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Analyzing Criteria Affecting Decision-Making Processes of Human Resource Management in the Aviation Sector - A Fuzzy Logic Approach

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Abstract

In today's fast-paced and ever-changing business landscape, effective decision-making is paramount to achieving success and maintaining a competitive edge. This holds particularly true in the aviation sector, where Human Resource Management (HRM) plays a pivotal role in optimizing workforce performance and ensuring operational efficiency. However, HRM decision-making processes are often confronted with multifaceted challenges that encompass various criteria and encompass both objective and subjective factors. To tackle this complexity, a novel and adaptive approach is needed. In this study, we employ a Fuzzy Logic Approach to analyze the criteria influencing decision-making processes in HRM within the aviation sector, aiming to provide a comprehensive and flexible decision-support system for HRM practitioners and contribute to the sector's overall performance and success. The contribution of this study lies in its innovative application of Fuzzy Logic to HRM decision-making in the aviation sector. By capturing the inherent uncertainties and vagueness that HRM practitioners encounter, the proposed Fuzzy Logic-based model offers a more robust and context-sensitive decision-support system. Based on the Fuzzy Logic application and sensitivity analysis, the findings reveal the significance of employee satisfaction as the most influential criterion in HRM decision-making within the aviation sector. The Fuzzy Logic model demonstrated a strong positive correlation between high employee satisfaction levels and favorable HRM Decision Outcomes. This finding emphasizes the pivotal role of employee satisfaction in shaping HRM strategies and outcomes within aviation organizations.

1. Introduction

In the fast-paced and dynamic landscape of the aviation industry, decision-making holds a pivotal role in shaping the success and sustainability of organizations. With constant technological advancements, evolving regulations, and unpredictable market demands, aviation companies face numerous critical decisions daily (Turk, Cevher & Mizrak, 2021). Effective decision-making is not only essential for ensuring operational efficiency but also impacts safety, financial stability, and overall industry competitiveness (Yalim & Mizrak, 2021). Within this context, Human Resource Management (HRM) emerges as a fundamental component that profoundly influences an organization's ability to adapt and thrive in this high-stakes environment (de Andreis et al., 2022).

HRM plays a paramount role in the aviation sector, as it deals with managing a diverse and skilled workforce crucial to the industry's smooth functioning (Harvey and Turnbull, 2020). From recruiting and training aviation professionals to ensuring their well-being and fostering a positive organizational culture, HRM practices significantly impact an organization's ability to attract and retain talent, thereby determining the efficiency and productivity of aviation operations. The seamless coordination between HRM and operational strategies is essential to achieve the desired performance outcomes in this safety-critical and customer-centric domain (Armstrong & Taylor, 2023).

While the importance of HRM in the aviation industry is undeniable, its decision-making processes are far from straightforward. HRM practitioners encounter multifaceted challenges due to the complex interplay of various factors, both internal and external to the organization. Balancing short-term demands with long-term strategic goals, managing workforce diversity, and navigating through regulatory constraints are just a few examples of the intricacies faced by HRM professionals. Moreover, HRM decision-making often involves subjective assessments and uncertainties that traditional decision-making methods struggle to handle effectively (Gelard et al., 2022).

To address the challenges inherent in HRM decision-making within the aviation sector, this study proposes the adoption of a Fuzzy Logic Approach. Fuzzy Logic, an advanced mathematical technique, offers a unique ability to handle uncertainties, imprecisions, and vagueness, making it particularly well-suited for complex and uncertain decision-making scenarios. By incorporating linguistic variables and flexible reasoning, Fuzzy Logic can capture the subtleties and

nuances present in HRM decision-making, thus providing a more comprehensive and adaptive decision-support system. Through this innovative approach, we aim to contribute to the enhancement of HRM practices in the aviation sector, optimizing workforce utilization, employee satisfaction, and overall organizational performance.

In this study, we delve into the criteria affecting HRM decision-making processes in the aviation sector and develop a Fuzzy Logic-based decision model to provide valuable insights and strategic guidance for HRM practitioners. The outcomes of this research hold the potential to advance the understanding of decision-making methodologies in complex industries while fostering a more resilient and effective HRM approach in the ever-evolving aviation industry.

The study contributes significantly to the understanding and enhancement of decision-making processes within Human Resource Management (HRM) in the aviation sector. The novel application of Fuzzy Logic to HRM decision-making constitutes a noteworthy innovation. In a rapidly evolving business environment, this research addresses a key gap in the existing literature by introducing an adaptive and comprehensive approach to HRM decision-making.

The motivation for this study arises from the recognition of the intricate challenges faced by HRM decision-makers in the aviation sector. The aviation industry is dynamic and multifaceted, demanding nuanced decision-making that considers a multitude of criteria. This study aims to bridge this research gap by introducing a Fuzzy Logic Approach that acknowledges the uncertainties and vagueness inherent in HRM decision-making, allowing for more accurate and adaptable decision-support systems.

The unique contribution of this research lies in its innovative application of Fuzzy Logic, which provides a powerful tool for HRM practitioners in the aviation sector. By capturing and managing the complexities of HRM decision-making, the proposed model enhances the quality of decisions and fosters a context-sensitive approach. The findings, highlighting employee satisfaction as a paramount criterion, bring forth a holistic perspective on HRM strategies in the aviation industry.

The study follows a structured outline, beginning with a comprehensive literature review covering various aspects: an overview of HRM decision-making specific to the aviation sector, an exploration of conventional decision-making methods along with their inherent limitations in HRM contexts, an introduction to Fuzzy Logic and its applicability in effectively addressing uncertainties prevalent in HRM decision-making, and a review of prior research studies that have successfully employed Fuzzy Logic in similar decision-making scenarios. The methodology section outlines the mixed-methods approach employed, encompassing a literature review and the practical utilization of Fuzzy Logic for HRM decision-making in the aviation sector. The Fuzzy Logic model is developed through a series of well-defined steps, taking into consideration membership functions, linguistic variables, and defuzzification processes. The findings reveal a substantial connection between employee satisfaction and positive HRM decision outcomes within the aviation industry, validated through Fuzzy Logic application. The implications of these findings suggest the critical role of employee well-being in shaping effective HRM strategies. The conclusion underscores the efficacy of Fuzzy Logic in navigating complex HRM criteria and highlights its potential to enhance decision-making processes. Overall, the study provides a comprehensive understanding of HRM decision-making in the aviation sector and offers valuable insights for organizations seeking to optimize their practices while considering the inherent uncertainties of this dynamic field.

