



## Information Visualization for Food Mobile Application: Hangri 2.0

Aslina Baharum<sup>1\*</sup>, Nadia Hanin Nazlan<sup>2</sup>, Noorsidi Aizuddin Mat Noor<sup>3</sup>, Rozita Hanapi<sup>4</sup>, Ismassabah Ismail<sup>5</sup>, Nor Azida Mohamed Noh<sup>5</sup>

<sup>1</sup>Faculty of Computing and Informatics, Universiti Malaysia Sabah, 88400 Kota Kinabalu, Sabah, Malaysia, aslina@ums.edu.my

<sup>2</sup>Faculty of Hotel & Tourism Management, Universiti Teknologi MARA Cawangan Selangor, 42300 Bandar Puncak Alam, Selangor, Malaysia.

<sup>3</sup>UTM CRES, Faculty of Built Environment and Surveying, Universiti Teknologi Malaysia, 81310 Johor Bahru, Johor, Malaysia.

<sup>4</sup>Faculty of Business Management, Universiti Teknologi MARA Cawangan Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

<sup>5</sup>Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, Kampus Jasin, 77300 Merlimau, Melaka, Malaysia.

### ABSTRACT

Information is easily available through social medias, newspapers, notice boards, books, radio, television with each medium having its unique presentation techniques. This holds true for mobile applications with applications being developed to provide direct information pertaining shopping, travel, hotel and restaurant bookings, as well as reviews. To encourage usage and ensure user satisfaction, mobile applications should be developed creatively with user friendly interface. It is essential for app developers to understand the techniques of information presentation. This project's goal is to develop a mobile application that can efficiently provide information on food and beverage establishments that are available throughout Universiti Malaysia Sabah's (UMS) campus. With daily foot traffic of more than thousands ranging from students, staffs, and visitors, it is essential to have a medium to convey food and beverage information that can be easily accessible anytime and anywhere. Information visualization technique was used to aid information presentation in the development of a mobile app using the Android platform. This application allows users to identify information on meals that are available throughout the campus, and the food and beverage vendors will be able to market their daily specials to a wider audience.

**Key words:** Information Visualization, Mobile Application, Food and Beverage

### 1. INTRODUCTION

Good data presentation is essential in attracting people to read and understand the message being conveyed. Information that is seen as attractive activates individuals' heuristic information processing. Salient information acts as a shortcut that triggers memory retrieval, allowing for fast decision making. Though access to information aids in decision

making, abundant information can cause information overload. Therefore, the development of a medium that can efficiently present food and beverage (F&B) information and allows users to compare and filter information is timely in the context of Universiti Malaysia Sabah (UMS). UMS houses a number of F&B establishments in various locations located sporadically across the large campus. While each of these establishments provide an array of food choices, the information regarding meals being offered can only be observed through a menu board that is normally hung near the respective F&B premises. Due to space constraints, this menu board will typically display a list of menu items with their respective price that is neither appealing nor enticing to prospective consumers. Having to walk to a particular establishment just to see the meals that are being offered for the day limits prospective consumers' choice to select the best meal option that they could afford. Majority of the consumers tend to resort to having lunch at the nearest food premises without knowing that they could actually have a better meal at the same amount of price elsewhere. Currently, on campus foodservice operators do not have a medium to advertise their daily specials or promotions to the larger campus crowd, limiting their market to the nearby foot traffic. Having an application that can act as a medium to disseminate information attractively would be the perfect solution to this problem.

The following are the problem statements of the project:

- There are limited mobile applications that has been developed using the information visualization technique. Such constraints are caused by devices limitations (e.g. screen size), making development intricate (Chittaro, 2006). Moreover, there are scarce research that proves information visualization technique is useful in mobile applications.
- The effectiveness of a message can be affected by the way it is presented. Information that are visually appealing are more effective than the same information provided in a textual format (Mitchell, 1986). Conveying information and

shortening users' information processing time can be achieved through proper information presentation methods.

Therefore, implementing information visualization technique in the development of mobile applications assist users in understanding the message presented while reduce their cognitive efforts and decision making time. Such mobile application is beneficial to users and admins alike as it is convenient and easy to use.

## 2. INFORMATION VISUALIZATION

Information visualization is a process that represents data or information in the form of chart, diagram, picture, or other graphical format. It helps user to make sense of data and better understand it. It also allows visual manipulation by the users, permitting them to view information through different perspectives. Information visualization plays an important role in making data more digestible while simultaneously turning raw information into actionable insights. It mostly involves the interactivity of web and applications. Keim et al. (2006) define information visualization as the communication of abstract data through the use of interactive visual interfaces.

Penrose (1998) stated that visualization is a graphical representation that best conveys complicated ideas clearly, precisely and efficiently. These graphical depictions are easily understood and can be interpreted effectively. The process of creating data visualization starts with understanding the information needed by the users. Based on the information gathered, information needed will be determined. Visualization techniques consist of graphs, maps, diagram, or graphics, will be applied based on the information gauged.

Albeit small, visualization has a crucial and expanding role in human cognitive systems. Card (2008) stated that the purpose of information visualization is not just to create interesting pictures but to amplify cognitive performance. According to Chittaro (2006), the six steps in designing a well-disciplined visualization are mapping, selection, presentation, interactivity, usability and evaluation.

