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# Smart Campus Food Ordering and Recommendation System with Emotion Booster: A First Design.

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***Abstract*—** A healthy food intake is necessary for every person to function to their optimum potential. Apart from keeping the body fit and full of energy, food is also known to boost people's moods and ward off negative emotions. Typically, people order food, considering their budget, the time of the day as well as what they are craving. Consequently, this study proposes a system that can detect users' moods depending on their facial expression and accordingly, recommends food that they usually order during that particular emotion or related food, to subsequently improve how they feel. The system keeps track of a user's budget, the time of the day, the users' current emotions, and provides recommendations with a view to boosting their mood through foods that they like or through foods that are scientifically proven to help improve their mood. The system is intertwined with a campus food ordering system specifically designed for on-campus food stalls in their respective hostels. This food ordering system allows us to get an insight into the student's preferences and include them in our recommendations as well as providing a delivery system that allows students to save time from standing in queues usually during rush hour. The usability evaluation conducted to evaluate the system proved successful as all the users that evaluated the system provided positive feedback and most of the tasks assigned to them were satisfactorily completed.

***Keywords*—** food recommendation system, mood, emotion detection, user preference, ordering system, delivery system.

## I. Introduction

Food is an integral part of life. Not only is it crucial to sustenance, but it is also one of the daily satisfactions that people look forward to during their day-to-day lives. Science has come a long way in understanding how different foods have different impacts on our bodies. Food science is a field that breaks down and studies food to their components such as proteins, carbohydrates, fats, etc. as well as how they react to different processes. It equally involves understanding how fresh the food is, how it has been made, and the way it has been preserved. All this is understood through an in-depth study of food chemistry, microbiology, biochemistry, and human nutrition. Through these studies, we can understand the required nutrients for the body for optimal growth, physiological development as well emotional booster. Accordingly, it is expected that in order to grow physiologically and have emotional balance, foods that are rich in beneficial and adequate nutrients are crucial.

However, although nutrition studies are available, most people do not know how or what is required by their bodies. People buy food in bulk encompassing what they believe to be healthy and required. This does lead to several problems such as overeating which could lead to obesity, consumption of unhealthy foods, or a surplus of some type of nutrients being consumed compared to fractions of other needed nutrients, over budget, and most importantly food wastage. Fast food is a common example of such an eating trends which is favoured for its quick and fulfilling qualities. Research [1] shows that such gratification from enjoying unhealthy foods leads to repetitive activation of the reward and pleasure centres of our brains which activates dopamine production. This gratification feeling overpowers our signals of hunger and satiety which leads to potential obesity. Food wastage is a sad reality of the present times. Knowing what to eat may allow us to waste food less by ordering less food in the right amount.

Food ordering systems are nothing novel and have been used for more or less a decade. They are beneficial for a variety of reasons, for both the customers and the business owners. They provide an efficient manner to order food, reduce time spent in queues, less crowding during peak hours, no hassle with cash denominations, afford the business owners to present menus online in more appealing forms, no middlemen such as waiters, easier and cheaper marketing to attract new customers, as well as better insight into customer preferences and lots more. Therefore, combining a food ordering system with a system that captures one's mood and recommends what replenishments they need would be an ideal system that encompasses our goal.

Often, when provided with an abundance of food choices, people do not know what to order. Studies also have shown that people tend to go for conventionally

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attractive food [11] which could lead them to go over budget. Moreover, often people experience different emotions and are unable to decide what to eat. When experiencing negative emotions like stress, anxiety, or sadness, individuals are more likely to seek out comforting, palatable foods, leading to overeating [2] and poor nutritional choices.

Another major issue is the lack of comprehensive online food ordering systems at most educational institutions and university campuses. Existing platforms fail to account for key student needs and preferences, leading to a variety of problems. It is established by [3] that people are even willing to pay more for a good service provided through online food delivery services.

Therefore, this study aims to bridge this gap by developing an intelligent food recommendation and delivery system tailored to university students' budgets, emotions, preferences, and nutritional needs. The proposed system detects mood through facial recognition, linking specific emotions to food choices. It then suggests healthy, affordable menu items scientifically proven to improve that mood. This personalized approach accounts for the budget of the user and the popularity of food items, minimizing overspending and food wastage while enhancing mental well-being.

