ISSN: 2414-1895 DOI: 10.6919/ICJE.202402_10(2).0007

# Data-Driven Method and Technological Implementation of Safety Risk Analysis for Civil Aviation Employees

Hao Tu[1,2], Ping Zhang[1,2], Jinhong Wei[1,2], Tie Cao[1,2]

[1] The Second Research Institute of CAAC, Chengdu 610041, China

[2] Civil Aviation Electronic Technology Co., Ltd, Chengdu 611430, China

## Abstract

**Civil aviation safety work is of paramount importance, and due to the unique nature of their work, civil aviation employees should be subject to strict scrutiny and regulation. Currently, the supervision of civil aviation employees at airports primarily relies on background checks and monitoring of individuals with criminal records, which cannot effectively address potential yet-to-occur safety risks. There is a lack of proactivity in preventing civil aviation safety risks. This article proposes a data-driven approach for analyzing the safety risks of civil aviation employees. By collecting civil aviation business feature data, establishing profiles of civil aviation employees, and constructing a safety analysis model, it becomes possible to dynamically analyze and predict risks associated with civil aviation employees. This enables proactive intervention and timely handling of potential civil aviation safety risks.**

## Keywords

**Civil Aviation Safety; Risk Analysis of Civil Aviation Employees; User Profiling; Data-Driven.**

## 1. Introduction

Civil aviation safety is the cornerstone of the aviation industry, and civil aviation employees are directly involved in ensuring aviation safety, especially those who need to access airport control zones and aircraft [1]. Therefore, ensuring strict supervision of civil aviation employees has always been one of the key priorities in aviation safety work.

Currently, the civil aviation industry is flourishing, with a rapid increase in air passenger traffic, leading to a corresponding rise in the number of civil aviation employees. This poses significant challenges to aviation safety work. Many civil aviation employees have a history of illegal activities, including drug abuse, theft, fraud, sexual harassment, illegal border crossing, physical altercations, and various other offenses. Some of these criminal incidents even occur within the restricted security zones of airports, causing significant direct or indirect risks to aviation safety [2].

Regarding the supervision of civil aviation employees, the current measures primarily focus on whether they have a history of previous criminal activities or involvement in drug-related and terrorism-related issues. However, illegal and criminal behaviors possess characteristics such as being covert, dynamic, and ever-changing. With the current regulatory methods, it is difficult to actively and comprehensively explore and analyze relevant intelligence information[3]. It becomes challenging to effectively discover and control potential safety risks that may impact aviation safety but have not yet occurred. The civil aviation regulatory authorities urgently need to explore new approaches and methods to analyze and predict safety risks associated with civil aviation employees, promptly take necessary measures, and prevent issues from escalating [4].

ISSN: 2414-1895 DOI: 10.6919/ICJE.202402_10(2).0007

With the rapid advancement of technology and the exponential development of information technology, it has brought about significant changes in public safety and civil aviation safety, while promoting the transformation of social production modes and reshaping people's lifestyles. Through a person's digital footprint on the Internet, it is possible to construct their "digital persona [5]," which greatly assists in analyzing their potential criminal risks. Therefore, in the field of public safety, many scholars have conducted research on new mechanisms and methods based on big data and user profiling technologies. For example, Lu Rui proposed the construction of a standardized Internet public security intelligence workflow to facilitate the effective role of intelligence work[6]. Wang Jiaqi proposed the optimization research of the civil aviation crime intelligence analysis process based on a personnel classification model[7]. Wang Zhongmin suggested the use of big data information from e-commerce platforms, telecom operators, and geographic trajectories to identify groups that may pose potential harm to social order and public safety[8]. Shang Pu proposed a crime prediction framework based on user profiling technology[9]. However, there is still a lack of research on the analysis of safety risks associated with civil aviation employees. Therefore, this paper proposes a data-driven proactive analysis method, utilizing big data technology and user profiling techniques to establish a profile for civil aviation employees. This, combined with machine learning algorithms, aims to establish a safety risk model for civil aviation employees to fill the gap in this field.

## 2. Technical Principles

### 2.1 User Profiling Technology

User profiling is a method of labeling user information. It involves analyzing, mining, and modeling user data to characterize their behavioral, social, and natural features. Ultimately, it creates a descriptive model that can be used to describe and predict user interests, needs, and behaviors. After initially being used to help businesses or organizations better understand and serve users, user profiling has been widely applied in various fields [10].

