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Financial and Operational Performance Analysis Using LOPCOW Based MARCOS Method: A Case Study of the Asian Airline Market

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Abstract

The purpose of the study is to view how companies operating in the Asian airline market responded to the crisis caused by the COVID-19 pandemic. Additionally, it aims to compare the financial and operational performance of airlines in the Asian airline market before, during, and after the COVID-19 pandemic. In this context, the financial and operational performance of 18 airlines in the Asian airline market for the period 2019-2022 was analysed using the Lopcow-based Marcos method. Firstly, financial and operational variables related to airlines were weighted using the Lopcow method. As a result of the weighting conducted with the Lopcow method, it was determined that the Dept Ratio and ROA variables had the most weight on the performance of these airlines. Subsequently, the performance ranking of airlines was conducted using the Marcos method. According to the ranking results obtained by the Marcos method; Spring Airlines (2019), Qantas Airways (2020), Air Arabia (2021) and Singapore Airlines (2022) were found to have the best performance. This study will make a significant contribution to the performance management of airlines in the Asian airline market. It will provide airline managers with insights and guidance on how to enhance the performance of their airlines during periods of crisis, such as the COVID-19 pandemic.

Keywords: Financial Performance, Operational Performance, Lopcow Method, Marcos Method, Airlines.

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1. INTRODUCTION

The aviation industry, which had positive sentiments towards the industry and its future, suddenly transformed into a structure characterized by negative sentiments because of the crisis triggered by the COVID-19 pandemic. Until the end of 2019, forecasts for the aviation industry's future were quite optimistic. For instance, Airbus and Boeing projected an average growth of 4.3% and 4.6%, respectively, for the period 2019-2038, along with an expected increase of around 39,000 to 44,000 in new aircraft orders (Airbus, 2019; Boeing, 2019). However, these optimistic forecasts vanished with the spread of the COVID-19 pandemic worldwide in the early months of 2020. The implementation of quarantines and lockdown measures along with restrictions on movement negatively affected the aviation industry. In subsequent periods, as lockdown measures and quarantines were gradually lifted, the aviation industry started showing signs of recovery. However, the figures indicate that the aviation industry has not yet reached the levels of 2019. Globally, the total number of passengers decreased by 60% in 2020 compared to 2019, by 49% in 2021, and by 29% in 2022. Similarly, the total amount of losses in the aviation industry was $372 million in 2020, $324 million in 2021, and $175 million in 2022 (The International Civil Aviation Organization [ICAO], 2023).

The sudden decline in passenger demand during the COVID-19 pandemic resulted in a substantial decline in airlines' total revenues. This situation weakened the financial structure of airlines. Airlines seeking to strengthen their financial structure have pursued various strategies such as reducing costs, maintaining cash flow, and increasing security measures. To reduce costs, airlines have grounded aircraft, phased out old and inefficient aircraft from their fleets, implemented pay cuts for employees, or laid off staff. To maintain cash flow, airlines have repositioned their aircraft from business-focused routes to leisure-focused routes, converted passenger aircraft into cargo aircraft to meet increased cargo demand, sought subsidies from governments, and lowered ticket prices to stimulate demand. In order to increase safety measures, airlines have made mask usage mandatory on aircraft, left middle seats empty to increase social distancing, improved aircraft cleaning processes with cabin ventilation systems, ensured the use of protective equipment for cabin crew, and developed passenger screening measures such as COVID-19 tests during boarding processes (Albers & Rundshagen, 2020; Adrienne et al., 2020; Bombelli, 2020; Dube et al., 2021; Milne et al., 2021; Gualini et al., 2023).

The Asian aviation market, one of the largest in the world, was severely affected by the COVID-19 pandemic. Many airlines had to reduce the number of flights as a result of the pandemic, but still had to make debt payments on purchases, aircraft maintenance and leasing fees. This situation increased the risk of bankruptcy risk for some airlines (Thai Airways, Cathay Dragon, Philippine Airlines) (Abdullah et al., 2020). Furthermore, the international travel restrictions imposed during the pandemic period prompted traditional airlines with international flight networks to return to domestic routes. The concentration of traditional and low-cost carrier (LCC) airlines on domestic routes led to an intensification of competition However, Asian airlines were not equally affected by the negative effects

of the COVID-19 pandemic. Some airlines have distinguished themselves from their competitors by demonstrating superior performance. For instance, major, traditional airlines such as Air China, China Eastern Airlines, and China Southern Airlines incurred losses amounting to $6.3 billion in 2021, whereas Spring Airlines, the largest LCC Airlines in China, generated a profit of $6.2 million (Wu et al., 2025). The principal aim of this study is to examine the financial and operational performance of traditional and low-cost carrier (LCC) airlines in the Asian airline market, with a particular focus on the period preceding, during and following the pandemic.

This study is regarded as a significant contribution to the expanding body of literature examining the impact of the COVID-19 pandemic on the aviation industry. The study's key contributions to this as follows:

1. This study provides information on the financial and operational performance of traditional and LCC airlines in Asia before, during and after the COVID-19 pandemic.
2. This study compares the financial and operational performance of airlines using different business models in the Asian air transport market.
3. In accordance with the model proposed in this study, performance criteria of significance to the airlines in question have been identified.
4. This study provides an opportunity to evaluate whether these airlines are affected by the COVID-19 outbreak depending on the performance criteria included in the analysis.

The main reasons for using the LOPCOW method in this study can be explained as follows; (a) it allows the objective data to be evaluated together, (b) it can be used by decision makers without the need for any software program, (c) it makes objective weighting by taking into account the negative values in the data set, (d) it is an objective weighting method based on a simple mathematical basis (Ecer & Pamucar, 2020). The main reasons for using the MARCOS method are (a) it allows ranking in terms of ideal and non-ideal solutions, (b) although it is a relatively new method, it is a flexible, effective and practical method, (c) it is simple and applicable for decision makers to make objective and consistent decisions (Stević & Brković, 2020).

In the subsequent sections of the study, detailed information about the studies in the literature is provided in section 2. The data included in the analysis and the methods used are explained in section 3. The findings obtained from the analysis are discussed in section 4. In conclusion, the research findings are assessed in the final section.

2. LITERATURE

The Marcos method, introduced by Stević et al. in 2020, is a flexible and effective technique designed to tackle multi-criteria decision-making (MCDM) challenges. Since then, numerous studies employing the Marcos method have been added to the literature. For instance, Pamucar et al. (2021) utilized the SWARA and Grey MARCOS methods to assess the service quality of airports in Spain. As

a result of the research, it was determined that Wi-Fi connection and car park access at airports are critical factors in evaluating service quality. Özdağoğlu et al. (2021) analysed the operational performance of the world's busiest airports in 2019 using the PIPRECIA-E, SMART, and MARCOS methods. The study revealed that Beijing Airport exhibited the most optimal performance, whereas Amsterdam Airport demonstrated the least favourable performance. Miškić et al. (2021) applied the SWARA-based MARCOS method to evaluate criteria in inventory management within the logistics sector and to effectively classify products. The research findings indicated that the model could be effectively employed in inventory management and product classification. Additionally, Altıntaş (2022) used the MABAC and MARCOS methods to study the innovation performance of countries that contribute most to energy innovation globally. The findings of the research indicated that Finland exhibited the most optimal performance, whereas Estonia demonstrated the least favourable performance. Gönüllü (2022) measured the financial performance of 20 companies in the Borsa Istanbul Metal Main Index during the pandemic period using the ENTROPY and MARCOS methods. The study revealed that the majority of companies included in the research exhibited a decline in financial performance during the period of the pandemic. Ghoushchi et al. (2023) employed both the SWARA and MARCOS methodologies to identify critical factors in road safety, prioritise accident risk factors and improve the decision-making process. The findings of the research indicated that the human factor is a more significant contributor to accident risk than other factors. Uzgör (2024) analyed the environmental performance of the five largest airports in Turkey using the SWARA, COCOSO, MARCOS, TOPSIS, VIKOR and BORDO methods. As a result of the research, it is seen that Istanbul airport has the best performance in terms of environmental performance, while Izmir Adnan Menderes Airport has the worst performance.

