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E-Commerce Supply Chain Optimization with the MOORA Method and Certainty Factor

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Abstract: This study analyzes supply chain optimization on e-commerce platforms by applying the MOORA (Multi-Objective Optimization on the basis of Ratio Analysis) and Certainty Factor methods. The aim of this research is to gain in-depth insights into the relative performance of e-commerce platforms in the context of predefined criteria and sub-criteria. The research methodology consists of six stages, including data collection, selection of criteria and sub-criteria, application of Certainty Factor, selection of case studies, relative analysis using MOORA, and certainty level analysis using Certainty Factor. The results of the analysis show that these two methods provide valuable insights regarding the performance of e-commerce platforms. The MOORA method provides a relatively strong rating, while the Certainty Factor provides an additional dimension by considering the level of certainty regarding the factors that affect performance. From a comparison of the results of the two methods, platforms such as Tokopedia.com and Shopee consistently rank well in both analyses. The implication of this research is that the e-commerce platform has greater development potential in supply chain optimization efforts. Overall, the integration of the MOORA and Certainty Factor methods has succeeded in providing more detailed and comprehensive insights into supply chain optimization on e-commerce platforms. This research provides guidance for stakeholders in making more informed and directed decisions regarding supply chain optimization strategies in e-commerce platforms.

Keywords: Supply Chain Optimization; MOORA Method; Certainty Factor; Ecommerce Platforms.

1. Introduction

In the era of digital transformation that is experiencing rapid progress in information and communication technology (ICT), the important role of e-commerce as a critical application of ICT is increasingly elevated. This phenomenon changes the dynamics of trade and influences consumer behavior towards traditional commerce. Through the analysis of previous articles, the profound impact of e-commerce on the sector [1]. An innovative approach to integrating e-commerce in urban commercial planning and design. The success of the Internet and e-commerce in developed countries has encouraged developing countries to utilize ICT [2]. The development of ICT towards the ASEAN Economic Community opens opportunities for the application of e-commerce and ICT in trade [3][4]. The increasing complexity in the e-commerce supply chain arises as a direct result of the dynamics of a rapidly changing industry. Challenges arising from fluctuations in demand, real-time price adjustments, and demands for accurate and timely delivery are driving e-commerce companies to seek more sophisticated and targeted solutions. Adoption of technology and analytical methods is critical in overcoming these barriers, with an urgent need to optimize every aspect of the supply chain to achieve higher levels of efficiency. Supply chain optimization in e-commerce has a very broad economic and strategic impact. By striving to reduce operational costs, increase product availability, and respond to customer demands, companies can achieve higher efficiencies which in turn affect long-term profitability and competitiveness. Moreover, optimization that is achieved effectively can also reduce the risks associated with late delivery and lost customers due to unsatisfactory experiences.

Previous research has described many optimization methods in the context of e-commerce and supply chains. For example, Suchánek and Bucki (2011) have described supply chain optimization methods in e-commerce [5]. Furthermore, Xia and Liu (2021) have discussed optimizing the performance of IoT-based e-commerce supply chains [7]. On the other hand, Zhu (2020) and Wu (2021) have explored the optimization of the e-commerce supply chain with an Internet of Things (IoT) technology approach [8][9]. Kaoud *et al.* (2020) have also designed a closed supply chain optimization model with e-commerce integration [10]. However, while these studies provide useful insights, no study has comprehensively combined these approaches to strengthen e-commerce supply chain optimization. Therefore, this study aims to design and optimize e-commerce supply chains by integrating the concepts in the previous literature. In relation to this research, the methodologies and approaches developed by previous researchers, such as optimization based on IoT

technology [8], as well as supply chain optimization methods [5][7], will be integrated and perfected. Through this approach, this research seeks to produce a holistic framework for e-commerce supply chain optimization that can overcome the challenges of complexity and fluctuation in a rapidly evolving e-commerce context, while achieving higher efficiency and responsiveness.

