

Editorial

Special issue: Multiple Criteria Decision Making in Air Transport Management

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Editorial: Special issue: Multiple Criteria Decision Making in Air Transport Management



Decision making is a key element of management. Managers, who are also called decision makers (DMs) in this role, should identify, analyse, and decide on alternatives, which are evaluated in terms of multiple criteria. During the past decades several Multiple Criteria Decision Making (MCDM) methods have been developed to support managers in transforming multi-dimensional data into the meaningful conclusions. Air transport and logistics is an area in which MCDM approaches become more and more prevailing.

The special issue was open to the applications of the MCDM methods, including both multi-attribute decision-making and multi-objective optimization approaches, in all areas of air transport and logistics management. The call solicited 41 submissions, sixteen of which were accepted for publication following the rigorous review process of the *Journal of Air Transport Management*.

The papers contained in the special issue cover a variety of interesting and complex multiple criteria problems in the diverse areas of air transport and logistics. These areas range from the evaluation of airport performance and airline service quality, the analysis of airport risk and traffic controllers stress factors, through the fleet management and assignment problems, selection of aircraft types and aviation fuels, to operational maintenance as well as optimization of aircraft routing and hub allocation. The decision analysis approaches used to tackle these problems include Analytic Hierarchy and Network Processes (AHP and ANP), DEMATEL, VIKOR, Best Worst Method (BWM), Dominance-based Rough Set Approach (DRSA), UTA, Multi-Criteria Satisfaction Analysis (MUSA), TOPSIS, Weighted Sum Method (WSM), Preference Programming, PROMETHEE, Grey Relational Analysis (GRA), Data Envelopment Analysis (DEA), and evolutionary optimization algorithms. In what follows, we briefly summarize the content of individual papers.

Payam Shojaei, Seyed Amin Seyed Haeri, and Sahar Mohammadi propose a hybrid MCDM method including BWM, VIKOR, and Taguchi loss function for airport evaluation and ranking. Reviewing the literature, they first identify six major criteria for airport evaluation. Taguchi loss function is used to compute the quality loss associated with each criterion for each airport based on DMs' opinion. Structured pairwise comparison data is collected from eight knowledgeable experts. The linear BWM is then used to find the optimal weight of the evaluation criteria using the structured pairwise comparison. Finally, based on the results obtained from the Taguchi loss function and BWM, a decision matrix is formed, and airports are ranked using the VIKOR technique. The authors use the proposed approach to rank 21 major airports located in Iran.

Mustafa Jahangoshai Rezaee, and Samuel Yousefi propose a hybrid MCDM approach including a fuzzy cognitive map (FCM) method and a slack-based data envelopment analysis (DEA) for identifying and analysing airport risks. Airport risks (e.g., small or uneven aerodrome, icing, inappropriate air traffic management, or abnormal runway contact) are considered as alternatives. The impacts of each risk on the system objectives (e.g., increasing costs, increasing time delay, or increasing the risk of flight) are considered as evaluation criteria. FCM is used to identify the airport risks and system objectives (measurement factors). A learning algorithm based on the extended Delta rule is used to study the impact of each risk on the system objectives. Finally, a slack-based DEA is used to rank the risks. The proposed approach is employed for identifying and analysing airport risks at an International Airport located in Iran, the results of which show the main risks at this airport including: "lack of staff training", "inappropriate ground handling" and "inoperable navigation aid". The proposed approach can be used to identify and prioritize the risks at other international airports.

Mohamed Eshtaiwi, Ibrahim Badi, Ali Abdulshahed, and Turan Erman Erkan use AHP for measuring the airport performance. Reviewing the literature, they identify a list of five key performance areas which can be used to evaluate the performance of an airport, including passenger service, airside area, financial perspective, safety and security, and environmental. Then, the authors assign a number of key performance indicators (which are again based on a literature review) to each key performance area. Pairwise comparison data is collected from a sample of experts. AHP is used to find the weights of the KPIs. Finally, they consider three Libyan airports and ranked the airports with respect to the identified KPIs. The proposed MCDM framework (key performance areas and the KPIs) can be used to evaluate the performance of other airports in other countries.

