cells or organisms. In recent years, gene technology has been used in the agricultural industry to genetically modify crops.

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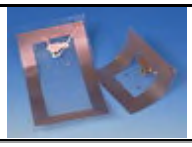
Populations in developing countries are gradually aware of controversial issues related to GMF and paying greater attention toward the product information of GMF in the market. Nevertheless, it is common that the basic product information provided in the product label is not adequate for consumers to make purchase decision [2]. Some consumers might require more details information about the product (such as location of plantation, and pesticide used), which are not available from the package label. Additionally, majority of consumers are lacking of proficiency to accurately or objectively interpret the product label of GMF products. The interpretation of the label might be influenced by perception of society or influences of mass media. These situations imply that consumers are lacking of information to make due purchase decision, thus a mechanism which able to provide adequate, accurate, and customizable information [3] is much appreciated.

Hence, the purpose of this paper is to introduce a mobile tagging system which provides the consumers the access to accurate and adequate information of a GMF product. Subsequently, this study assesses Malaysia public's perception and acceptance toward the proposed mobile tagging system for Genetic Modified Food. Data is collected through questionnaire survey conducted.

In the proposed mobile tagging environment, consumers capture the 2D barcodes on the product packaging and send to the system for decoding, subsequently the system will retrieve information stored in the central database server and send to the requestor in a Multimedia Messaging Service (MMS) format. The information retrieved can be customized according to consumer's preference and need. Additionally, an URL is attached to enable consumers to use their phone browser to access more detailed information. On the system backend, the construction of database in the proposed mobile tagging system requires collaboration across the crop producers, retailers, related government agencies and other supply chain information [4] to provide independent, accurate, and sufficient information on the GMF products.

The next section reviews and compares the various technologies which possible to be applied to the proposed

Table 1 Comparison between 2D barcode and other automatic identification technologies

Information media	Magnetic card	OCR identification	Biological identification	RFID	2D barcode
Identification speed	0.3－2s	4－8s	1－5s	0.3－0.5s	0.3－1s
Bit error rate	Up to life of magnetic media	1/ 1,000	1/300	Up to noise and angle	1/1,000,000
Technical advantage	Portable and data rewritable	Quick in image and symbol operation	Non- counterfeitable	Quick and batch processing	Quick and accurate
Print cost	Intermediate	Low	High	Very high	Very low (only ink cost)
Sample					

mobile tagging system. Section 3 introduces the architecture and system design of the proposed mobile tagging system for genetically modified food.

II. Literature Review

This section represents the fundamental technologies and research which form the foundation of the research background and justification for the selection of identification techniques or technologies.

A. Identification Methods

As a part of the mobile tagging system, identification technique is one of the core functionalities to make captured image readable by the application or system. However, there are various identification techniques available. This section provides the justification of the techniques selection based on the comparison on the features of different identification techniques. The 1D barcode is not being considered because the capacity of 1D barcode is not sufficient to embed information such as URL address in this case.

Table 1 provides the comparison between 2D barcode and other automatic identification technologies such as magnetic card and Radio Frequency Identification (RFID). Compared to other methods, 2D barcode shows its superior performance in terms of identification speed, bit error rate, and printing cost [5, 6]. In the food label tagging, 2D barcode is the more appropriate identification method compared to others in the comparisons. The single most important reason is the low printing cost, as the margin of food product is not wide, thus high printing cost method such as RFID is impractical [7]. Hence, the selection of identification method is narrowed down to 2D codes.

Next step takes the comparison down to the various 2D codes, namely Data Matrix, Quick Response (QR), PDF417, and GM as shown in Table 2. Among the 2D codes, QR codes have the appropriateness to be applied in the GMT-MT system, given its content capacity, camera readability, and cost [8]. Furthermore, the QR format's specification is available royalty-free [9]. The owner has promised not to exert patent right on it. Additionally, QR codes house 3 KB of data, which provide the scalability to embed other information or media in future.