There are numerous studies that use MCDM techniques to analyse airlines from a financial and operational perspective. These studies are aimed at solving complex decision problems in the air transport sector, increasing companies' efficiency, controlling costs and improving service quality. For example, Avcı and Çınaroğlu (2018) employed TOPSIS and AHP methods to examine the financial performance of five European-based airlines for the period 2012-2016. The study found that Ryanair had the best financial performance, while Lufthansa had the worst. Pineda et al. (2018) proposed a hybrid model consisting of DRSA, DEMATEL, DANP and VIKOR approaches for determining the key criteria that significantly enhance airline performance. The research demonstrated that the proposed model is applicable for comparing the operational and financial performance of different airlines. Kiracı and Bakır (2019) used the CRITIC-based EDAS method to analyse the operational performance of 13 airlines over the specified period 2005-2012, using criteria specific to the air transport sector. The study found that there were no significant changes in the airlines' performance rankings over the period. Kiracı (2019) scrutinized the financial performance of Star Alliance member airlines before and after joining the alliance. The investigation utilized trend analysis and CRITIC-based TOPSIS techniques. The

findings indicated that participating in global alliances impacts airlines' financial performance. Kiracı and Bakır (2020) evaluated the financial performance of Star Alliance member airlines for the period 2015-2017 using CRITIC and CODAS methods. The results indicated that financial criteria had a greater impact on performance than operational criteria, and that there were differences in how airlines were affected by the global crisis. Bakır et al. (2020) assessed the operational performance of 11 airlines in developing nations employing the PIPRECIA and MAIRCA methodologies. The study found that operating costs were the most important performance criterion. Sumerli Sarıgül et al. (2023) examined the financial performance of six airlines based in Europe for the period 2019-2021 using CRITIC, MAUT and MARCOS methods. The study found differences in the airlines' financial performance rankings. Tanrıverdi et al. (2023) analysed the financial, operational, and environmental performance of 56 airlines for the period 2017-2021 using MEREC-based CoCoSo and Borda methods. The results showed that low-cost carriers (LCCs) and traditional airlines, which operate more extensively in national networks, had better performance.

There is a multitude of studies in the literature investigating how the COVID-19 pandemic has affected the financial performance of firms. These studies typically focus on country economic indicators, sectoral analysis and the financial status of firms. For example, Bağcı et al. (2020) analysed the effect of the reported number of COVID-19 cases worldwide on the stock prices of global airlines using the quantile-quantile regression method. The results of the analysis indicated that airline stock prices were adversely impacted by the COVID-19 pandemic. Chen and Yeh (2021) analysed the effect of the COVID-19 pandemic on the stock markets across different countries, contrasting it with the global financial and economic crisis of 2008-2009. The results of the study indicated that the adverse effects of the COVID-19 pandemic on countries' stock markets was more severe than during the global economic crisis. Czerny et al. (2021) evaluated the recovery model affected by the Chinese government's aviation policy decisions during the COVID-19 pandemic. The study found that China's domestic aviation sector recovered more quickly than the domestic aviation sectors of other countries. Kiracı and Asker (2021) analysed the effect of the COVID-19 pandemic on airline performance using MCDM methods. In this context, they evaluated the operational performance of six airlines from the first quarter of 2018 to the third quarter of 2020, employing CRITIC-based EDAS and trend analysis methodologies. The results of the study showed that the COVID-19 pandemic had a negative impact on the performance of the airlines. Pereira and Mello (2021) measured the operational performance of Brazilian airlines throughout the COVID-19 pandemic using Data Envelopment Analysis. The analysis showed that demand and efficiency in the air transport industry decreased due to flight restrictions during the pandemic. Hu and Zhang (2021) examined the financial performance of international firms during the COVID-19 pandemic. The study concluded that the pandemic exerted a significant negative impact on firms' financial performance and that firms with more developed financial systems were less affected by the pandemic. Tanrıverdi and Eryaşar (2022) analysed the performance of 35 airlines that are part of the

Star Alliance, SkyTeam, and Oneworld alliances, before and during the COVID-19 pandemic using CRITIC and CoCoSo methods. The findings indicated that operating profit and load factor emerged as crucial success indicators for global airline alliances during the period in question. Asker (2023) examined the financial performance of LCC airlines for the period 2019Q4-2021Q4 during the COVID-19 pandemic using CRITIC and ARAS methods. The study found variations in the financial performance of LCC airlines. Gualini et al. (2023) examined the strategies implemented by airlines within the US air transport market amidst the COVID-19 pandemic. The study concluded that LCC airlines were less affected by the pandemic due to their stronger position in domestic markets. Kaffash and Khezrimotlagh (2023) measured the effect of the COVID-19 pandemic on the performance of US airlines using Network Data Envelopment Analysis. The study found that LCC airlines were more efficient than traditional airlines.

A review of the literature on the impact of the COVID-19 pandemic on the air transport sector reveals that early studies focused on the effects of the pandemic on airlines, particularly on the decline in demand and revenue (Sanchez et al., 2020; Lacus et al., 2020). Subsequent studies have examined the strategies employed by airlines during the pandemic period (Czerny et al., 2021; Bauer et al., 2020). A number of studies have examined the influence of the pandemic on the business models of airlines (Perez et al., 2022; Kaffash and Khezrimotlagh, 2023). However, it has been observed that these studies cover airlines in the USA and focus exclusively on performance measurement before and during the pandemic. There is no study in the literature that examines the performance of airlines operating in Asia before and after the COVID-19 pandemic. In this respect, this study, which examines the performance of airlines in Asia before and after the pandemic, is thought to fill this gap in the literature.

3. DATA AND METHODOLOGY

This study employs the Lopcow and Marcos methods to analyse the financial and operational performance of 18 airlines operating in the airline transport market in Asia for the period 2019-2022. The analysis focuses on 10 criteria. The reason for choosing this time period is that the COVID-19 pandemic emerged in the last months of 2019, spread to a large part of the world in 2020, its effects started to decrease in 2021 and its effects decreased significantly in 2022. In order to examine the impact of the pandemic on airlines operating in Asia, data for the 2019-2022 period are included in the analysis.

In order to analyse airlines' responses to situations caused by external influences, the characteristics and context of the situation in question should be the same for all parties (Sartal et al., 2017). The effects of the COVID-19 pandemic on the air transport sector have varied by region and time. For example, in early 2020, airlines in Europe and America continued to operate normally, while airlines in Asia were struggling with the COVID-19 pandemic. For these reasons, it was decided to examine airlines in Asia, which have a significant share of global flight traffic. Three of these airlines are LCC airlines (Air Arabia, Cebu Air, Spring Airlines). LCC airlines offer lower fares than traditional

airlines by reducing the services provided in the cabin (Malighetti et al., 2009). Previous studies have revealed that traditional airlines and LCC airlines adopted disparate strategies during the pandemic period, with traditional airlines exhibiting superior performance compared to LCC airlines (Asker, 2024). However, other studies have yielded contrasting findings (Kaffash & Khezrimotlagh, 2023). In this respect, it is quite remarkable to examine the performance comparison between traditional airlines and LCC airlines.

The financial and operational criteria employed in the study were selected from the most commonly utilised criteria in studies on performance measurement within the air transport sector. The financial and operational performance criteria utilised in the study are presented in Table 1.