The contributions of this work are two-fold: (1) to develop an online food ordering platform that allows the user to browse, order, pay for food online, and collect their order from any restaurant within the campus. (2) to recommend mood-boosting menu items based on emotion detection, budget, preferences, and nutrition. This approach will provide an invaluable tool for improving nutrition and mental health among university populations.

## II. Related Work

Food as a mood booster has always been studied extensively. A study done by [1] carefully detailed how research has shown that food can influence brain neural systems directly which can alter brain structure, chemistry, and physiology. At the same time, mood also influences our food choices, making it a 2-way relation. This is agreed upon by [4] where it is stated that people make good food choices when in a good mood but fall into bad choices such as fast food when in a bad mood.

Table I. Food Recommendation Systems Studied

| System | Function |
|---|---|
| Food Recommender System | Analyses the user's health and suggests food based on it using a content-filtering algorithm and the K-Nearest Neighbours Algorithm [16]. |
| Healthy Recipe Recommender System | Recommends healthy recipes using content-based, collaborative-based, and hybrid approaches [17]. |
| Flavor-Inclusive Recommendation System | Includes flavour into their recommendation systems considering collaborative filtering, content-based filtering TF-IDF without flavour, and content-based filtering TF-IDF with flavour, to determine or classify flavours of food [18]. |

Another study conducted by [5] found that mood significantly improves after eating and that the amount of food intake directly affects mood improvement for the first 5 minutes of eating.

The study in [6] states that in a large-scale study of Canadians which included over 8000 participants, they were asked to answer questions regarding their vegetable & fruit intake along with their physical and psychological activity. According to the results, there were negative correlations between fresh fruit and depressive mental state, but positive correlations between fast food and depression symptoms. This shows us that foods that we generally want like fast food aren't necessarily improving our mood but are rather doing the opposite. Table 1 presents a summary of the existing food recommendation systems.

In their research on the effect of fruits and vegetables, the study in [7] found that a common link was that the more often fruits and vegetables are being eaten by participants, the better their mental well-being. Citing one study in [8], fruits and berries were a significant determinant of mental stability in the prime ages of 18-29.

Coffee has been a staple in the lives of many working-class people and students even though they may not know the full extent of its effects. It is usually taken as a sleep deterrent. Halder & Khaled [2], in their work, detailed that as a mood enhancer, coffee is one of the safest and fastest agents on earth. Coffee enhances the flow of blood in the brain and invigorates the mind. It enhances alertness and motivation, facilitates thought formation and concentration, and decreases mental fatigue. A study published in Harvard's Archives of Internal Medicine, states that drinking caffeinated coffee lowered rates of depression among women.

As far as smart food ordering systems go, various methods have been used to replace traditional food ordering systems. Jakhete & Mankar [9] proposed a model that replaced the traditional menu with an Android device that will be presented at every table in a restaurant. Users would open their mobile devices to connect to the restaurant's Android devices and order food. However, this system is not practical in universities where there are thousands of students.

Another similar Smart Menu Ordering System was designed by [10] which replaces the paper-based menu system with a user-friendly Matrix keypad-based menu card. The matrix keypad sensor is integrated into an LCD screen for users to have a graphical display. The food chosen is forwarded to the microcontroller that forwards it to the NRF at the receiving end. The customer then gets the selected food through the use of a conveyor belt. This method does automate food ordering but relies on the single conveyor belt to deliver food which is limiting.

Foody is another smart restaurant ordering mobile application designed by Liyanage et. al [11] that aims to reduce time wasted on ordering and customer dissatisfaction. Similar to what this paper aims to achieve, they provide a menu based on the specific customer basing the recommendation on their social media activity. This is done through Facebook's Graph API which collects data

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from the user's activity on the platform. The app also provides a 3D-modelled menu to help the customers get a better sense of the size of food they are ordering. This approach does take into consideration the preferences of the people, but it may not be viable as it may intrude on customer's privacy when collecting data.

