

Food Delivery Applications with Data Mining Methods: Evaluating End-Users' Experience

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Online food delivery applications (OFD apps) have existed in Malaysia for more than a decade. It has received a wide range of customer acceptance among the young and adults in Malaysia. However, the paradigm of customer satisfaction in the OFD apps has shifted since the COVID-19 pandemic struck the world. There were several recent research conducted to identify the factors that affected Malaysian tertiary students' satisfaction towards OFD apps. However, past research did not study the aspect of OFD apps' content and user interface (UI) design from a mobile application's usability study perspective. Moreover, past research also did not classify or cluster the customers to understand them from a deeper perspective. This research attempted to explore the factors affecting Malaysia tertiary students' satisfaction with OFD apps with two data mining methods namely the multiple regression analysis (MRA) and K-means clustering analysis, by using questionnaire data collected from 156 Malaysia tertiary students. The output of the analysis will help the OFD service providers to understand their customers better and be able to plan the right resources to manage the app's quality and services.

Keywords: K-means, Multiple regression analysis, Online food delivery (OFD), Usability study.

1. Introduction

Online food delivery (OFD) refers to the delivery of food to a customer's doorstep via a website or mobile application (apps) purchase. OFD apps have existed in Malaysia for more than a decade. Some famous merchants' OFD apps include McDonald's and Domino's Pizza. Among the famous third-party delivery apps include Grab, Foodpanda, Airasia Food, and Shopee Food [1]. According to the study conducted by Oppotus in the year 2023 [2], Malaysia's OFD service market was highly competitive and projected to grow by 14.28% in

the coming years. The demographic study also showed that customers aged 18-24 years old were the second largest customer group of OFD with 33%. Hence, it is necessary to explore the factors that affect the satisfaction level in using OFD apps among Malaysian tertiary students who fall within the age range of 18-24 years old.

There were several research conducted to explore the factors that influenced Malaysian university students' satisfaction with OFD apps in the past few years. Vijayan, et. al [3] in their research in the year 2020 explored the factors of food quality, perceived price, service quality, and mobile application user experience. Azman, et. al [4] in their research in the year 2021 covered the factors of delivery service, time, security/privacy, and price. In 2021, Chong, et. al [5] found that security and promotion were significant factors that affect students' satisfaction with using OFD apps. Meanwhile, Harun [6] in the year 2022 discovered other university students' satisfaction factors such as information quality, price-saving orientation, time-saving orientation, and effort expectancy.

Despite numerous research were conducted to understand the factors affecting tertiary students' satisfaction towards OFD apps, none of the research covered the area of apps' usability study such as apps content and user interface (UI) design, as well as in-apps payment support. It is felt that these factors are equally important in comparison to other customer satisfaction factors that were adopted from various technology adoption frameworks and models. As such, this research explored the factors that affect Malaysian tertiary students' satisfaction with OFD apps which included apps content and user interface design, perceived e-service quality, payment methods applied, perceived ease of use, privacy, and security through a quantitative questionnaire survey. Two data mining methods were adopted to analyze the data collected from the survey. The multiple regression analysis (MRA) is used to determine the factors that have positive and significant relationships with OFD apps' satisfaction as well as the ranking of the factor among the factor group of study. Meanwhile, the K-means clustering is used to group the survey respondents into five clusters, based on their agreement rating of the factors that affect their satisfaction level towards OFD apps. The study could help the OFD service providers understand the tertiary student customer group better and enable the service providers to plan their OFD services effectively.

This paper elaborates on the customer satisfaction factors and data mining methods used in the research in the literature review section. Following on, the research processes and design are explained in the methodology section. The analysis and findings of data mining processes are discussed in the subsequent section. This paper also includes a discussion on the efficacy of the adopted data mining methods in this research context, before the conclusion, recommendation, and future work are provided in the last section of the paper.

2. LITERATURE REVIEW

A. Factors Related to Customer Satisfaction in OFD Apps

Several usability-related factors could contribute to customer satisfaction in OFD apps. For example, ease of use and design contents and layout were important usability factors that could increase customer satisfaction in using apps and turn the browsing experience into

purchase behavior in apps [7]. Several research discovered that good apps design such as an easy purchase process, easy navigation layout, as well as interactive design, would increase customer satisfaction for mobile commerce apps [8-10]. However, the study of usability-related factors such as design contents and layout in relationship with OFD apps' customer satisfaction was not explored in the context of Malaysian tertiary students yet.