## 3. RELATED WORKS

Information visualization is a hot topic in the field of data and information services. Kanae (2011) proposed that information visualization combines several theories and methods such as scientific visualization, human-computer interaction, data mining, figure, graphics, cognitive science, and discussions on it are still developing.

Fayyad et al. (2002) suggested that information visualization uses a combination of data visualization with data mining techniques. Data mining deals with large databases and has been growing steadily to a point that requires information visualization with graphical displays. This assists in data comprehension.

According to Yu (2012), information visualization works with

cloud computing to accelerate computing speed and display efficient large-scale information visualization. But human computer interactions needs to be further improved in order to reduce user waiting time.

There are a lot of information visualization techniques that are used in our everyday life. Try comparing information presented in the newspaper and the television, and you'll see vast differences. Google has Google Maps and Google Earth. Users' ulterior need when using Google Maps is to get visual picture of a location, and the routes to get to specific destinations. Google Maps provide information in the form of maps, pictures, interactive, and static navigation with transportation and time options. The information provided by Google Maps explains how to get to a particular location and the amount of time needed to get there. On the other hand, Google Earth allows user to access street view and other details of a specific destination.

In terms of mobile applications, visualization is often used to create interactivity with the user. Chittaro (2006) concludes that visualization can be an important component of mobile application development, allowing the creations of mobile applications that are more useful, intuitive and productive.

## 4. METHODOLOGY

The development of mobile applications requires good methodology practices to achieve the optimum output. Various types of methodology can be used in the development of mobile applications. For this project, the mobile-D methodology was chosen for the development of Hangri 2.0. The mobile-D method is based on extreme programming (development practices), Crystal methodology (method scalability), and the Rational Unified Process (life cycle coverage).

This project is organized into five separate phases. The first phase of it is 'explore'. During this phase, the project's objectives, scopes, and outcomes are thoroughly discussed. The project's objectives are guided by the problem statements. Users for this project were selected based on the project's scope, the community of UMS, Kota Kinabalu.

The second phase of the project is to initialize. A preliminary study was conducted to assess users' requirements and as well as the appropriate features that are important to be included in a mobile app. Questionnaires and interviews were conducted to gauge users' requirements and expectations on mobile applications, food being offered in UMS, its location and price. Based on the data collected, required features were included in the development of Hangri 2.0.

The third phase is productionize. After analysing the data collected, an initial prototype was developed. The development begins with drawing a DFD and ERD diagrams to obtain a clear view on the development process. A database for the application was then created followed by the designing

of user interface for prototype 1. User testing was conducted to get users' feedback and perception on prototype 1.

The fourth phase is stabilize, where the improvement of the prototype will be done based on users' feedback of prototype 1. A content management system is then created as a method of updating the application information from time to time. Only food service operators and administrator will have the special access to the system. Another round of user testing is then conducted for system testing of the currently-improved-prototype.

The final phase is system test & fix. Hangri 2.0 application was published in this phase. Usability testing was conducted to evaluate the app's usability. CUE-Model method was applied to evaluate usability. The process of testing, updating and analysing were repeatedly conducted until all user requirements have been fulfilled. A documentation is then produced for future references of the development.

## 5. ANALYSIS

### 5.1 Research Design

To obtain in depth understanding of user requirements and their food choices, a mixed research design this study. Content analysis, survey, and interview was conducted to gauge respondents' food preferences and their purchasing habits.

#### 5.1.1. Content Analysis

Prior application development, a content analysis was conducted to study the features and characteristics of existing F&B related mobile applications. Four food mobile applications was analysed: 'JJCM', 'Jom Makan', 'Makan Jom' and 'Burpple'. Based on the content analysis, 'Burpple' has the most optimal features and functions in terms of food searches. 'Burpple' was chosen as an anchor to determine appropriate function and features to be included in the development of F&B related mobile application. The other three applications was analysed for the user requirements.

#### 5.1.2 Interview

Interviews was conducted to gauge both users' and foodservice operators' needs and requirements. According to Morgan (2001), interviewing is a specific form of emphasizing, participating and observing trends that takes place between two people (the interviewer and the interviewee). A minimum of five foodservice operators and five consumers were interviewed. This method allows the researcher to gain in-depth understanding of the phenomena of interest. The qualitative methods are also helpful in understanding or explaining unusual situations that could not be identified through quantitative methods.

In this project, the researchers created a friendly, non-threatening atmosphere for the interview session. The questions asked during the interview were adapted from Johnson et al. (2014). The questions were as follows:

- What did you like about this application?
- What did you not like about this application?

- Is there something that we should add to make this application better?
- How would you use this application in your daily life? Do you see yourself using this application to help with your food choice?
- Do you think the colours and images influence your decision?

The questions were adapted to suit the purpose of the interview, which is to gauge users' perception and requirements of food mobile application. Respondents were initially asked easy questions, followed by questions that requires deliberate thinking.

