HR Analytics in the Commercial Aviation Sector: A Literature Review

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Abstract: HR Analytics is the area of Human Resources Management (HRM) that uses the techniques of artificial Intelligence, social sciences, and innovation to extract, treat, and present data for decision-making. This has been a big trend in HR in recent years, with already business cases, academic studies, and industry applications, but it is still in an early stage of development. The commercial aviation industry has people at the heart of its strategy, as it is a people-to-people service. But there are no satisfied customers without satisfied employees. In addition, the topic of aviation safety is a central one, and the sector has extensive regulations on the subject. Aviation safety is also based on human-machine interaction and crew resource management (CRM). People must therefore be in the core strategy of aviation companies because, for the provision of their service, the human factor in the interaction with the machine, the team, and the customer is a critical success factor. An appropriate approach to HR Analytics is to start with the problems that the business faces and, from there, create indicators and models that can measure them. In this paper, a sectoral and problem-based HR analytics is discussed, which is one of its main contributions. HR analytics techniques are descriptive, predictive, and prescriptive. Starting from the nature of the air operation and its problems, HR analytics is an essential strategy to better know and act on the evidence of aviation service and operation. The purpose of this publication is to understand what academic studies exist on the applications of HR Analytics to the aviation industry. Through a literature review, it was concluded that the aviation sector has also few academic studies about HR analytics; however, there are already some indicators and models that can point in the right direction for the future. This is an area that can help measure performance indicators of HR policies and provide management with important data for decision-making in human resources management. The results of this research are presented, future research paths are suggested, and the limitations of this study are pointed out.

Keywords: Human resources management, HR analytics, Aviation, Literature review, Strategy, KPI

1. Introduction: HR Analytics

From a purely administrative approach to human resources management in the past, people management started to be considered a key partner in the business strategy. People have gone from being mere resources to a source of competitive advantage for the organization. In knowledge societies today, human resources have a strong strategic component in business.

Since the beginning of the millennium, there has been greater pressure on human resources departments to show an impact on organizational performance. In order to evaluate this performance, ways of evaluating performance and useful indicators emerged that could measure various indicators of people management (Ergle, Ludviga, and Kalvina, 2017). These are ways of quantifying human resource management activities (Bassi, 2011; Fitz-Enz, 2010). Examples of metrics are, for example, retention rate, turnover rate, and cost of hire, but these data being useful, they are only one part of analytics. That data is descriptive; with analytics, the aim is higher and the scope is larger. Insights are powerful inputs to business and decision-making that are not evident in simple raw data outputs. Analytics is when a predictive component is added. Through data and other information, comparisons, and correlations, we are able to generate models that predict a particular phenomenon from the data. So analytics is less about the past and more about predicting the future (Ergle, Ludviga, and Kalvina, 2017).

According to Tursunbayeva *et al.* (2018, p. 231), HR Analytics, or "People Analytics", "is an area of HRM practice, research, and innovation concerned with the use of information technologies, descriptive and predictive data analytics, and visualization tools for generating actionable insights about workforce dynamics, human capital, and individual and team performance that can be used strategically to optimize organizational effectiveness, efficiency, and outcomes, and improve employee experience". According to the Global Human Capital Trends survey (Deloitte Insights, 2018), 84% of respondents reported HR Analytics as being important or very important, making it the second highest ranked HR trend (Tursunbayeva *et al.*, 2021). More recently, NTT Data conducted a survey of 70 companies in Portugal and concluded that only 4% admitted having a high level of maturity in HR

Analytics (NTT Data, 2023). By maturity, they meant using the predictive component to create insights for decision-making in HR.

The big data revolution also has echoes in people management. In a modern approach to HRM in which people are the competitive advantage of the organization (Sullivan, 2013), similarly to marketing, which aims to put the customer first, in the HR area, the internal customer is the one the company wants to serve. To serve, the company needs to know who it serves. Kitchin (2014, p. 68) describes Big Data with the following characteristics: "huge in volume, high in velocity, diverse in variety, exhaustive in scope, fine-grained in resolution, relational in nature, and flexible in trait".