B. Quick Response (QR) Code

The Quick Response (QR) Code is a 2-dimensional symbol invented by Denso Wave in 1994. Denso Wave is a division of Denso Corporation and one of the major Toyota group companies. Another advantage of using the QR Code is that the camera does not have to be lined-up in a specific manner in order to read a barcode. Although the user's hand needs to be stable, a good QR Code reader comes with the ability to sharpen up and correct a 'shaky' scanned QR Code and read it. QR code indirectly enables the ubiquitous computing; allow user to access the information at anywhere and anytime. QR code is commonly adopted by companies for advertising purposes.

The Quick Response (QR) Code is capable of high-speed reading in all directions (360°) from three corners implemented with the finder patterns to notify the position of the code. The black and white ratio of the code among the scan line is 1:1:3:1:1 through the finder patterns from any direction 360° surrounding the code [7]. Through this ratio, the position of the Quick Response (QR) Code can be detected in a short period of time through the finder pattern captured by the sensor.

QR codes are resistant to distortion. The barcode is attached onto a curved surface resulting in a distorted code image and causing difficulties for the scanner to decode the barcode. The alignment pattern in the Quick Response (QR) Code is arranged at a regular interval in the code to resolve this distortion. The center position of the alignment pattern from the outer shape of the code and the alignment pattern of the actual center position of the code is calculated. The calculated variance is used to map the adjusted position of the code for identifying the center position alignment pattern of each cell. This will make the distorted code readable.

Table 2 Comparison between Quick Response (QR) and other 2D barcodes

2D barcode	**Data Matrix**	**QR**	**PDF417**	**GM**
Layout	Matrix	Matrix	Layers (1D layout)	Matrix
Max capacity	1.5KB	3 KB	1 KB	2 KB
Readable direction	Full direction	Full direction	Upward/downward	360o full direction
Image "dead point"	Yes (no tarnishing for positioning image)	Yes (no tarnishing for positioning image)	Yes (no tarnishing for positioning image)	No
Chinese encoding efficiency	Bad (16bit)	Bad (16bit)	Bad (16bit)	Good (13bit)
Photoelectrical sensor (core part of a reader)	Made in Japan or US	Made in Japan	Made in Japan or US	Made in China
Intellectual property rights	US	Japan	US	China
Sample picture				

The error correction function of the Quick Response (QR) code adopts the high resistance to bursts of errors from the Reed-Solomon code, overcoming the smudges or damages on each code. Reed-Solomon codes are implemented in the Quick Response (QR) Code data area. The error correction levels of the Quick Response (QR) Code are 7%, 15%, 25%, and 30% per code area [9]. Within the error correction level, the code can still be decoded correctly although they are smudged or damaged through this error correction function. For codes which are susceptible to damages or smudges, it is recommended that a correction level of until 30% can be adopted.

A single Quick Response (QR) Code can be divided into several portions of code through the linking function [10]. A single code can be divided into 16 portions of code at maximum. The entire data will be compiled and sent to the computer despite the sequence of the code read by the scanner. If the printing surface area is limited, the Quick Response (QR) Code still can be printed through this linking function.

The Quick Response (QR) Code can be encrypted by linking the relationship of the specified data storage to the types of characters for unique usage. The confidential Quick Response (QR) Code cannot be decoded until the permission of conversion between the specify data storage and the type of character is deciphered. This function can be used to boost the security of high value corporate information.

III. Proposed Mobile Tagging System for GMF

This section introduces the proposed mobile tagging system which uses QR code to tag GMF product. The proposed system is named as "Tagpreneur" in the rest of this paper.

A. Overall Architecture

Fig. 1 illustrates the system overview of the Genetically Modified Food Mobile Tagging Services. The system acts as an informediary between the consumer, the crop producer and the middle retailer. Tagpreneur will define the mobile tag for those crop producers and middle retailers who agree to let Tagpreneur to tag their product. The information in the mobile tag is customized according to the customer preferences.

Tagpreneur is offering a free 2-Dimensional Quick Response (QR) code reply to consumers requesting information about the genetically modified product tagged with a 2-Dimensional Quick Response (QR) code. Tagpreneur will decode the 2-Dimensional Quick Response (QR) code into text form via the SMS and reply to the consumer complete with a link to the Tagpreneur's web site in the replied text message. Consumers can access the link and browse the web site via their personal mobile device.

