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E-Commerce Platform Selection Among UiTM Students by Using Graph Theory and Matrix Approach (GTMA)

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ABSTRACT

There are a variety of e-commerce platforms to make a business, each with a different set of features. Most e-commerce research believes that these features are all independent of one another. Previous research on e-commerce platforms focused on specific features and ignored the most popular platforms. Instead, they tended to simply list all the platforms without ranking them in order of preference. This study aims to identify and rank the preferred online shopping platform among students based on selected attributes using the Graph Theory and Matrix Approach (GTMA). Data were collected from the survey that has been distributed to all KPPIM students. Using GTMA to develop a weighted graph assuming all attributes are dependent on each other and formulate a relative importance matrix using the arithmetic mean (average). The e-commerce platforms were then ranked using preference index values calculated using the permanent function. As a result, six selected attributes and twelve e-commerce platforms are determined, and the ranking for the most preferred e-commerce platform are obtain. In conclusion, Food Panda is the top-ranking e-commerce site among KPPIM students, followed by Grab, TikTok, Shopee, Zalora, Lazada, Shein, Carousell, Amazon, eBay, Mudah, and Facebook coming in last. As UiTM's current mission is to become a globally renowned university of science, technology, humanities, and entrepreneurship, this result can be useful in letting UiTM know which students have engaged in online business.

Keywords: *e-commerce platform; e-commerce selection; graph theory; matrix approach*

1.0 INTRODUCTION

In Malaysia, more people have become interested in online business, especially during the lockdown, making it a growing trend. Social media usage has eventually risen and many people rely on the platform for communication and business activities. As a result, electronic commerce (e-commerce) continues to

grow along with higher internet usage. According to the Department of Statistics Malaysia, e-commerce performance in the third quarter of 2021 rose by 17.1%, reaching an income of RM279.0 billion. It also showed a 4.3% increase compared to the previous quarter. From January to September 2021, total e-commerce revenue is RM801.2 billion, which is a 23.1% year-on-year increased. Market analytics also show that Malaysia ranked as the 33rd largest e-commerce market in 2023, placing ahead of Peru and just behind Chile, with revenue of US$8,567.7 million. With an expected growth of 10% in 2023, Malaysia contributed to the global e-commerce growth rate of 9.6%. Similar to global trends, e-commerce sales in Malaysia are expected to continue rising in the coming years.

Among Malaysians who are interested in e-commerce activities are youngster which include university students. As e-commerce becomes a popular career choice, UiTM students particularly, need to identify the most suitable platform for starting their online retail businesses. Example of the e-commerce platforms are Lazada, Grab, Tiktok or Shopee and etc. However, choosing the best platform can be challenging due to various factors such as product offerings, delivery time, pricing, and shipping methods. Previous studies (Yusoff et al., 2020; Musa et al., 2022) have mainly focused on online shopping behavior, leaving limited research on selecting the most suitable e-commerce platform.

Therefore, this study aims to rank preferred e-commerce platforms among students of the College of Computing, Informatics, and Media (KPPIM), UiTM Shah Alam, using the Graph Theory and Matrix Approach (GTMA) as a systematic decision-making tool. GTMA is chosen in this study due to its capability to capture information on the interrelationship between attributes (Rao and Padmanabhan, 2006), a feature not commonly found in other decision-making methods. Besides, it offers a fresh perspective compared to the other statistical methods (e.g., SEM, regression).

2.0 LITERATURE REVIEW

The following six literatures are analysed in order to compare and contrast their models' characteristics with the proposed study.

Table 1: Selected Literature Review

No.	Author(s)	Year	Title	Journal / Source
I	Anushia Chelvarayan	2022	Online Purchase Intention: A Study Among Gen X in Malaysia	International Journal of Entrepreneurship, Business and Creative
II	Mofokeng	2021	The impact of online shopping attributes on customer satisfaction and loyalty: Moderating effects of e-commerce experience	Cogent Business & Management, 1-33
III	Kassim & Abdullah	2010	The effect of perceived service quality dimensions on customer satisfaction, trust, and loyalty in e-commerce settings	Asia Pacific Journal of Marketing and Logistics, 22(3), 351–371
IV	Musa, Nasaratnam, Rethinam, Varatharajoo & Shanmugam	2022	A Study of Factors Influencing Online Shopping Behavior in Malaysia: A Structural Approach	WSEAS Transactions on Business and Economics, 19, 531–541
V	Yusoff, M. M., Alomari & Misbahudin	2020	Involvement of Graduate Students in E-Commerce: A Case Study in Malaysian Universities	International Journal of Engineering Trends and Technology, 125–129
VI	Yusoff, H., Alomari, Latiff & Hamzah	2020	Evaluation on Customer Satisfaction in Using E-Commerce Platforms: Malaysia as a Case Study	International Journal of Engineering Trends and Technology, 32–37

Next, the gap analysis for the selected references above on the attributes, method, and e-commerce platform is presented in Table 2 to 4.