In the field of business and society, for example, in the consumer goods distribution sector, a supermarket that receives thousands of customers a day At one point, it was necessary to store and process the amount of data generated by millions of transactions, whether the amounts spent, the items purchased, the time the purchase was made, the buyer profile, etc. All data with value for the CRM (Customer Relationship Management) systems that allowed one-to-one marketing up to the latest Big Data concept, integrating artificial intelligence and predictive models. Through patterns and associations, how will managers be able to anticipate the new consumption trend? This is one of the questions that can be raised by a Big Data strategy. Through this data, managers can predict, based on the type of items purchased, which item the customer will buy next, what psychographic profile can be drawn, and so on.

With the rise of the internet came the data revolution. In the first phase, the so-called Web 1.0 was read-only, with the passive participation of the user, without being able to develop and publish content. In the second phase came the revolution of social networks with high interactivity and user participation in the production of contents (Almeida, 2017)—the Web 2.0. With Web 2.0 came the revolution of content, but the majority of all that data tends to be unstructured. With Web 3.0 and especially Web 4.0, develop tools and methodologies are developed that would turn this data, from unstructured to structured, from raw data, into valuable knowledge to generate useful insights for industry and for scientific research, be it in the natural sciences or in the social sciences.

eople management cannot ignore the need to make decisions based on evidence and use more than common sense. HRM can take advantage of the powerful tools of big data, which opens up a whole new range of sources of evidence.

Web 4.0 has several definitions and encompasses several dimensions, and each of them offers a different but complementary view of the 4.0 paradigm. Social networks and technologies such as the Internet of Things, Big Data, artificial intelligence, and M2M (machine-to-machine communication) offer a comprehensive image of the Web 4.0 application (Almeida, 2017; Brito, 2022).

The National Bank of Australia (Green, 2020a) has demonstrated that a highly motivated and involved employee influences the client and makes him more satisfied. The next question was, “What causes this?” And it turned out to be the leaders, so it was decided to select better leaders and provide them with better training and support. The National Bank of Australia, therefore, believes it will achieve these results. This value chain is created for everyone—employees and customers. This example shows that the organization can only apply measures and make decisions based on verified evidence from the data.

However, despite the buzz around the topic of HR Analytics, the implementation of this technology in companies could be more agile than expected. The reasons for this are the lack of skills in the technical areas of artificial intelligence and social sciences in HR departments, little sponsorship and interest from managers, risks related to privacy and data security, and high investment in IT infrastructure and means in HR (Marler and Boudreau, 2016).

There is some scientific and industry consensus that there are various stages of HR Analytics development in companies (Margherita, 2022; NTT Data, 2023). These stages express levels of maturity and difficulty in analyzing, processing, and extracting value from the data. As stated, analytics is more than the past; it is also important to predict the future. The various stages of development are descriptive, prescriptive, and predictive (Davenport, 2013; Roy *et al.*, 2022), in this order of difficulty, complexity, and value created. Descriptive analytics is the most elementary stage of HR analytics management and is concerned with "what happened, why it happened, and what is happening." It refers to human resources metrics such as head count, age of employees, salary, geographic origin, gender, etc. Predictive analytics aims to answer questions such as "what will happen and why will it happen in the future". In this approach, using the data and using statistical and artificial intelligence approaches, it is possible to predict certain trends and behaviors related to the workforce. This is

the most difficult and valuable approach to achieve and one that abounds less in the reality of HR departments, as it is the one that requires the most knowledge and complexity in the treatment of data. Finally, prescriptive analytics aims to answer questions such as "what should I do and why should I do it?" (Davenport, 2013; Margherita, 2022; NTT Data, 2023; Roy *et al.*, 2022).

Starting from the premise of Rasmussen (2015), which proposes an HR Analytics approach that focuses on business problems, the sectoral analysis of the implementation of HR Analytics becomes essential because each professional sector has different problems and specificities. The proponent of this paper has worked in the aviation industry for about 10 years and has a personal idea of the problems faced in the business. Often, a problem encountered in the HR analytics approach is that it is not only detached from business problems but also that this area is too closed in the human resources department (Green, 2020a; Rasmussen, 2015), when there should be contact and dialogue with the different departments of the company, from the commercial area to operations. It is equally important not to have an uncritical or random investigation of the data but an approach based on business problems. Thus, with this dialogue, the strategic alignment of human resources with the business strategy is adopted, a strategic perspective of HR analytics management is adopted, and this can be a true tool in decision-making and in the creation of value not only for people but also for the business (Gabanová, 2012).