Tagpreneur provides the necessary feedback and its comment function to enable consumers to interact with other consumers virtually. These comments are capitulated back to Tagpreneur's backend system to generate a customized profile of each customer who opts for the services [11]. Through the data extraction and data mining technique, customized marketing messages will be delivered to the targeted customer.

As an additional service, Tagpreneur rewards the loyal customers with e-coupons, e-vouchers, and redeemed points to keep the loyal customer and attract new customer to adopt the service. Crop producers and middle retailers can advertise through Tagpreneur to the targeted consumer. The customer can use the e-coupons, e-vouchers, and redeemed points to get discount rate from the crop producer and middle retailer who advertise through Tagpreneur.

B. System Design

The main font end functionality of the system is to allow user to retrieve information about particular GMF product, the steps of the interaction between the user and system are described as:

1. Point the mobile phone camera to the product.
2. Take a picture of the 2-Dimensional QR code with the camera hand phone

3. Send the code to the message centre
4. Wait for a while for the decoding
5. Replied product information in text message from message center
6. Customers can link to Tagpreneur's website for further browsing activity

The replied message comes with a list of information about the product. The figure in Fig. 2 illustrates the prototype user interface which showing the product information of a particular GMF product. The replied message consist of the details description of the product will lead a positive perception on consumer in the purchasing process. The details of the description include:

1. The suitability of planting site
2. Transition period from conventional to organic system of production
3. Pesticide residue and heavy metal
4. Crop buffer and buffer zone distance
5. Soil fertility management
6. Good water management
7. Use of seed and plant material
8. Use of fertilizers
9. Soil conditioners
10. Pest and disease control materials
11. Management of weeds, pests and diseases,
12. Packaging, storage and transport of farm products

Fig. 2 Sample Interface of Product Details

The detail description lead better convince on consumer to make procurement. Consumers can browse through the Tagpreneur's website via the direct link at the bottom of the replied message for further information.

Through the data mining technique, the intelligent advertisement software in Tagpreneur's back-end system has the ability to provide content and services tailored to an individual's preference and behavior. This highly personalized service is available to each targeted consumer. The information obtained from the customer's transactional history enables the company to construct individual profiles containing facts about that particular customer and redefine the rules describing customers' behavior.

Fig. 3 illustrate the customized advertisement contents delivered to targeted consumers who have the potential to buy the product based on that particular consumer's purchase history. Richer media content can be implemented in the advertisement such as spokesperson recommendation for the product, product tutorial videos, and e-books.

Fig. 3 Sample Interface of Customizable Advertisements

Fig. 4 Sample Interface of Detailed Advertisement

IV. Research Methodology

A. Overview of Methodology

In order to collect generalizable data to represent whole population from the samples, questionnaire survey is adopted as a data collection method. Additionally, questionnaire survey is a common method used in similar researches [z]. Barrie (2002) claimed that an off-line approach is to obtain from individuals an indication of degree of attention they pay to a medium. This study adopts questionnaire survey in order to quantify the various variables toward the GMF products and

mobile tagging, such as the following:

1. Demographic of the respondents.
2. Level of understanding about mobile tagging services of the respondents.
3. Percentage of camera mobile phone users among the respondents.
4. Consumer awareness on genetically modified food in terms of health and religious views.
5. Acceptance level of mobile tagging services of the respondents.
6. Market size of mobile tagging services on genetically modified products in Malaysia.
7. Motivational factors and attitude of the respondents in using mobile tagging services.
8. The following sections discuss the results obtained through the survey questionnaire.

B. Instrument Development

There are total 38 questions assigned into four parts in the questionnaire. Questions in part 1 are designed to collect the general information and knowledge about mobile tagging of the respondents. Questions in part 2 are designed to test the understanding of respondents of genetically modified product. Questions in part 3 are designed to test the acceptance level of mobile tagging services usage. The questions in part 4 are designed to find out the motivational factors and attitudes of consumers in using the mobile tagging services. The questionnaire is designed according to the Likert scale, its questions using 5 point Likert scale. To reduce the uncertainty of the respondents, certain questions in the questionnaire have adopted the 4 point Likert scale as a force choice method to let respondents select one Likert item in the particular question.