The establishment of user profiles requires a large amount of user data, such as basic information (such as age, gender, education level), behavioral data (such as browsing history, search records, purchase records), social media data, and geographical location data. The more data available, the higher the accuracy of the user profile characterization. By analyzing, mining, and modeling this data, information about user interests, preferences, and consumption habits can be obtained. This enables more precise personalized recommendations, targeted advertising, and services. User profiling has extensive applications in areas such as marketing, e-commerce, and social networks. For example, in the e-commerce field, e-commerce platforms leverage user profiles to gain better insights into users' purchasing preferences and consumption habits, providing personalized product recommendations and marketing strategies. In the realm of social networks, social media platforms can also utilize user profiling to gain better understanding of users' social relationships and interests, enabling more accurate social services and targeted advertising.

### 2.2 Civil Aviation Employees Safety Analysis Model

The Civil Aviation Employees Safety Analysis Model involves the application of user profiling technology in the field of civil aviation safety. It analyzes, mines, and models aspects such as the social relationships, behavioral habits, and psychological conditions of civil aviation employees to establish profiles of these individuals. This enables the description and rating of safety risks associated with civil aviation employees, ultimately leading to the development of a comprehensive model for analyzing and evaluating the safety risks of civil aviation employees. It can assist regulatory authorities in gaining a better understanding of the safety conditions and risks associated with civil aviation employees, particularly in terms of criminal tendencies and risks. This, in turn, helps regulatory authorities formulate more effective preventive measures to mitigate potential incidents.

Similarly, the establishment of the Civil Aviation Employees Safety Analysis Model requires a significant amount of data related to civil aviation employees. Unlike fields such as marketing, e-

ISSN: 2414-1895 DOI: 10.6919/ICJE.202402_10(2).0007

commerce, and social networks, this data primarily consists of information relevant to civil aviation safety, such as social relationships, criminal records, security training records, and work violations.

By creating profiles of civil aviation employees' safety, a better understanding of their safety characteristics and risks can be obtained, allowing for the development of more targeted safety management and preventive measures. In terms of civil aviation safety training, creating profiles of civil aviation employees' safety can provide insights into their knowledge and skill gaps, enabling more precise safety training and improvement. In the domain of civil aviation safety assessment, establishing profiles of civil aviation employees' safety can facilitate a better evaluation of safety risks and contributions, thereby enabling more scientific safety assessment and management practices.

## 3. Civil Aviation Employees Safety Analysis Model Structure

### 3.1 Basic Framework

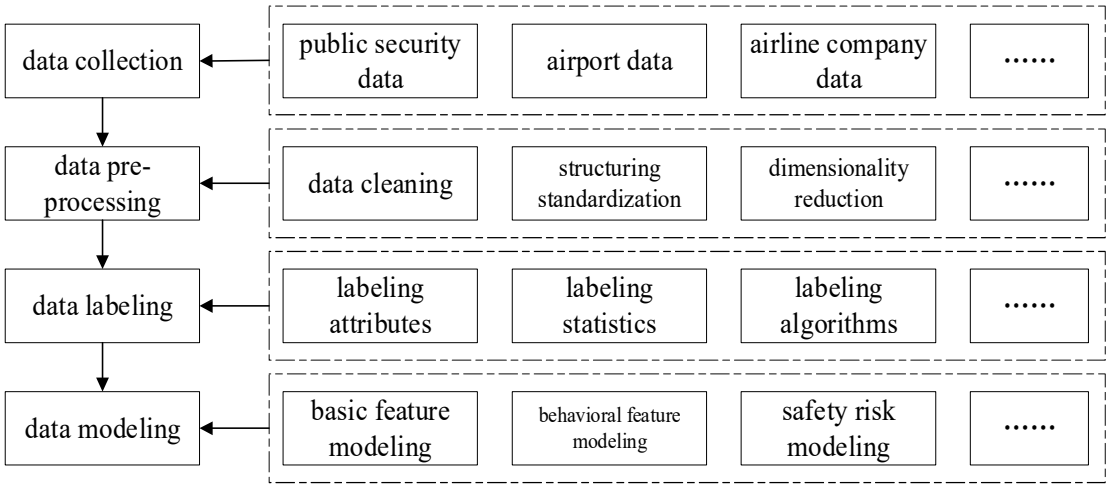


**Fig. 1** Modeling process of civil aviation employees' safety analysis model

As described in section 2.2,This model is data-driven, and it's establishment process is closely linked to the data. The basic workflow consists of four main parts: data collection, data pre-processing, data labeling, and data modeling. By collecting fragmented, heterogeneous data from multiple sources and processing it, a feature labeling system for civil aviation employees is constructed. Ultimately, the Civil Aviation Employees Safety Analysis Model is established, enabling the analysis of safety risks associated with civil aviation employees.