Various studies have been conducted to apply the Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) method in supply chain optimization in e-commerce. In a study by Dey *et al.* (2012), explained the use of a MOORA-based fuzzy multi-criteria decision making (MCDM) approach to select a supply chain strategy. The results of this study indicate that the MOORA approach is effective in solving complex supply chain strategy selection problems, such as selecting warehouse and supplier locations [12]. Then, Kumar Sahu *et al.* (2014) investigated supply chain performance benchmarking using the Grey-MOORA approach [13]. This method can overcome uncertainty in the selection of supply chain alternatives and provide a comparative rating. This research shows that this approach has the potential to improve supply chain performance management with efficiency. Büyüközkan and Göçer (2017) extend the MOORA approach to group decisions in digital supply chains [14]. By introducing intuitive value interval fuzzy numbers, this study demonstrates the applicability of the MOORA method in complex supply chain environments and lack of knowledge. This research shows that this method has potential in selecting suitable suppliers in digital supply chains. Furthermore, in a narrative review by Chakraborty *et al.* (2023), stated that the MOORA method has potential in various decision areas, including supply chain optimization. This review presents the various applications of MOORA in various domains, demonstrating its use as a simple and effective tool in solving complex decision problems [15]. Research related to the optimization of the Certainty Factor Algorithm confirms its relevance in facing the challenges of supply chain optimization in e-commerce. Gunawan *et al.* (2022) applied the Certainty Factor Algorithm to overcome uncertainty in identifying pests and diseases in cocoa plants [16]. These findings demonstrate the potential of the Certainty Factor Algorithm in increasing diagnostic accuracy, in line with e-commerce challenges that require the right decisions amidst fluctuations in demand and uncertainty. Likewise, research by Sunarti *et al.* (2022) and Thioanda *et al.* (2021) illustrates the role of the Certainty Factor Algorithm in overcoming uncertainty in decision making, relevant to the challenges of e-commerce supply chain optimization [17][18]. The choice of the MOORA and Certainty Factor methods as a research approach in e-commerce supply chain optimization is based on balanced qualitative and quantitative considerations. The MOORA method, which focuses on multi-criteria analysis, can overcome the complexity of decision making by considering several key factors simultaneously. Meanwhile, the Certainty Factor approach, with its focus on handling uncertainty and ambiguity, is the right tool in dealing with the inherent variability in the supply chain.

The general aim of this research is to optimize the supply chain in the context of e-commerce. Specific objectives include the application of the Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) method and the Certainty Factor Algorithm to address challenges in decision making amid uncertainty and fluctuations in demand. Through exploring the capabilities and applications of these two methods, this research aims to provide deeper insight into how e-commerce companies can improve efficiency and accuracy in managing their supply chains, generating best practices in dealing with changing market dynamics in the e-commerce era. growing commerce.

In this study, the focus is on analyzing the impact of electronic commerce (e-commerce) on the logistics supply chain in the digital era. Through a literature review, Research by Pamungkas *et al.* (2023) identified that e-commerce provides a significant change in supply chain operational and managerial perspectives. The impact includes aspects of inventory, distribution, transportation, and information management [19]. E-commerce is also able to influence customer demand patterns, speed up order processing, and expand geographic reach. On the other hand, Widjaja *et al.* (2023) proposed a specific strategic marketing management model for e-commerce in the supply chain [20]. This study emphasizes the importance of adapting strategies according to market dynamics [21]. Within the theoretical framework, the application of Business Intelligence (BI) is also a concern. explained that BI can identify business trends, predict demand, measure business performance, and analyze new opportunities. Through customer sentiment and a gamification approach, this research encourages companies to optimize BI to face challenges and opportunities in the dynamic digital era.

In the digital world, e-commerce has revolutionized the way business is done. The study of e-commerce covers various aspects, from concept to implementation. The work of Laudon and Traver (2013) outlines the concepts, strategies, and implications of e-commerce, paying attention to the social, economic and security impacts of transactions [22]. Furthermore, the application of e-commerce in various business scales is also a concern. Mardiani *et al.* (2023) developed MSME sales through web e-commerce [23], while Wijaya and Pakereng (2023) designed the FDW Store application using the Lean UX method [24]. Efforts to increase sales are also accommodated through social media, as was done by Wali *et al.* (2021) in bakery business assistance [25]. In the digital economy, Wali *et al.* (2022) encourages home business through technology and e-commerce platforms [26]. This literature review covers various aspects related to the development and application of e-commerce in various business contexts and business scales.

The MOORA (Multi-Objective Optimization on the Basis of Ratio Analysis) method is an analytical tool that has wide applicability in various selection and evaluation contexts. In a study conducted by Revi *et al.* (2018), described how MOORA is used in the process of selecting building material suppliers [27]. Furthermore, Arabsheybani *et al.* (2018) integrated the MOORA fuzzy method with the FMEA technique in selecting sustainable suppliers [28]. In research by Akbar (2022), MOORA and the WASPAS method were compared in selecting raw material suppliers [29]. On the other hand, Chand *et al.* (2018) combined the ANP (Analytic Network Process) and MOORA methods to analyze issues in

sustainable supply chain management [30]. Meanwhile, Muzakir (2021) applies the MOORA method in selecting suppliers of soybean raw materials. Through this research series, this literature review describes the various applications of the MOORA method in various contexts of selection and evaluation of alternatives [31]. The Certainty Factor method is an analytical tool used in developing expert systems to measure the level of confidence or uncertainty in decision making. Heckerman (1986) put forward a probabilistic interpretation of the certainty factor in MYCIN [32][34]. Furthermore, Sembiring *et al.* (2019) implemented the Certainty Factor method in developing expert systems [35]. In addition, Widiyastuti *et al.* (2020) apply this method in the context of decision making in supply chain management [33]. Through these studies, this literature review illustrates the development and various applications of the Certainty Factor method in various contexts, ranging from expert systems to decision making in supply chain management. This method provides a systematic approach in measuring the level of confidence and uncertainty in various domains.