TABLE II. FOOD AND RESTAURANTS SYSTEMS STUDIED

| System | Function |
|---|---|
| Smart Restaurant | The menu was replaced with an Android device for ease of ordering [9]. |
| Smart Menu Ordering System | Matrix keypad-based menu card for faster ordering [10]. |
| Foody | Recommendations based on customer preferences learned from social media activity [11]. |
| Smart Restaurant Management System | The system uses NFC on customer's devices for ease of dining such as finding parking and ordering food on devices [12]. |

Saeed et. al [12] also proposed a Smart Restaurant Management System that would try to minimize the intricacies of the traditional restaurant like customer waiting times, menus with limited information, waiting for waiters to take orders and bill, etc. Their proposed system would allow customers to find parking easily using the NFC feature to connect to the restaurant parking system and show any available spots. The NFC feature is also used to connect to the NFC tag on their tables and then order their desired food. This system uses a combination of IoT, ICT, NFC, and cloud computing to achieve its goal. A summary of the food and restaurant systems is presented in Fig. II.

In a study conducted by [13], they found that those who are prone to anxiety felt an improvement in their mood after consuming milk chocolates. Those who are not so prone to anxiety levels perceived a decrease in their perceived anxiety level after consuming dark chocolate.

Rice is the staple food for over half the world's population. Carbohydrates which are the major nutrient in rice, and their effect on mood was studied by [14]. They found that there was no significant improvement in mood post-intake of carbohydrates, rather there was a decrease in alertness and an increase in fatigue post-eating.

Contrary to [14], the study in [15] found that consumption of foods high in carbohydrates enhances moods by releasing serotonin in the brain which helps in managing stress. [15] also found that protein-rich foods may cause a disturbance in the production of serotonin. A summary of the effects of different foods or nutrients on the mood is presented in Fig. III.

The tables below synthesize key findings from the literature, categorizing pertinent works on automated restaurant systems, food recommendation platforms, and scientific evidence regarding nutritional influences on human mood and psychology. These summaries contextualize the state of knowledge in domains integral to this research and system development

TABLE III. THE EFFECTS OF DIFFERENT FOODS OR NUTRIENTS ON THE MOOD

| Food/Nutrients | Influence on humans |
|---|---|
| Coffee | Enhances blood flow and mental alertness [2]. |
| Chocolate | Can help in reducing anxiety for high anxiety people [13]. |
| Fruits & Vegetables | Improves mental well-being [7], [6]. |
| Carbohydrates | Can enhance mood but also causes a decrease in alertness and an increase in fatigue [14]. |
| Protein | Causes a decrease in serotonin thereby decreasing stress-handling capacity [15]. |

## III. METHODOLOGY

To fulfill the objectives of this study, a web-based online food ordering system named "i-Café" has been developed adapting existing systems [19], [20] to provide features that will enable food items from restaurants within the campus to be sold and delivered directly to the customers. These features include an auto food recommendation system, a food browsing system, an ordering system, a payment system, a delivery system, a reward system, and a profiling system as seen in Fig. 1.

Since this work is about developing a smart food ordering system, the main feature of i-Cafe will be the auto food recommendation system. This system will be invisible to the user and will run in the background as the user uses the i-Café system. Every time the user successfully pays for an order, the system will record the food's name, the user's mood or emotions, the amount of money spent, and the time ordered. Using this information and as the user uses the system over a period, the system will slowly learn what food items the user buys while feeling certain emotions, their budget, likings, and at what time of the day they order a particular food. Based on these four factors, the system will then generate a food recommendation list and display it in future browsing sessions. These four factors will be determined as shown in the detail below:

1) Emotion:

Whenever a user buys a food item, their mood or emotions will be recorded and associated with that particular food. This will be detected through the camera of the user's device. While the user browses for food items to buy, their faces will be captured and processed in real-time by the system through the use of Application Programming Interfaces (API) dedicated to face recognition. The moment the user clicks on a food item, the system will take note of their mood. If the user proceeds to buy it, then that particular mood will be linked to that food by the system. So, every time the system detects that mood in future browsing sessions, it will recommend that particular food. Moreover, other food items that have been scientifically shown to improve that mood will also appear in the list of food recommendations.