In this study, it is proposed to look at the aviation sector and understand, firstly, what literature exists on the implementation of HR Analytics to address the problems and challenges of the sector. This publication will review the literature in two of the main scientific repositories, WOS (Web of Science) and SCOPUS. From this research, it will be possible to understand what studies and applications of this approach exist, with the objective of guiding new research paths in the HR Analytics field and in the commercial aviation sector's HR management. Secondly, a problem-based HR analytics sectoral analysis is proposed.

2. Methodology

The methodology adopted for this literature review was to search two of the most prestigious scientific repositories, WOS and SCOPUS, for literature related to HR Analytics applied to the aviation sector. Based on the suggestion of Margherita (2022), the term "HR Analytics" was used, as it is the most commonly used term in the most recent literature on this topic. In the search engines of the respective repositories, the following search terms were used: "HR Analytics + Aviation" and the search term "Big Data AND Aviation". The search term "Big Data AND Aviation" was based on the study of Sousa *et al.* (2019), applied to the health sector. The filters applied were papers found in English; the terms should appear in the title; and only scientific peer-reviewed publications from 2015 until 2023. After this search, the papers were analyzed, with the results resumed in the "Results and Discussion" section ahead in this paper. A previous theoretical contribution in this paper is the need for more research in HR analytics. As a problem-based approach is necessary, each sector faces very specific business and people management problems, so research and the study of applications for the industry must be analyzed in this way. In addition, more case studies are needed on the applications of HR analytics to the concrete reality of companies (Margherita, 2022). Below, in Figure 1, is the conceptual model developed to carry out this publication.

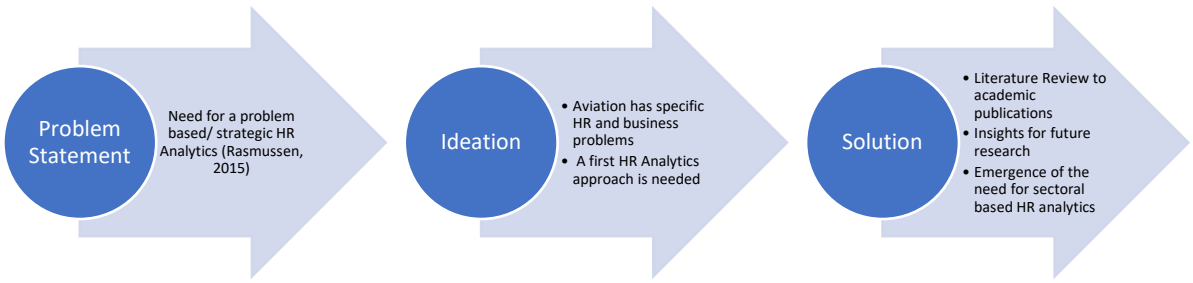

Figure 1: Conceptual model of the paper

Regarding the steps followed to carry out the literature review, the research question (RQ) will be the beginning, and it is: "What is the existing academic literature on HR Analytics applied to the commercial aviation Sector?". The methodology of the literature review will be used to answer this question. From the results obtained, conclusions will be drawn about the study. The initial and most appropriate scientific approach to knowing

something about a topic that is not known is to start the investigation with a literature review. Below is a schematic with the steps followed to perform this literature review (Figure 2).

Figure 2: Steps taken to complete the literature review

3. Results and Discussion

In this literature review, a main conclusion was drawn. There is also few academic literature on HR Analytics in the specific field of aviation. In the search done in two of the most important scientific repositories, WOS and Scopus, for the search term "HR Analytics + Aviation", there were 0 (zero) results. If the same search term is present in "all fields" of the search engine, then two results are retrieved. For the search term "Big Data AND aviation," there were 18 results in WOS, resulting in 12 valid In total, 12 + 2 were validated, or 14 papers. The search term "Big Data AND Aviation" was based on the study of Sousa *et al.* (2019). The filters applied to the search were: papers found in English; the terms should appear in the title; only scientific peer-reviewed publications from 2015 until 2023. After this search, the papers were analyzed, with the results summarized below in Table 1.