C. Subject and Procedure

The data used in this study were collected via online and face-to-face survey. The data was collected from a random sample of university students and general public. Young adult with age around 20 to 35 were primarily chosen in this study because they are the key target market for mobile advertising as the majority of them grew up in the technological age. This researcher has spent five weeks collecting the data through the questionnaire from the respondents.

The opening section of the questionnaire briefly explains the definition of genetically modified food and mobile tagging technology to ensure a common frame of reference to all candidates. In the data collection process, there are total of 150 sets of questionnaires distributed to the potential candidates due to time and budget constraint during the data collection process. 118 out of 150 sets of questionnaire have been successfully collected and usable, which constitute of 78.6 percent of respond rate that is considerable good.

V. Demographic of Respondents

Demographic of respondents is important variable that indicate the profile of respondents. Table 3 shows the demographic of respondents.

Table 3 Demographic of Respondents

Item	Frequency	Percentage (%)
Gender		
Male	47	39.8%
Female	71	60.2%
Total	**118**	**100%**
Age		
21-25	69	58.5%
26-30	32	27.1%
31-35	7	5.9%
36-40	7	5.9%
41-45	1	0.8%
46-50	1	0.8%
51-55	1	0.8%
Total	**118**	**100%**
Race		
Malay	14	11.9%
Chinese	87	73.7%
Indian	12	10.2%
Others	5	4.2%
Total	**118**	**100%**
Monthly Gross Income	19	16.1%
Less than RM 1,000	9	7.6%
RM1,000-RM1,500	58	49.2%
RM1,501-RM2,000	24	20.3%
RM2,001-RM2,500	5	4.2%
RM2,501-RM3,000	3	2.5%
Above RM3,000		
Total	**118**	**100%**

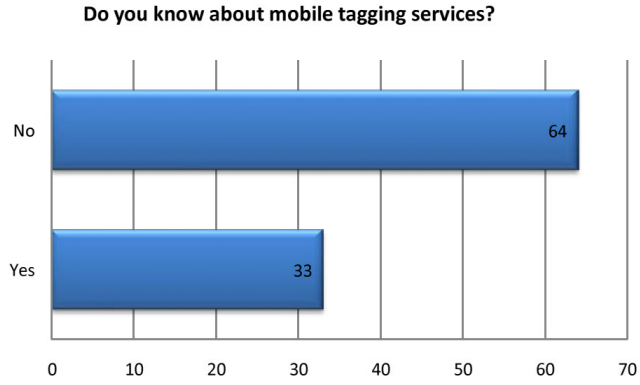
From Table 3, the data indicates that approximately 91 percent of the respondents are come from age range of 21 to 35. These youth adult constitute the major market for mobile phone applications. Additionally, about 77 percent of the respondents' month income is below RM2, 000, which is the common salary rate of fresh graduates and young adults.

VI. Data Analysis

A. Level of understanding of mobile tagging services

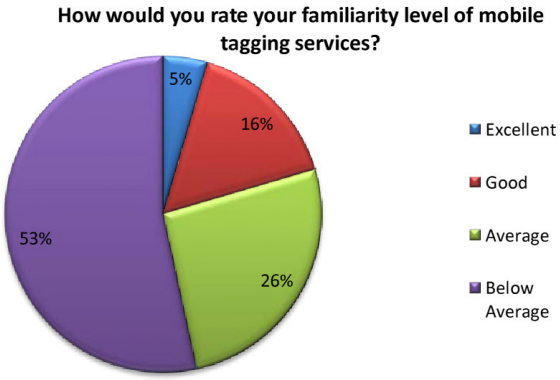
The level of understanding of mobile tagging services of the respondents can be referred to question 6 and question 10 in the survey questionnaire. The Fig. 5, 6, and 7 shows the number of respondents in relation to their level of understanding of mobile tagging services.