Table 1. Performance İndicators Used in the Analysis

Classification	Indicators	Code	Formula	References
Financial	ROA	C1	$\frac{Net\ Profit}{Total\ Assets}$	(Dave & Dave, 2012; Dinçer et al., 2017; Pires & Fernandes, 2012)
	ROE	C2	$\frac{Net\ Profit}{Total\ Equity}$	(Wang, 2008; Pineda et al., 2018)
	Current Ratio	C3	$\frac{Current\ Assets}{Current\ Liabilities}$	(Kiracı & Bakır, 2020; Asker & Aydın, 2021)
	Dept Ratio	C4	$\frac{Total\ Dept}{Total\ Assets}$	(Al-Najjar & Kalaf, 2012; Jandghi & Ramshini, 2014; Asker & Aydın, 2021; Kiracı et al., 2022)
	Net Profit Margin	C5	$\frac{Net\ Profit}{Total\ Revenue}$	(Teker et al., 2016; Asker, 2022)
	Operating Margin	C6	$\frac{Operating\ Income}{Total\ Revenue}$	(Merkert & Pearson, 2015; Asker, 2022)
Operational	CASK	C7	$\frac{Operating\ Costs}{ASK}$	(Sakthidharan & Sivaraman, 2018; Gramani, 2012)
	RASK	C8	$\frac{Total\ Revenue}{ASK}$	(Mhlanga, 2019)
	RRPK	C9	$\frac{Total\ Revenue}{RPK}$	(Barros & Peypoch, 2009)
	Load Factor	C10	$\frac{RPK}{ASK} * 100$	(Min & Joo, 2016; Asker, 2021)

Source: Author's own elaboration.

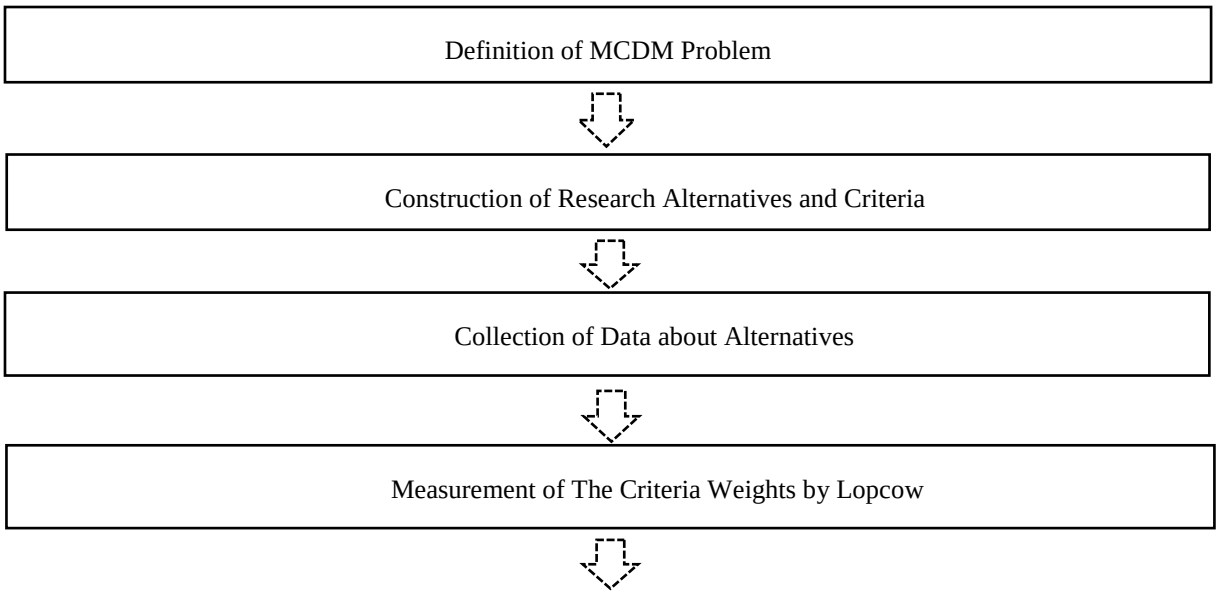
As illustrated in Table 1, six variables were identified for the assessment of the financial performance of airlines in Asia. The return on assets (ROA) indicates the profitability of a companies

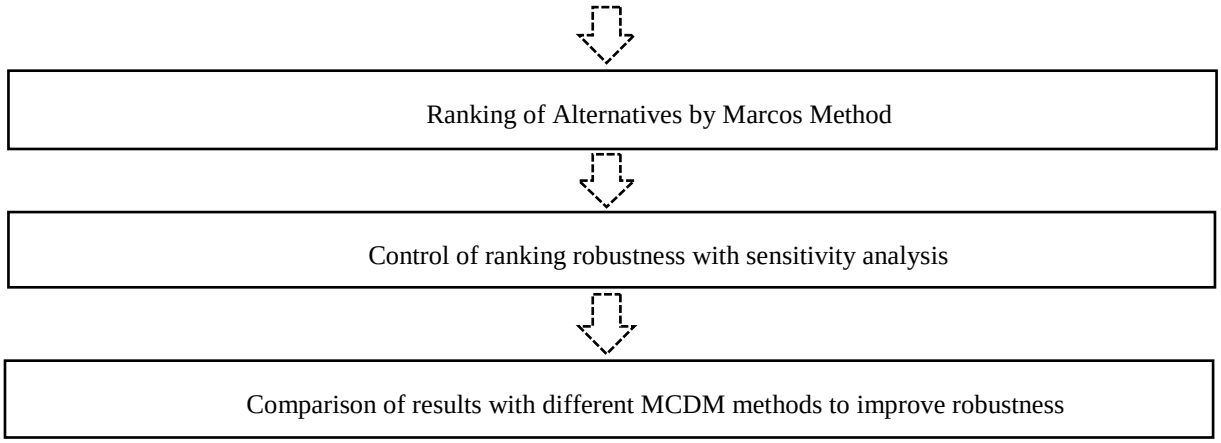
in relation to its assets. In other words, it is an important ratio that demonstrates the efficiency with which the company utilises its assets (Dave & Dave, 2012). The return on equity (ROE) is a significant financial ratio that demonstrates the profitability of a company in relation to the capital invested by its shareholders (Zhang et al., 2014). The current ratio is an important financial ratio that expresses the ability of a companies to pay its short-term debts using its current assets (Dinçer et al., 2017). The debt ratio is an important financial ratio that provides insight into the solvency of companies. A high debt ratio is indicative of an elevated financial risk (Al-Najjar & Kalaf, 2012). The net profit margin is an important ratio that demonstrates the extent to which a company's revenues generate profit (Teker et al., 2016). The operating margin is an important ratio that indicates the profitability of a company's activities (Merkert & Pearson, 2015).

In the context of the study, four variables were identified as key metrics for evaluating operational performance. All of these variables are related to the concepts of ASK (Available Seat Kilometre) and RPK (Revenue Passenger Kilometre). The variable ASK is calculated by multiplying the available seat capacity by the distance flown. RPK is defined as the number of seats sold multiplied by the distance flown (Barros & Peypoch, 2009). CASK represents the cost per seat for aircraft owned by airlines. CASK represents the primary operational cost measurement indicator within the airline transport sector (Sakthidharan & Sivaraman, 2018). RASK demonstrates the revenue generated per seat on aircraft owned by the airline. It is a crucial operational revenue indicator in the airline industry (Mhlanga, 2019). RRPK represents revenue per passenger in the airline sector (Vasigh et al., 2015). Load Factor is a significant operational indicator that expresses the occupancy rate of aircraft under the ownership of airlines (Min & Joo, 2016).

Financial data related to airlines was obtained from the Bloomberg database, while operational data was obtained from the airlines' annual reports.

Figure 1. Flow chart of the application model





Source: Author's own elaboration.

In Figure 1, the Lopcow and Marcos methods used in the study are presented within a flowchart. In the first step, the problem related to MCDM (Multi-Criteria Decision Making) was identified. In the second step, alternatives related to the problem and the financial and operational criteria for these alternatives were determined. The third step involved collecting data for these criteria. In the fourth step, the aforementioned financial and operational criteria were weighted using the Lopcow method. In the fifth stage, the Marcos method was utilized to rank the performance of the alternatives (airlines). In the last step, the obtained ranking results were compared with those of other MCDM methods to strengthen the reliability of the proposed model.