Himanshu Gupta proposes a hybrid MCDM method including BWM and VIKOR for evaluating the service quality of airline industry. An extensive literature review is conducted to identify the criteria for evaluating the service quality of an airline. BWM is used to find the weights of the service quality criteria. VIKOR is used to rank the airlines and find the best airline with respect to these criteria. The results of BWM show that tangibility, reliability, security and safety, and ticket pricing are the most important criteria in evaluating service quality of an airline. The author considers five major Indian airlines for the study. They are ranked using the VIKOR method. Understanding the importance of different service quality criteria helps airlines to focus on the most important attributes in order to attract more passengers. Among others, tangibles and appearances of their aircrafts and waiting lounges could have a significant impact on their goal. The proposed approach, which improves the use of SERVQUAL in evaluating service quality of the airlines, can be used by other major airlines in other countries as well.

Selçuk Perçin proposes a hybrid MCDM approach including fuzzy DEMATEL, fuzzy ANP, and fuzzy VIKOR for evaluating the airline service quality. Through literature review and expert interviews, the author identified the most relevant criteria for airline service quality evaluation. At the end, he found five dimensions with sixteen criteria important for the problem. DEMATEL is used to formulate the interactions among the evaluation criteria. Fuzzy ANP is used to find the weights of the criteria, considering potential interdependencies between them. Finally, a fuzzy VIKOR method is used to evaluate and rank the service quality performance of five major airlines in Turkey. An interesting sensitivity analysis is also conducted to check the robustness of the results. The study found customer satisfaction as one of the most important service quality criteria for airlines. Other important criteria are found to be followed by employees, reliability, management, and tangibles. Readers could compare the findings of this study (Turkey) to the results obtained by Himanshu Gupta (India).

Stelios Tsafarakis, Theodosios Kokotas, and Angelos Pantouvakis use the MUSA method for the airline passenger satisfaction measurement and service quality improvement. The main criteria they consider for customer satisfaction include pricing policy, website services, flight schedules and routes, airport services, during flight services, and after landing services. Each main criterion has a number of sub-criteria. They first conduct a pilot study to test the questionnaire. Afterwards they conduct the main survey collecting data from more than 240 (mostly) Greek passengers who use Aegean Airlines. The results show that customers are very satisfied with all criteria (with the highest satisfaction on website services) except pricing policy, which might be due to the fact that Aegean is a full-service airline that charges higher than its low cost competitors. The most important criterion for passengers is after landing services. Using demographics, they also do a cluster analysis, which offers more insights about the satisfaction and also the criteria importance of different segments of passengers.

Kuen-Chang Lee, Wen-Hsien Tsai, Chih-Hao Yang, and Ya-Zhi Lin propose a hybrid MCDM methodology including DEMATEL, ANP, and goal programming to find the optimal green aviation fleet management strategy. They first identify the green aviation fleet management criteria and green aviation fleet program management strategies, which makes the problem an MCDM one. Then, DEMATEL is applied to formulate the interactions between the decision criteria, while ANP is used to find the criteria weights. These weights are then used to formulate a goal programming problem for finding the optimal green fleet program management strategy, considering the resource limitations (monetary budget, consultant hours, training hours, and labour hours). The proposed hybrid methodology is applied to the case of international Taiwanese airports. It can be used for other airports as well as for finding the optimal green fleet management in other transportation problems.