Table 2: Analysis on Attributes

	Attributes	I	II	III	IV	V	VI	Frequency	This study
1	User Interface			/			/	2	
2	Consumer Loyalty	/	/	/				3	
3	Product & Service Quality	/	/	/			/	4	/
4	Consumer Satisfaction	/	/	/	/		/	5	/
5	Delivery Time	/	/		/		/	4	/
6	Price					/	/	2	
7	Shipping Method							0	
8	Payment Experience						/	1	
9	Product Catalog		/					1	
10	Security	/		/	/		/	4	/
11	Web design			/	/		/	3	/
12	Convenience				/	/	/	3	/
13	Online Shopping Behavior				/			1	
14	Product Brand				/			1	
15	Perceived Usefulness				/			1	

As in Table 1, fifteen (15) attributes are included in the previous studies related to e-commerce activities. Most of the studies are focusing on the attribute of consumer satisfaction in their research. However, other attributes such as consumer loyalty, delivery, security, product & service quality are highly considered. In this study, the highly recommended attributes are selected by looking at the high number of frequency of attribute been used in the previous studies such as Product & Service Quality, Customer Satisfaction, Delivery Time, Security, Web design and Convenience.

Table 3: Analysis on Method

	Method	I	II	III	IV	V	VI	This study
1	Convenience Sampling	/		/				
2	Statistical Package for the Social Sciences	/						
3	Confirmatory Factor Analysis		/					
4	Structural Equation Modelling		/	/	/			
5	Descriptive Methodology					/		
6	Simple Random Sampling Method						/	
7	Graph Theory Matrix Approach							/

Table 3 above shows six (6) different methods are used in the previous studies. None of the studies utilized GTMA in the e-commerce research.

Table 4: Analysis on E-commerce Platform

	E-commerce Platform	I	II	III	IV	V	VI	This study
1	Shopee				/	/	/	/
2	Lazada				/	/	/	/
3	Foodpanda							/
4	Grab							/
5	Zalora						/	/
6	Shein							/
7	Mudah						/	/
8	Carousell							/
9	Amazon		/				/	/
10	E-bay						/	/
11	Facebook				/	/	/	/
12	Tiktok							/
13	Instagram				/	/	/	
14	Twitter				/	/		

Based on the Table 4, Shopee and Lazada, along with Facebook and Instagram, are the platforms that have received the most interest. However, there are few platforms such as TikTok, Caroussel, Grab, FoodPanda and Shien that are not among researcher's interest. Thus, the platforms are selected in this study.

3.0 METHODOLOGY

The proposed method for this study is Graph Theory and Matrix Approach (GTMA). GTMA is a technique that helps with decision-making, which is a logical and systematic approach. This approach consists of a digraph representation, a matrix representation, and a permanent function. The digraph representation consists of a number of nodes and directed edges while the matrix representation of the graph represents a model which is then analyzed using a permanent function to provide the information of decision-making. The step-by-step explanation of the methodology is as follows:

Step 1: List all the attributes of the e-commerce platform for e-commerce selection.

In this step, the alternatives involved in this study have been selected through a literature review.

Step 2: Develop a digraph representation of the interrelationship among the attributes. Digraph representation has proved to be useful in modeling and analyzing various systems. It consists of a set of nodes $V = \{v_i\}$ for $i = 1, 2, 3, \ldots, m$ and a set of directed edges $E = \{e_{ij}\}$ for $i, j = 1, 2, 3, \ldots, m$. The number of nodes m corresponds to the number of e-commerce platform properties, and the directed edges e_{ij} show how important each property is in relation to each other. The reason the edge from node "i" to node "j" is oriented in that direction is only because attribute "i" is more important than attribute "j". The attribute "j" is more important than the attribute "i" if the edge is directed from node "j" to node "i". The interrelationship among attributes is illustrated in Figure 1.