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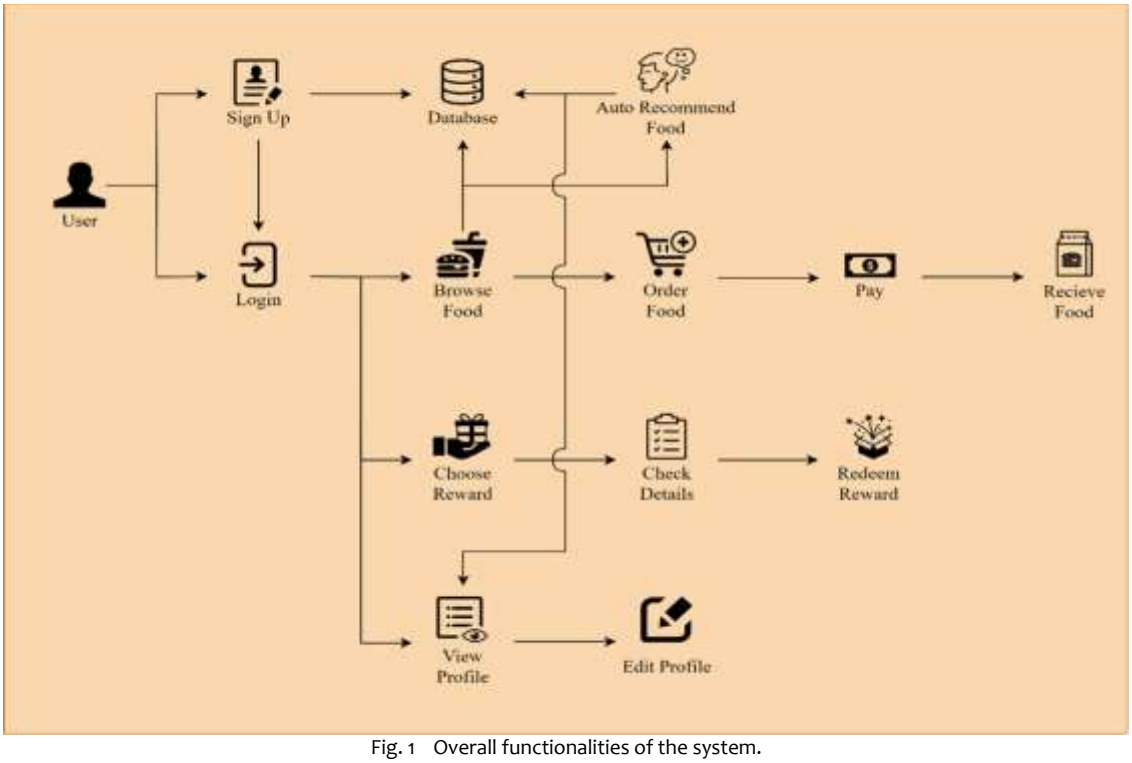


Fig. 1 Overall functionalities of the system.

At the most basic level, to integrate it into the website, the system runs with the help of the TensorFlow AI framework combined with JavaScript. We combine AI in the web browser to track faces in real-time and a deep learning model, which is built on a convolution neural network with several hidden layers [21]. This deep learning model helps us classify the different emotions on a person's face. After combining the two frameworks, we can successfully detect and classify emotions in real-time through the website.

For instance, let us say a user just woke up and is browsing through the food menus. The system senses through the camera that the user looks sleepy. As the user maintains this sleepy expression, he/she orders a cup of coffee. The system will then link the user's sleepiness to the coffee he/she just ordered. Using this information, if the system again detects that the user is sleepy in future browsing sessions, it will suggest a cup of coffee along with similar food items in the list of food recommendations. Furthermore, food items that are scientifically known to help with sleepiness and increase your energy, such as foods that have a lot of sugar, will also appear on the list.