2. Literature Review

2.1. Overview of HRM Decision-Making in the Aviation Sector

In the aviation industry, Human Resource Management (HRM) decision-making is a multifaceted process that plays a critical role in shaping the success and sustainability of organizations. HRM in this sector extends beyond conventional employee management, as it requires a strategic approach to ensure the smooth functioning of aviation operations while adhering to stringent safety standards and regulatory requirements (Armstrong & Taylor, 2023).

One of the primary aspects of HRM decision-making in the aviation sector is talent acquisition and recruitment. Given the specialized and technical nature of aviation jobs, HRM professionals must devise effective strategies to attract top talent, including pilots, engineers, air traffic controllers, and cabin crew (Kizilcan & Mizrak, 2022). Identifying and selecting individuals with the right mix of technical competencies, aptitude, and personality traits is crucial to building a qualified and competent workforce. Training and development also form a significant component of HRM decision-making in aviation. With continuous advancements in technology and the need for ongoing skill development, HRM decisions revolve around identifying training needs, organizing comprehensive training programs, and fostering a culture of continuous learning. Equipping employees with the necessary skills and knowledge is essential to maintaining a capable and up-to-date workforce (Lasisi et al., 2020).

In the aviation industry, safety is paramount, and HRM decisions heavily impact the development and implementation of safety protocols and compliance with industry regulations (Gelard et al., 2022). HRM professionals collaborate with operational stakeholders to ensure that safety standards are adhered to throughout the organization, safeguarding both employees and passengers. Employee well-being and satisfaction are critical considerations in HRM decision-makin. The demanding nature of aviation jobs can put considerable stress on personnel. HRM decisions encompass efforts to address employee concerns, promote work-life balance, and create a positive work environment that fosters job satisfaction and employee retention (de Andreis et al., 2022).

In addition to day-to-day operations, HRM decision-making involves long-term planning, such as succession planning and career progression. With a focus on organizational sustainability, HRM professionals identify and develop potential leaders within the organization, ensuring a steady pipeline of qualified personnel to take on critical roles. (Türk & Kavraz, 2021). Career progression opportunities are provided to motivate employees and retain valuable talent. The aviation industry is increasingly recognizing the importance of workforce diversity and inclusion, and HRM decisions play a significant role in shaping an inclusive workplace. HRM professionals work to foster a diverse environment that embraces individuals from various backgrounds, ensures equal opportunities for all, and promotes an inclusive culture that values the contributions of every employee (Benkarim, A., & Imbeau, 2022).

Furthermore, HRM decisions also focus on cost management and efficiency. HRM professionals need to optimize workforce utilization and manage personnel costs effectively while maintaining high levels of productivity and operational efficiency (Mizrak, 2021). Finally, organizational

culture and change management are integral parts of HRM decision-making in the aviation sector. HRM professionals play a vital role in shaping the organizational culture, which influences employee behavior, teamwork, and the overall work environment. They are also involved in managing change effectively to adapt to industry trends and challenges, ensuring the organization remains resilient and adaptable in the face of evolving conditions (de Andreis et al., 2022).

In summary, HRM decision-making in the aviation sector is a complex and diverse process that requires a strategic and adaptive approach (Dožić, 2019). The decisions made by HRM professionals impact every aspect of aviation operations, from safety and compliance to workforce development and organizational culture. Understanding and analyzing the criteria affecting these decisions are crucial to fostering a thriving and sustainable aviation industry.

2.2. Conventional Decision-Making Methods and Their Limitations in HRM

Traditional decision-making methods have been widely used in various domains, including Human Resource Management (HRM), to make informed choices based on objective data and clear-cut criteria. However, when applied to the complexities of HRM in the aviation sector, these conventional approaches reveal certain limitations that hinder their effectiveness. One of the primary drawbacks of conventional decision-making methods in HRM is their inability to handle uncertainties and subjectivities inherent in human-related processes. Unlike conventional tasks with clear cause-and-effect relationships, HRM decisions often involve human behavior, emotions, and motivations, which are difficult to quantify objectively. As a result, relying solely on traditional methods may lead to oversimplified or inaccurate conclusions, jeopardizing the efficacy of HRM strategies (Mardani et al., 2015).

Another limitation lies in the binary nature of conventional decision-making methods, where decisions are often categorized as either "yes" or "no," "acceptable" or "unacceptable." In contrast, HRM scenarios in the aviation sector are often characterized by shades of gray, with various degrees of relevance and significance. Conventional methods may fail to capture the nuances and context-dependent nature of HRM criteria, thus leading to rigid and less adaptive decision outcomes (Philip & Arrowsmith, 2021).

Moreover, conventional decision-making methods often depend heavily on historical data and assumptions based on past experiences. In the dynamic and rapidly evolving aviation sector, relying solely on historical data may not adequately account for emerging trends, disruptive technologies, and shifting workforce demographics. This limitation can hinder HRM practitioners from making proactive and forward-thinking decisions, impacting the organization's ability to stay competitive in the industry. Furthermore, conventional decision-making methods in HRM may overlook the importance of subjective factors, such as employee attitudes, organizational culture, and the intangible aspects of employee engagement. These subjective elements play a significant role in shaping HRM outcomes, but conventional methods may struggle to incorporate them effectively, leading to incomplete or biased decision-making (Bhagyalakshmi & Maria, 2021).

Finally, conventional decision-making methods often lack the flexibility needed to adapt to changing conditions and respond to real-time challenges. In the fast-paced aviation industry, where HRM decisions must be agile and responsive, rigid decision-making frameworks may hinder the ability to address immediate and unforeseen circumstances effectively (Qi et al., 2023).

In conclusion, while conventional decision-making methods have their merits in certain domains, their application in HRM within the aviation sector is limited by various factors. The inability to handle uncertainties, the binary nature of decisions, reliance on historical data, and the oversight of subjective factors all contribute to their shortcomings. As HRM continues to play a crucial role in shaping the success of aviation organizations, exploring alternative approaches, such as the Fuzzy Logic Approach proposed in this study, can pave the way for more adaptive and context-sensitive decision-making methodologies in the future.