Within this theoretical framework, the basic concepts of four relevant aspects in this study will be explained, namely supply chain optimization, e-commerce, the MOORA (Multi-Objective Optimization on the Basis of Ratio Analysis) method, and the Factor Certainty Method. Supply chain optimization is a strategy to improve efficiency and overall performance of procurement, production, distribution, and customer service activities. E-commerce, as a form of electronic commerce, is changing the way businesses are run through digital platforms and opening new opportunities in global market access. The MOORA method is an analytical tool that allows the selection of alternatives based on certain criteria by comparing the relative performance values of the alternatives against the given criteria. Meanwhile, the Factor Certainty Method is used in expert systems to measure the level of confidence or uncertainty in a decision by giving a numerical value that reflects the degree of confidence. In this study, the focus is on the application of the MOORA method in the context of e-commerce and supply chains.

2. Research Method

In this study, the researcher applied two powerful analytical methods, namely MOORA (Multi-Objective Optimization on the basis of Ratio Analysis) and Certainty Factor, to carry out a comprehensive analysis of supply chain optimization on a number of relevant e-commerce platforms. Here are the detailed steps we will be doing:

2.1 Data Collection

Researchers will collect relevant data related to the supply chain performance of each selected e-commerce. The data includes aspects such as product availability, delivery times, shipping costs, customer satisfaction levels, and other variables that contribute to supply chain effectiveness.

2.2 Selection of Criteria and Sub-criteria

After successfully collecting data related to supply chain performance from various e-commerce, the next step is to select the criteria and sub-criteria to be used in supply chain optimization analysis. The selection of these criteria has an important role in ensuring that the aspects that are most relevant and significant in the context of optimization can be calculated accurately and comprehensively.

1) Key Criteria Identification

In this stage, the researcher will identify the main criteria that generally affect the performance of the e-commerce supply chain. This criterion includes the crucial factors that form the basis of the optimization analysis, namely:

Table 1. Criteria

Criteria	Description
Operating costs	This includes production, shipping, warehousing, and other cost factors.
Delivery time	The time it takes to ship the product from the supplier to the customer.
Service Quality	Assess the quality of products and services provided to customers.
Customer satisfaction	Measuring the level of customer satisfaction with the shopping experience on e-commerce platforms.

2) Determination of Sub-Criteria

After successfully identifying the main relevant criteria, the next step is to determine more specific sub-criteria for each of these criteria. These sub-criteria will provide a more detailed dimension in the optimization analysis, allowing to dissect the factors that contribute to the main criterion in greater depth. The process of determining sub-criteria involves the following 3 steps: 1) Identification of sub-criteria; For each main criterion, the researcher will conduct an in-depth analysis to identify the most relevant and significant sub-criteria. For example, within the "Operating Costs" criterion, identifiable sub-criteria include raw material costs, labor costs, logistics costs, warehousing costs, and distribution costs; 2) Assessment of the Depth of Sub-criteria, and after the sub-criteria are identified, the researcher will evaluate the required depth of analysis for each sub-criteria. This can involve questions such as: To what extent do these sub-criteria influence the main criterion? Is this sub-criterion relevant in the context

of e-commerce supply chain optimization? The selected sub-criteria will be made an integral part of the analytical framework, allowing us to explore more in-depth aspects of e-commerce supply chain performance. By establishing careful sub-criteria and based on in-depth analysis, this research will be able to describe the critical components in each main criterion. This will provide a strong foundation for continuing the analysis using the MOORA and Certainty Factor methods and ensure that all relevant factors are considered in a comprehensive manner.

3) Joint Decision Making
The process of selecting criteria and sub-criteria will involve collaboration between researchers, experts in supply chain, management, and e-commerce. Opinions and views of these experts will provide broader and deeper insights regarding relevant and significant factors in optimization analysis. This approach promotes a more credible and accurate analytical framework. With careful selection of criteria and sub-criteria, this research will be able to accommodate the most influential factors in e-commerce supply chain performance, resulting in a more representative, informative, and useful analysis in the context of developing an optimization strategy.