2) Budget:

As the user uses the system, a history of what he/she orders will be collected. This history will also include the price of every purchased item. Using this history, the system will determine the user's budget by calculating the average cost per item. Based on this, the system will recommend food items that are closest to this budget, as shown in this equation:

$$Budget = \frac{\sum_{n=0}^{Orders}(Price\ of\ Item \times Quantity)}{Total\ Items\ Bought} \quad (1)$$

For example, let us say a user purchases 3 food items that cost RM 21 in total in one day. On the following day, that user buys 4 food items that total up to RM 28. Then the next day, the user buys 2 items costing a total of RM 14. The food recommendation system will then calculate the average cost per item and record it as the user's budget, which in this example would be RM 7 per item. Using this value, the system will then recommend to the user food items with a similar price, like RM 6 to RM 8.

3) Time:

Along with the user's mood and the food item's price, the time in which the food items were ordered by the user will also be recorded. This information will be used by the system to figure out which food items the user buys at a particular time (i.e.: morning, afternoon, evening, etc.) and recommend those during that time. This information will be tracked through the use of a few counters as shown in the pseudocode in Algorithm 1.

**Algorithm 1: Total times items ordered at specific times of the day**

**Data: Orders as the list of all past orders and Items as the list of all items**
**Result: Total times every item has been ordered at what time of the day**

```
int n ← Orders.size
for int = 0; i < n; i++ do
    int time_ordered ← Orders[n].time_ordered
    int item_id ← Orders[n].item_id
    If time_ordered is in the morning then
        Items[item_id].morning_sales += 1
    If time_ordered is in the afternoon then
        Items[item_id].afternoon_sales+= 1
    If time_ordered is in the evening then
        Items[item_id].evening_sales+= 1
    If time_ordered is in the night then
        Items[item_id].night_sales+= 1
    If time_ordered is past midnight then
        Items[item_id].midnight_sales+= 1
end for
```

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For instance, imagine a user orders a specific food item, say Nasi Goreng, in the afternoon consecutively for a week. The recommendation system will keep track of this by recording the exact time the Nasi Goreng was ordered and how many times through the use of a counter. The system will then compare these data with other food items that have been ordered by the user in the past in the afternoon and determine the food items that have been bought most often in the afternoon. Food items that have been bought most in the afternoon will appear higher in the list of food recommendations in the afternoon.

4) Popularity:

As mentioned previously, as the system is used, what user orders will be recorded by the system. This record will include the food items and how frequently they were bought at different times of the day. Using this information, the system will then determine which food items the user buys most frequently, or the popularity score, and recommend them in the food recommendations list while considering the current time.

The pseudocode of how this is implemented is presented in Algorithm 2.

**Algorithm 2: Popularity score based on the time**

```
Data: Items as the list of all items
Result: Popularity score of every item based on the current time
int n ← Items.size
for int = 0; i < n; i++ do
    If current time is in the morning then
        Items[n].popularity = Items[n].total_sold +
                              Items[n].morning_sales
    If current time is in the afternoon then
        Items[n].popularity = Items[n].total_sold +
                              Items[n].afternoon_sales
    If current time is in the evening then
        Items[n].popularity = Items[n].total_sold +
                              Items[n].evening_sales
    If current time is in the night then
        Items[n].popularity = Items[n].total_sold +
                              Items[n].night_sales
    If current time is past midnight then
        Items[n].popularity = Items[n].total_sold +
                              Items[n].midnight_sales
end for
```

As an example, imagine Nasi Ayam has been sold a total of 39 times, 13 of which have been bought in the afternoon. Then, if the current time is in the afternoon, the popularity score will be 39 plus 13, resulting in 52. This popularity score will then be compared with the score of other food items and arranged in the food recommendation list with the highest on top.

Finally, based on all these four key factors, the food recommendation system will suggest food items that are most suitable to the user. Figure 2 gives an overall picture of how the recommendation system works. In this case, the user orders Roti Naan Biasa. When the user clicks the "Add to Cart" button, the system processes the order by determining the four factors explained above: emotion, budget, time, and popularity. Once this process is completed, our system stores the result of this process and uses it in future browsing sessions to generate the food recommendation list.