Table 1: Results of the Literature Review for "Big Data + Aviation" and "HR Analytics + Aviation"

	Title	Author	Findings	HRM-related (Y/N)	HR Metrics and Analytics
1	Airline Route profitability analysis and Optimization using BIG DATA analytics on aviation data sets under heuristic techniques	Kasturi, E., *et al.* (2016)	Algorithms that optimize flight routes	N	Operational staff cost Aviation Crew Cost
2	Development of a Data Fusion Framework to Support the Analysis of Aviation Big Data	Mangortey, E. *et al.* (2019)	Algorithms that predict weather-related ground delay programs	N	None
3	Big Data and Data Analytics in Aviation (Advances in Aeronautical Informatics)	Burmester, G., *et al.* (2018)	Theoretical	N	Pilot and crew safety
4	Big data and a smart aviation information management system	Dou, X. (2020)	Areas of study and methodology for big data in aviation	N	Crew management
5	Big Data Analytics on Aviation Social Media: The Case of China Southern Airlines on Sina Weibo	Chen, S., Huang, Y., and Huang, W. (2016)	Social Media Analytics passenger value model	N	none
6	Cross-Platform Aviation Analytics Using Big-Data Methods	Larsen, T. (2022)	Cloud-based data analytics	N	Air Safety Report Databases
7	Flight Delay Prediction Based on Aviation Big Data and Machine Learning	Gui, G. *et al.* (2019)	Prediction of flight delays based on Machine Learning	N	none
8	Knowledge-Based Retrieval Scheme From Big Data for the Aviation Industry	Singh, A., and Kaushik, A. (2015)	Methodological Scheme for Data Retrieval	N	none

	Title	Author	Findings	HRM-related (Y/N)	HR Metrics and Analytics
9	The Establishment of an LTO Emission Inventory of Civil Aviation Airports Based on Big Data	Lu, C., *et al.* (2017)	Using Big Data to calculate LTO emissions in Airports	N	none
10	Machine Learning-Aided Air Traffic Flow Analysis Based on Aviation Big Data	Gui, G. (2020)	Air Traffic Flow Prediction	N	none
11	Predictive Analytics with Aviation Big Data	Ayhan, S. *et al.* (2022)	Air Traffic Predictions and Flight Plans	N	None
12	Research on Technology Trends for Civil Aviation Safety Based on Big Data Analysis	Yuan, Y., Yu, J., and Zhang, Y.	Aviation Safety	N	None
13	Role of HR metrics in enhancing firm performance at selected UAE Airline Companies	Hazarika *et al.* (2019)	Relationship between employee strength and financial results	Y	Predictive model
14	Turning Data into valuable insights: the case study of an aviation sector company	Ergle, Ludvina, and Kalvina, 2017	Information, teamwork, and remuneration are correlated with engagement and commitment.	Y	Predictive model

After this literature review search, the main conclusion is that the majority of the papers found were about applications of artificial intelligence to the operational area of aviation, not the human area. Although in the area of people management, the literature review of the papers sought to find some HR dimensions and measures, mainly "crew management", "crew cost", "crew safety" and "air safety crew factors," all from a descriptive perspective, not a predictive or prescriptive perspective. The only two results mentioned with the predictive approach of HR analytics appeared when "all fields" of search were activated in WOS. The papers are about predictive HR analytics in aviation (Ergle, Ludvina, and Kalvina, 2017; Hazarika *et al.*, 2019). The study by Ergle, Ludvina, and Kalvina (2017) did a case study of an aviation company and demonstrated the usefulness of HR Analytics. Using interviews and SEM (structural equation modeling), it is intended to demonstrate the usefulness of HR Analytics in the aviation sector. It was concluded through the interviews that recruitment is the main responsibility of the HR department. Through the company's data, it was concluded that there is a relationship between information, teamwork, compensation, and employee engagement and commitment. Hazarika *et al.* (2019) use the example of two airlines and seek to compare them according to a simple linear regression analysis of their data. The paper makes the case that employee strength explains the positive financial results and the number of passengers carried. In conclusion, both papers use predictive models, SEM, and simple linear regression to create predictive models for decision-making. In the case of Ergle, Ludvina, and Kalvina (2017), a mixed qualitative and quantitative methodology gives robustness to the model because it starts precisely with the needs of the business and HR obtained through interview data, only to later create the predictive model. Thus, it fulfills the desideratum of performing problem-based HR analytics, as mentioned before, and not creating analyses that are not based on the real needs of aviation. These two examples can serve as inspiration in their models and methodologies for future studies on HR analytics in the field of aviation.