### 5.1.3 Survey

A survey on food selection behavior was conducted. The survey was randomly distributed across campus and 100 usable responses were obtained. Respondents were approached randomly on campus and were asked to participate in the questionnaire using a link provided. The online link was opened for a minimum of 10 days and was promoted only to the UMS community. The questionnaire was designed to gauge respondents' requirements of the food mobile application, appropriate features for data presentation, as well as their demographic profiling.

## 6. RESULTS

Respondents' demographic profile was collected in the first section of the questionnaire. Table 1 illustrates respondents' demographic profiling. There are 36% of male and 64% of female. 33% of them resides inside the UMS campus while 67% are living outside the campus. 63% of the respondents are between 22-24 years of age, 17% are aged between 18-21, 6% are between 25-27 years of age and only 14 are at least 28 years old. Based on the data collected, vast differences can be observed in the number of male and female. This is not unusual as the male to female ratio is almost similar across all universities in Malaysia.

Table1: Statistics of Demography

<b>Gender</b>	Male	36%
	Female	64%
<b>Occupation in UMS</b>	Student	77%
	Staff	13%
	Entrepreneur	3%
	Visitor	7%
<b>Residencies</b>	Inside campus	33%
	Outside campus	67%
<b>Age</b>	18 - 21	17%
	22 - 24	63%
	25 - 27	6%
	28 above	14%

Figure 1 reports the factors influencing respondents' selection of where to eat. Majority of the respondents believe that affordability is the main factor that influences their meal selection, followed by distance, and environment. It is

surprising to observe that food taste, quality, cleanliness and others are not as important as the first three factors. This information is used to determine the appropriate features that needs to be included in the application. This information is also used in deciding whether an application must contain food prices, location, rating, pictures of the premises and user-generated reviews.

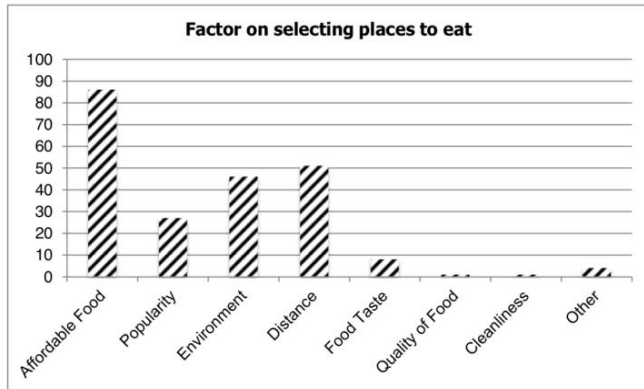


Figure 1: Factors selected to choose places to eat

Figure 2 shows the price range that the consumers are willing to spend for food. The result indicates that most students typically expect to purchase a meal that has a price range of between RM4-RM8. 18% of students are willing to pay between RM 1 - RM4 for their meal. This question determines what is considered as affordable by the UMS community, particularly the students. Based on this information, a function that allows users to sort food based on its price were included in the application.

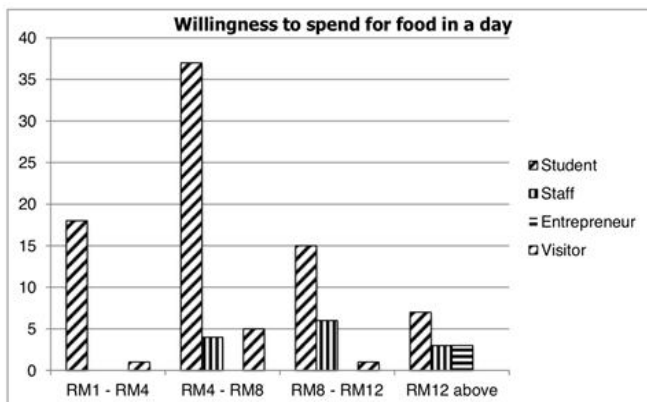


Figure 2: Selected range of price to spend for food

Figure 3 illustrates the frequency of eating in UMS food premises. 65% of the respondents are reported to eat at least once a day in UMS food premises. 25% eats at least twice a day on campus. 6.25% eats three times and only 2% of the respondents do not eat on campus. The findings indicate that there are sufficient number consumers who frequent the foodservice establishments in UMS. Therefore, the development of food related mobile application is appropriate and timely.

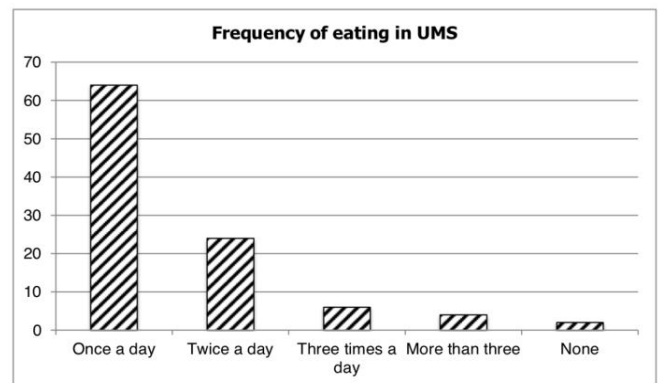


Figure 3: Frequency of eating in UMS

Figure 4 shows the factors influencing respondents' food and beverage choices. In tandem with affordability which was stated in Figure 1, price (70%) was voted as the most important factor affecting respondents' food selection, followed by food description (14%), recommendation (10%), and location (6%). Based on the findings, Hangri 2.0 was developed with a focus on food prices.