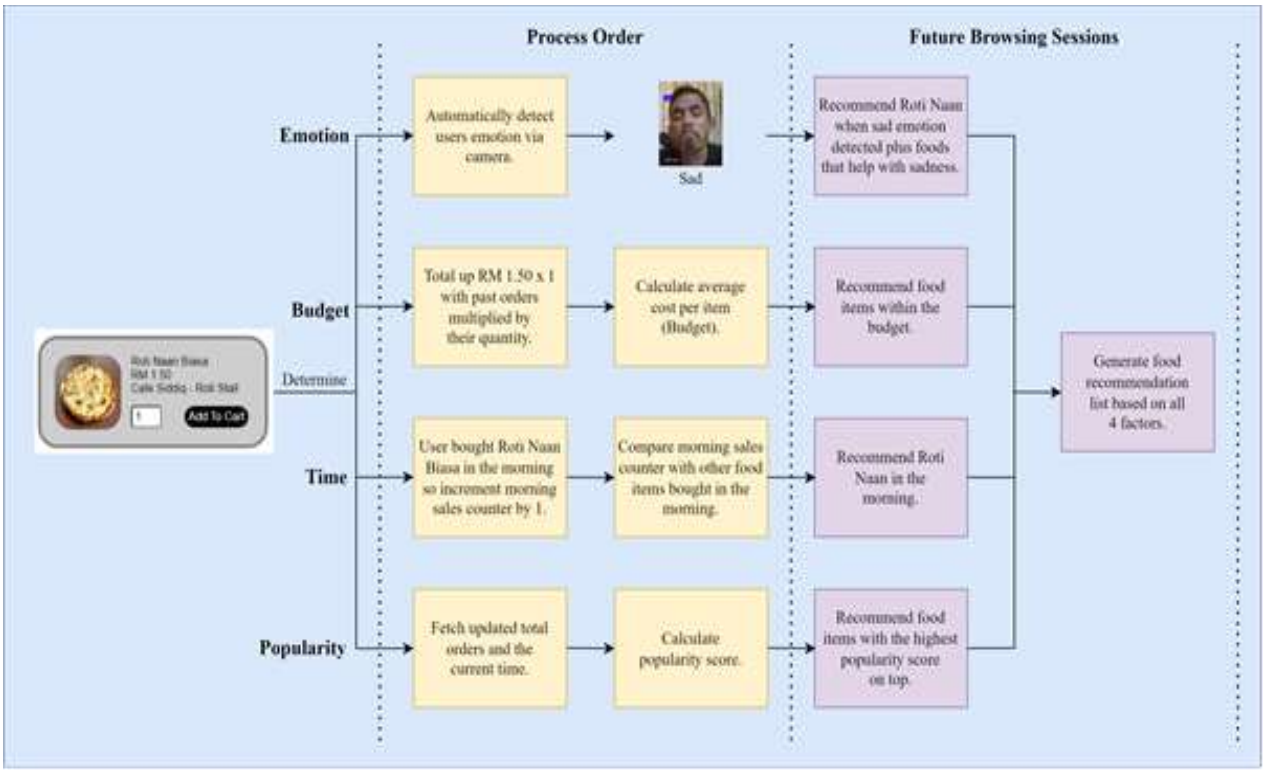


Fig. 2 Recommendation system based on emotion, budget, time, and popularity.

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## IV. Result and Discussion

By following the aforementioned methodology, a prototype of i-Café has been developed to achieve the objectives of the study. Both the frontend and backend of the system have been built, which includes the user interface for every page of the website, and the database. The Home page is shown in Fig. 3. On this page, two sections can be seen. The first is the recommendations list which displays food items based on the four factors discussed earlier: emotion, budget, time, and popularity. As for the second section, it includes all the food items arranged based on popularity only.

### 1) Recommendation Generation

Through these features, a few unique advancements have been achieved by the system. Firstly, by recommending food items to the users based on their emotions, the system may potentially enable the enhancement of their mood. Moreover, the system allows the user to save money by recommending food items based on their budget. Finally, by taking the time ordered and popularity of food items into consideration when recommending food items, our system is able to adapt to changing market trends and user preferences. Overall, this will allow the user to have a much more personalized experience.