Fig. 5 level of understanding about mobile tagging services



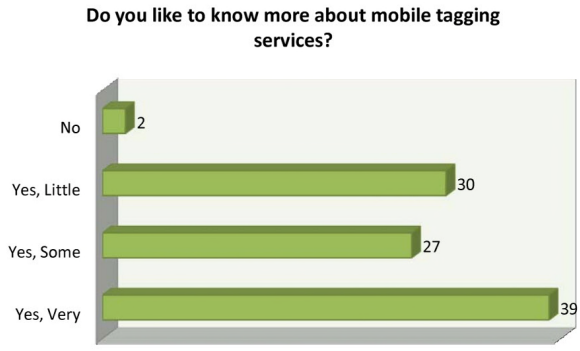
From Fig. 4, findings of this study indicate that more than half of the respondents do not know about mobile tagging services prior to the survey. This implies that the mobile tagging service market in Malaysia is widely unexplored. Nonetheless, customer education is vital in order to increase awareness of the public. Fig. 6 shows that 53.4% of the respondents' familiarity level to the mobile tagging services is below average.

Fig. 6 Familiarity Level of Mobile Tagging Services



Although the majority of the respondents show they are not familiar with or are ignorant of this technology, they have demonstrated a desire to acquire more information about it. 98 percent of the respondents show an interest in finding out more about mobile tagging services. This number implies that the mobile tagging services able to attract interest and attention of the public, trigger them to search for more information about the technology.

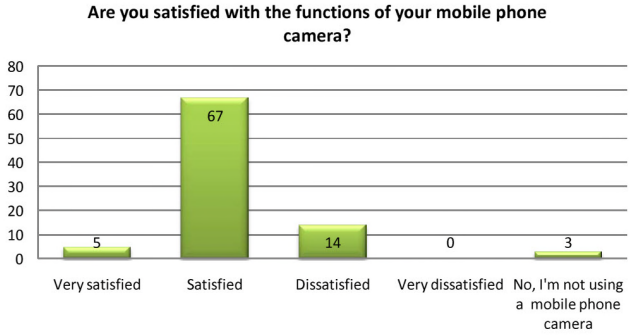
Fig. 7 Respondents who like to know more about Mobile Tagging Services



B. Mobil Phone Camera User

According to the findings, only 3 out of 89 respondents do not own mobile phone with camera. In other words, 96.6% of the respondents fulfill the basic requirements to adopt the mobile tagging services. In such cases, acceptance toward the mobile tagging service is expected to be higher as users can utilize their existing device to use the service. The implementation is mostly done from the software perspective, no additional hardware is needed. Fig. 8 shows the satisfaction of respondents toward their mobile phone camera.

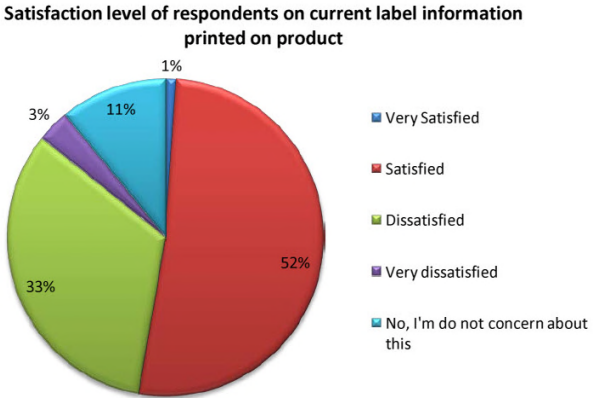
Fig. 8 Satisfaction toward Camera Functionality



C. Attention toward Product Labeling and Information

According the findings as shown in Fig. 9, more than half of respondents (52.7 %) show very satisfied and satisfied with the current label information printed on product. This indicates that existing product label might not provide sufficient, accurate, or misleading information. Additionally, the information provided might be too complicated to be understood by normal consumers. Further investigation can be done in future to examine which aspect of the existing product label is not satisfying the consumers. Such information is valuable to result in improvement in the proposed mobile tagging services by addressing the needs of consumers.

Fig. 9 Satisfaction toward Existing Product Labeling



D. Respondents' perception on genetically modified food

As shown above, 57% of the respondents agree that genetically modified food is safe for consumption but they show concerned to buy due to lack of information about the genetically modified food in the purchasing process. Furthermore, respondents show that they are concern about the genetically modified food been tested before put into the market and they prefer to obtain more information regarding the product prior to purchase as show in Fig.