3.1. Lopcow Method

Ecer and Pamucar introduced the Lopcow (Logarithmic Percentage Change-driven Objective Weighting) method to the literature (Ecer & Pamucar, 2020, pp. 4-5). The Lopcow method provides benefit or cost-oriented solutions for criteria without the need for any criterion constraints. The most significant difference of this method from other criterion weighting methods is the elimination of the difference (gap) caused by the size of the series by considering the standard deviation percentage and mean squares of the series. Another feature of the method is that it is not affected by data with negative values (Ecer et al., 2023). The application steps of the Lopcow method are shown below (Ecer & Pamucar, 2020, p. 5):

Step 1: In the first step of the method, an initial decision matrix (IDM) consisting of "m" alternatives and "n" criteria is arranged for the determination and resolution of the decision problem, as specified in Equation (1).

$$IDM = \begin{bmatrix} y_{11} & y_{12} & \cdots & y_{1n} \\ y_{21} & y_{22} & \cdots & y_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ y_{m1} & y_{m2} & \cdots & y_{mn} \end{bmatrix} \quad (1)$$

Step 2: In the second step of the method, the evaluation criteria in the decision matrix are normalized according to whether they are benefit-oriented or cost-oriented using Equation (2) or Equation (3).

$$r_{ij} = \frac{x_{max} - x_{ij}}{x_{max} - x_{min}} \qquad if\ j \in C \tag{2}$$

$$r_{ij} = \frac{x_{ij} - x_{min}}{x_{max} - x_{min}} \qquad if\ j \in B \tag{3}$$

Step 3: In the third step of the method, the percentage value (PV value) for each evaluation criterion is calculated using Equation (4).

$$PV_{ij} = \left| \ln \left\{ \frac{\sqrt{\frac{\sum_{i=1}^{m} r_{ij}^2}{m}}}{\sigma} \right\} * 100 \right| \tag{4}$$

Where "m" stands for the quantity of alternatives, and "σ" denotes the standard deviation.

Step 4: In the final step of the method, the importance weight value for each criterion is calculated using Equation (4).

$$W_j = \frac{PV_{ij}}{\sum_{i=1}^{n} PV_{ij}} \tag{5}$$

3.2. Marcos Method

The Marcos Method, developed by Stević et al., (2020), establishes associations between alternatives and reference values (ideal and non-ideal alternatives) to rank alternative performance, as outlined by Stević and Brković, (2020). This method employs benefit functions to assess alternatives based on these relationships, facilitating the ranking process relative to the reference values. Benefit functions indicate the positioning of each decision alternative concerning ideal and non-ideal solutions. Consequently, the alternative with the highest ranking is closest to the ideal reference point and farthest from the non-ideal reference point. The procedural steps of the Marcos method, as outlined by Stević et al., (2020):

Step 1: The initial decision matrix consisting of evaluation criteria and decision alternatives is arranged as specified in Equation (1).

$$Y = [y_{ij}] = \begin{bmatrix} y_{11} & y_{12} & \cdots & y_{1n} \\ y_{21} & y_{22} & \cdots & y_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ y_{m1} & y_{m2} & \cdots & y_{mn} \end{bmatrix} \tag{1}$$

Step 2: Ideal (AI) and non-ideal (AAI) solution values are determined, and the initial decision matrix is expanded as indicated in Equation (6).

$$Y= \begin{matrix} AAI \\ A_1 \\ A_2 \\ A_m \\ AI \end{matrix} \begin{bmatrix} C_1 & C_2 & C_n \\ y_{aa1} & y_{aa2} & \cdots & y_{aan} \\ y_{11} & y_{12} & \cdots & y_{1n} \\ y_{21} & y_{22} & \cdots & y_{2n} \\ y_{m1} & y_{m2} & \cdots & y_{mn} \\ y_{ai1} & y_{ai2} & \cdots & y_{ain} \end{bmatrix} \quad (6)$$

The values (AI) and (AAI) in Equation (6) represent the best ideal and worst ideal solutions, respectively. These values are calculated using Equation (7) and Equation (8).

$$\text{AAI} = min_i y_{ij} \; if \;\; j\epsilon \; B \; ve \; max_i y_{ij} \; if \; j\epsilon \; C \quad (7)$$

$$\text{AI} = max_i y_{ij} \; if \;\; j\epsilon \; B \; ve \; min_i y_{ij} \; if \; j\epsilon \; C \quad (8)$$

In these equations, the benefit criterion is denoted by "B" and the cost criterion by "C".

Step 3: The criteria in the expanded initial decision matrix are normalized according to whether they are cost-oriented or benefit-oriented using Equation (9) and Equation (10).

$$n_{ij} = \frac{x_{ai}}{x_{ij}} \;\; if \; j \; \epsilon \; C \quad (9)$$

$$n_{ij} = \frac{x_{ij}}{x_{ai}} \;\; if \; j \; \epsilon \; B \quad (10)$$

Step 4: The normalized decision matrix is weighted by the weight values of the criteria obtained through the Lopcow method, as specified in Equation (11).

$$V_{ij} = n_{ij} * \; w_j \quad (11)$$

Step 5: The benefit degrees of decision alternatives (K_i) are calculated based on ideal and non-ideal solutions using Equation (12) and Equation (13).

$$H_i^- \frac{S_i}{S_{aai}} \quad (12)$$

$$H_i^+ \frac{S_i}{S_{ai}} \quad (13)$$

The value (S_i) represents the total value of weighted matrix elements for each alternative, calculated using Equation (14).

$$S_i = \sum_{i=1}^{m} V_{ij} \quad (14)$$

Step 6: Benefit functions of alternatives $f(H_i)$ are calculated using Equation (15).

$$f(H_i) = \frac{H_i^+ + H_i^-}{1 + \frac{1 - f(H_i^+)}{f(H_i^+)} + \frac{1 - f(H_i^-)}{f(H_i^-)}} \quad (15)$$

The value $f(H_i^-)$ in the formula represents the benefit function relative to the non-ideal solution, while $f(K_i^+)$ represents the benefit function relative to the ideal solution. These functions are calculated using Equation (16) and Equation (17).

$$f(H_i^+) = \frac{H_i^-}{H_i^+ + H_i^-} \tag{16}$$

$$f(H_i^-) = \frac{H_i^-}{H_i^+ + H_i^-} \tag{17}$$

Step 7: In the final step, as indicated in Equation (15), alternatives are ranked in descending order based on the values of $f(H_i)$. The alternative with the highest $f(H_i)$ value is considered the best alternative.

4. RESULTS

In this section, the operational and financial performance of 15 traditional and 3 LCC airlines operating in the Asian airline market before and after the COVID-19 pandemic were examined using the Lopcow-based Marcos method. To enhance the robustness of the applied model, sensitivity analysis was performed. Then the obtained results were compared with other MCDM methods. The operational and financial performance of 18 airlines for the period 2019-2022 was compared within the scope of the study.

4.1. Lopcow Results

In this section, the weights of criteria in the initial decision matrix concerning airlines (alternatives) were determined using the Lopcow method. The initial decision matrix consists of values for alternatives and criteria. In this study, a decision matrix of 18 × 10 was created for each year covering the period 2019-2022. When looking at Table 2, we can observe both the variation within each criterion and over time. It is noted that the variable with the highest weight is Dept Ratio in 2019 and 2022, while it is ROA in the period of 2020-2021. The variable with the lowest weight is Current Ratio in 2019, CASK in 2020, RRPK in 2021, and ROE in 2022.

Table 2. Lopcow Method Performance Criteria Weight, 2019–2022

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
2019	0.1101	0.1184	0.0619	**0.1308**	0.0872	0.1204	0.1206	0.0643	0.0646	0.1218
2020	**0.1938**	0.0501	0.0802	0.1270	0.1724	0.1492	0.0327	0.0521	0.0496	0.0924
2021	**0.1925**	0.0223	0.0855	0.1560	0.1693	0.1484	0.0726	0.0203	0.0115	0.1211
2022	0.0511	0.0257	0.0910	**0.1913**	0.1048	0.1540	0.1116	0.0483	0.0485	0.1738

Source: Author's own calculation.