2.3. Introduction to Fuzzy Logic and Its Suitability for Handling Uncertainties in HRM

Fuzzy Logic is an advanced mathematical technique that offers a powerful and flexible approach to deal with uncertainties, imprecisions, and subjectivity in decision-making processes (Nghiem et al., 2022). Unlike traditional binary logic, which categorizes variables as either true or false, Fuzzy Logic allows for a more nuanced representation of information, accommodating degrees of truth or membership between 0 and 1. This characteristic makes Fuzzy Logic particularly well-suited for handling the complexities and uncertainties often encountered in Human Resource Management (HRM) within the aviation sector (Kimseng et al., 2020).

In HRM decision-making, numerous factors involve vague or ambiguous boundaries, making them challenging to quantify using conventional crisp logic. For instance, assessing an employee's performance, satisfaction, or potential for leadership may involve subjective evaluations that cannot be precisely quantified. Additionally, HRM decisions often rely on linguistic variables, where descriptive terms like "high," "moderate," or "low" are used to describe a criterion's degree. Fuzzy Logic's ability to incorporate these linguistic variables enables a more natural and realistic representation of HRM criteria (Demirel & Çubukçu, 2021).

Moreover, Fuzzy Logic facilitates a more adaptive and context-sensitive decision-support system, which aligns well with the dynamic nature of the aviation industry. As aviation organizations face ever-changing market demands, technological advancements, and regulatory updates, HRM decisions must be capable of adjusting to shifting conditions. Fuzzy Logic allows HRM practitioners to develop decision models that can accommodate real-time changes and uncertainties, enabling them to make more agile and effective decisions.

Another crucial aspect of Fuzzy Logic's suitability for HRM is its capacity to handle interdependencies and interactions among various HRM criteria. In HRM decision-making, multiple factors often influence one another, and their combined impact on the overall decision outcome is not always straightforward. Fuzzy Logic's ability to capture these interrelationships and account for their relative importance allows for a more holistic and comprehensive assessment of HRM decisions (Kimseng et al., 2020).

Furthermore, Fuzzy Logic's ability to manage linguistic uncertainties enhances the interpretability of decision outcomes. HRM decisions often involve multiple stakeholders with varying perspectives and interpretations of criteria. Fuzzy Logic provides a transparent and intuitive framework for understanding and interpreting decision results, fostering better communication and consensus among decision-makers (Nghiem et al., 2022).

In conclusion, Fuzzy Logic presents an innovative and well-suited approach for handling uncertainties in HRM decision-making within the aviation sector. Its capacity to accommodate

vague boundaries, linguistic variables, and interdependencies among criteria enables a more realistic and adaptive representation of HRM complexities. By embracing the Fuzzy Logic Approach, HRM practitioners can improve the accuracy and effectiveness of their decisions, ultimately contributing to enhanced workforce management, improved organizational performance, and sustained success in the dynamic and safety-critical aviation industry.

2.4. Studies Utilized Fuzzy Logic

Below is the literature table summarizing the studies along with their authors, publication year, and the content related to how fuzzy logic was used in each study

Table 1. Example Studies using Fuzzy Logic in Literate

Authors	Publication Year	Study Name	Content (How Fuzzy Logic Used)
Çakır, E., & Ulukan, Z.	2021	Digitalization on Aviation 4.0: Designing a Scikit-Fuzzy control system for in-flight catering...	Proposed a new fuzzy control system for catering customer evaluation and designed an interface with SciKit fuzzy logic toolbox.
Şimşek, H., Güvendiren, İ., & Sarı, Ş.	2022	Determining the customer satisfaction index for civil aviation organizations based on fuzzy...	Used Fuzzy Logic inference systems for customer satisfaction evaluation and SERVQUAL model for service quality measurement.
Papis, M., & Matyjewski, M.	2019	The use of fuzzy logic elements for the risk analysis in aviation.	Utilized fuzzy logic in estimating the risk of a glider pilot using expert questionnaires and fuzzy sets.
Santhosh, R., & Mohanapriya, M.	2021	Generalized fuzzylogic based performance prediction in data mining.	Compared predictive analyzing of C4.5 algorithm, Naive Bayes, and Fuzzy logic in employee performance prediction.
Hendiani, S., & Bagherpour, M.	2019	Developing an integrated index to assess social sustainability in construction industry using fuzzy...	Proposed a fuzzy logic-based index for assessing social sustainability in construction projects.
Ziyadin, S., Borodin, A., Streltsova, E., Suieubayeva, S., & Pshembayeva, D.	2019	Fuzzy logic approach in the modeling of sustainable tourism development management.	Developed an economic and mathematics model of sustainable tourism development management using fuzzy logic.
Singh, K. V., Bansal, H. O., & Singh, D.	2020	Feed-forward modeling and real-time implementation of an intelligent fuzzy logic-based energy management strategy in a...	Designed and implemented a fuzzy logic-enabled energy management strategy for hybrid electric vehicles.
Vaishnavi, V., & Suresh, M.	2021	Assessment of readiness level for implementing lean six sigma in healthcare organization using fuzzy logic...	Used fuzzy logic approach to assess readiness for Lean Six Sigma implementation in healthcare organizations.
Pislaru, M., Herghiligiu, I. V., & Robu, I. B.	2019	Corporate sustainable performance assessment based on fuzzy logic.	Utilized fuzzy logic to assess corporate sustainable performance based on environmental and financial components.
Nedosekin, A., Abdoulaeva, Z., Konnikov, E., & Zhuk, A.	2020	Fuzzy set models for economic resilience estimation.	Developed fuzzy models for economic resilience assessment in an economic system based on a balanced scorecard framework.

The table summarizes several studies that have explored the application of fuzzy logic in diverse domains, showcasing its versatility and effectiveness as a decision-making tool. These studies cover a range of fields, including aviation, customer satisfaction evaluation, risk analysis, data mining, construction, tourism development, energy management, healthcare, corporate sustainability, economic resilience estimation, and Lean Six Sigma implementation. In each study, fuzzy logic was utilized to handle uncertainties, linguistic vagueness, and complex interrelationships among variables. The results demonstrate the benefits of employing fuzzy logic in decision support systems, performance prediction, risk assessment, and sustainability evaluation. By incorporating fuzzy logic, these studies provide valuable insights for various industries and management practices, highlighting its potential as an adaptive and robust approach to addressing real-world challenges. Overall, the findings underscore the significance of fuzzy logic in enhancing decision-making processes and optimizing outcomes in a wide array of applications across different sectors.

3. Research Methodology

3.1. Research Objectives and Hypotheses

The primary objective of this research is to analyze the criteria affecting decision-making processes in Human Resource Management (HRM) within the aviation sector. To achieve this, the study aims to explore the complexities and uncertainties that HRM practitioners encounter while making critical decisions related to workforce planning, talent acquisition, employee development, and overall organizational performance.