### 3.2 Data Collection

**Table 1.** Basic data of the civil aviation employees' safety analysis model

| Data source | Data content |
|---|---|
| Civil aviation data | Security training records, work misconduct records, security inspection records, flight travel records and so on. |
| Additional data | Social relationships,undesirable behavior, credit record and so on. |

The data required for the civil aviation employees' safety analysis model exhibits typical characteristics specific to civil aviation. The data sources can be divided into two categories: civil aviation data and other data. Civil aviation data originates from records generated during the employees' work and air travel, including security training records, records of work violations, security check records, flight records, and more. The other category includes data such as social relationships, misconduct, and credit records. The collection process involves collaboration among relevant departments in different locations to gather intelligence data elements related to civil aviation employees. These data elements are then uniformly transmitted to the input end of the warning center

ISSN: 2414-1895 DOI: 10.6919/ICJE.202402_10(2).0007

or data center for the model. The more comprehensive and diverse the data from multiple sources, the better the model's comprehensiveness and multidimensionality can be ensured.

### 3.3 Data Pre-processing

The collected data of civil aviation employees needs to undergo a series of preprocessing steps, including data cleaning, data structuring, and data standardization, before being analyzed to construct profiles. The accuracy of the model relies on the accuracy and scientific nature of the data. Therefore, the first step is to clean the data by removing duplicate and abnormal data from the raw data, reducing the impact of erroneous data on the model. Data structuring aims to unify the structure and standards of data from different sources, formats, and characteristics, enabling logical or physical integration and comprehensive sharing. Although the massive data of civil aviation employees has been structured and standardized, it cannot be directly used as input for data analysis. Doing so would burden the computational analysis devices significantly and may even hinder the analysis process. Therefore, dimensionality reduction is necessary to eliminate redundant content.

### 3.4 Data Labeling

Label design is a crucial step in establishing the civil aviation employees' safety analysis model. Labels are highly condensed identifiers derived from comprehensive analysis of civil aviation employees' information during the creation of user profiles. They serve as standardized abstract expressions of civil aviation employees' characteristics. Data labeling can be understood as assigning labels to preprocessed data. Since the labels in the labeling system possess their own standards, they can be embedded as feature vectors and easily extracted, clustered, and processed by computers.

### 3.5 Data Modeling

After data collection, pre-processing, and labeling, a civil aviation employees' profile labeling system is established from the original data. By combining an integral evaluation model with machine learning techniques, the integral evaluation model can continuously fit and approximate real-world situations. This process enables the development of an analysis and evaluation model that reflects the safety risks of civil aviation employees. Consequently, the basic and behavioral characteristics of civil aviation employees can be depicted. With such a model, regulatory authorities can comprehensively and from multiple perspectives grasp the potential safety risks of civil aviation employees.

## 4. Application of Civil Aviation Employees Safety Analysis Model

### 4.1 Analysis and Assessment of High-Risk Individuals among Civil Aviation Employees

The primary application of the Civil Aviation Employees Safety Analysis Model is to assess the risks associated with high-risk individuals among civil aviation employees, identifying those who may pose potential risks. By collecting data and analyzing the model's results, it is possible to identify civil aviation employees who exhibit potential risks, such as significant changes in their social relationships, major work incidents, financial difficulties, or abnormal behavior. The model not only confirms individuals with potential risks but also reflects the types of behaviors that high-risk individuals may engage in, which could potentially jeopardize civil aviation safety. Identifying such situations in a timely manner allows regulatory authorities to provide prompt assistance and guidance to the civil aviation employees who may need help, as well as to exercise strict supervision and intervention on those who may have malicious intentions within the civil aviation industry.