TABLE IV. Technologies Used

| Component | Technologies |
|---|---|
| Website User Interface | Languages used were HTML, CSS, JavaSript, PHP, and MySQL |
| Emotion Detector | The laptop's camera was used to detect the users' emotions. It was integrated into the website using JavaSript. |
| Local Server | The software used were XAMPP, Apache, and phpMyAdmin. To interact with this local server, MySQL was used. |
| Pubic Server | The website was hosted on www.infinityfree.com, FileZilla was used to upload files, and MySQL was used to interact with this public server. |

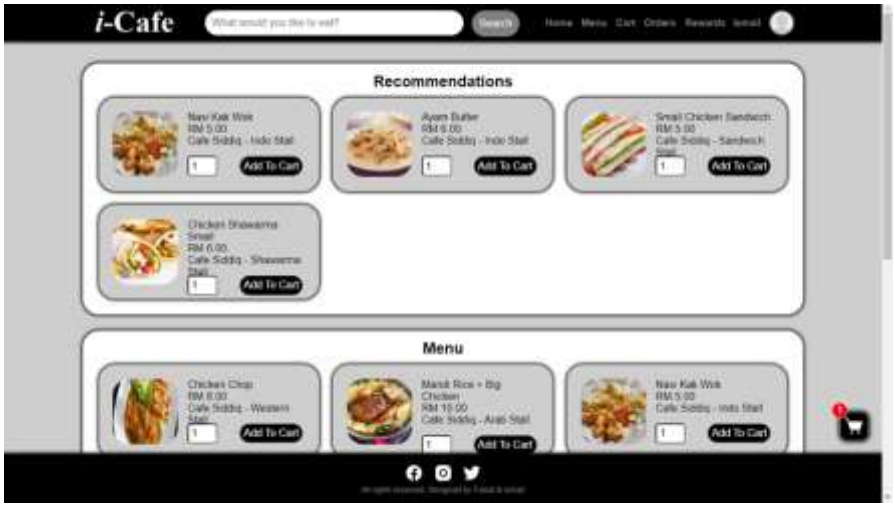


Fig. 3 Home Page

Thus, these two sections combined fulfill the second objective of this study: to recommend food items to users based on their emotions, budget, and eating habits to boost their emotions. Once the user chooses their food items and adds them to the cart, they may proceed to the Checkout page as shown below. Over here, the user is first shown what they have ordered and the grand total. If satisfied, they may proceed by entering the address of where they would like their order to be delivered and their payment details. Once this is completed, the respective restaurants will be notified of the orders to prepare them. Upon completion, the user may collect their food from the respective restaurant.

By implementing the above, some new improvements to the day-to-day life of students on the university campus, the target users of the system, may be accomplished. For instance, these features will allow them to order their food from anywhere within the campus, eliminating the hassle of queuing up in restaurants to order food. This can potentially save a lot of valuable time for the user. Moreover, restaurant owners will be able to manage orders more efficiently than before.

Therefore, the features of both the Home page and the Checkout page together fulfill the first objective of our system: to allow the user to browse, order, pay for food online, and collect their order from any restaurant within the campus.

### 2) Usability Evaluation.

However, to properly gauge the effectiveness of the proposed system, it needs to be tested by the users. In the case of i-Café, the students within the campus are the targeted users. The students were therefore chosen for the usability evaluation of the i-Café system. The usability evaluation depends upon the basic understanding of the system by the user.