Fig. 10 Public Perception toward GMF

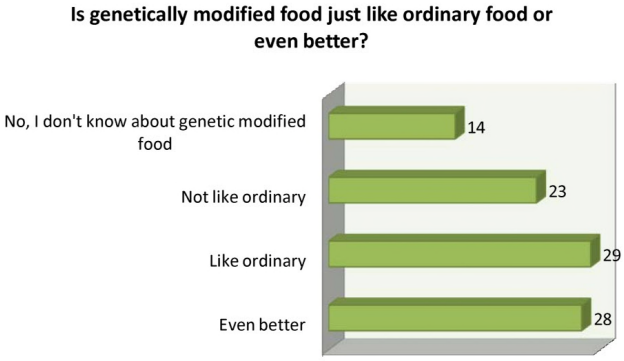
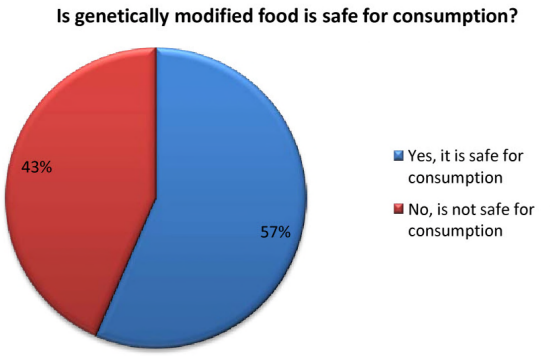


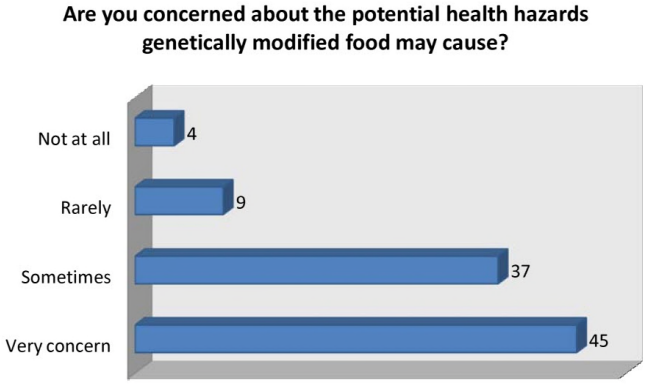
Fig. 11 Public Perception toward GMF 2



E. Respondents' awareness level against genetically modified food in relation to health and religious views

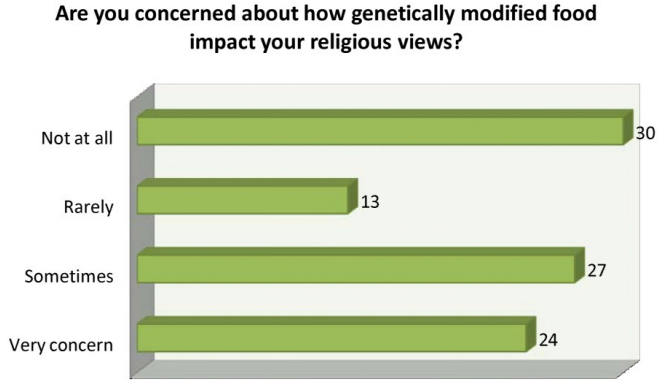
Question 19 and 24 in the survey questionnaire are tailored to investigate respondent awareness level of genetically modified food in regards to health and religious views. From question 19, 45 of 95 respondents at 47.4% show that they are very concerned about the potential health hazards genetically modified food may cause as illustrated in Fig. 12. These findings indicate that health-related information about the GMF product would be much appreciated by consumers.

Fig. 12 Perception toward impact of GMF on health



According to Fig. 13 more than half (64 percent) of the respondents expressed their concerns over how this technology would correspond to their religious practices. As Malaysia is an Islamic country, information regarding genetically modified food from the religion aspect able to provide vital information for the consumers in Malaysia, thus helping them to make informed decision.

