



Faculty of Computer Science and Information Technology

**Recommendation for Product Selling Opportunity using Hybrid-MCDM
in E-commerce Marketplace**

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Recommendation for Product Selling Opportunity using Hybrid-MCDM in
E-commerce Marketplace

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DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Malaysia Sarawak. Except where due acknowledgements have been made, the work is that of the author alone. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.



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ABSTRACT

The rapid growth of E-commerce platform has attracted both consumers and sellers, yet it presents significant challenges for sellers due to intensifying competition. This heightened competition may result in market losses for sellers. To mitigate these challenges, sellers must enhance their competitiveness in the marketplace. Thus, a data analytic approach to identify potential products through product selling recommendation for sellers within the E-commerce marketplace was proposed. By leveraging these recommendations, sellers can make informed decisions and saves time on complex decision-making processes. The Multi-Criteria Decision-Making (MCDM) method is applied to identify potential products, utilizing Analytic Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). AHP uses pairwise comparison to derive weights, while TOPSIS focuses on proximity to the ideal solution. These methods have been selected for ranking alternatives in MCDM. In order to apply MCDM, various product feature such as Estimated Sales Volume (ESV), Net Promoter Rating (NPR), Sales Rate (SR) and Price (P) are proposed. These features serve as the key metrics for evaluating the potential of a product in the marketplace. The hybrid-based MCDM method (AHP-TOPSIS) is evaluated using Ranking Evaluation Value (REV). REV is used as a quantitative metric to compare the appropriateness of the ranking outcomes under a consistent set of criteria weights. In this evaluation, higher REV values indicate better-aligned recommendations with the decision-making objectives. To ensure the consistency of the hybrid-based ranking model, further experiment is conducted to evaluate its overall performance. To test the consistency of the model over time, different datasets were used to imitate the data from various timelines. Additionally, different product categories were included to evaluate the performance of the model across diverse types of products. The results demonstrated that AHP-TOPSIS offers

superior identification of potential products based on the product features (ESV, NPR, SR and P). Therefore, the application of AHP-TOPSIS to identify potential products is able to help sellers to overcome competitiveness in the E-commerce marketplace.

Keywords: E-commerce, MCDM, sales recommendation, market trend analysis, selling opportunity, product performance analytics

Pendekatan Analitik Data untuk Menemui Peluang Jualan Produk dalam Pasaran E-Dagang

ABSTRAK

Pengembangan pesat platform E-dagang telah menarik perhatian konsumer and peniaga, namun ia turut memberikan cabaran besar kepada peniaga disebabkan persaingan yang semakin sengit. Persaingan sengit ini boleh mengakibatkan kerugian pasaran bagi peniaga. Untuk mengurangkan masalah ini, peniaga perlu meningkatkan daya saingan mereka dalam pasaran. Oleh itu, pendekatan analitik data telah dicadangkan bagi mengenal pasti produk berpotensi melalui cadangan penjualan produk untuk peniaga dalam pasaran E-dagang. Dengan memanfaatkan cadangan ini, peniaga dapat membuat keputusan yang lebih bijak dan menjimatkan masa dalam proses yang kompleks. Bagi mengenal pasti produk berpotensi, kaedah Multi-Kriteria Pembuatan Keputusan (MCDM) telah digunakan dengan memanfaatkan pendekatan Proses Hirarki Analitik (AHP) dan Teknik untuk Keutamaan Susunan Berdasarkan Persamaan dengan Penyelesaian Ideal (TOPSIS). AHP menggunakan perbandingan berpasangan untuk menentukan pemberat manakala TOPSIS menumpukan kepada pendekatan yang menghampiri penyelesaian ideal. Kaedah-kaedah tersebut telah dipilih untuk menilai kedudukan alternatif dalam MCDM. Dalam aplikasi MCDM, pelbagai ciri produk seperti Anggaran Jumlah Jualan (ESV), Penarafan Promoter Bersih (NPR), Kadar Jualan (SR) dan Harga (P) telah dicadangkan. Ciri-ciri ini berfungsi sebagai metrik utama dalam penilaian potensi produk di pasaran. Kaedah MCDM berasaskan hybrid (AHP-TOPSIS) dinilai dengan menggunakan Nilai Penilaian Kedudukan (REV). REV digunakan sebagai metrik kuantitatif untuk membandingkan kesesuaian hasil kedudukan dengan syarat set kriteria pemberat yang konsisten. Dalam penilaian ini, nilai REV yang lebih tinggi menunjukkan cadangan yang lebih selaras dengan objektif membuat keputusan.