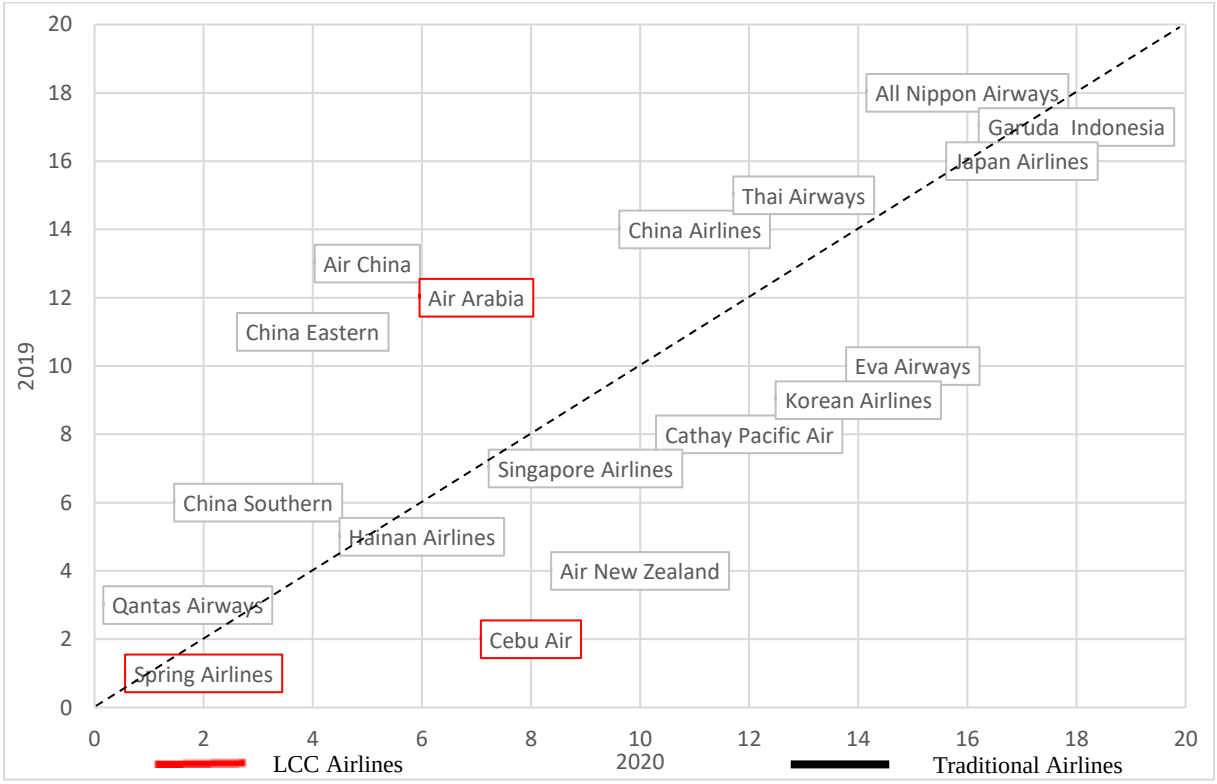
4.2. Marcos Results

After determining the criterion weights of airlines using the Lopcow method, their performance rankings were established using the Marcos method. Initially, the performance rankings of airlines in

2019 (Before Covid-19) were compared, followed by those in 2020 (During Covid-19). As indicated in Figure 2, according to the ranking results of the Marcos method for the year 2019, Spring Airlines demonstrated the best performance, while All Nippon Airways showed the worst performance. Regarding the ranking results for the year 2020, Qantas Airways exhibited the best performance, while Garuda Indonesia showed the worst performance. It can be observed that China Southern, Hainan Airlines, and Cebu Air consistently ranked high in both operational and financial performance for both 2019 and 2020, whereas Japan Airlines, Thai Airways, Garuda Indonesia, and All Nippon Airways were consistently ranked lower.

It has been observed that low-cost carrier (LCC) airlines such as Spring Airlines and Cebu Air demonstrated better performance compared to a significant portion of traditional airlines during the 2019-2020 period. LCC airlines are characterized by their utilization of secondary airports, offering paid in-flight services, and operating fleets consisting solely of narrow-body aircraft. Due to these characteristics, LCC airlines are able to significantly reduce their operational costs. LCC airlines in the study performed better 2019-2020 period due to their cost-efficient operations

Figure 2. Performance Ranking of Asian Airlines According to the Marcos Method (2019-2020)

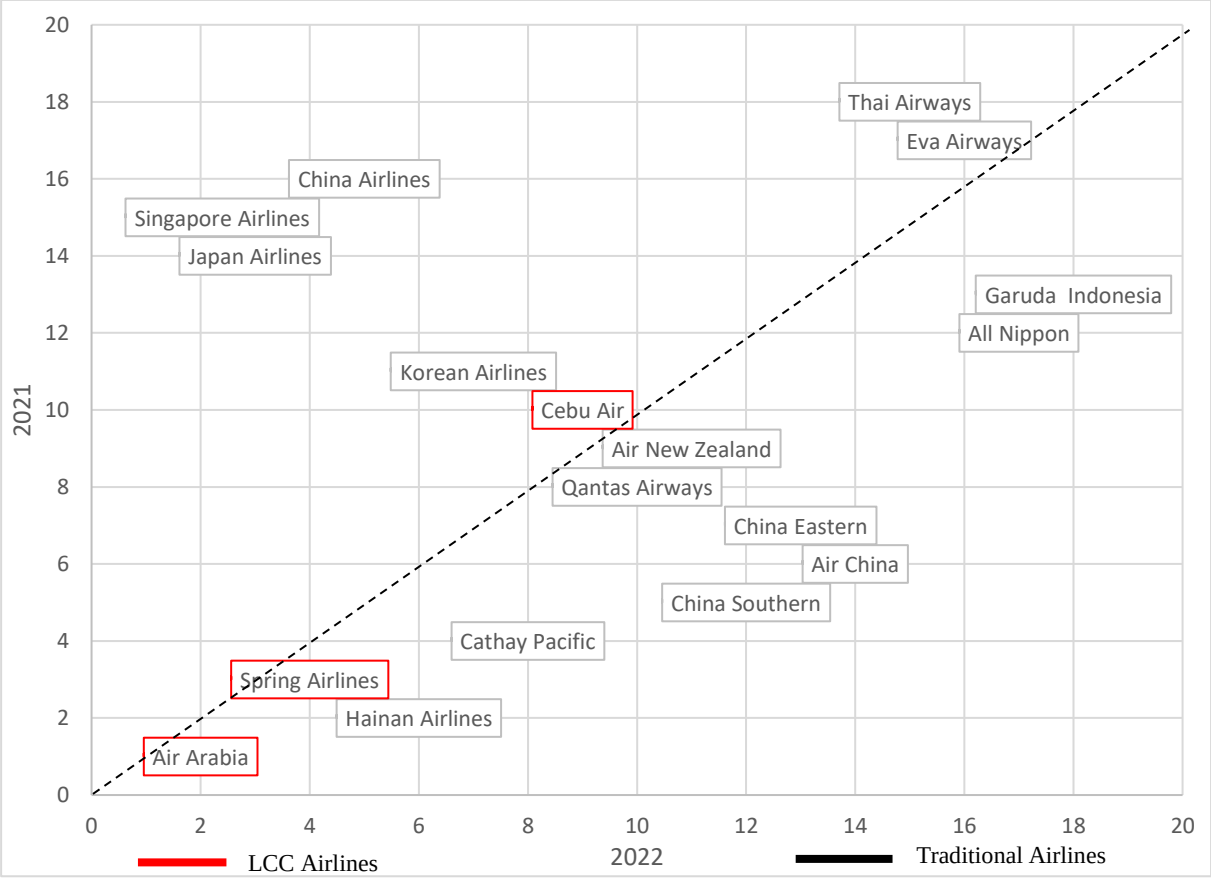


Source: Author's own calculation.