Fig. 13 Perception toward impact of GMF from religious view

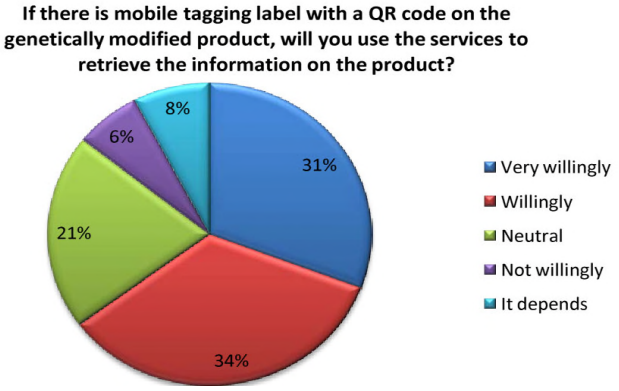


F. Acceptance level of mobile tagging services on genetically modified products

Findings from this study show that 41.8% of respondents reading the information label on nutritional facts on the product very often before purchasing it. The percentage of respondents who will read very often of the nutritional facts on information label printed on the product has increase to 47.3% when the question specified genetically modified product. As

illustrated in Fig. 14, 30.8% of the respondents are very willing to use the mobile tagging services to retrieve the information regarding genetically modified product whereas 34.1% are willing to utilize it. In other words, approximately 65 percent of the respondents shows positive attitude in willing to utilize the proposed mobile tagging system on genetically modified food. Nevertheless, the groups in which reluctant to utilize the proposed system constitute another 35 percent, which are considerable large portions of the respondents. This finding indicates that concrete actions should be taken in order to increase awareness and educate those consumers who currently no willing to accept the proposed technology for retrieving information.

Fig. 14 Acceptance level of Proposed Mobile Tagging



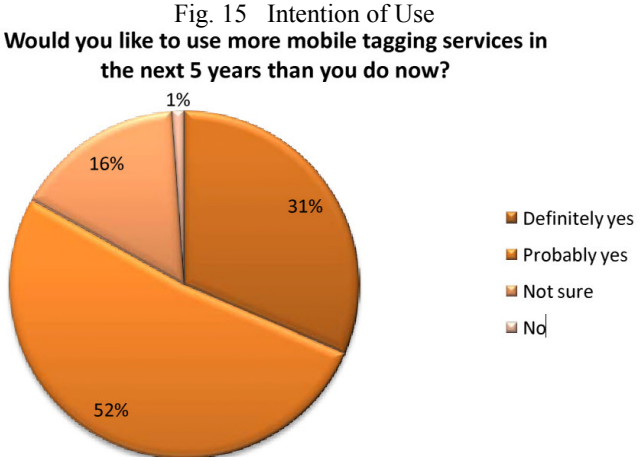
G. Perceptions toward General Mobile Tagging Technology

Findings of this study show that only 8 percent of the respondents are existing user of mobile tagging services. The others do not have experience of using mobile tagging service.

Nevertheless, more than 80 percent of these respondents respond that they would like to use mobile tagging services within the next 5 years as shown in Fig. 15. This finding indicates that with proper awareness increasing campaign and marketing effort, this unexplored market is potentially opened at faster speed. In other words, consumers possess the intention to use the technology, but marketing efforts should be carried out to catalyze the process of technology adoption.

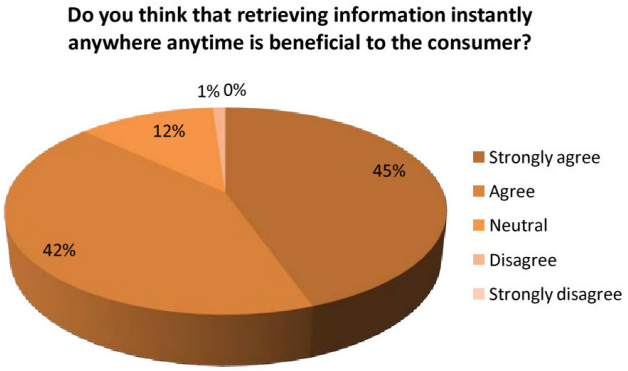
Additionally, more than 85 percent of the respondents