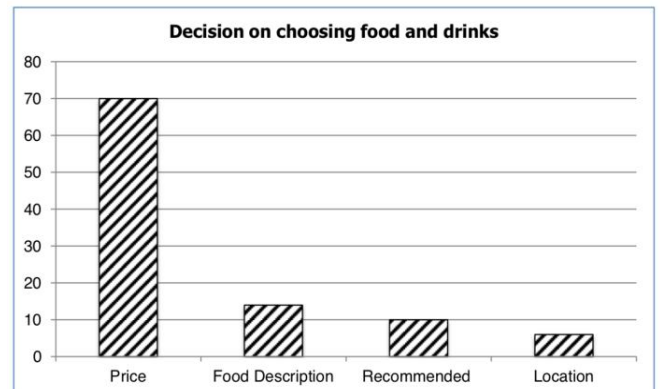


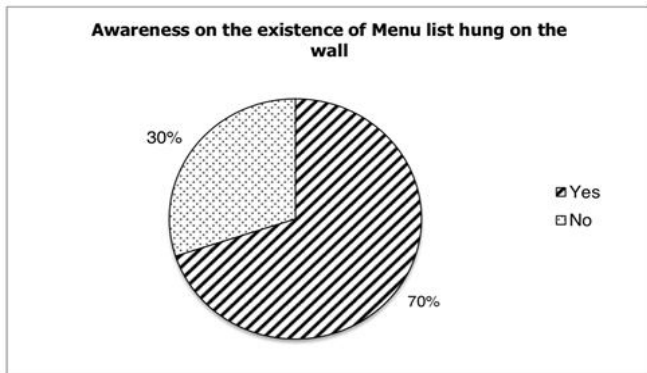
Figure 4: Food and drinks decision

Figure 5 suggests that 94% of the respondents believe that the food price in UMS are not standardized. Therefore, having a mobile application that allows the user to compare food prices will be beneficial for the entire UMS community, especially for students whom price seemed to be a main concern. The need for a price comparison feature in Hangri 2.0 is therefore validated.



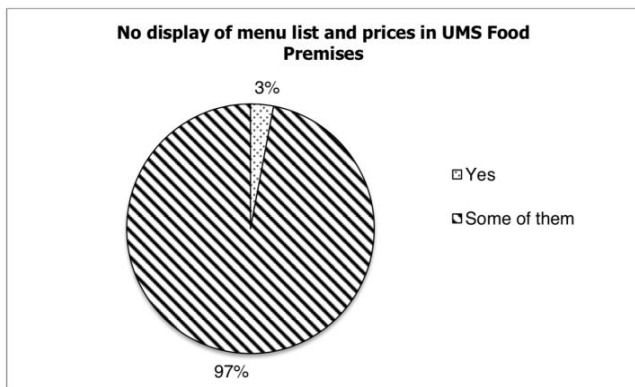
Figure 5: Food prices in UMS are not standardize

Figure 6 displays the level of consumer awareness on the existence of a menu board often hung on the wall of some foodservice establishments across campus. The menu board is typically used in small food premises around UMS. Results indicate that 30% of the respondents did not notice the existence of the menu list. This may be attributed to the menu board being placed at the back of the premise wall, decreasing the likelihood for it to be noticed by everyone. Therefore, a medium of information that can disseminate available food options on campus at the touch of one's finger is beneficial for the campus community at large.



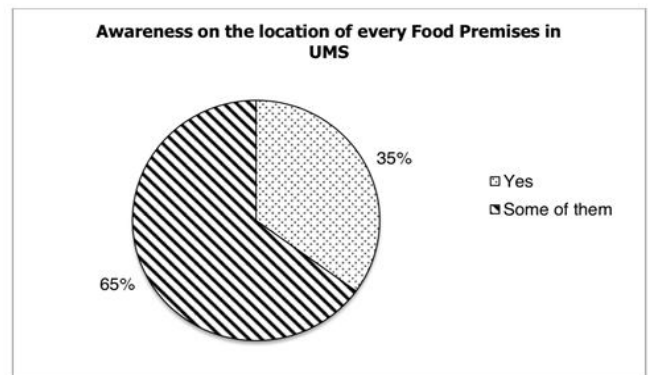
**Figure 6:** Awareness on the existence of menu list

Figure 7 suggests that a small percentage of the food premises in UMS do not have a menu and price list being displayed. This indicates that not all on campus foodservice operators understand the effect that prices have on consumer decision making. This result also support the need for a food related mobile application that displays the availability of food options and its prices on UMS campus.