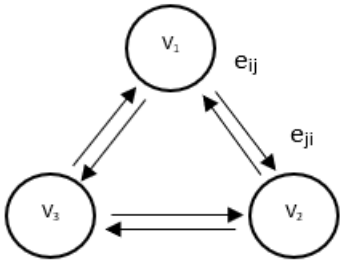

Figure 1: Diagraph Representation of Interrelationship among Attributes.

Step 3: Obtain the relative importance of e-commerce platform attributes x_{ij} on the suitable scale.

In this case, the value of relative importance of e-commerce platform attributes x_{ij} for attribute *i* to attribute *j* is collected via questionnaire by using the relative importance attributes scale shown in Table 5. The questionnaire is developed and modified based on existing questionnaire in Rao and Padmanabhan (2006) and distributed randomly to KPPIM students.

Table 5: Relative Importance Attributes Scale (Agrawal et al., 2016).

Description	x_{ij}	$1-x_{ij}$
Two attributes are equally important	0.5	0.5
One attribute (i) is slightly more important over the other (j)	0.6	0.4
One attribute (i) is strongly more important over the other (j)	0.7	0.3
One attribute (i) is extremely more important over the other (j)	0.9	1.0
One attribute (i) is exceptionally more important over the other (j)	1.0	0.0

Step 4: Develop the relative importance matrix [A] for the graph.

A matrix [A] is a square matrix whose diagonal and off-diagonal components are each composed of two parts. The expression for the matrix [A] is written as:

$$[A] = \begin{array}{c} \\ 1 \\ 2 \\ - \\ - \\ M \end{array} \begin{array}{c} \begin{array}{ccccc} 1 & 2 & - & - & M \end{array} \\ \begin{bmatrix} y_1 & x_{12} & - & - & x_{1M} \\ x_{21} & y_2 & - & & x_{2M} \\ - & - & y_3 & - & - \\ - & - & & y_4 & - \\ x_{M1} & x_{M2} & - & - & y_M \end{bmatrix} \end{array} \quad (1)$$

The off-diagonal elements of the matrix [A] are represented as $x$ij for $i \neq j$ and is calculated using arithmetic mean formula as follows:

$$x_{ij} = \frac{1}{n} \sum_{k=1}^{n} x_{ij}^{k} \text{for i} \neq \text{j} \quad (2)$$

where

$x_{ij} =$ = Constitute the off-diagonal element of matrix [A].

$n =$ The number of decision maker.

$x_{ij}^{k} =$ the relative importance value given by decision maker k which is based on the scale in Table 4.

Meanwhile, the diagonal elements of matrix [A] is the value of the importance of attributes for each e-commerce platform alternative were represented as y_i for $i = 1, 2, 3, \ldots, n$ and is assigned based on the following scale in Table 6. The value of the importance of attributes y_i for each alternative i is then calculated using the arithmetic mean formula. Here, the off-diagonal elements of matrix [A] are equal for all e-commerce alternatives but the diagonal elements value may be differing for each e-commerce alternative.

Table 6: The Importance of Attributes Scale For Each E-commerce Platform Alternative

Qualitative measure of attributes	Assigned value of y_i
Exceptionally low (E)	0.0
Extremely low (EL)	0.1
Very low (VL)	0.2
Low (L)	0.3
Below average (BA)	0.4
Average (A)	0.5
Above average (AA)	0.6
High (H)	0.7
Very high (VH)	0.8
Extremely high (EH)	0.9
Exceptionally high (EPH)	1.0

Step 5: Obtain the permanent function for each of the e-commerce platform alternatives. The permanent function is a standard matrix and is used in combinational mathematics (Geetha & Sekar, 2016). The permanent function is what determines how all attributes connect and how important each attribute is in relation to other attributes. In this study, the permanent function per (A) is developed based on Rao and Padmanabhan (2006) and (Agrawal et al., 2016). The sum of all possible products of the attributes of matrix [A] is taken one from each row and one from each column, without any attribute being repeated. Permanent function is used in analyzing complex systems where attribute interactions play a crucial role in determining the overall outcome. Then a preference index which is a numerical representation of the permanent function is calculated for each of e-commerce platform alternatives by using Ryser Algorithm (Luke, 2023) with the help of MATLAB software.

4.0 RESULT AND DISCUSSION

This section explained the result obtained for each of the step:

Step 1: Six articles as in Table 1 are analyzed in order to select the attributes and alternatives for e-commerce platforms. Based on the literature attributes such as Web Design (WB), Customer Satisfaction (CS), Delivery Time (DT), Product & Quality (PT), Security (S), and Convenience (C) are selected in this study since they are among the most frequent attributes appeared and analyzed in the previous study. Furthermore, alternative platforms such as Shopee (A_1), Lazada (A_2), Zalora (A_3), Shein (A_4), Mudah (A_5), Carousell (A_6), Amazon (A_7), E-bay (A_7), Facebook (A_9), TikTok (A_{10}), Food Panda (A_{11}), Grab (A_{12}) are selected.