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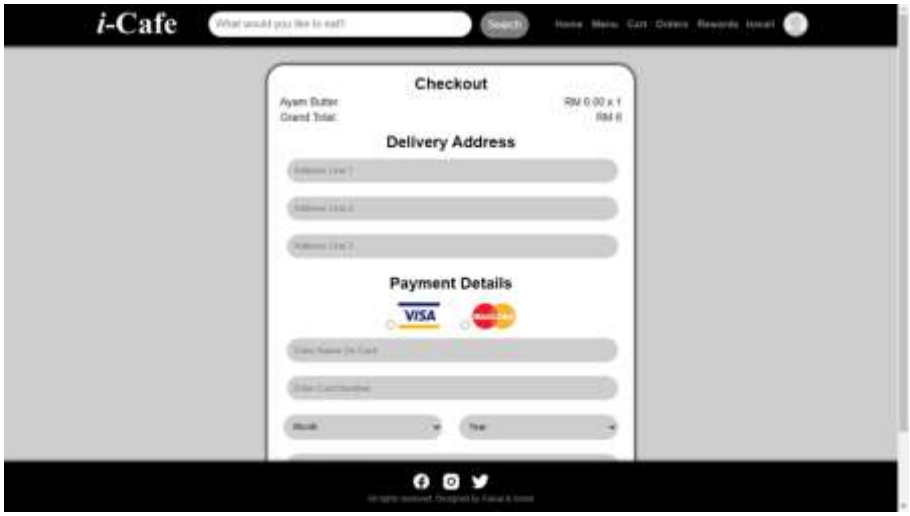

Fig. 4 Checkout Page

One of the key metrics examined was the time taken for users to complete core tasks, including registration, browsing menus, ordering food items, entering delivery details, and payment. Subjective feedback was also gathered through questionnaires and interviews gauging users' perceptions, problems faced, and suggested improvements. If the system is complicated to use, the time taken for an order to complete will be longer which is the opposite of what the system is expected to accomplish. The other more clear-cut way to assess the evaluation is by asking the users how they feel about the system. This allows for a more detailed insight into their perception of the system. This provides an opportunity to learn about the problems or shortcomings of the system and use that feedback to improve upon them. This also allows users to detail specific problems they faced during their use of the system as well as allows for suggestions to improve the system that the users feel are necessary.

To carry out the evaluation, the website was made public by uploading it to a server. A total of 10 users were asked to evaluate the system. Their task would be to register as a new user, successfully complete an order, browse the website, and get an overall feel of the system. They would then answer a questionnaire provided to them that aims to detail their experience.

All users successfully registered, placed orders, and checked out in under 2 minutes, indicating a seamless user experience. Moreover, 80% of participants rated the system's usability 4 out of 5 or higher. From the subjective feedbacks received, users would prefer an improvement in UI aesthetics with more vibrant colour palettes. Participants wanted user budgets displayed prominently on the home page. They agreed that the design of the system was simple and efficient.

However, some technical issues were found by the users that were helpful to find some problems in the system. The emotion detector encountered some problems when the website was made public. Moreover, the search bar malfunctioned showed an error, and logged out the user abruptly from the website. One user reported a minor bug with the navigation system when trying to access their profile or log out. A hindrance to the users' testing was that the website was not yet ready for the use of smartphones and users would have to run it on their personal computers or laptops, to which a user also suggested for the system to be compatible with any device. The users also made suggestions to the UI of the website, stating that a livelier colour palette would be an improvement. When asked if any features of the website were particularly interesting, they mostly commended the simple and efficient design of the system. This also helps us understand that the budget feature that is calculated for the user was not easily visible and needs to be displayed on the home page of the system, not just on their profile pages. Overall, all users agreed that having such a system would benefit the students and hostel cafeterias alike.

## V. Conclusion

An online food ordering system can be a very beneficial addition to the university, especially with features that take into account users' emotions, budgets and having an overall food recommendation system. Scientifically, various foods exist that can help improve the mood of a student, and providing them with knowledge about such food is helpful. The study contributes in two ways. Firstly, the proposed system was developed to provide an online food ordering platform that allows the user to browse, order, pay for food online, and collect their order from any restaurant within the campus. Secondly, the system is equipped with facial emotion recognition to aid in recommending mood-boosting menu items based on the users' emotions detected, budgets, preferences, and food nutritional contents. This approach provides an invaluable tool for improving nutrition and mental health among university populations. From the usability testing, it is apparent that if a system with a simple UI such as this were to be implemented, it would benefit the students and the food vendors alike. A future enhancement to the system would focus firstly on resolving some of the identified challenges highlighted by the users that evaluated the system such as compatibility with a wide variety of common devices as well as using mobile platforms rather than a website on a laptop.

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## VI. CONFLICT OF INTEREST

The authors declare that there is no conflict of interest

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