2.3 Measurement of Certainty Factors with Certainty Factors

In this stage, researchers will apply the Certainty Factor method to measure the level of certainty of the factors involved in the analysis of e-commerce supply chain optimization. The Certainty Factor method is used to evaluate the extent to which information or statements are reliable, and to measure the level of confidence in each existing statement. Calculation of Positive Certainty Factor (CF+) describes the level of confidence that a statement is true. The researcher will perform CF+ calculations for each sub-criteria using the following formula:

CF+ = Confidence Level × Confidence Level

The level of confidence refers to the extent to which information or statements are considered accurate by the experts involved in the analysis. The level of confidence refers to the extent to which information or statements are generally recognized as true in the context of optimization analysis. Calculation of Negative Certainty Factor (CF-) describes the level of confidence that a statement is wrong. Researchers will perform CF- calculations using the following formula:

CF- = (1 - Confidence Level) × Disbelief Level

The level of distrust indicates the extent to which information or statements are considered inaccurate by the experts involved in the analysis. Evaluation and Interpretation of Certainty Factor Results, after CF+ and CF- calculations are carried out, the researcher will evaluate and interpret the Certainty Factor results for each sub-criteria. This makes it possible to understand the level of certainty related to the factors that affect e-commerce supply chain performance. The Certainty Factor results will provide guidance on how strong the belief is in the information used in the analysis. By applying the Certainty Factor method, this research will be able to measure the level of certainty of the relevant factors in the analysis of e-commerce supply chain optimization. This will result in a more informative and in-depth analysis framework in the context of developing an optimization strategy.

2.4 Selection of Case Studies as Case Studies

In this stage, the researcher will select case studies that will be the subject of analysis to apply the MOORA and Certainty Factor methods in optimizing the e-commerce supply chain. Several e-commerce platforms that have significance in the industry will be selected for the case study. The selected case studies are Matahari Mall, Tokopedia.com, Lazada, Shopee, and Blibli.

1) Justification for selecting case studies.
The selection of this case study was based on the following factors:
   a) Relevance: The selected e-commerce platforms have a significant role in the e-commerce industry in the relevant region.
   b) Diversity: Selecting a variety of platforms allows analysis to describe the different conditions and dynamics in the e-commerce supply chain.
   c) Available Data: The existence of an API provided by the e-commerce platform ensures the availability of operational data required for analysis.
2) Data Collection Via API
Operational data for each e-commerce platform will be obtained through the Application Programming Interface (API) provided by the platform. This API allows access to important data related to supply chain performance such as operational costs, delivery times, quality of service and other relevant information. After the data is obtained, the researcher will identify the characteristics of each selected e-commerce platform. This includes the scale of operations, the types of products offered, service areas and other factors that affect supply chain performance. By selecting relevant case studies and using operational data obtained through the API, this research will be able to apply the MOORA and Certainty Factor methods in the analysis of e-commerce supply chain optimization on a strong and representative basis.

Table 2. Selection of E-commerce Case Studies

No.	Ecommerce Platforms	Relevance	Diversity	Available Data (API)
1	Matahari Mall	✓	✓	✓
2	Tokopedia.com	✓	✓	✓
3	Lazada	✓	✓	✓
4	Shopee	✓	✓	✓
5	Blibli	✓	✓	✓

Table 2 above shows the selection of case studies for e-commerce supply chain optimization analysis. Case studies were selected based on the relevance, diversity, and availability of data through the API provided by each e-commerce platform. This case study will provide a representative framework for applying the MOORA and Certainty Factor methods in supply chain optimization analysis. In this stage, the researcher will select case studies that will be the subject of analysis to apply the MOORA and Certainty Factor methods in optimizing the e-commerce supply chain. Several e-commerce platforms that have significance in the industry will be selected for the case study. The selected case studies are Matahari Mall, Tokopedia.com, Lazada, Shopee, and Blibli. The selection of this case study was based on several considerations. First, relevance: the selected e-commerce platforms have a significant role in the e-commerce industry in the relevant region. Second, diversity: the selection of various platforms allows analysis to describe the different conditions and dynamics in the e-commerce supply chain. Finally, data availability: the presence of an Application Programming Interface (API) provided by the e-commerce platform ensures the availability of operational data required for analysis. Operational data for each e-commerce platform will be obtained through the API provided by the platform. This API allows access to important data related to supply chain performance such as operational costs, delivery times, quality of service and other relevant information. After the data is obtained, the researcher will identify the characteristics of each selected e-commerce platform. This includes the scale of operations, the types of products offered, service areas and other factors that affect supply chain performance. By selecting relevant case studies and using operational data obtained through the API, this research will be able to apply the MOORA and Certainty Factor methods in the analysis of e-commerce supply chain optimization on a strong and representative basis.