In the second step of the analysis, we compared the performance rankings of airlines in the years 2021 (New Normal) and 2022 (After Covid-19) using the Marcos method. As shown in Figure 3, according to the rankings obtained from the Marcos method in 2021, Air Arabia demonstrated the best performance, while Thai Airways exhibited the worst performance. Regarding the rankings in 2022,

Singapore Airlines showed the best performance, while Garuda Indonesia showed the worst performance. It can be observed that Air Arabia, Hainan Airlines, and Spring Airlines consistently ranked at the top in terms of operational and financial performance in both 2021 and 2022. On the other hand, All Nippon Airways, Eva Airways, Garuda Indonesia, and Thai Airways consistently ranked at the bottom in both years.

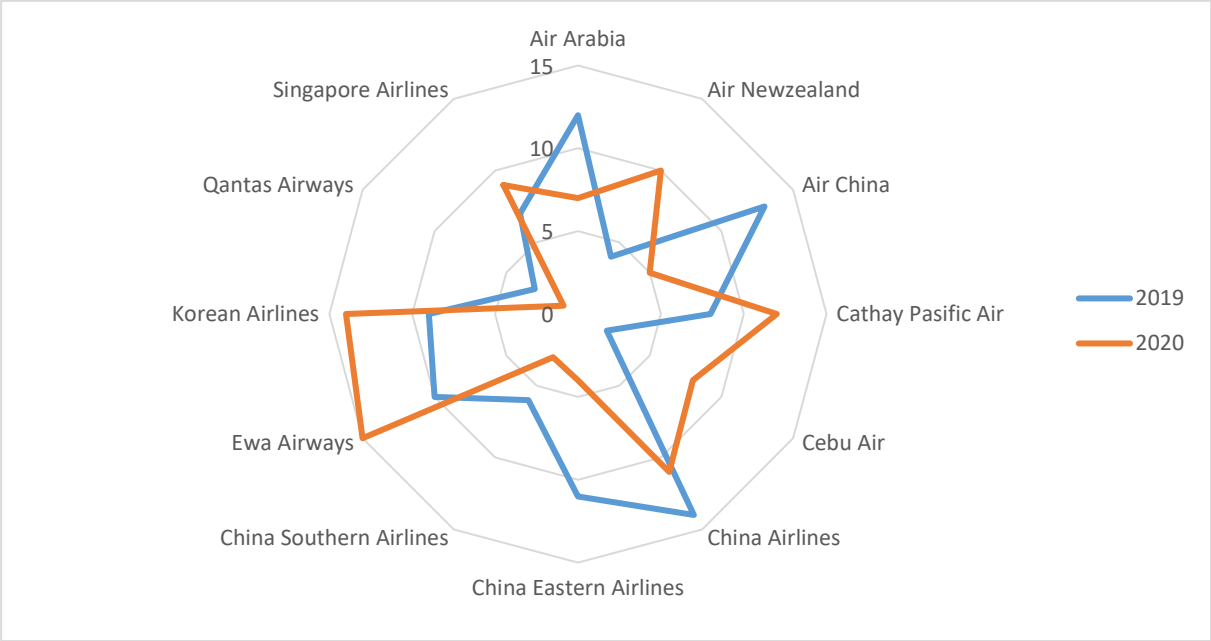
Figure 3. Performance Ranking of Asian Airlines According to the Marcos Method (2021-2022)



Source: Author's own calculation.

Based on the ranking results obtained from the Marcos method, as indicated in Figure 4, the performance of Air New Zealand, Cathay Pacific Air, Ewa Airways, Korean Airlines, Singapore Airlines, and Cebu Air in 2020 was significantly lower compared to 2019. Possible reasons for this could include a substantial decrease in operational revenues and the deterioration of liquidity structures for these airlines. On the other hand, improvements in performance rankings from the previous year were observed for Air Arabia, China Airlines, Air China, China Eastern Airlines, Qantas Airways, and China Southern Airlines in 2020. This improvement can be attributed to the strong liquidity structure of these airlines.

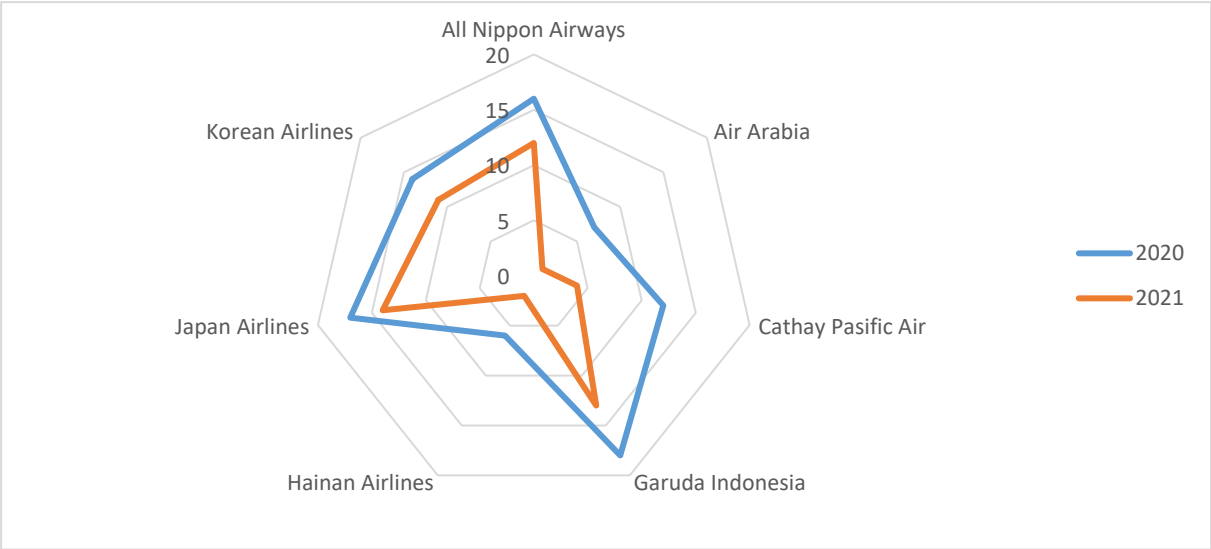
Figure 4. Performance Ranking of Some Airlines According to the Marcos Methods (2019-2020)



Source: Author's own calculation.

Based on the findings depicted in Figure 5, it is evident that All Nippon Airways, Air Arabia, Garuda Indonesia, Cathay Pacific Air, Hainan Airlines, Korean Airlines, and Japan Airlines exhibited improved performance in 2021 compared to the preceding year. Possible reasons for this could include subsidies provided by governments and the lifting of travel restrictions.

Figure 5. Performance Ranking of Some Airlines According to the Marcos Methods (2020-2021)

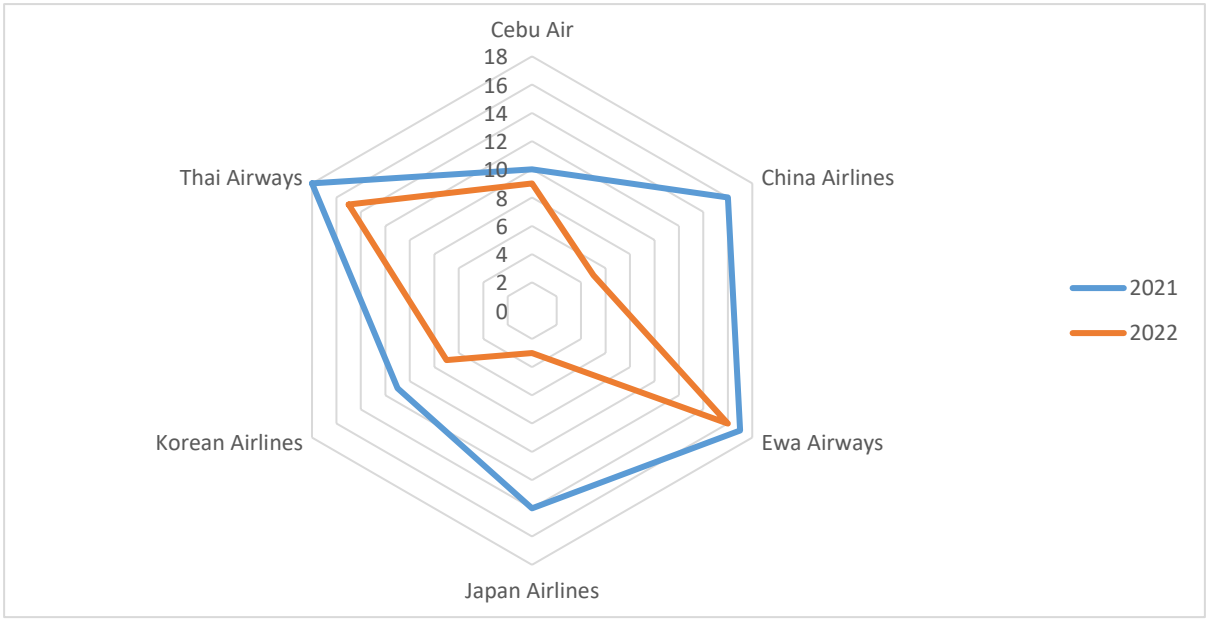


Source: Author's own calculation.