The factors of service quality, payment method, and privacy were popularly used in the OFD customer satisfaction research [3-6]. Numerous past research found that these factors had positive and significant relationships with customer satisfaction in using OFD apps [11 – 14]. These included the research conducted in the country of India and Malaysia.

While various factors have been studied in different research regarding the factors' relationship with customer satisfaction in using OFD apps, the research combines the factors from usability study (apps content and user interface design and perceived ease of use) and technology acceptance framework (perceived e-service quality, payment methods, privacy and security) have not been conducted among the tertiary students in Malaysia. This combination of factors is important to understand the tertiary students' satisfaction from both technical app-related and business decision-related perspectives.

B. The Data Mining Methods

Regression is a type of data mining technique that is used to detect the relationship and analyze features between a set of variables (often referred to as independent variables/factors) to another variable (often referred to as dependent variable). The types of regression include decision tree regression, random forest regression, ElasticNet regression, standard/stepwise multiple regression, hierarchical regression, and set-wise regression [15]. Each regression method has its unique characteristics and limitations. Researchers usually choose the right type of regression method based on the characteristics of the dataset and the purpose of data and knowledge discovery.

In this research, the aim is to determine the group of factors that have a positive and significant relationship with OFD apps satisfaction among Malaysian tertiary students. The analysis should be conducted by deploying all the factors at once. As such, standard multiple regression is used where the predictive ability for every independent variable is assessed at the same time. This analysis method can provide coefficient beta value for each variable/factor that forms the prediction model of the research context. The variable/factor with a higher coefficient beta value is said to have a stronger relationship with the dependent variable.

To achieve another research objective of finding the groups of Malaysian tertiary students by using the explored usability-related factors and technology adoption-related factors, the clustering method with the K-means algorithm is chosen. K-means clustering is chosen as the OFD apps satisfaction factors are independent and assumed to be an undefined group. It is also suitable for small datasets in comparison to other clustering methods. Moreover, it has proven its ability to generate various types of grouping such as behavioral segmentation, segmentation by purchase history, persona definition based on interests, and many more [16].

3. METHODOLOGY

This research began by designing a questionnaire to collect responses from tertiary students in Malaysia. The questionnaire covered three sections: section one collected the demographics and background information of the respondents; Section 2 collected the respondent's feedback on the factors being investigated such as Apps Content and UI Design (UID), Perceived Ease of Use (PEOU), Privacy and Security (PS), Payment Method (PM), and Perceive E-service Quality (PEQ). There were five questions for each factor. The response was measured by using a 5-point Likert scale of 1 strongly disagree to 5 strongly agree; Section 3 collected the respondents' overall satisfaction level towards OFD apps with the same Likert scale as Section 2. The research aimed to collect at least 150 responses by using a purposive sampling method. The questionnaire was distributed via online Google Form to target respondents via social media and community communication sharing.

A pre-processing activity was conducted before MRA and K-means clustering analysis. A reliability test was conducted to assess the consistency of a respondent's answer to all questions in the factor/variable group. All the factors should achieve a Cronbach Alpha value of 0.6 and above to be included as the item in the MRA and K-means analysis later.

Further on, MRA was conducted by using SPSS Statistical Package version 28. The factors that have positive and significant relationships with Tertiary students' satisfaction with using OFD apps will be determined. The finding of MRA also informed which factor has the highest relationship with tertiary students' satisfaction in using OFD apps among all the significant factors. K-Means clustering was conducted subsequently to understand the tertiary students in Malaysia by using the measurement of students' ratings for the five factors. The analysis was conducted by using Weka software and followed the steps given in [17]. The findings of the clusters will be presented in tables and charts.

4. ANALYSIS AND FINDINGS

A. Reliability Analysis

The reliability analysis was conducted to determine the consistency of answers for the response data set. The analysis was conducted for five independent variables and one dependent variable. The analysis was conducted in a pilot test with 30 responses and a full test with 156 responses. The result is shown in Table 1.