In none of the other twelve papers, the research problem or subject was HR analytics in aviation. Although some useful information was retrieved, namely HRM indicators and dimensions in aviation, it was considered relevant and valuable to analyze in order to create value. Two of the most important subjects in the field of aviation with strategic, tactical, and operational implications are safety and commercial areas (Brito, 2020). The first one is crucial in aviation. Without the first, there’s no commercial perspective whatsoever. The imperative of a safe operation will allow commercial success. Also, in the area of people management, the literature review of the papers sought to find dimensions and measures of HR Analytics according to the model used by Sousa *et al.* (2019) for healthcare organizations. In these publications, operational issues such as weather forecasting and air traffic flow were invariably found, and in the people area, the following areas of interest were retrieved from the text by content analysis:

- Operational Staff
- Aviation crew cost
- Pilot/Crew Safety
- Crew Management
- Air Safety Crew Factors

In summary, from the literature consulted, there are three important dimensions or measures that can be analyzed in terms of HR analytics in the aviation area that have not yet been sufficiently studied: 1) cost factors related to crew; 2) air safety; 3) crew management There are two specific areas of the aviation sector that can be studied from an HR Analytics perspective: crew resource management (CRM) (Muoz-Marron, 2018) and human factors (Brito, 2020; Kharoufah *et al.*, 2018). The first is a training program for crews focused on teamwork, communication, and the avoidance of human error. "CRM can be defined as the optimal use by crews of all available resources (information, equipment, and human resources) to achieve an efficient and safe flight operation" (Lauber, 1984, cited by Kharoufah *et al.* 2018, p. 192). The second issue related to flight safety is human factors, which are also extensively addressed in the initial training of pilots and deal with the issue of man-machine interaction. It is estimated that 70% of aviation accidents are explained by human error (Kharoufah *et al.* 2018). Hence the importance of the topic for the sector and for further research.

In addition to these indicators and areas, which may be the subject of several studies in the future in the three Analytics perspectives of descriptive, prescriptive, and predictive, other artificial intelligence approaches such as machine learning, which includes decision trees, neural networks, random forest, and SVM (support vector machine), can be used in order to present increasingly robust predictive HR analytics models.

4. Conclusions, Limitations, and Future Directions

Aviation is a people-to-people activity, so it is very important to address in management the most valuable asset of a company: its people. HR Analytics is one of the biggest trends in HRM in recent times, and the majority of the research in this field has been published in the last ten years (Margherita, 2022). HR analytics is following the most recent approach in HRM, which is to focus on the employee experience to drive more job satisfaction and create the most value for the company (Tursunbayeva *et al.* 2018). However, people and business goals cannot be divorced because they are both important pillars of sustainability. There has been recent awareness in the area of HR Analytics that data analysis and its use for decision-making have to start from the concrete problems of the business (Rasmussen, 2015) in order to have a strategic aspect that truly creates value (Gabanová, 2012).

One of the first contributions of this study is to use the example of the aviation sector to propose a new approach to HR analytics based on sectoral analysis. If HR analytics must start with the problems of the business, then the academic and industry analysis by sector is not insignificant. The aim of this study was to understand the existing academic literature on HR analytics applied to the aviation sector. A literature review was carried out, and it was concluded that there is little scientific production in this area, following the trend of the HR analytics area in general.

The limitations of this study may be the reduced number of papers analyzed (N = 23), but as it is still an incipient area, it is a number at this time.

As future avenues of investigation, more case studies are needed (Margherita, 2022) in HR in general and in the applications of HR analytics to the aviation sector and predictive models based on people management indicators and variables. By analyzing the existing literature, it was concluded that there are three areas that may be of interest in studying in the future and are another contribution of this study to research: crew resource management, human factors, and crew management, in general, as key areas of value creation that can be better managed with data analysis and the extraction of insights for decision-making. Also, more predictive models in HR analytics in the field of aviation are needed, and with the use of various artificial intelligence algorithms as machine learning, that can bring more complexity but also robustness to the studies.

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