According to the ranking results, as shown in Figure 6, it is observed that Cebu Air, China Airlines, Ewa Airways, Japan Airlines, and Korean Airlines' performance in 2022 was better compared

to the previous year. This indicates that these airlines recovered faster than other airlines in terms of financial and operational performance in the post-pandemic period.

Figure 6. Performance Ranking of Some Airlines According to the Marcos Methods (2021-2022)



Source: Author's own calculation.

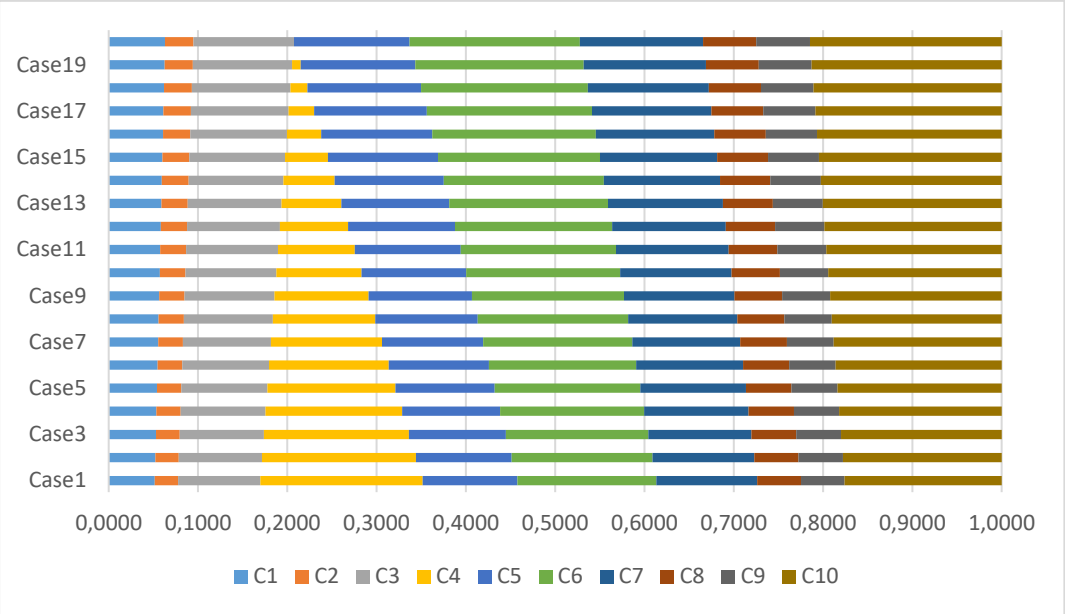
4.3. Robustness and Validation

In the final step of the analysis, a two-step sensitivity analysis was conducted to verify the applicability and robustness of the proposed model. In the first step, the impact of different weights of the criteria on the results was tested. For this purpose, 20 different scenarios were created based on the criterion with the highest weight (C4) obtained from the 2022 analysis using the Lopcow method. The weights for each scenario were calculated using equation (18).

$$W_{n\beta} = (1 - W_{n\alpha}) * \frac{W_{\beta}}{(1 - W_n)} \tag{18}$$

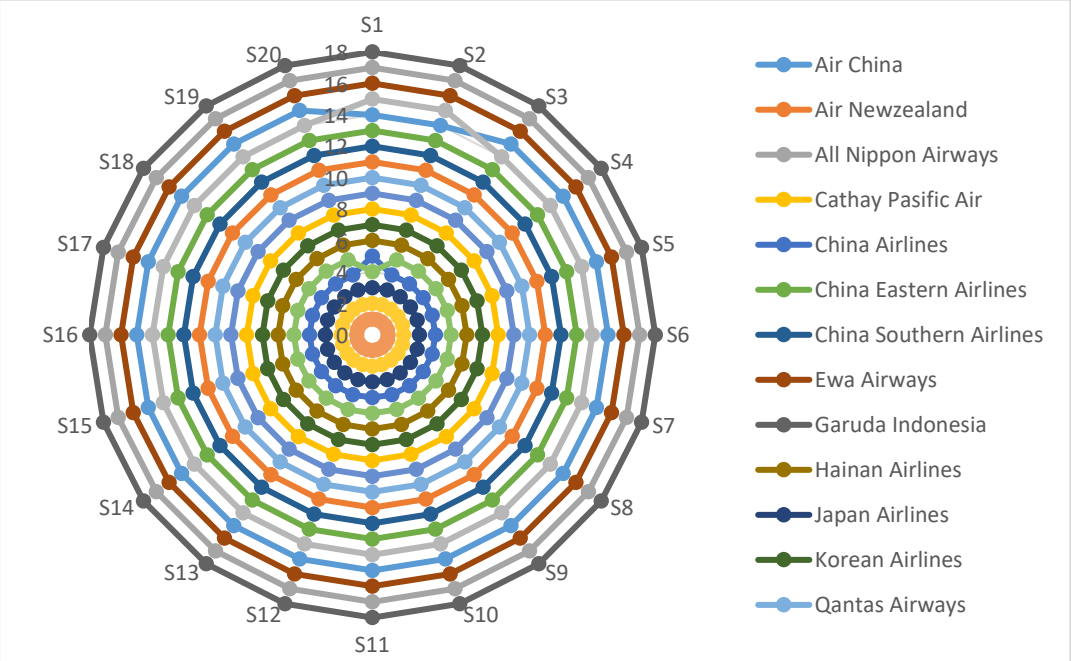
In the formula, W_{β} denotes the original weight of the criteria, W_n denotes the original weight of the most important criterion (C4), $W_{n\alpha}$ denotes the reduced values of the most important criterion (C4) and $W_{n\beta}$ denotes the weights of each scenario (Kirkwood, 1997). In the analysis, the reduction rate of the $W_{n\alpha}$ value was set at 5%. The weight values of the criteria for 20 scenarios are shown in Figure 7. In addition, the scenario-based rankings of the airlines in question are shown in Figure 8. There is no significant change in the performance rankings of the airlines in the scenario-based rankings. This supports the validity and reliability of the proposed model.

Figure 7. Weights of Criteria According to 20 Scenarios



Source: Author's own calculation.

Figure 8. Ranking of Airlines According to all Scenarios



Source: Author's own calculation.

In the subsequent phase of the analysis, the reliability and robustness of the ranking results produced by the Marcos method were assessed by comparing them with results from other MCDM methods. In this context, the sample was subjected to the ARAS, MABAC, TOPSIS, and WASPAS methods. The ranking results for the airlines according to all MCDM methods for the year 2022 are shown in Table 3.