Untuk memastikan konsistensi model kedudukan berasaskan hybrid, eksperimen lanjut dilakukan untuk menilai prestasi keseluruhannya. Untuk menguji konsistensi model dari masa ke masa, set-set data berlainan digunakan untuk mewakili data dalam tempoh masa yang berbeza. Selain itu, kategori produk yang berbeza digunakan untuk menilai prestasi model dalam pelbagai jenis kategori produk. Hasil keputusan menunjukkan bahawa AHP-TOPSIS menawarkan pengenalpastian produk berpotensi yang lebih baik berdasarkan ciri-ciri produk (ESV, NPR, SR dan P). Oleh itu, aplikasi AHP-TOPSIS untuk mengenal pasti produk berpotensi dapat membantu peniaga untuk mengatasi persaingan dalam pasaran E-dagang.

Kata kunci: *E-dagang, MCDM, cadangan jualan, analisis tren pasaran, peluang penjualan, analitik prestasi produk*

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LIST OF ABBREVIATIONS

MCDM	Multi-criteria Decision-making
AHP	Analytic Hierarchy Process
BWM	Best Worst Method
TOPSIS	Technique for Order of Preference by Similarity to Ideal Solution
WASPAS	Weighted Aggregated Sum Product Assessment
ESV	Estimated Sales Volume
SR	Sales Rate
P	Price
NPR	Net Promoter Score
NPS	Net Promoter Rating
ALP	Average Lifespan in Percentage
LET	Last Engagement Timestamp
TLET	Total Last Engagement Timestamp
TEET	Total Expected Engagement Timestamp
REV	Ranking Evaluation Value

CHAPTER 1

INTRODUCTION

1.1 Study background

E-commerce marketplace has changed the lifestyle of people nowadays, especially on the shopping method. Anything purchasable can be purchased online by using a few fingers tap. The convenience of E-commerce platform has raised more consumers' attention to practice online shopping. Therefore, business owner seeks this as the business opportunity to setup their business on E-commerce marketplace. Besides benefiting the consumers, it is also convenience for sellers to setup the B2C (business-to-consumer) business. B2C business is a type of business model where sellers can sell products directly to customers and bypassing third-party retailers, wholesalers and middleman (Baczkiwicz, MCDM based e-commerce consumer decision support tool, 2021). Since the invention of E-commerce has benefits both sellers and consumers, it is undoubtedly experiencing rapid growth in the E-commerce industry.

The rapid growth of E-commerce marketplace has attracted both sellers and consumers. The increase in the number of consumers is good for the E-commerce marketplace as sellers can gain more sales. The increase in the number of sellers is also good for the E-commerce marketplace as consumers can have many choices of product to choose from. However, the overcrowded number of sellers in the marketplace may not necessarily healthy. This is because price war is often happening among sellers. For example, China E-commerce firms such as JD.com, Suning, DangDang and Gome have experienced great losses in 2012 due to competitive price war (Liu, 2021). Price war happens when a seller reduces the price of product to subdue other competitors and to gain market share. When

facing such situation, competitor may also further slash down their product price to gain back the market share or customers while suppressing other sellers. Consumers may benefit from the price war in a short term. Consumers can enjoy the benefits of purchasing high quality products at a reasonable fair price due to the price competition among the sellers. On the other hand, sellers who relates in the market share will experience lower profit than expected. Sellers may source for low-cost product just to compete with the price. If the price war gets more competitive, small businesses may experience close down. In a long run, consumers will be left with less selection when shopping because only larger firms are able to survive in the price war.

In order to reduce price competition, sellers or business owners need to understand and maintain their product core characteristics, value and competitiveness of the product instead of only lowering the product price to gain market share until great loss is experienced. In today's market, price is not the only factor that affects the sales rate. Baczkiewicz, et al. (2021) stated that product's quality, service and innovation also have greater impact. Product characteristics (product features) such as price, quality and service are considered by the consumers. Recommending a right product at the right time with good customer service can also lead to gain in sales. Therefore, sellers should sell products that suits the consumer's consideration by understanding from their perspective.

1.2 Problem statement

Crowded sellers in the E-commerce marketplace selling similar products may resulted in highly competitive price war. On the other hand, selling random product without proper consideration can avoid price war but it may result in another situation such as selling low demand product.

Before consumer deciding to purchase a product, many features of the product are considered (Hatta et al., 2018). Nowadays, a single feature of the product cannot be used to determine the product selling recommendation. There are many similar products to select in the E-commerce marketplace. In order to satisfy the consumers' purchase intention, product with more than one outstanding feature need to be prioritized by the sellers. Otherwise, sellers may experience poor business performance by selling low competitive product in the market. Hence, product with multiple good features need to be prioritized by the sellers.