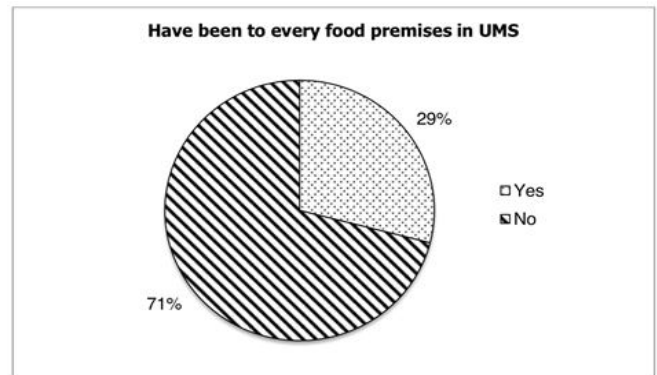
**Figure 7:** Awareness on the existence of menu list

Figure 8 indicates respondents' knowledge on all available food premises in UMS. Only 35% of the respondents are aware of all available food premises while the remaining 65% only know some of these premises. This is not surprising considering the size of the campus. Having navigational features on Hangri 2.0 is therefore justified.



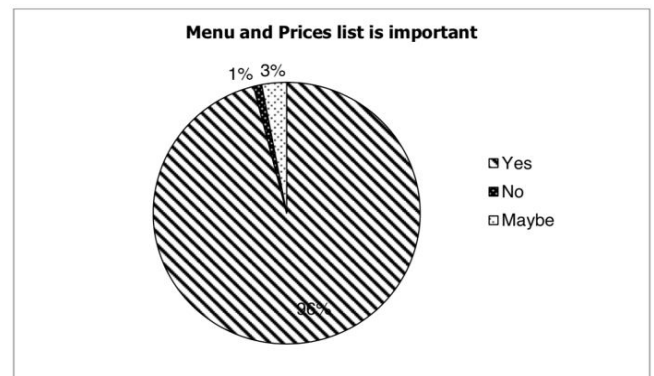
**Figure 8:** Awareness of food premises location

Figure 9 indicates that 71% of the respondents have not been to all of the available food premises on campus, while only 29% have actually visited all available premises. This can be attributed to the fact that these 71% are not aware of the premises' location. Having a navigational feature will solve this issue.



**Figure 9:** Food Premises Familiarity

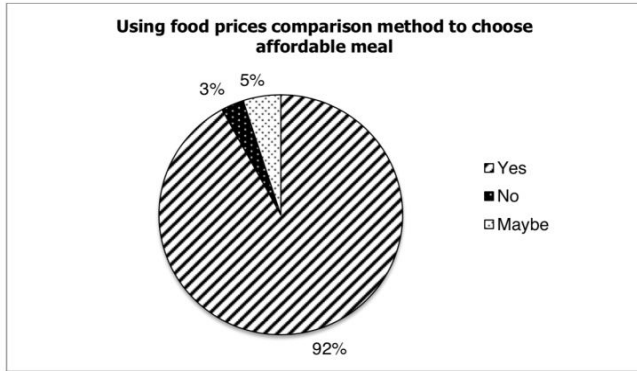
Figure 10 show that 96% of the respondents agree that the menu and price list is important. While, only 1% is saying no and 3% is undecided. This finding validates the need to access the list of available food options and prices to be displayed.



**Figure 10:** Importance of menu and prices list

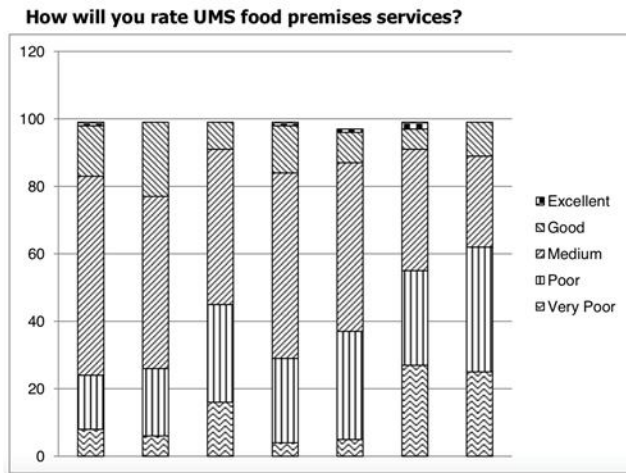
Figure 11 suggests that majority of the respondents (92%) agree that food price comparison will help consumers in choosing meals that is of the best value to them. This finding supports the development of food prices comparison feature

on the application.



**Figure 11:** Food prices comparison

Figure 12 indicates respondents' perception of the foodservice operators' performance in UMS. The food vendors' performance was evaluated based on quality, affordability, prices consistency, menu display, special menus and advertising. The findings suggest that consumers are generally unsatisfied with the performance of the foodservice operators. Quality, menu display, special menus, affordability were barely satisfactory, and prices were inconsistent. Hangri 2.0 will assist to improve services provided by these vendors by becoming a platform of updated menu information and promotion.



**Figure 12:** Analysis on food premises services

Figure 13 displays two forms of data presentation, namely list 1 and list 2. List 1 utilizes a full text presentation that includes menu item name, price and description while list 2 displays visual imagery of the food item with its name and price. Based on the survey, 91% of the respondents selected List 2 with a various reasons. Among the reasons provided by the respondents are: list 2 is attractive, simple, described the food, visual attractiveness, clear vision of what the meal will look like, tangible. This finding indicates that using visual presentation is a good data presentation technique. Based on the survey's result, appropriate needs and requirements were taken into consideration during the application development.