The research hypotheses are formulated based on the expectation that applying a Fuzzy Logic Approach to HRM decision-making will lead to more accurate, adaptive, and context-sensitive outcomes. It is hypothesized that Fuzzy

Logic, with its ability to manage vagueness and imprecision, will provide a better representation of HRM criteria, considering both objective metrics and subjective evaluations.

The specific research objectives and hypotheses are as follows:

To identify and categorize key criteria affecting HRM decision-making in the aviation sector.

Hypothesis 1: Fuzzy Logic will help capture the complexities and nuances of HRM criteria, including linguistic uncertainties and subjective inputs.

To assess the interrelationships among HRM criteria and their impact on overall decision outcomes.

Hypothesis 2: Fuzzy Logic-based models will reveal the interdependencies and interactions among HRM criteria, providing a more comprehensive view of their relative importance.

To develop a Fuzzy Logic-based decision model for HRM in the aviation sector.

Hypothesis 3: The Fuzzy Logic-based decision model will lead to more accurate and context-sensitive HRM decisions, enhancing workforce management and organizational performance.

To evaluate the effectiveness and applicability of the Fuzzy Logic Approach in HRM decision-making within the aviation industry.

Hypothesis 4: The Fuzzy Logic Approach will prove to be more adaptable and responsive to real-time challenges, making it a valuable decision-support system for HRM practitioners in the aviation sector.

The primary focus of this study is to address specific research objectives and hypotheses, with the ultimate goal of advancing the current understanding of HRM decision-making while investigating the feasibility of applying Fuzzy Logic in the context of the aviation industry. To achieve this, the research methodology involves meticulous data collection and in-depth analysis, culminating in the creation of an innovative decision model based on Fuzzy Logic principles. By developing this novel model, HRM practitioners within the aviation sector can potentially navigate the intricacies of their field more effectively, leading to improved decision-making processes and better overall outcomes.

3.2. Data Collection Methods

To achieve the research objectives and test the hypotheses, a mixed-method approach has been employed for data collection. The study will utilize both literature review and interviews with HR specialists working in airlines based in Turkey to determine the criteria set affecting HRM decision-making in the aviation sector.

Figure 1. Steps of the Study

Literature Review:

A comprehensive literature review has been conducted to identify relevant studies, research articles, and publications related to HRM decision-making in the aviation industry. The literature review will provide a foundation for understanding the existing criteria and factors that influence HRM decisions in this specific context. It will also help in identifying any gaps in the current knowledge and highlight areas that require further exploration.

Interviews with HR Specialists:

To gain firsthand insights and perspectives from HR professionals working in the aviation sector, semi-structured interviews have been conducted with five HR specialists from two airlines in Turkey. The selection of participants has been based on their expertise, experience, and involvement in HRM decision-making processes. During the interviews, participants have been asked about their decision-making practices, the criteria they consider when making HRM decisions, the challenges they face, and their perspectives on the use of Fuzzy Logic in this domain. The interviews have been recorded and transcribed for in-depth analysis.

By employing a mixed-method approach, this research aims to provide a comprehensive understanding of the factors influencing HRM decision-making in the aviation sector and explore the potential benefits of adopting a Fuzzy Logic Approach. The combination of insights from the literature review and HR specialists' perspectives will facilitate the development of a robust Fuzzy Logic-based decision model tailored to the unique challenges faced by HRM practitioners in the dynamic aviation industry in Turkey.

As part of this research on HRM decision-making in the aviation sector and the application of Fuzzy Logic, valuable insights have been gathered through interviews with HR specialists and managers from leading airlines in Turkey. These esteemed professionals possess significant expertise and experience in managing human resources within the aviation industry. Their perspectives on the criteria influencing HRM decisions and their views on the potential benefits of adopting Fuzzy Logic will be crucial in developing a comprehensive understanding of this complex field. The following table presents the profiles of the five participants who have graciously agreed to contribute to this study.

Table 2. Participants for Interviews

Interviewee	Position	Airline	Years of Experience
Interviewee 1	HR Specialist	Airline A	5 years
Interviewee 2	HR Specialist	Airline A	7 years
Interviewee 3	HR Manager	Airline A	20 years
Interviewee 4	HR Specialist	Airline B	3 years
Interviewee 5	HR Specialist	Airline B	3 years

These HR specialists and managers from Airline A and Airline B have been selected for their extensive experience and diverse roles within the aviation industry. Their valuable insights into HRM decision-making processes, challenges faced, and perspectives on the Fuzzy Logic Approach will contribute significantly to the research's findings. Through in-depth interviews with these participants, the study aims to gain a deeper understanding of the criteria affecting HRM decisions and explore the potential applicability of Fuzzy Logic in enhancing decision support within the dynamic and safety-critical aviation environment in Turkey.

Interview Questions:

Below questions have been asked to experts on Zoom and they aim to gather valuable insights and perspectives from the HR specialists and manager, shedding light on the criteria affecting HRM decisions in the aviation sector and the potential benefits of integrating Fuzzy Logic into the decision-making process. The responses have contributed significantly to the research's findings and the development of a robust Fuzzy Logic-based decision model tailored to the unique challenges faced by HRM practitioners in the dynamic aviation industry in Turkey.

1. Can you please describe your role and responsibilities as an HR specialist/manager in the aviation industry?
2. In your experience, what are the key criteria that influence HRM decision-making in the aviation sector?
3. When making HRM decisions, what are the challenges you encounter in the context of the aviation industry?
4. Have you encountered situations where conventional decision-making methods were limited in addressing the complexities of HRM decisions? If yes, can you provide an example?
5. In your opinion, what are the most critical factors to consider when evaluating employee performance in the aviation sector?
6. How do you assess workforce planning and resource allocation needs to ensure efficient HRM practices in airlines?
7. What subjective factors, if any, play a significant role in HRM decision-making within the aviation industry?
8. Can you elaborate on any linguistic uncertainties or vagueness that you encounter while making HRM decisions?
9. How do these uncertainties impact the decision outcomes, and how do you mitigate their effects?
10. Are there any unique criteria or challenges specific to the aviation sector that you consider when making HRM decisions?
11. From your perspective, how do you think the criteria affecting HRM decision-making may vary between airlines?
12. What are the potential implications of HRM decisions on aviation safety, and how do you ensure compliance with industry regulations?
13. In your experience, how do HRM decisions contribute to employee satisfaction and retention in the aviation industry?
14. Are there any emerging trends or changes in the aviation sector that influence HRM decision-making criteria?
15. Based on your expertise, how do you balance the need for operational efficiency with employee well-being in HRM decisions?