Fig. 15 Intention of Use



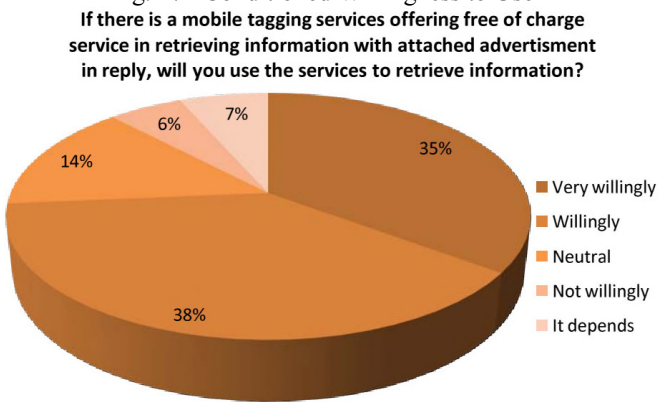
replied that the mobile tagging service which enables them to retrieve information everywhere and anytime is beneficial for the consumers. Putting in other words, the mobility or ubiquitous provided by the service is an undeniable advantage that is appreciated by the users. Further functionalities to enhance the ubiquitous of information should be incorporate to improve the acceptance level.

Fig. 16 Perceived Usefulness and Benefits



This study also interested to examine the willingness of consumers to use general mobile tagging services with advertisement attached in the reply message. In return, the service is provided with no cost on consumers. As illustrated in Fig. 17, about 73 percent of respondents willing to use mobile tagging service that is free of charge but advertisement is attached in the reply message. This finding implies that this method might able to generate better acceptance level than require the user to pay. Moreover, users would tend to increase the frequency of using the service if it is provided free of charge.

Fig. 17 Conditioned Willingness to Use



H. Other Preferable Application Areas of Mobile Tagging

Table 4 indicates the various application areas which respondents have interest to use the mobile tagging service. Location-based information service is the ranked the highest interest level, followed by E-ticketing booking, and others. The findings here provided important information for researchers in exploring the other potential areas to apply the

mobile tagging technology which tend to receive better acceptance from consumers.

Table 4 Other Application Areas of Mobile Tagging

No	Area	Interested Level of respondents
1.	Location information services	42.7%
2.	E-ticketing booking	41.6%
3.	Pharmaceutical	41.6%
4.	Web-browsing	38.2%
5.	Travel route guide/arrangement	38.2%
6.	Genetically modified products nutritional facts	31.5%

VII. Conclusion

With the wide availability of camera phone and increasing awareness of toward GMF products, the proposed system is technically and financially practical to be implemented. The proposed system has the potential to change the existing way of retrieving shopping information and advertising.

Nonetheless, the major challenge of implementing this system is the need of collaboration across various parties in the supply chain and government agencies as well. Thus, it is important to ensure the system will grow to incorporate more sophisticate functions and introducing attractive revenue stream to the participants of the system.

As one of the limitations of this study, the survey is conducted in northern region of Malaysia, where the attitude and perception of respondents might different from other parts of Malaysia. Hence, the findings of this result are more accurately reflect the consumers from 20 to 35 years old live urban areas. Respondents from rural area of Malaysia might provide different respond to the survey. The same limitation applied when attempt to generalize the findings to other developing countries, which the use of smart phone is not prevalent. Furthermore, it important to note that the respondents of this study composes of young adults ranged from 20 to 40 years old, somehow public who older than that (such as housewife) is important decision maker for shopping as well. Thus, future study can investigate this age range in more details and improve the mobile tagging service to be user friendly enough for the older age groups and general mobile phone to use.

In terms of academic and research, this paper proposed an application of mobile tagging technology in the genetically modified food, which is an emerging trend, especially in developing country. This study provide a foundation for future study to propose more comprehensive application and solution in application area of genetically modified food tagging, which is much neglected in the computer science study.

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T. Shiang-Yen is a Fellow at School of Computer Science. His research areas are Enterprise Computing and Strategic Information System. (Phone: +60168229499; fax: +604-6573335; e-mail: tsy09_com036@student.usm)

L. Y. Foo was a postgraduate student with School of Computer Science, who specialize in Technopreneurship.

R. Idrus is a senior lecturer with the School of Computer Sciences, National Advanced IPv6 Center, and CEMACS at Universiti Sains Malaysia, who specializes in Information Systems Development, Technopreneurship, and ERP systems for SMEs (e-mail: rosnah@cs.usm.my).