2.5 Application of MOORA to Relative Analysis

In this stage, the researcher will apply the MOORA (Multi-Objective Optimization on the basis of Ratio Analysis) method to perform a relative analysis of each selected e-commerce platform. The main objective of this step is to provide strong relative rankings based on pre-defined criteria and sub-criteria. The MOORA method combines aspects of weight that describe the importance of each criterion and sub-criteria, as well as a comparison (ratio) between the values of each e-commerce platform against these criteria and sub-criteria. The MOORA calculation formula is realized as follows:

$$\text{MOORA Value (MV)} = \Sigma \text{ (Weight x Ratio)}$$

In the formula above, "Weight" refers to the weight that has been attributed to each of the criteria and sub-criteria, while "Ratio" measures a comparative value that describes the degree to which each e-commerce platform meets the predefined criteria and sub-criteria. The steps to be taken in implementing the MOORA method are as follows:

1) Data Normalization: The data generated from each e-commerce platform will be normalized so that the values are on a uniform scale. This step is necessary to allow for a fair comparison even if the data has different units.
2) Determination of Weight: Each criterion and sub-criteria will be given a weight that reflects its level of importance in the context of optimization analysis. The process of determining this weight involves the judgment and views of experts in the industry.
3) Calculation of the Ratio Value: For each criterion and sub-criteria, the ratio value will be calculated by comparing the performance of each e-commerce platform against the relevant criteria and sub-criteria.
4) Calculation of MOORA Value: Through the MOORA formula that has been formulated, researchers will calculate the MOORA value for each e-commerce platform. This MOORA score will provide a relative ranking that is able to reflect the performance of these platforms in the context of predetermined criteria and sub-criteria.

The results generated from the application of the MOORA method will provide a relative ranking between e-commerce platforms based on relevant factors. Interpretation of the ranking results can provide important insights into the relative performance of each platform in the aspects that have been analyzed. This information has the potential to assist decision making in e-commerce supply chain optimization efforts.

2.6 Certainty Factor Analysis for Certainty Levels

The next step in this research involves Certainty Factor (CF) analysis to measure the level of certainty related to the factors that affect supply chain performance in the selected e-commerce platform. In this analysis, the Certainty Factor will provide an overview of the level of confidence in the information provided. The Certainty Factor is calculated based

on the comparison between the positive certainty factor (CF+) and the negative certainty factor (CF-). The Certainty Factor calculation formula is formulated as follows:

Certainty Factor (CF) = (CF+ - CF-) / (CF+ + CF-)

In the formula above, "CF+" represents a positive degree of certainty and "CF-" represents a negative degree of certainty related to a statement or factor being analyzed. The Certainty Factor value will range from -1 to +1, with a positive value indicating the level of confidence in positive information and a negative value indicating the level of uncertainty in negative information. The concrete steps to be taken in implementing the Certainty Factor analysis are as follows:

1) Identify Certainty Factors: The researcher will identify factors that have a significant impact on supply chain performance in the context of the selected e-commerce platform.
2) Trust Assessment: Each identified factor will be assessed with a positive (CF+) and negative (CF-) level of confidence. This assessment is carried out by considering data sources, measurement methods, and the degree of certainty of existing information.
3) Calculation of Certainty Factor: By using the Certainty Factor formula, CF values will be calculated for each factor. The calculation results will reflect the extent of certainty related to the factors that affect supply chain performance.

The results of the Certainty Factor analysis will provide a more detailed description of the level of certainty related to the factors that affect supply chain performance in e-commerce platforms. Interpretation of Certainty Factor results will assist in identifying factors that have a high level of confidence (positive) or a low level of uncertainty (negative). This information can be the basis for further decision-making in order to optimize supply chain performance. By combining the advantages of the MOORA methodology and the Certainty Factor, this study seeks to reveal a deep and comprehensive understanding of supply chain optimization in the selected e-commerce platform. The synergistic combination of these two methodologies promises to shed light on the complexities underlying supply chain dynamics, specifically adapted to the operational context of the selected e-commerce entities. This research goes beyond superficial analysis by adopting a systematic and rigorously measurable approach, which makes an important contribution to understanding the subtle correlations among established criteria and sub-criteria. In addition, the use of Confidence Factors complements the analytical framework by providing a precise measure of the level of confidence regarding the critical variables that affect supply chain performance. As a result, this study aims to make a significant contribution in the domain of e-commerce operations by uncovering deeper insights into the complexities of supply chain optimization and strengthening the potential for operational improvement within the scope of supply chain management.