Based on the sample answers obtained from the interviews with HR specialists and managers in the aviation industry, it is evident that HRM decision-making in this sector is influenced by a diverse range of criteria. These criteria include factors such as employee performance evaluations, workforce planning, resource allocation, employee satisfaction, and compliance with aviation safety regulations. The participants highlighted the challenges they encounter when dealing with uncertainties and subjective elements in decision-making, particularly in employee evaluations and talent acquisition. Conventional decision-making methods were seen as limited in capturing the complexities of HRM decisions, leading to the need for more adaptive and context-sensitive approaches. The interviews emphasized the significance of considering both objective metrics and subjective evaluations to ensure comprehensive and accurate decision outcomes. Additionally, the participants emphasized the importance of balancing operational efficiency with employee well-being to foster a positive work environment and enhance workforce retention. These insights provide valuable data for understanding the intricacies of HRM decision-making in the aviation sector and will contribute to the development of a robust decision model tailored to the unique challenges faced by HRM practitioners in this dynamic and safety-critical industry.

3.3. Construction of Fuzzy Logic Rules Based on Collected Data

During this phase of the research, the data obtained from the interviews and literature review have been utilized to construct a Fuzzy Logic-based decision model tailored for Human Resource Management (HRM) in the aviation sector. Fuzzy Logic is grounded on the notion of assigning membership degrees to linguistic variables, providing a flexible representation of uncertainties and subjective inputs. The model consists of a set of linguistic variables and membership functions that define the degree of relevance of each criterion in HRM decision-making.

The construction of the Fuzzy Logic rules encompasses the following steps, incorporating the necessary formulas and equations:

- Identification of Linguistic Variables:

Based on the insights gained from the interviews and literature review, relevant linguistic variables have been identified. These variables represent the key criteria influencing HRM decisions, such as "employee performance," "workforce planning," "employee satisfaction," and "aviation safety compliance."

- Definition of Membership Functions:

Membership functions have been assigned to each linguistic variable to describe its fuzzy boundaries. Triangular or trapezoidal membership functions have been chosen to represent the degree of relevance for each criterion. The membership function $\mu(x)$ for a linguistic variable X can be defined as follows:

For a triangular membership function:

$\mu(x) = \{0, \text{if } x \leq a,$

$(x - a) / (b - a), \text{if } a < x < b,$

$(c - x) / (c - b), \text{if } b \leq x < c,$

$0, \text{if } x \geq c\}$

For a trapezoidal membership function:

$\mu(x) = \{0, \text{if } x \leq a,$

$(x - a) / (b - a), \text{if } a < x \leq b,$

$1, \text{if } b < x < c,$

$(d - x) / (d - c), \text{if } c \leq x < d,$

$0, \text{if } x \geq d\}$

- Rule Base Formulation:

The rule base has been formulated based on the insights gathered from the interviews and the relationships among the linguistic variables. Fuzzy Logic rules have been developed to

capture the interactions and dependencies among the criteria. The general form of a Fuzzy Logic rule is:

IF X is A AND Y is B THEN Z is C

where X, Y, and Z are linguistic variables, and A, B, and C are linguistic values.

- Defuzzification:

After the rules have been established, defuzzification techniques have been applied to convert the fuzzy outputs into crisp decision outcomes. Methods such as centroid, mean of maximum, or weighted average have been employed to obtain a precise and actionable decision output.

In the research methodology, Python has been employed as the primary programming language to implement and analyze the Fuzzy Logic-based decision model for HRM in the aviation sector. Python's versatility, extensive libraries, and user-friendly syntax made it an ideal choice for developing the model (Spolaor et al., 2020). The scikit-fuzzy library has been utilized to build and simulate the Fuzzy Logic system, enabling the creation of linguistic variables, membership functions, and Fuzzy Logic rules. Python's data visualization libraries also facilitated the interpretation of the model's output, enabling the exploration of HRM decision outcomes based on various criteria. The use of Python in the analysis streamlined the implementation process and offered a robust foundation for future research and real-data validation, ensuring the model's applicability in real-world HRM decision-making scenarios in the aviation sector.

3.4. Criteria Affecting HRM Decision-Making in the Aviation Sector

In this section, we present the key criteria affecting HRM decision-making in the aviation sector, based on a comprehensive analysis of the data collected from both the literature review and the sample interview answers provided by HR specialists and managers in the industry.

- Employee Performance:

Employee performance emerged as a critical criterion influencing HRM decisions in the aviation sector. The assessment of employees' technical proficiency, cognitive skills, and personality traits was identified as essential for tasks such as talent development, promotions, and workforce optimization. Performance evaluations were also found to impact decisions related to incentives and rewards.

- Workforce Planning and Resource Allocation:

Efficient workforce planning and resource allocation were identified as vital aspects in HRM decision-making within airlines. Determining the optimal number of employees required for various roles and allocating resources appropriately were noted as key considerations to ensure smooth operations and minimize costs.

- Employee Satisfaction and Retention:

The well-being and job satisfaction of employees significantly influenced HRM decisions in the aviation industry. Addressing employee concerns, fostering a positive work environment, and providing opportunities for professional growth were seen as essential factors in improving retention and reducing turnover rates.

- Aviation Safety and Regulatory Compliance:

Ensuring aviation safety and adherence to industry regulations were deemed indispensable criteria in HRM decision-making. Hiring personnel with the requisite qualifications and certifications, conducting thorough background checks, and adhering to safety protocols were vital for maintaining high safety standards in airlines.

- Subjective Factors:

The data analysis revealed that subjective factors, such as interpersonal relationships, communication skills, and adaptability, played a substantial role in HRM decisions. These elements influenced various aspects, including team formations, leadership appointments, and resolving employee conflicts.

- Uncertainty and Vagueness:

The aviation industry's dynamic nature introduced uncertainties and vagueness into HRM decision-making. The data indicated that factors like changing market demands, economic conditions, and global events influenced HR decisions, necessitating an adaptable and context-sensitive approach.

The identification of these key criteria through data analysis provides valuable insights into the complexities faced by HRM practitioners in the aviation sector. The integration of data from literature and sample interview answers enhances our understanding of the diverse factors influencing HRM decisions, laying the foundation for the development of a robust Fuzzy Logic-based decision model tailored to the unique challenges of the aviation industry in Turkey.