Table 3. Ranking Results According to all MCDM Methods

AIRLINES	ARAS	MABAC	MARCOS	TOPSIS	WASPAS
Air China	16	18	14	14	14
Air New Zealand	12	10	11	11	7
All Nippon Airways	17	16	17	18	17
Cathay Pacific Air	8	6	8	8	8
China Airlines	6	4	5	5	6
China Eastern Airlines	18	17	13	13	15
China Southern Airlines	14	13	12	12	9
Ewa Airways	10	12	16	16	13
Garuda Indonesia	13	14	18	17	16
Hainan Airlines	9	9	6	6	10
Japan Airlines	2	5	3	3	4
Korean Airlines	3	3	7	7	2
Qantas Airways	7	11	10	10	11
Singapore Airlines	4	2	**1**	**1**	3
Thai Airways	15	15	15	15	18
Air Arabia	**1**	**1**	2	2	**1**
Cebu Air	11	7	9	9	12
Spring Airlines	5	8	4	4	5

Source: Author's own calculation.

According to Table 3, Air Arabia ranks highest according to 3 different MCDM methods (ARAS, MABAC, WASPAS), while Singapore Airlines ranks highest according to 2 different MCDM methods (MARCOS, TOPSIS). Additionally, although there are some differences, generally similar ranking results are observed across all 5 different methods. These results support the reliability and robustness of the proposed model. Furthermore, to show the direction and strength of the relationship between the proposed model and other MCDM methods, Spearman correlation analysis was conducted. The outcomes of the Spearman correlation analysis are presented in Table 4.

Table 4. Spearman Correlation Results for All MCDM Methods

ARAS	MABAC	MARCOS	TOPSIS	WASPAS
ARAS	1			
MABAC	0.919505	1		
MARCOS	0.849329	0.872033	1	
TOPSIS	0.857585	0.876161	0.997936	1

Source: Author's own calculation.

Based on the correlation results in Table 4, there is a strong positive correlation among all MCDM methods. These findings support the results of the Lopcow-based Marcos method.

5. DISCUSSION

The evaluation of the financial and operational performance of airlines plays a pivotal role in the identification of deficiencies, effective risk management, the facilitation of future planning and the enhancement of passenger satisfaction. The evaluation of the sustainable performance of airlines with effective and robust methods, which take into account financial and operational criteria, enables a multitude of stakeholders associated with the airline sector to make more rational, robust and practical decisions.

Crises such as the COVID-19 pandemic and similar events are highly likely to recur. Such crises pose great challenges for the air transport sector. Authorities can learn lessons from the events experienced during the pandemic period and take some measures to help the air transport sector overcome these challenges. For example, when such a crisis occurs, authorities may reduce airport usage and landing fees to reduce airlines' operating costs. Financial rescue packages can be offered to airlines in order to provide support, maintain operational activities, ensure cash flow and prevent insolvencies. In addition, taking into account the changing nature of the pandemic, it can contribute to the establishment of unified health guidelines and protocols to avoid different and inconsistent practices applied in various countries. In addition, competent authorities can act in harmony with other competent authorities in the measures taken internationally to reduce the effects of the pandemic and to eliminate it completely.

This study, which analyses the financial and operational performance of airlines in Asia, has several practical implications. Firstly, it provides a new framework for assessing the multidimensional performance of airlines. Secondly, the proposed model has a procedure that can be easily applied by decision makers with a basic knowledge of mathematics. Thirdly, the findings from sensitivity and comparison analyses support the conclusion that the proposed model provides consistent and robust results.

The findings of this study have implications for the management of airlines. Primarily, the results, which focus on the financial and operational performance of airlines, are useful to the senior management teams and boards of directors of these airlines in improving the overall performance of the airlines and achieving sustainable competitive advantage. Secondly, the comparison of the multidimensional performance of these airlines provides important information to all stakeholders about the success of the strategies followed by the airlines.

6. CONCLUSION

This research investigates the adverse impacts of quarantine measures and travel restrictions implemented because of the COVID-19 pandemic on the operational and financial performance of airlines in the Asian aviation sector. Moreover, it contrasts the operational and financial performance of

Asian airlines both pre and post the pandemic. To achieve this, the operational and financial performance of 18 Asian airlines from 2019 to 2022 has been scrutinized utilizing the Lopcow-based Marcos method.

In the analysis stage, operational and financial data of airlines were first weighted using the Lopcow method. Based on the results of the Lopcow method, it was determined that Dept Ratio was the variable with the highest weight on the performance of these airlines in 2019 and 2022, while ROA had the highest weight during the period of 2020-2021. From this perspective, it can be said that foreign resource utilization had a greater impact on the performance of these airlines both before and after the pandemic. Furthermore, it is evident that financial indicators play a pivotal role in the operations of the airlines under consideration. Given the crucial role of financial performance in enabling airlines to maintain their operations and viability, this outcome is to be expected. This result is similar to the results of Avcı and Çınaroğlu (2018), Kiracı and Bakır (2020) and Tanrıverdi et al. (2023), but not similar to the results of Bakır et al. (2020) and Kiracı and Asker (2021). This situation is thought to be due to the airline sample selected or the different period examined. In the second stage of the analysis, the performance ranking of airlines was conducted using the Marcos method. According to the ranking results of the Marcos method, Spring Airlines (2019), Qantas Airways (2020), Air Arabia (2021), and Singapore Airlines (2022) were found to have the best performance. It was also observed that some LCC airlines (Spring Airlines, Cebu Air) performed better than Traditional airlines in the pre-pandemic period (2019) and some (Air Arabia, Spring Airlines) in the post-pandemic period (2021-2022). This result is similar to the results of Kaffash and Khezrimotlagh (2023) and Taliah and Zervopoulos (2024), while is not similar to the results of Jaroenjitrkam et al. (2023), Asker (2024) and Wu et al. (2024). It is thought that this situation is due to the difference in the period analysed and the performance criteria selected.

The results of the proposed Lopcow-based Marcos method provide a detailed insight into the performance of airlines operating in the Asian airline market during the period of 2019-2022. Additionally, they indicate differences in the relative performance rankings of these airlines before, during, and after the COVID-19 pandemic. For example, it was observed that the performance rankings of Air New Zealand, Cathay Pacific Air, Cebu Air, Ewa Airways, Korean Airlines, and Singapore Airlines in 2020 lagged significantly behind those of 2019. This could be explained by a significant decrease in operational revenues and disruption in liquidity structure for these airlines. However, Air Arabia, China Airlines, Air China, China Southern Airlines, China Eastern Airlines, and Qantas Airways showed improvements in their performance rankings in 2020 compared to the previous year. Among the possible reasons for this could be the strong liquidity structure of these airlines.

Based on the analysis results, it was found that the performance rankings of All Nippon Airways, Air Arabia, Garuda Indonesia, Cathay Pacific Air, Japan Airlines, Hainan Airlines, and Korean Airlines were higher in 2021 compared to 2020. Among the possible reasons for this could be the subsidies provided by governments and the lifting of travel restrictions.

According to the ranking results of the Marcos method, it is observed that the performance of Cebu Air, China Airlines, Ewa Airways, Japan Airlines, and Korean Airlines in 2022 is better compared to the previous year. This indicates that these airlines have recovered more quickly in terms of financial and operational performance than other airlines in the post-pandemic period.

It is believed that this study, utilizing the Lopcow and Marcos methods, will add to the growing body of literature regarding the impact of the COVID-19 pandemic on the aviation industry. In addition, it is thought that the findings obtained will contribute to the performance management of these airlines and will provide airline managers with the opportunity to make managerial inferences in improving the performance of these airlines in crisis periods similar to the COVID-19 pandemic. It also provides stakeholders in the aviation industry with information on the operational and financial performance of airlines in Asia. However, the study has some limitations. These limitations include focusing on a specific market, examining performance only from operational and financial perspectives, the relative nature of the MCDM methods used to measure performance, including only airlines engaged in passenger transportation in the research, and the potential variation in performance rankings based on the variables used. It is recommended that future studies expand the sample size, examine a range of performance dimensions, and employ a more comprehensive performance evaluation approach that incorporates diverse variables into the analytical process. Furthermore, airlines can be evaluated using a variety of multidimensional performance measurement methods.

Ethics Committee approval was not required for this study.

The authors declare that the study was conducted in accordance with research and publication ethics.

The authors confirm that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The authors affirm that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article. Additionally, there are no conflicts of interest among the authors.

The authors affirm that they contributed equally to all aspects of the research.

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