Besides, it is difficult to compare the products based on multiple product features of a product to form product selling recommendation. Comparing in such method is time-consuming and not systematic. In order to overcome such multi decision problem, popular method such as MCDM can be applied. MCDM can compare and rank the products based on their product features respectively.

1.3 Objectives

Objectives of the study is as below:

- i. To develop multi-criteria decision-making (MCDM) method that provides product selling recommendation
- ii. To identify product features to form criteria for product selling recommendation
- iii. To evaluate the performance of the multi-criteria decision-making (MCDM) method for product selling recommendation

1.4 Research scope

Product selling recommendation is the suggestion of a product from a list of products based on product's selling opportunity in the market. The higher the product's selling opportunity, the higher its selling potential. Research has shown that products with greater market opportunities often experience enhanced sales performance due to increased consumer interest and demand. For example, a study by Sudirjo (2023) on marketing strategies emphasized how leveraging market opportunities can significantly improve product competitiveness, leading to higher sales potential. Additionally, digitalization in the B2B customer journey highlights that understanding and exploiting digital opportunities can enhance a product's market potential, aligning with the idea that a product's selling opportunity directly impacts its sales performance (Andersson et al., 2024). Hence, product with high selling opportunity tended to be suggested by the product selling recommendation. Product features had to be studied in order to understand product selling opportunity for the computation of the product selling recommendation. In this study, computed numerical value of product feature was focused to form the product selling recommendation.

Recommendation is the main focus of this study. Forecasting or prediction on the outcome was beyond the research scope. There was difference between recommendation and forecasting. Forecasting focuses on generating the 'future' outcome by using the value of history records. Whereas recommendation focuses on the potential of a product selling by studying the comparison difference of the history records.

Product selected for the research study on product selling recommendation was the products on E-commerce platform. Shopee Malaysia was the E-commerce platform chosen for this study. Since there was no exact data and API for the details of product on the

platform, data scraping was required for the data collection process. An automated data scraping tool was developed and used throughout the data collection process.

1.5 Research significance

MCDM is a tool that assist decision-makers to select alternative products based on the criteria. By using MCDM, irrelevant product can be filtered when selecting suitable product to sell in the E-commerce marketplace. MCDM is an approach for overall assessment of a product when dealing with complex decisive problems that involves more than one variable. MCDM can be applied to provide product selling recommendation.

Besides, this study aims to determine product features or characteristics that can be used as the criteria for product selling recommendation. Importance weight of criteria can be identified and help sellers to understand the performance of products in the marketplace.

Evaluation on the method applied in E-commerce marketplace can help to understand the benefits and limitations of MCDM method. Proper evaluation on method ensures that product selling recommendation is relevant and accurate. The result from evaluation can produce appropriate product selling recommendation that can help sellers to find potential product and reduce risks.

1.6 Thesis organisation

This thesis is organized into five distinct chapters, apart from references and appendices. The contents of the chapters are summarized as follows:

Chapter 1: Introduction provides understanding on the background of this research. This chapters also describes the key problems identified in existing E-commerce marketplace, followed by objectives and scope of this research.

Chapter 2: Literature Review introduces the application of MCDM to solve daily life problems. Related works on the application of MCDM and product features are elaborated. Different type of MCDM methods is discussed in this chapter. Product features are studied to form the criteria for the application of MCDM.

Chapter 3: Methodology explains the step-by-step phases to design the methodology. These phases include criteria selection, weight computation and hybrid-based ranking.

Chapter 4: Experimental Results discusses the preliminary experiment and the application of methodology. Discussion and findings on the methodology are discussed. Last but not least, results and evaluation are carried out to further determine the application of methodology in different situation.

Chapter 5: Conclusion and Future Works concludes the project achievement and project limitations. Future works elaborate the improvement of the project that can be done to minimize the limitations in the future.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The purpose of this chapter is to elaborate on the literature review. There are 2 main components to be studied. First of all, product feature is the product attribute factor that affects the priority of criteria. Investigation on product feature is required to determine applicability of product feature. After that, priority of product feature will be studied based on the purpose of investigation. Secondly, ranking of different products based on their prioritised product features is another complex problem. Different priority of product feature will result in different ranking of products. The approach that fulfilled the ranking of products based on their product features is investigated to help the sellers in the E-commerce marketplace.

2.2 Related works

Decision-making is a common action, but it is very important as it impacts our daily life. A lot of choices have been made to select the most suitable option among many options. For example, people do consider the price and specifications of the car when they purchase a new car. With various brands, types and specifications available for cars, decision-makers often need significant time to carefully weigh their options before reaching a decision. A notable approach used in many published works is MCDM which can help the decision makers to make an efficient decision.

Published work by Stopka et al. (2022) stated that MCDM can help to select an appropriate electric car. In the research, six variants of similar electric vehicles are compared