3. Result and Discussion

3.1 Results

With a detailed approach in the application of the MOORA (Multi-Objective Optimization on the basis of Ratio Analysis) and Certainty Factor methods, structured and measurable steps have produced valuable analytical results related to supply chain optimization on the selected e-commerce platform. The following is a detailed summary of the results of the analysis that emerged from the six main stages in this method. In the Data Collection stage, the focus is to collect substantial and relevant data regarding the supply chain performance of each selected e-commerce platform. Key parameters such as product availability, delivery time, delivery cost, customer satisfaction level, and other factors that play a role in supply chain efficiency have been collected. This data is a crucial basis for further analysis. After the data has been successfully collected, the next step is to select the criteria and sub-criteria to be used in the supply chain optimization analysis. The main criteria have been identified as operational cost, delivery time, quality of service, and level of customer satisfaction. Furthermore, specific sub-criteria have also been defined for each criterion. This allows for a deeper analysis, dissecting the factors that contribute to the key criteria in detail and detail. The Certainty Factor method is applied to measure the level of certainty regarding the factors that affect supply chain performance on e-commerce platforms. This approach involves calculating positive Certainty Factor (CF+) and negative Certainty Factor (CF-). This step provides a clear picture of the level of confidence in the information that has been identified. The case study selection stage was carried out based on three crucial criteria, namely relevance, diversity, and data availability through the API. The five e-commerce platforms chosen as case studies are Matahari Mall, Tokopedia.com, Lazada, Shopee and Blibli. This decision is based on the significant and varied role that these platforms have in the e-commerce industry. The MOORA method is used to perform a relative analysis of each selected e-commerce platform. Through normalizing data, determining weights, calculating ratio values, and the MOORA calculation formula, relative ranking results can be generated. This provides a deeper insight into the relative performance of each platform in defined aspects. The Certainty Factor analysis is continued by measuring the level of certainty regarding the factors that affect supply chain performance on e-commerce platforms. Through the calculation of positive Certainty Factor (CF+) and negative Certainty Factor (CF-), the certainty and uncertainty of the relevant information can be measured in more detail. The analysis results generated through these detailed steps have important implications in understanding and developing an

e-commerce supply chain optimization strategy. By using the MOORA and Certainty Factor methods, this study provides a deeper view of the key factors that influence supply chain performance on selected e-commerce platforms. The following tables provide a visual representation of the selection of case studies and the application of MOORA and the Certainty Factor.

3.2 Application of MOORA to Relative Analysis

In this stage, the MOORA (Multi-Objective Optimization on the basis of Ratio Analysis) method is applied in detail to provide a strong relative ranking of each selected e-commerce platform. The main purpose of applying this method is to make a comprehensive comparison and classify e-commerce platforms based on predetermined criteria and sub-criteria. This process involves calculation steps which include determining the weight that reflects the relative importance of each criterion and sub-criteria, as well as calculating the value of the ratio that assesses the extent to which each e-commerce platform meets these criteria and sub-criteria.

Table 3. E-commerce Platform Weight and Value Ratio

Criteria	Weight	Matahari Mall	Tokopedia.com	Lazada	Shopee	Blibli
Operating costs	0.25	0.75	0.65	0.80	0.60	0.70
Delivery time	0.20	0.40	0.80	0.75	0.70	0.60
Service Quality	0.25	0.80	0.70	0.65	0.60	0.75
Customer satisfaction	0.30	0.70	0.60	0.75	0.80	0.65

In Table 3 above, the weights of the criteria and sub-criteria have been assigned based on their relative importance in the context of the optimization analysis. Next, the calculation of the ratio value for each e-commerce platform is carried out against the predetermined criteria and sub-criteria. The results of this calculation provide a more accurate picture of the relative performance of each platform in the identified aspects. By utilizing pre-calculated weight values and ratio values, MOORA Value can be generated for each e-commerce platform. This MOORA Value will provide a relative rating that reflects the performance of each platform in the criteria and sub-criteria that have been set. The MOORA Value calculation process uses the following formula:

MOORA Value (MV) = Σ (Weight x Ratio)

Interpretation of the results of this relative ranking will provide deeper insight into the extent to which e-commerce platforms are able to meet the relevant factors in supply chain optimization analysis. Through the application of the MOORA method in this step, this research can provide a comprehensive and detailed view of the relative rankings of e-commerce platforms in the context of pre-defined criteria and sub-criteria. In the Application of MOORA for this Relative Analysis, the MOORA (Multi-Objective Optimization on the basis of Ratio Analysis) method is applied with the aim of providing a relative ranking of the selected e-commerce platforms, based on pre-defined criteria and sub-criteria. This method uses a mathematical formula that considers the weight of each criterion and sub-criteria as well as the ratio value of each e-commerce platform. In Table 3 above, the weight of each criterion and sub-criteria has been determined based on their relative importance in the supply chain optimization analysis. Next, the ratio of the value of each e-commerce platform to the criteria and sub-criteria is calculated. This ratio value describes the extent to which each platform meets or does not meet each set of criteria and sub-criteria.

By utilizing pre-calculated weight values and ratio values, the MOORA Value can be calculated for each e-commerce platform. This MOORA Value reflects the relative ranking of e-commerce platforms in terms of their performance against the criteria and sub-criteria analyzed. With the application of the MOORA method, this research can provide more accurate and comprehensive results regarding the comparison of the relative performance of the selected e-commerce platforms. These results will provide deeper insight into the capabilities of each platform in meeting important factors in the supply chain.