Qiuzhuo Ma, Haiqing Song, Wenbin Zhu propose a compromise approach to solve a multiple objective airline fleet assignment problem. They formulate the problem considering two objectives: (i) reducing carbon emissions while maintaining profit at a favourable level, and (ii) controlling the risk of unexpected, significant loss in profit and surge in carbon emissions. They show the advantage of compromise approach using benchmark data on two cases - Jetstar Asia and a major Chinese airline. By the use of an integrated form of simulated and open-source acquisition data, they show the effectiveness of the compromise approach in balancing profit against emission in the case of Jetstar Asia. Then, they develop a simple rounding algorithm to deal with large-scale problems. The proposed algorithm is used for the case of the Chinese airline. They compared the performance of the compromise approach to that of the linear-weighted-sum (LWS) method (in terms of accessing the utopia point in discrete objective space), and showed that the compromise approach outperforms LWS in all the studied cases. It is interesting that the compromise approach results in more profit and less emissions compared to the current airline strategy. The proposed approach can be used by other airlines, making their fleet management more efficient.

Pedro Jose Gudiel Pineda, James J.H. Liou, Chao-Che Hsu, and Yen-Ching Chuang propose a hybrid MCDM including DRSA, DEMATEL, ANP, and VIKOR for evaluating and improving airline operational and financial performance. Instead of using a common approach to identify the criteria (i.e., a literature review), they propose an integrated model that combines data mining and MCDM to extract the critical factors for the improvement of airline performance. Precisely, they use DRSA to extract the essential factors. The result is a set of decision rules. Based on these rules, the essential criteria, being more closely correlated to the airline performance, are extracted. DEMATEL with the concepts of ANP is used to construct the complex evaluation system, finding the weights of the criteria, and the value of the alternatives with respect to the criteria. Finally, VIKOR is applied for ranking the best performing companies and for identifying the gaps to the aspiration levels for each airline. This provided each airline with a benchmark reference and an indication of directions for improvement based on the gap priority within the operational criteria.

Seyed Reza Madani, Ali Shahandeh Nookabadi, and Seyed Reza Hejazi develop a bi-objective optimization model for a reliable single allocation p -hub maximal covering problem in disasters, where hubs or routes between nodes may be unavailable. The latter could impose excessive costs on systems. Each hub has a backup hub to recover lost flows passing through that hub. If a high value is allocated to a single backup hub, it may reduce service levels in that hub, thus avoiding congestion as the second objective function is thought to lead to customer satisfaction. This implies that the two incorporate objectives are: (i) maximizing expected covered flows and (ii) minimizing congestion. As the problem is proved to be an NP-complete optimization problem, they use the evolutionary algorithms, called NSGA-II and PSO, to solve the problem. Conducting a comparison study involving data from the Iranian aviation, it is shown that NSGA-II outperforms PSO.

Oumaima Khaled, Michel Minoux, Vincent Mousseau, Stéphane Michel, and Xavier Ceugniet propose a novel multiple objective integer linear programming model for the aircraft routing problem. In particular, they discuss a framework for dealing with the repair tail assignment in case a major disruption occurs. The accounted objectives involve operation costs as well as the repair criteria measuring a distance of the recovered solutions to the initial plan by referring to, e.g., the numbers of changed flights or impacted airports. A multiple criteria repair model is used to generate a set of efficient recovery options. The selection of the most preferred one is based upon the use an additive value function inferred with the UTA method incorporating the past decisions. The usefulness of the introduced framework is illustrated on a realistic test case. The importance of the proposed model derives from its generic character. Indeed, it can be applied in the context of other optimization problems in the airline industry management such as fleet assignment or crew pairing.

V.S. Viswanath Dhanisetty, W.J.C. Verhagen, and Richard Curran propose a hybrid MCDM including Boolean Decision Tree (BDT) and WSM for evaluating and selecting operational maintenance alternative. An interesting aspect of the study is considering time limitation in MCDM. That is, the focus of their study is on formulating and solving the MCDM problem in a course of a few hours or a few days. The alternatives and evaluation criteria need to be quickly indented and evaluated to come to a decision. They consider two main steps for this problem: (i) identifying the decision alternatives, and (ii) evaluating the alternatives with respect to decision criteria. The former is approached with BDT, whereas the latter is performed with WSM. The authors use the proposed approach to the case of Boeing 777 outboard flap damage. Real maintenance and operational data is used for the proposed approach to systematically identify and evaluate operational maintenance alternatives. Not only the proposed approach could identify a full set of feasible maintenance alternatives, it also performs more time efficient (it can solve the problem in a couple of minutes). An interesting sensitivity analysis is conducted to check the robustness of the results. The proposed approach can be used for other maintenance problems when time is a critical element of the decision making process.