Step 2: The attributes represent a set of nodes V such as V= {v_1, v_2, v_3, v_4, v_5, v_6} where v_1 = WB, v_2 = CS, v_3 = DT, v_4 = PT, v_5 = S, and v_6 = C. Next, the interrelationship between attributes which represented as directed edge e_{ij} for i, j = 1, …, 6 is developed. If there is a relationship between attributed *i* to attributed *j* the edge is directed from attributed *i* to *j*. In this study, assumption is made whereby there exists a relationship between every attribute to another. The edges are represented as set E such that E = {e_{12}, e_{13}, e_{14}, e_{15}, e_{16}, e_{21}, e_{23}, e_{24}, e_{25}, e_{26}, e_{31}, e_{32}, e_{34}, e_{35}, e_{36}, e_{41}, e_{42}, e_{43}, e_{45}, e_{46}, e_{51}, e_{52}, e_{53}, e_{54}, e_{56}, e_{61}, e_{62}, e_{63}, e_{64}, e_{65}}. Thus, the graph is illustrated as in Figure 2.

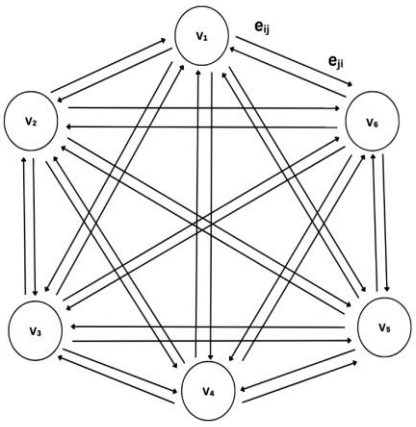

Figure 2: Digraph Representation of Interrelationship Between Attributes.

Step 3: Here, the value of relative importance of e-commerce platform attributes x_{ij} for attribute *i* to attribute *j* is collected through questionnaire using relative importance attributes scale as in Table 1. The questionnaire is distributed to the KPPIM students in the evaluation of e-commerce platforms based on the student's preference. A total of 56 KPPIM students are randomly participated in the survey. Of these, 42 respondents (75%) were female and 14 respondents (25%) were male. Additionally, 18 respondents (32.1%) were involved in selling goods, while the remaining 38 respondents (67.9%) preferred to buy rather than sell. Subsequently, a pairwise comparison for each attribute for every respondent is examined and arithmetic mean is calculated to obtain the off diagonal element of matrix [A].

Step 4: The off-diagonal element of matrix [A] are as follows:

$$[A] = \begin{array}{c} \\ \text{WB} \\ \text{CS} \\ \text{DT} \\ \text{PQ} \\ \text{S} \\ \text{C} \end{array} \begin{array}{c} \begin{array}{cccccc} \text{WB} & \text{CS} & \text{DT} & \text{PQ} & \text{S} & \text{C} \end{array} \\ \begin{bmatrix} y_1 & 0.379 & 0.423 & 0.395 & 0.407 & 0.389 \\ 0.621 & y_2 & 0.441 & 0.407 & 0.427 & 0.411 \\ 0.577 & 0.559 & y_3 & 0.363 & 0.395 & 0.405 \\ 0.605 & 0.593 & 0.637 & y_4 & 0.461 & 0.496 \\ 0.593 & 0.573 & 0.605 & 0.539 & y_5 & 0.427 \\ 0.611 & 0.589 & 0.595 & 0.504 & 0.573 & y_6 \end{bmatrix} \end{array}$$

Next, the calculation of the importance of attributes for each smartphone alternative y_i where the data is collected through questionnaire. The average value of the importance of the attributes with respect to each alternative is then calculated which then constitutes the diagonal element of matrix [A]. The diagonal elements for each e-commerce platform's alternative are obtained and shown in Table 7.

Table 7: Diagonal Element Values for Each E-commerce Platform Alternatives.