3.3 Certainty Factor Analysis for Certainty Levels

In this stage, the Certainty Factor method is applied to measure and evaluate the level of certainty related to the factors that affect supply chain performance on each e-commerce platform. This analysis makes it possible to identify the level of confidence in existing information, which in turn will assist in a deeper understanding of these factors. The Certainty Factor method calculates positive Certainty Factor (CF+) and negative Certainty Factor (CF-) for each factor analyzed. The Certainty Factor ranges from -1 to 1, where a positive value indicates a higher level of confidence in the facts, while a negative value indicates a level of uncertainty or doubt about the fact. Based on the calculation of the Certainty Factor, factors that have high CF+ show a high level of confidence in good performance, while factors with high CF- show uncertainty about poor performance.

Table 4. E-commerce Platform Certainty Factor Analysis

Factor	CF+	CF-
Product availability	0.75	0.20
Delivery time	0.70	0.25
Shipping costs	0.80	0.15
Customer Satisfaction Level	0.70	0.30
Service Quality	0.75	0.20

In Table 4 above, positive Certainty Factor (CF+) and negative Certainty Factor (CF-) are calculated for each of the factors that affect supply chain performance on the selected e-commerce platform. These Certainty Factor values represent the degree of certainty of these factors. A higher value than CF+ indicates that this factor has a strong level of confidence in good performance. Conversely, a higher value of CF- indicates doubt about poor performance. This Certainty Factor analysis helps in describing how certain factors have an impact on supply chain performance in the context of the selected e-commerce platform. Thus, this analysis provides deeper insight into the critical factors that need to be considered in supply chain optimization efforts. Through the application of the Certainty Factor method in this step, this research can describe in more depth the level of certainty regarding the key factors that affect supply chain performance on each e-commerce platform. By combining this Certainty Factor analysis with the previous MOORA method, this research can provide a more comprehensive and detailed picture of the relative performance and certainty level of these factors in the context of supply chain optimization analysis.

3.4 Comparison of Results

This stage involves an in-depth comparison between the results of the analysis resulting from the application of the MOORA method and the Certainty Factor. Both methods provide comprehensive and structured insights related to supply chain optimization on the selected e-commerce platform. The application of the MOORA method provides a relative rating for each e-commerce platform, enabling identification of the performance of each platform based on predefined criteria and sub-criteria. Table 5 below presents the relative rankings of e-commerce platforms that have been analyzed using the MOORA method.

Table 5. Relative Ranking of E-commerce Platforms Based on the MOORA Method

Rating	Platforms
1	Tokopedia.com
2	Shopee
3	Lazada
4	Blibli
5	Matahari Mall

The results of the MOORA method show that Tokopedia.com and Shopee rank highest in performance related to predefined criteria and sub-criteria. On the other hand, Certainty Factor analysis provides a perspective related to the level of certainty regarding the factors that affect supply chain performance on each e-commerce platform. Table 4 describes the results of the Certainty Factor calculations for each of the factors analyzed. Through Certainty Factor analysis, an overview is obtained of factors that have a higher level of confidence or a lower level of uncertainty related to supply chain performance on each e-commerce platform. By comparing the results of the two methods, e-commerce platforms such as Tokopedia.com and Shopee consistently rank well in both analyses. However, the Certainty Factor method provides an additional dimension by considering the level of certainty regarding the factors that affect performance. The implication of the results of this analysis is that these platforms have greater potential for development in supply chain optimization efforts. By integrating the MOORA and Certainty Factor methods, this research succeeded in providing a more holistic and detailed insight into supply chain optimization on the selected e-commerce platform. The results of this analysis have the potential to assist stakeholders in making more informed and directed decisions regarding supply chain optimization strategies in the context of e-commerce platforms.

3.5 Discussion

With the in-depth application of the MOORA (Multi-Objective Optimization based on Ratio Analysis) and Certainty Factor methods, the results of a structured and measurable analysis have resulted in an in-depth view of supply chain optimization on the selected e-commerce platform. Both methods provide comprehensive and structured insights into the relative performance of e-commerce platforms in the context of predefined criteria and sub-criteria. These results are based on six main stages that follow a detailed methodological approach. Firstly, during the Data Collection stage, we collect substantial and relevant data on the supply chain performance of each e-commerce platform that we examine. This data covers key parameters such as product availability, delivery times, shipping costs, customer satisfaction levels, and other factors that affect supply chain efficiency. This step is a crucial foundation for further analysis. Second, we proceed by selecting the criteria and sub-criteria to be used in the supply chain optimization analysis. The main criteria that we

determine include operational costs, delivery times, service quality, and customer satisfaction levels. Then, we define more specific sub-criteria for each criterion, enabling in-depth analysis of the factors that impact e-commerce platform performance. The third step involves applying the Certainty Factor method to measure the extent to which factors affecting supply chain performance are reliable. By calculating the positive Certainty Factor (CF+) and negative Certainty Factor (CF-), we assess the level of confidence and uncertainty in the relevant information. This process provides deeper insight into these factors. Next, we carefully select case studies, considering the criteria of relevance, diversity, and availability of data through the API. The five selected e-commerce platforms, namely Matahari Mall, Tokopedia.com, Lazada, Shopee, and Blibli, represent a wide variety in the e-commerce industry.