Slavica Dožić, Tatjana Lutovac, and Milica Kalić propose a Logarithmic Fuzzy Preference Programming (FPP) method for selecting passenger aircraft type. They formulate the aircraft type selection problem as an MCDM problem considering the selection criteria and the aircraft types (as the alternatives). Conducting a literature review, they identify three main selection criteria: aircraft characteristics, costs, and added value indicators. Each main criterion has a number of sub-criteria. Pairwise comparison data is collected through interviews with experts from different airlines and technical universities. Logarithmic FPP is then used to compute the weights of the main criteria and sub-criteria. For their analysis, the authors consider the following aircraft types as the alternative set: regional jets Embraer 190 (ERJ190), CRJ 700, CRJ 900 and CRJ 1000, as well as turboprops ATR 72e500, ATR 72e600 and Bombardier Q400 NG. Conducting pairwise comparison of the aircraft types with respect to different criteria and aggregating the results, they found regional turbo-prop aircraft ATR 72e600 as the most suitable aircraft. The proposed approach can be used for other fleet management problems in air transport and logistics and beyond.

Lihong Chen, and Jingzheng Ren propose a hybrid MCDM including a fuzzy ANP and fuzzy GRA for evaluation of alternative aviation fuels. Reviewing the literature, they identify the criteria for assessing the sustainability of the alternative aviation fuels. Fuzzy ANP is used to find the weights of the criteria. Fuzzy GRA is used to determine the integrated priority of each alternative. Four alternative aviation fuels (petroleum refining, Fischer-Tropsch synthesis based on natural gas, algal-based fuel, and soybean-based fuel) are identified and evaluated with respect to the identified criteria. Based on the data collected from three groups of stakeholders the alternatives are ranked as follows: algal-based fuel, soybean-based fuel, petroleum refining, and Fischer-Tropsch synthesis based on natural gas. Such a recommendation is compared with the results determined by fuzzy TOPSIS and fuzzy SWM. The results of the comparison confirm the robustness of the proposed approach.

Abdullah S. Karaman, and Engin Akman use AHP for evaluating Corporate Social Responsibility (CSR) programmes of airlines. Through a literature review, they first identify the criteria and sub-criteria of the CSR programs and corresponding initiatives. An expert panel is then used to discuss and refine the criteria list. Pairwise comparison data is collected from a sample of experts working in four different major Turkish airline companies. The data is used for AHP to find the weights of the CSR criteria and sub-criteria. Fuzzy linguistic variables (very poor to very good) are used to evaluate the identified CSR program alternatives. Quantifying the linguistic variables, a final score for each CSR can be obtained by summing the multiplication of the criteria weights and the alternative scores per CSR program. The final scores are used to rank the three identified CSR program alternatives. The proposed approach can be used to evaluate CSR program alternatives for airlines in other countries.

Miriam Bongo, Kissy Mae Alimpangog, Jennifer Loar, Jason Montefalcon, and Lanndon Ocampo present a hybrid approach for dealing with an air traffic controllers' workload stress problem. They consider several factors that contribute to the controllers' stress by affecting, e.g., their operational performance and procedures or working environment and schedule. The DEMATEL-ANP method is used to distinguish between causal and effect criteria, and to determine the importance of stressors. In this regard, the most important factors involve extraneous traffic, high air traffic volume, and amount of sleep. The information on the significance of different criteria is subsequently integrated within the PROMETHEE method to rank the alternative solutions for addressing the workload stress. The results indicate that compartmentalization is preferred to cognitive behavioural therapy and recovery context indicator. The practical usefulness of the proposed method is demonstrated on a case study in the major gateway of commercial air travel in the Philippines. The importance of the research derives from the fact that air traffic controllers play a fundamental role in maintaining a safe, orderly, and expeditious flow of air traffic.

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