Table 1 shows Cronbach's Alpha coefficient value for each variable in the ideal range of 0.783 to 0.867 respectively in the full test. Thus, all variables fulfilled the minimum requirements for good reliability and the questions could be used for subsequent statistical and data mining analysis.

TABLE 1. RESULT OF CRONBACH'S ALPHA IN RELIABILITY ANALYSIS

Items used for the pilot test with 30 responses	Cronbach's Alpha	Items used for the full test with 156 responses	Cronbach's Alpha
PEOU1 – PEOU5 - Perceived ease of use	0.790 (after removed PEOU4 and PEOU5)	PEOU1 – PEOU3	0.838
PS1 – PS5 - Privacy and security	0.803	PS1 – PS5	0.854
PM1 – PM5 - Payment method	0.854	PM1 – PM5	0.867
UID1 – UID4 - Apps Content and UI Design	0.883 (after removed UID5)	UID1 – UID4	0.828
PEQ1 – PEQ5 - Perceived E-Service Quality	0.789	PEQ1 – PEQ5	0.826
CS2 – CS4 - Customer Satisfaction	0.891	CS2 – CS4	0.783

B. Multiple Regression Analysis

The result of MRA is shown in Table 2. The first run of MRA showed that the factor of privacy and security (PS) did not have a significant relationship with customer satisfaction (CS). Thus, it was removed and MRA was run for the second time. The result showed the factor that has the highest positive relationship with customer satisfaction is apps content and UI design (UID) with unstandardized coefficients beta value of 0.328, followed by payment method (PM = 0.199), perceived e-service quality (PEQ = 0.187), and perceived ease of use (PEOU = 0.159).

TABLE 2. RESULT OF MRA

Measurement	First Run	Second Run
R	0.771	0.771
R Square	0.594	0.594
Unstandardized Coefficients B	Constant 0.592 PEOU 0.159 PS 0.002 * PM 0.199	Constant 0.594 PEOU 0.159 PM 0.199 UID 0.328

	UID 0.328	PEQ 0.187
	PEQ 0.187	

* Variable PS is not significant with p value = 0.970. This variable was removed in the second run of MRA.

C. K-Means Clustering

The K-means clustering process was conducted by using the Weka software. The dataset which comprises 156 questionnaire responses from the Malaysia tertiary students was input in K-means modeling by applying the Euclidean distance calculation method. A total of 22 attributes from the questions used for the MRA full test, representing five factors that have relationships with Malaysian tertiary students' satisfaction in using OFD apps were used in the clustering process, with the number of clusters $k = 5$.

The clustering process was completed with 15 iterations. As shown in Fig1, the cluster with the highest number of students was cluster 1 (45 students), followed by cluster 4 (44 students), cluster 5 (36 students), cluster 3 (17 students), and cluster 2 (14 students).

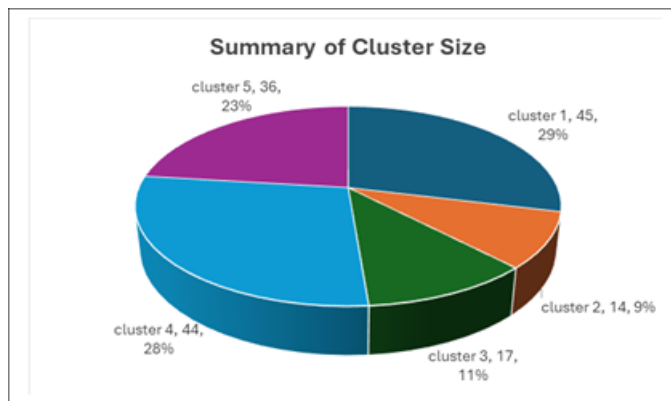


Fig. 1. Summary of cluster size for K-means clustering

To profile the clusters with the OFD apps satisfaction's related factors, the means of each factor is computed and shown in Fig 2. The clustering result showed that students in cluster 4 strongly agreed (with an average rating of 4.6-4.8) that the factors of perceived ease of use, privacy and security, payment method, apps content and user interface design, and perceived quality were important. However, the largest cluster 1 showed slightly lower factor' agreement among the students with a rating of 3.8 to 4.2. Cluster 3 showed the group of students with the lowest agreement rating with an average rating of 2.9 to 3.5. Cluster numbers 2 and 5 showed students who had high agreement in some factors while less agreement in some factors.