The MOORA method is applied in the Relative Analysis stage to provide a relative ranking for each of the selected e-commerce platforms. Through data normalization, determining weights, calculating ratio values, and MOORA calculation formulas, we produce a deeper ranking of the relative performance of each platform in each aspect. The sixth stage involves the continuation of Certainty Analysis with the Certainty Factor method. We calculate the positive Certainty Factor (CF+) and negative Certainty Factor (CF-) for each of the factors that affect supply chain performance on e-commerce platforms. The results of these calculations provide clearer insight into the level of confidence and uncertainty related to these factors.

By comparing the results of the two methods, we identify concordance in the relative rankings of the best performing e-commerce platforms. Platforms like Tokopedia.com and Shopee consistently rank highly in both analyses. Nevertheless, the Certainty Factor method provides an additional dimension by considering the level of certainty regarding the factors that affect performance. In implication, the e-commerce platform has greater development potential in supply chain optimization efforts compared to other platforms.

By integrating the MOORA and Certainty Factor methods, this research succeeded in providing deeper and more comprehensive insights into supply chain optimization on selected e-commerce platforms. The results of this analysis have the potential to support stakeholders in making more informed and informed decisions regarding supply chain optimization strategies in the context of e-commerce platforms. Through structured and measurable analysis stages, this research has succeeded in producing a deeper understanding of the key factors that influence supply chain performance on selected e-commerce platforms. In addition, the resulting tables provide a visual picture that helps in understanding the results of the analysis, selecting case studies, and applying the MOORA and Certainty Factor methods.

4. Related Work

Related studies in this research provide in-depth insights into supply chain optimization efforts in the context of e-commerce platforms. Several previous studies have investigated aspects of supply chain optimization, but this study explores a new approach by combining the MOORA (Multi-Objective Optimization on the basis of Ratio Analysis) method and the Factor Certainty Method. For example, research by Prasad & Sounderpandian (2003) focuses on analyzing the factors that affect supply chain efficiency in various industrial sectors but have not yet integrated the MOORA and Factor Certainty methods [36]. Related research by Chen (2019) discusses the relative analysis of the performance of e-commerce platforms using the Analytic Hierarchy Process (AHP) method [37]. However, this research does not consider the level of certainty regarding the factors that affect supply chain performance. This research also relates to the study by Tirtiroglu (2007), which describes the use of the MOORA method in the context of supply chain optimization but does not involve the Factor Certainty Method to measure the level of certainty regarding factors [38]. However, this research shows a gap in the approach by combining the MOORA method and the Certainty Factor Method to provide a more comprehensive view of supply chain optimization on e-commerce platforms. The integration of these two methods allows for a more structured and measurable analysis of the relative performance and level of certainty of the factors affecting the supply chain. Thus, this research makes a significant contribution to the development of a more informational and targeted supply chain optimization strategy in the context of an e-commerce platform. By overcoming the limitations of previous studies, this research provides new insights in developing a comprehensive approach to optimizing supply chains in the rapidly growing e-commerce industry.

5. Conclusion

In this study, we apply the MOORA (Multi-Objective Optimization on the basis of Ratio Analysis) and Certainty Factor methods to analyze supply chain optimization on selected e-commerce platforms. Through six methodological steps that are structured and measurable, we managed to produce an in-depth view of the relative performance of e-commerce platforms in the context of pre-defined criteria and sub-criteria. The results of the analysis show that these two methods provide valuable insights. The MOORA method provides a strong relative ranking of each e-commerce platform, allowing identification of performance based on relevant criteria and sub-criteria. Meanwhile, the Certainty Factor method provides an additional dimension by considering the level of certainty regarding the factors that affect performance. From the comparison of the results of the MOORA and Certainty Factor methods, platforms such as Tokopedia.com and Shopee

consistently rank well in both analyses. However, through the Certainty Factor method, we can recognize factors that have a greater level of confidence or a lower level of uncertainty regarding supply chain performance. The implication of this research is that these e-commerce platforms have greater development potential in supply chain optimization efforts, making them the focus in performance improvement strategies. Overall, the integration of the MOORA and Certainty Factor methods has succeeded in providing more detailed and comprehensive insights into supply chain optimization on the selected e-commerce platforms. This research makes an important contribution in understanding the key factors affecting supply chain performance and provides guidance for stakeholders to make more informed and informed decisions regarding supply chain optimization strategies in the context of e-commerce platforms. In addition, the structured methodological approach could be adapted in the context of similar analyzes in the future, with the potential to generate deeper and more relevant understanding in this evolving domain.

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