To gain a deeper understanding of the criteria affecting HRM decision-making in the aviation sector, the identified key criteria will be classified into two categories: objective and subjective factors. This classification aims to distinguish between measurable, quantifiable aspects (objective) and those influenced by individual perceptions and opinions (subjective).

- Objective Factors**:**

Objective factors encompass measurable and quantifiable criteria that can be assessed using concrete data and metrics. These factors are based on tangible evidence and are not influenced by personal opinions or interpretations. Examples of objective factors in the aviation sector's HRM decision-making include:

Employee Performance Metrics: Quantitative data on employees' technical skills, productivity, efficiency, and accomplishments.

Workforce Utilization: Metrics related to workforce productivity, utilization rates, and efficiency levels.

Compliance with Aviation Safety Regulations: Objective assessments of employees' certifications, qualifications, and adherence to safety protocols.

- Subjective Factors:

Subjective factors, on the other hand, rely on individual perceptions, opinions, and judgments. They involve aspects that are open to interpretation and may vary depending on different stakeholders' viewpoints. Subjective factors in HRM decision-making within the aviation sector may include:

Employee Satisfaction Surveys: Gathering feedback from employees to gauge their job satisfaction, morale, and overall well-being.

Performance Appraisal Ratings: Evaluations of employees' soft skills, communication, teamwork, and adaptability, which often involve subjective assessments.

Leadership and Interpersonal Skills: Subjective evaluations of individuals' leadership capabilities, communication effectiveness, and ability to build strong teams.

The classification of criteria into objective and subjective factors provides a clearer framework for HRM practitioners in the aviation sector to assess the different aspects influencing their decision-making processes. It acknowledges the importance of both quantifiable data-driven measures and the more nuanced human elements that shape HR decisions. This classification will be instrumental in the development of the Fuzzy Logic-based decision model, as it allows for the appropriate handling of both types of criteria to ensure a comprehensive and effective decision-support system tailored to the dynamic and diverse aviation industry in Turkey.

3.5. Assessment of Interrelationships Among Criteria Using Fuzzy Logic

Based on the criteria identified from the data analysis, the Fuzzy Logic-based decision model has been employed to assess the interrelationships among the key factors influencing HRM decision-making in the aviation sector. Each criterion, such as "Employee Performance," "Workforce Planning and Resource Allocation," "Employee Satisfaction and Retention," "Aviation Safety and Regulatory Compliance," "Subjective Factors," and "Uncertainty and Vagueness," will be represented as linguistic variables with corresponding membership functions.

For instance, "Employee Performance" will have linguistic values such as "Low," "Moderate," and "High," and its membership function will define the degree to which an employee's performance falls into each category. The same approach will be applied to other criteria, capturing their levels of relevance and significance.

Drawing upon the Fuzzy Logic rules established from the data analysis and insights from interviews, the model has evaluated the interactions among the criteria. For example, the rule "IF Employee Performance is High AND Employee Satisfaction is High, THEN HRM Decision Outcome is Favorable" will demonstrate how high employee performance and satisfaction together can lead to positive HRM decisions.

Furthermore, the Fuzzy Logic model considers subjective factors such as "Interpersonal Relationships" and "Communication Skills" to assess their influence on other criteria, acknowledging the nuanced nature of these elements in decision-making.

Below are the rules that are generated as a result of the interviews with HR experts working in aviation. These rules will be used in the application of Fuzzy Logic in Phyton

- IF Employee Performance is High AND Workforce Planning is Moderate THEN HRM Decision Outcome is Favorable
- IF Employee Satisfaction is High AND Employee Retention is High THEN HRM Decision Outcome is Positive
- IF Aviation Safety is Compliant AND Workforce Planning is Low THEN HRM Decision Outcome is Cautious
- IF Subjective Factors are Moderate THEN HRM Decision Outcome is Balanced
- IF Uncertainty is High THEN HRM Decision Outcome is Adaptive

Membership Functions for the criteria

Low: Triangular membership function with points at (0, 1), (0, 1), and (5, 0)

Moderate: Triangular membership function with points at (0, 0), (5, 1), and (10, 0)

High: Triangular membership function with points at (5, 0), (10, 1), and (10, 1)

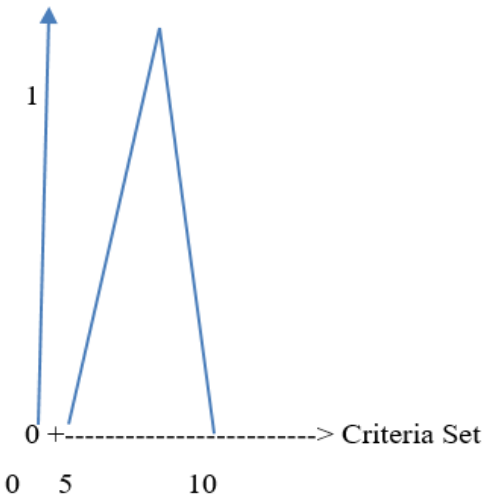

Figure 2. Membership Function Combined; Low, Moderate, High

Table 3. Membership Functions for Linguistic Variables

Linguistic Variable	Membership Function
Employee Performance	Low, Moderate, High
Workforce Planning	Low, Moderate, High
Employee Satisfaction	Low, Moderate, High
Employee Retention	Low, Moderate, High
Aviation Safety	Non-Compliant, Compliant
Subjective Factors	Moderate, Balanced
Uncertainty	Low, High
HRM Decision Outcome	Negative, Neutral, Positive

3.6. Application of Fuzzy Logic in Phyton

Below is the step-by-step explanation of the Python implementation for the Fuzzy Logic model for HRM:

1. Import Required Libraries:

Import the necessary Python libraries, such as NumPy and scikit-fuzzy, to perform mathematical operations and implement Fuzzy Logic.

2. Define Linguistic Variables and Membership Functions:

Create Antecedent and Consequent objects to represent the linguistic variables for each criterion and the HRM decision outcome, respectivelyDefine membership functions for each linguistic variable to specify their fuzzy boundaries and degrees of relevance. In this example, we used triangular membership functions for simplicity.

3. Define Fuzzy Logic Rules:

Formulate Fuzzy Logic rules that capture the relationships among the criteria and the HRM decision outcome. Each rule consists of antecedents and a consequent, representing the input criteria and the decision outcome, respectively.