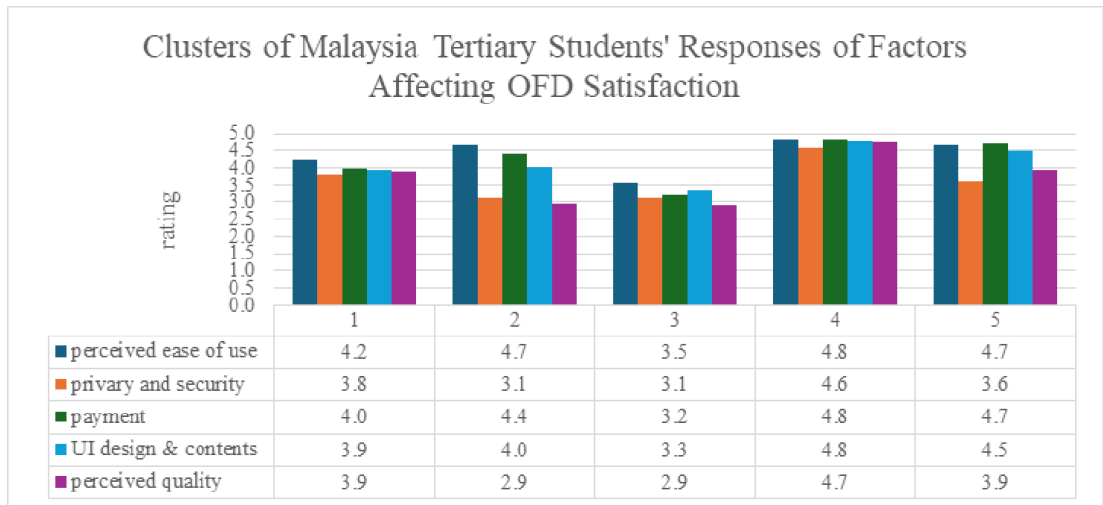


Fig. 2. Summary of cluster size for K-means clustering

5. DISCUSSION

From the MRA, it is discovered that the factor that has the strongest positive relationship with Malaysian tertiary students' satisfaction with OFD apps is UI design and apps content. It showed that the usability factor is more important than other technology and quality-related factors such as payment methods, security, and quality. Therefore, the OFD service providers must design apps that have comprehensive content and high usability UI design, to fulfill this group of customers.

On the other hand, the K-mean clustering analysis showed that the largest cluster of Malaysian tertiary students gave a rating of range 3.8 to 4.2 (skew towards rating 4 agree) for all factors while the second largest cluster gave a rating of nearly 5 (strongly agreed) for all factors. It represented more than half of the study population (57%). However, it is seen that privacy and security factors had the lowest agreement rating in all clusters. The students might not even use the apps if they do not trust the apps at all. The OFD providers could focus on fulfilling the five factors to maintain and further increase the satisfaction of the Malaysian tertiary students' group of customers. The correct focus on factors could allow the providers to plan the business resources effectively in making the right marketing initiatives and providing the correct service platform and services.

6. CONCLUSION AND FUTURE WORK

Through the data mining analysis methods, it is found that Malaysian tertiary students would be satisfied with OFD apps that have good UI design and contents, while still perceiving other factors such as perceived ease of use, perceived e-service quality, and payment methods. The privacy and security factor was not considered as a significant satisfaction factor when it was compared to the other four factors. While the tertiary student group is the second largest group of OFD apps' customers, it is necessary to design the OFD apps based

on the factors that contribute to high satisfaction levels.

In the future, a longitudinal study could be conducted for the OFD app's users who are 24-35 years old by the next five years. It could verify whether the same set of customer satisfaction factors are still applicable for the same group of customers when they are growing more mature. While more AI-based technological components could be developed and adopted by the OFD apps in the future, it is also ideal to explore the agreement of having the AI feature in OFD apps to increase customer satisfaction.

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