	Attributes					
Alternatives	WB	CS	DT	PQ	S	C
A_1	0.723	0.723	0.630	0.629	0.670	0.682
A_2	0.618	0.645	0.604	0.623	0.621	0.646
A_3	0.639	0.641	0.584	0.65	0.643	0.643
A_4	0.614	0.602	0.641	0.607	0.598	0.602
A_5	0.563	0.595	0.554	0.579	0.561	0.598
A_6	0.573	0.613	0.563	0.6	0.596	0.607
A_7	0.6	0.593	0.555	0.605	0.588	0.598
A_8	0.570	0.582	0.546	0.598	0.584	0.596
A_9	0.563	0.588	0.539	0.589	0.546	0.584
A_{10}	0.685	0.786	0.652	0.677	0.65	0.654
A_{11}	0.714	0.7	0.696	0.704	0.661	0.673
A_{12}	0.711	0.7	0.705	0.693	0.652	0.675

Step 5: In the study, twelve (12) relative importance matrix [A_i], i = 1, …, 12 are obtained and the permanent function for each matrix is calculated using permanent function retrieved from (Rao and Padmanabhan, 2006) and (Agrawal et al., 2016). The Preference index for permanent function of matrix [A_1], [A_2], [A_3], [A_4], [A_5], [A_6], [A_7], [A_8], [A_9], [A_{10}], [$A1_{11}$], and [A_{12}] were determined by using MATLAB-R2021a. The preference index measures the degree of choice for e-commerce platform alternatives with respect to all attributes. The higher the index value, the preferable e-commerce platform is. The value of preference index for this study is presented in Table 8.

Table 8: Preference Index and Ranking for The e-commerce Platform.

Alternative	Preference index	Ranking
Shopee (A_1)	15.0295	4
Lazada (A_2)	13.5881	6
Zalora (A_3)	13.7848	5
Shein (A_4)	13.1703	7
Mudah (A_5)	12.2504	11
Carousell (A_6)	12.6784	8
Amazon (A_7)	12.6244	9
E-bay (A_8)	12.3578	10
Facebook (A_9)	12.0818	12
TikTok (A_{10})	15.2645	3
Food Panda (A_{11})	15.5072	1
Grab (A_{12}).	15.4445	2

From Table 8, the highest preference index is 15.5072 representing the Food Panda platform. This shows the platforms that student KPPIM use is Food Panda platform followed by Grab platform, continued in third ranking TikTok platform, the fourth-ranking is Shopee, Next, ranking is from Zalora, Lazada, Shein, Carousell, Amazon, eBay and Mudah for ranking 5^{th}, 6^{th}, 7^{th}, 8^{th}, 9^{th}, 10^{th}, 11^{th}, respectively and lastly Facebook with the less platform that student KPPIM use with preference index 12.0818. The sequence for the ranking of e-commerce platforms alternative using preference index is Food Panda (A_{11}) > Grab (A_{12}) > TikTok (A_{10}) > Shopee (A_1) > Zalora (A_3) > Lazada (A_2) > Shein (A_4) > Carousell (A_6) > Amazon (A_7) > E bay (A_8) > Mudah (A_5) > Facebook (A_9).

The findings that students prefer Food Panda and Grab over other platforms are consistent with prior research on student behavior in Malaysia, which highlights convenience, speed, and accessibility as primary drivers for using food delivery apps (Lok, 2022; Osman et al., 2024). Similarly, the preference for TikTok, Shopee, and Lazada aligns with studies showing that youth consumers favor platforms that provide variety, social engagement, and ease of transactions (Asep, 2025; Zin et al., 2024).

For future research, the researcher should consider employing a different decision making method as it may offer a more comprehensive understanding of the e-commerce platform's attributes and how they relate to one another. Furthermore, the role of artificial intelligence (AI) is now getting more attention due to its capability to not only improves operational efficiency and innovation but also serves as a key element for business sustainability in the digital era (Efendi et al., 2025). Thus, the researcher could investigate how factors such as social media integration or AI could impact customer satisfaction and purchasing behavior on e-commerce platforms.

5.0 CONCLUSION

The study utilizes the Graph Theory and Matrix Approach (GTMA) to evaluate e-commerce platform selection among KPPIM students. A weighted directed graph for the six attributes and relative importance matrix are successfully obtained while permanent index for twelve e-commerce platform alternatives are calculated with the help of Ryser algorithm and MATLAB software. The study indicates that students choose

platforms like Shopee, Lazada, or TikTok when selling their products. Meanwhile, they mainly use Foodpanda and Grab for purchasing food. From the result, KPPIM can make informed decisions based on student preferences for improving services and tailoring platforms to meet student needs. This research can help develop targeted curriculum and training programs, preparing students for real-world challenges and establishing the university as a leader in e-commerce trends and technologies.

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