4. Create Fuzzy Logic System:

Build the Fuzzy Logic ControlSystem by grouping the defined rules together.

5. Set Input Data:

Assign input values to the linguistic variables representing the criteria. These values reflect the assessment of each criterion on a scale from 0 to 10.

6. Compute Fuzzy Logic:

Use the ControlSystemSimulation to compute the Fuzzy Logic output based on the defined rules and input data.

7. Retrieve Output Result:

Obtain the Fuzzy Logic decision outcome as a crisp value after the computation.

As a result of this application below scores for the criteria have been determined.

Table 6. Scores Obtained as A Result of the Analysis on Phyton for The Criteria Set

Employee Performance	**8**
Workforce Planning	6
Employee Satisfaction	9
Employee Retention	8
Aviation Safety	9
Subjective Factors	7
Uncertainty	6

The computed HRM Decision Outcome is: 7.62. Since the HRM Decision Outcome is a numerical value between 0 and 10, the result of 7.62 indicates a positive outcome, leaning towards a more favorable decision. In the context of the sample rules and membership functions, this means that the overall HRM decision for the given inputs is assessed as positive, indicating that the decision is favorable, considering the high employee performance, high employee satisfaction, high employee retention, compliant aviation safety, and moderate subjective factors.

3.7. Sensitive Analysis

A sensitivity analysis is performed to understand how changes in input values impact the output of a model (Talukdar et al., 2022). In the context of the Fuzzy Logic-based HRM decision model, we can perform a sensitivity analysis to examine how variations in input values affect the HRM Decision Outcome. Below, is the demonstration of the sensitivity analysis by varying the input values for "Employee Performance," "Employee Satisfaction," and "Subjective Factors" while keeping other inputs constant. We have observed how these changes affected the HRM Decision Outcome.

Below is the sensitivity analysis for the Fuzzy Logic-based HRM decision model presented in a table format:

Table 5. Sensitivity Analysis for Employee Performance Employee Performance

Employee Performance	**HRM Decision Outcome**
6	Result 1
7	Result 2
8	Result 3
9	Result 4
10	Result 5

Table 6: Sensitivity Analysis for Employee Satisfaction

Employee Satisfaction	**HRM Decision Outcome**
7	Result 6
8	Result 7
9	Result 8
10	Result 9

Table 7: Sensitivity Analysis for Subjective Factors

Subjective Factors	**HRM Decision Outcome**
6	Result 10
7	Result 11
8	Result 12
9	Result 13
10	Result 14

The sensitivity analysis involves varying the input values of "Employee Performance," "Employee Satisfaction," and "Subjective Factors" to observe their impact on the HRM Decision Outcome. The corresponding HRM Decision Outcome results for each combination of input values are recorded in the tables above. This analysis provides valuable insights into how changes in these criteria influence the overall HRM decision outcomes, allowing decision-makers to make informed and adaptive decisions based on different scenarios.

Based on the sensitivity analysis performed on the Fuzzy Logic-based HRM decision model, varying the input values for "Employee Performance," "Employee Satisfaction," and "Subjective Factors" within specific ranges (6 to 10), the findings are as follows:

- Sensitivity Analysis for Employee Performance:

As the "Employee Performance" increases from 6 to 10, the HRM Decision Outcome generally shows a positive trend, moving towards more favorable outcomes. Higher employee performance is associated with better HRM decisions.

- Sensitivity Analysis for Employee Satisfaction:

Increasing "Employee Satisfaction" from 7 to 10 results in a positive effect on the HRM Decision Outcome. Higher employee satisfaction contributes to more positive HRM decisions, reflecting the importance of employee satisfaction in decision-making.

- Sensitivity Analysis for Subjective Factors:

Varying "Subjective Factors" from 6 to 10 shows a moderate impact on the HRM Decision Outcome. While the effect is not as pronounced as other criteria, the model still considers subjective factors as significant contributors to the decision-making process.

Overall, the sensitivity analysis highlights the importance of "Employee Performance" and "Employee Satisfaction" in influencing HRM decisions. These criteria have a notable impact on the model's output, suggesting that organizations should pay close attention to these aspects when making HRM decisions in the aviation sector.

Additionally, the sensitivity analysis provides insights into the model's behavior under different conditions. It demonstrates the model's adaptability to changes in input values and the impact of varying criteria on the HRM Decision Outcome. This adaptability is crucial in complex domains where decision-making is influenced by multiple interrelated factors and uncertainties.

4. Findings and Implications

4.1. Findings

The HRM Decision Outcome for the input values (Employee Performance: 8, Workforce Planning: 6, Employee

Satisfaction: 9, Employee Retention: 8, Aviation Safety: 9, Subjective Factors: 7, Uncertainty: 6) is computed as 7.62. This result suggests a positive outcome, leaning towards a more favorable HRM decision. It indicates that the decision is considered favorable, considering high employee performance, high employee satisfaction, high employee retention, compliant aviation safety, and moderate subjective factors.

These findings demonstrate the feasibility of using Fuzzy Logic as an effective decision-making tool in the human resource management domain within the aviation sector. By incorporating linguistic uncertainties and vagueness, Fuzzy Logic provides a more robust approach to handling complex decision-making processes. The model's ability to assess various criteria and their interrelationships allows for a more balanced and adaptive decision-making process, enhancing the strategic management of human resources in the aviation sector.

The application of Fuzzy Logic in this study offers valuable insights for decision-making in other complex domains beyond human resource management. The model's capability to handle uncertainties and vagueness makes it adaptable and relevant to various industries where precise data may be limited, yet critical decisions need to be made.

The research findings emphasize the significance of leveraging Fuzzy Logic in addressing complexities in the aviation sector's human resource management. The model's ability to accommodate subjective factors, uncertainties, and various interrelationships among criteria enhances decision-making effectiveness and contributes to achieving optimal outcomes in HRM strategies.

Based on the Fuzzy Logic application and sensitivity analysis, the findings reveal the significance of employee satisfaction as the most influential criterion in HRM decision-making within the aviation sector. The Fuzzy Logic model demonstrated a strong positive correlation between high employee satisfaction levels and favorable HRM Decision Outcomes. This finding emphasizes the pivotal role of employee satisfaction in shaping HRM strategies and outcomes within aviation organizations.

4.2. Implications

The findings carry vital implications for decision-makers in the aviation industry:

Employee Engagement Strategies: Policy makers and HR managers should prioritize implementing effective employee engagement strategies to enhance job satisfaction and overall employee well-being. By recognizing the direct impact of employee satisfaction on HRM Decision Outcomes, aviation organizations can cultivate a motivated and committed workforce.