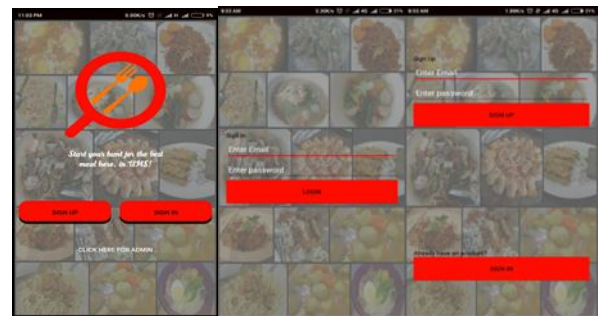
**Figure 13:** Data presentation style

## 7. DEVELOPMENT OF HANGRI 2.0

### 7.1. User Interface

Hangri 2.0's interface and features were built using Android Studio version 2.3.3. These features were then sync to to Firebase, an online real-time database by Google. Figures 14 to 28 illustrate the interface of Hangri 2.0.

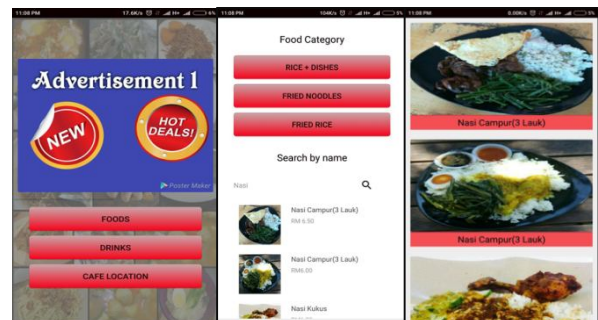
Figure 14 displays Hangri 2.0's start page. Users can sign in or sign up by clicking on the 'Sign Up' or 'Sign In' button. If user is an admin, they may choose for 'click here for admin' button. Figure 15 shows the 'Sign Up' page. Users need to fill in their email and create a password to sign up. Figure 16 shows the 'Sign In' page. Users need to enter their email and password to log in to the application.



**Figure 14**

**Figure 15**

**Figure 16**



**Figure 17**

**Figure 18**

**Figure 19**

Figure 17 displays the main page after users are signed in. On this page, the admins can publish promotions or deals that are available throughout campus. Figure 18 illustrates the food category option and the search function after the Food button

is clicked. Each button will bring user to the food list based on the food category. Users can utilize the search function by typing in their food choice. Figure 19 shows the food list page for rice category. It displays the image and name of each food. Users can click the menu item for further details.

Figure 20 shows the clicked food item details. Information such as the menu item’s name, price, description, and location is provided. The page also shows similar items that are available elsewhere. Figure 21 shows the list of café after “Cafe” button from the homepage is clicked. Cafés are listed by name and location. Figure 22 displays café details such as name, picture, and location. User can navigate via a map to the location by click on the View Location button. It will prompt a message as shown in Figure 23 to open a google maps in browser or google maps application to show directions to the cafe.

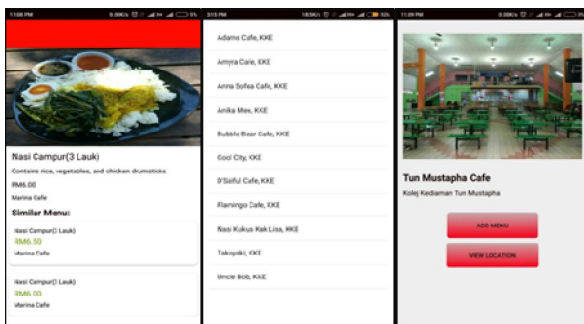


Figure 20                      Figure 21                      Figure 22

The ‘add’ menu button brings user to the add menu page as in Figure 24 to allow them to choose category of food to be added. Users may enter the food details in the page as shown in Figure 25. Figure 26 shows the authentication page for admin access. Admin need to Sign in with the given ID from the application administrator. Then, admin can publish new menu by category as in Figure 27 and publish advertisement as in Figure 28.

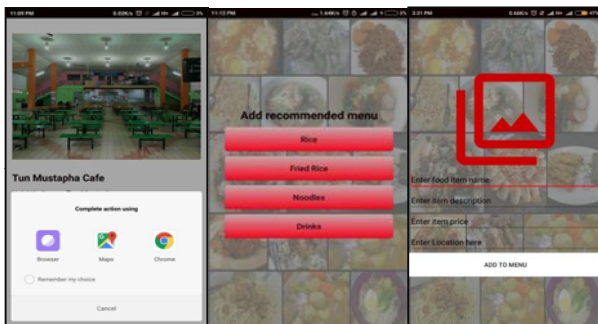


Figure 23                      Figure 24                      Figure 25



Figure 26                      Figure 27                      Figure 28

## 7.2. Evaluation on Usability of Hangri 2.0

A testing was conducted to evaluate the usability of Hangri 2.0 using the meCUE questionnaire. meCUE is a flexible, adaptable, and lean questionnaire that has been validated for measuring user experience based on the CUE model. meCUE has 4 set of modules that includes users’ perception on instrumental and non-instrumental qualities, user emotions, consequence of use and overall evaluation on the application. The questionnaire was adapted from the original document to match to test usability of a mobile application. There are total of 35 number of tester chosen using a clustering technique by faculties. Each faculty has 5 testers. The faculties involve are FKI, FKJ, FSSA, FKSJ, FPP, FSMP, FPEP and FPSK. 82.9 % of the tester were aged between 19-24, with 77.1% are living on campus and 22.9% are non-residents. The usability testing started with the distribution of the Hangri 2.0 application to the testers. After the testers have installed the application, they are required to complete the meCUE questionnaire.

The evaluation results are presented based on the separate modules below:

### Module 1: User Perception of Instrumental Qualities

Figure 29 shows respondents perception of Module 1, user perception of instrumental qualities. Majority of the respondents agrees that the application was quick and easy to use. They also agreed that the application is useful and helpful for the end users. It can be concluded that the application is beneficial to users.

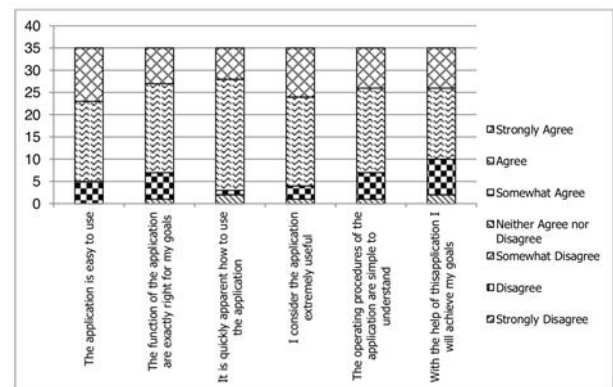


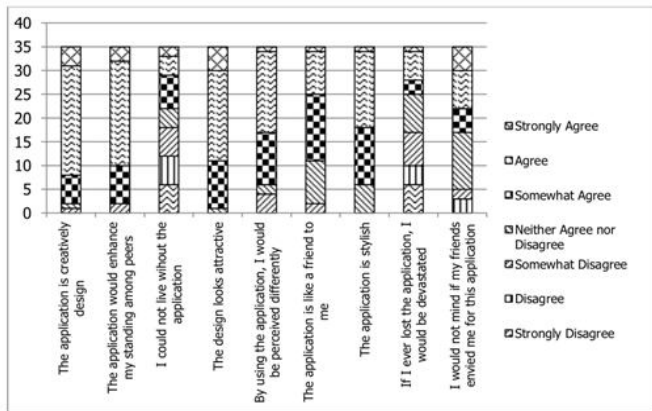
Figure 29: User perception of instrumental qualities

**Module 2: User Perception on Non-Instrumental Qualities**

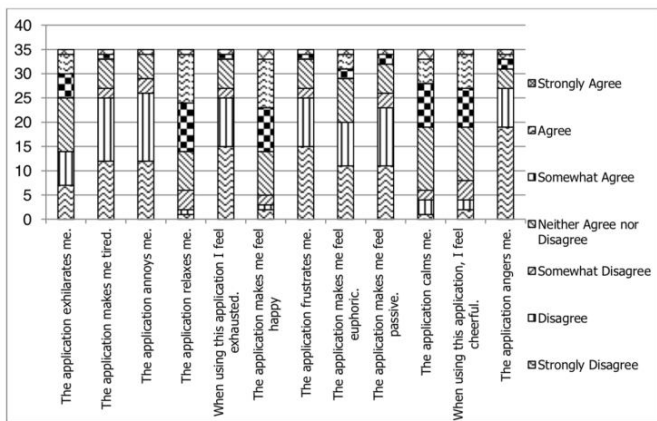
Figure 30 shows the chart for Module 2, user perception on non-instrumental qualities. This module is separated into two sections: positive and negative perceptions. For positive perception, majority of the respondents agree that the application was creatively designed (65%), attractive, stylish (46%), and enhances their standing among their peers (63%). As for the negative perception, testers were not unanimous in their votes on whether the application will make them devastated, envied and perceived differently. It can be concluded that this application will be greatly accepted.

**Module 3: User Emotion on using Hangri 2.0.**

The results indicate that users are not annoyed (40%), tired (37%), exhausted (43%), angry (54%) and passive while using the applications. Findings also indicate that the users believes that the application makes them calms and cheerful. Thus, Hangri2.0 does not burden the users.