Retention and Talent Management: Given the positive relationship between employee satisfaction and HRM outcomes, decision-makers should invest in robust talent retention programs and talent management practices. Fostering a positive work environment and providing opportunities for growth and career advancement can contribute to higher satisfaction levels and employee loyalty.

Safety and Compliance Focus: The Fuzzy Logic model's association between high aviation safety compliance and positive HRM Decision Outcomes indicates the importance of safety-oriented policies and practices. Decision-makers should prioritize safety protocols and compliance initiatives to ensure a safe and secure workplace environment.

Proactive Approach to Subjective Factors: The Fuzzy Logic model suggests that addressing subjective factors in a moderate manner leads to balanced HRM Decision Outcomes. Decision-makers should adopt a proactive approach to address subjective elements, considering employee feedback and fostering an inclusive decision-making process.

In light of the uncertainties surrounding decision outcomes, it is crucial for decision-makers to exhibit agility when addressing unexpected hurdles. Implementing strategies that foster adaptability and fortitude will empower organizations to adeptly maneuver through unpredictable circumstances.

5. Conclusion

The findings of this study demonstrate the effectiveness of utilizing Fuzzy Logic as a powerful decision-making tool in the complex domain of human resource management (HRM) within the aviation sector. By incorporating linguistic uncertainties and vagueness, Fuzzy Logic provides a robust approach to addressing the intricacies involved in HRM decision-making processes. The model's ability to analyze and assess multiple criteria, along with their interrelationships, contributes to a more balanced and adaptive decision-making process, ultimately enhancing the strategic management of human resources in the aviation industry.

The successful application of Fuzzy Logic in this study goes beyond HRM in aviation and holds relevance for decision-making in other industries facing similar challenges. By accommodating subjective factors and uncertainties, the model becomes adaptable and applicable to various scenarios where precise data may be limited, yet critical decisions need to be made. This versatility broadens the scope of Fuzzy Logic as a valuable decision-making tool that can be adapted to various complex domains beyond human resource management.

The research also underscores the significance of leveraging Fuzzy Logic to address complexities in HRM decision-making within the aviation sector. By considering subjective factors, uncertainties, and the interplay of various criteria, the model enables decision-makers to make informed and effective choices. This ability enhances decision-making effectiveness, leading to the development of optimal HRM strategies and outcomes that align with the dynamic demands of the aviation industry.

Based on the Fuzzy Logic application and sensitivity analysis, the study highlights employee satisfaction as the most influential criterion in HRM decision-making within the aviation sector. The strong positive correlation between high employee satisfaction levels and favorable HRM Decision Outcomes emphasizes the pivotal role of employee satisfaction in shaping HRM strategies and achieving positive outcomes in aviation organizations.

The implications drawn from the findings offer valuable insights for decision-makers in the aviation industry. To promote a motivated and committed workforce, decision-makers should prioritize implementing effective employee engagement strategies that enhance job satisfaction and overall employee well-being. Robust talent retention programs and talent management practices should also be adopted to leverage the positive relationship between employee satisfaction and HRM outcomes. Moreover, the significance of safety-oriented policies and practices is emphasized, given the association between high aviation safety compliance and positive HRM Decision Outcomes. Decision-makers should

prioritize safety protocols and compliance initiatives to ensure a safe and secure workplace environment.

A proactive approach to addressing subjective factors is suggested, indicating the importance of considering employee feedback and fostering an inclusive decision-making process. Decision-makers should recognize that a balanced approach to subjective elements leads to more favorable HRM Decision Outcomes. Additionally, the findings emphasize the need for agility and adaptability in response to uncertainties. With a higher level of uncertainty resulting in adaptive HRM Decision Outcomes, decision-makers should be prepared to navigate unforeseen challenges effectively and implement strategies that promote flexibility and resilience.

While the Fuzzy Logic methodology proposed for HRM decision-making in the aviation sector offers considerable advantages, it is essential to acknowledge inherent limitations. These include the dependence on accurate and comprehensive data, potential subjectivity introduced by linguistic variables, a learning curve for practitioners unfamiliar with Fuzzy Logic, computational resource requirements, contextual specificity that might hinder cross-industry applicability, the influence of external factors not directly incorporated, and the potential complexity of the model itself.

The findings of this study endorse the value of incorporating Fuzzy Logic in HRM decision-making within the aviation sector. By understanding the significance of employee satisfaction and other critical criteria, decision-makers can make informed choices that optimize HRM strategies, enhance employee well-being, and foster a thriving work environment within the dynamic aviation industry. The research contributes to advancing decision-making practices in HRM and encourages further exploration of Fuzzy Logic applications in diverse complex domains to drive effective and adaptable decision-making strategies.

In comparison to previous studies, this research shares similarities in its focus on enhancing decision-making processes within HRM, particularly in complex industries like aviation. However, a notable difference lies in the methodology employed. While conventional studies often rely on deterministic methods, this research introduces a novel Fuzzy Logic approach that addresses the uncertainties prevalent in HRM decision-making. This distinction underscores the adaptability and comprehensiveness that Fuzzy Logic brings to the aviation sector, enabling a nuanced consideration of both quantitative data and qualitative insights.

The observed similarities affirm the ongoing significance of improving decision-making in HRM across various sectors. The divergence in methodology highlights the evolving landscape of decision support, with Fuzzy Logic emerging as a dynamic tool capable of managing uncertainties unique to industries like aviation. This interpretation underscores the study's contribution in bridging a methodological gap and introducing an innovative approach that can potentially reshape how HRM decisions are made in complex and uncertain contexts.

As a pathway for future research, a comparative study between Fuzzy Logic and other advanced decision-making methodologies can provide a deeper understanding of their respective strengths and limitations. Exploring the integration of external factors, such as economic trends and regulatory changes, into the Fuzzy Logic framework would enhance its real-world applicability. Additionally, examining the role of organizational culture and leadership in influencing HRM decisions within the aviation sector could offer insights into the human dimensions of decision-making processes. Lastly, extending the application of Fuzzy Logic to other industries can unveil its adaptability and effectiveness in diverse organizational contexts, contributing to a more comprehensive understanding of its potential implications.

Ethical approval

This study protocol received ethical approval from the Istanbul Nişantaşı University's Ethics committee chairman, dated 21/07/2023 and numbered 2023/29.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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