**Figure 30:** User perception of non-instrumental qualities



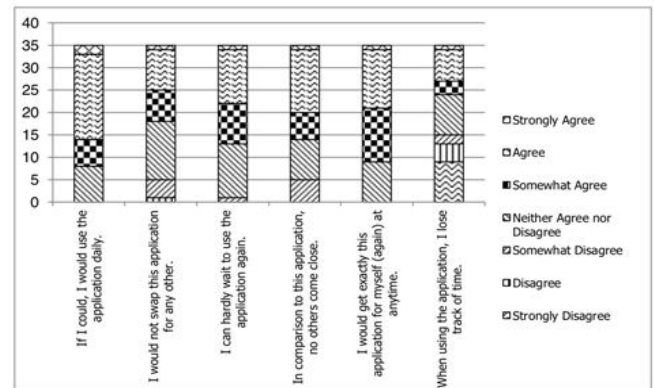
**Figure 31:** User emotions

**Module 4: The consequence use of Hangri 2.0**

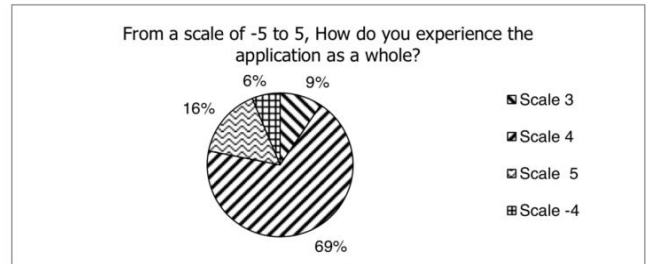
Figure 32 shows the graph for Module 4, the consequences use of Hangri 2.0. Based on the testers' votes, the application is likely to be used by users (54%). According to the testers, they may use the application daily (54%), unlikely to swap it

with other applications (28%), and would get Hangri 2.0 for themselves at any other time (37%).

Overall, Hangri 2.0's usability can be rated as 4 over 5. Figure 33 displays the result on the overall evaluation on user's experience pertaining to the use of the application. This module provide options on a scale of -5 to +5, with -5 to 0 being bad and 0 to 5 being good. Based on 35 respondents, 69% voted 4. 16% vote for scale 5 and 9% voted 3. Only 6% voted -4. It can be concluded that the average score for the overall evaluation is 4. This indicates that the testers rated Hangri 2.0 positively.



**Figure 32:** Consequences use of Hangri 2.0



**Figure 33:** Consequences use of Hangri 2.0

Based on the evaluation, Hangri 2.0 is useful based on its usability characteristics. The results of the evaluation survey for each module was used to measure the usability indicated positive feedbacks in which testers are satisfied for both instrumental and non-instrumental qualities. Testers also reported positive emotions while using the application, and suggested that they were likely to use the application again based on their positive encounter with Hangri 2.0.

**8. CONCLUSION**

Hangri 2.0 has become a useful platform for food search around UMS campus since most of the students are concerned about getting the most value out of their money. The comparison feature on the app allows students to compare food prices and avoid wasting money when they could have similar food item that are more affordable. The usage of information visualization technique has simplified the works of conveying the food information. Hangri 2.0 have a



potential to grow more in the future. This mobile application could be improved by adding more features such as variations of search filters, booking and order for food and simplified interface design to minimize the number of clicks. The information visualization concept on developing the application can be improved with more involvement of graphical contents such as café location by mapping to its location in an image instead of a list view.

## REFERENCES

1. Chittaro, L. (2006). **Visualizing Information on Mobile Devices, in Computer**, vol. 39, no. , pp. 40-45, 2006. doi:10.1109/MC.2006.109
2. Mitchell, A.A. (1986). **The Effect of Verbal and Visual Components of Advertisements on Brand Attitudes and Attitude Toward the Advertisement**. Journal of Consumer Research, 13(1), 12. doi:10.1086/209044
3. Keim, D., Mansmann, F., Schneidewind, J., & Ziegler, H. (2006). **Challenges in Visual Data Analysis. Tenth International Conference on Information Visualisation (IV'06)**. doi:10.1109/iv.2006.31
4. Penrose, J.M. (1998). **Book Reviews : Visual Explanations: Images and Quantities, Evidence and Narrative**. Edward R. Tufte. Cheshire, CT: Graphics Press, 1997. 157 pages. Journal of Business Communication, 35(2), 285-287. doi:10.1177/002194369803500207
5. Card, S.K. (2008). **Information Visualization. In book: The Human Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications.**, Edition: 2nd, Chapter: 26, Publisher: Mahwah, NJ: Lawrence Erlbaum Associates, Editors: Jacko, Julie and Sears, Andrew, pp. 509-543
6. Kanae, M., Masato, Y. and Hideki, S. (2011). **A Proposal of Framework for Information Visualization in Developing of Web Application**. IEEE/IPSJ 11th Informational Symposium on Applications and the Internet (SAINT), vol.#, pp. 98
7. Fayyad, U.M., Andreas, W. and George, G. (2002). **Information Visualization in Data Mining and Knowledge Discover**. USA: Morgan Kaufmann Publisher.
8. Yu, M. (2012). **Visualization method Based on Cloud Computing for Real Estate Information**. Service computation 2012: The Fourth International Conferences on Advanced Service Computing, pp. 100
9. Morgan, G.A., Harmon, R.J. (2001). **Data Collection techniques**. J. Ame. Acad. Child and Adolescent Psychiatry. William and Wilkins. 1-4.
10. Johnson, T., Vergara, J., Doll, C., Kramer, M., Sundararaman, G., Rajendran, H., Efrat, A. and Hingle, M. (2014). **A Mobile Food Recommendation System Based on The Traffic Light Diet**. CREU (Collaborative Research Experience for Undergraduates) final report, May 2013. <http://foodtracker.cs.arizona.edu>