### 4.2 Civil Aviation Accident Investigation and Analysis

In the event of a civil aviation accident, the Civil Aviation Employees Safety Analysis Model is also highly useful. It aids relevant departments in quickly identifying key individuals and assists in determining the focus of the accident investigation. Once key individuals are identified, more detailed data about them, such as social network data, internet search and browsing data, consumer data, and mobile network operator data, can be utilized as needed during the investigation. This allows for a

ISSN: 2414-1895 DOI: 10.6919/ICJE.202402_10(2).0007

more profound and multidimensional characterization of the key individuals, helping to determine the causes and responsibilities of the accident. Subsequently, improvement measures can be formulated to enhance aviation safety levels[11].

### 4.3 Enhancement of Civil Aviation Employees' Competence

By applying the Civil Aviation Employees Safety Analysis Model, it is possible to assess the professional qualities and capabilities of airport employees. For instance, by integrating training data and records of violations among civil aviation employees, the model can identify individuals with poor professional qualities and capabilities. In such cases, timely training is necessary to ensure that any aviation safety risks stemming from deficiencies in the competence of civil aviation employees are addressed.

## 5. Conclusion

In the field of civil aviation safety, it is crucial to analyze, assess, and regulate civil aviation employees who pose potential risks to aviation safety. However, such analysis methods rely on a massive amount of data, and traditional manual analysis methods are often inefficient, especially given the large number of civil aviation employees at present. Therefore, it is necessary to leverage advanced technological means. Data-driven analysis methods for assessing the safety risks of civil aviation employees are based on data, ensuring objectivity, scientific rigor, and strong adaptability. These methods can handle diverse and massive datasets and exhibit good scalability. By utilizing efficient and collaborative data collection methods, effective data processing techniques, and scientific modeling and evaluation models, data-driven analysis methods can effectively analyze potential safety risks associated with civil aviation employees, thereby providing robust support for aviation safety.

## References

[1] General Aviation Security and Protection Regulations [J]. Gazette of the State Council of the People's Republic of China, 2022(17): 47-51. (In Chinese).

[2] Han Dongwei. Research on Smuggling Crimes by Civil Aviation Employees in China [D]. Civil Aviation University of China, 2021. DOI: 10.27627/d.cnki.gzmhy.2021.000013. (In Chinese).

[3] Zeng Yang, Luo Shuyi, Cheng Jie. Research on Background Qualification Assessment of Civil Aviation Flight Attendants [J]. Journal of Civil Aviation Flight University of China, 2021, 32(01): 22-24. (In Chinese).

[4] Research Group of the 5th Advanced Seminar on China's Civil Aviation Development Policies. Analysis of the Application of New Technologies for Civil Aviation Safety during the "14th Five-Year Plan" Period [J]. Civil Aviation Management, 2021(12): 20-25. (In Chinese).

[5] Tai Jinghua. Model and Application of Passenger Air-Rail Intermodal Travel Planning Based on User Profiles [D]. Southeast University, 2021. DOI: 10.27014/d.cnki.gdnau.2021.000691. (In Chinese).

[6] Lu Rui, Mi Jia. Research on Standardized Process of Internet Public Security Intelligence Work [J]. Journal of People's Public Security University of China (Natural Science Edition), 2012, 18(04): 29-32. (In Chinese).

[7] Wang Jiaqi, Feng Wengang. Research on Optimization of Civil Aviation Crime Intelligence Analysis Process Based on Personnel Classification Model [J]. Journal of Hunan Police Academy, 2021, 33(01): 90-99. (In Chinese).

[8] Wang Zhongmin. Building a Modern Police Service Model to Enhance Police Work Efficiency: Exploration and Practice of the Reform of the "One Platform, Five Centers" Police Mechanism in Lin'an Public Security [J]. Journal of Zhejiang Police College, 2022(01): 113-117. (In Chinese).

[9] Shang Pu, Li Yake, Guo Loul. Big Data Investigation Based on User Profile Technology: Analysis and Design of a Framework [J]. Journal of People's Public Security University of China (Social Sciences Edition), 2022, 38(03): 32-43. (In Chinese).

ISSN: 2414-1895 DOI: 10.6919/ICJE.202402_10(2).0007

[10] Zhang Leihua, Zhang Huirong. Research on Relevant Issues of Investigative Portrait Technology Integrating Network Data [J]. Journal of People's Public Security University of China (Natural Science Edition), 2022, 28(04): 81-86. (In Chinese).

[11] Xu Yanping. Research on Dynamic Tracking and Investigation Technology of Key Vehicle Trajectories Based on Feature Portraits [D]. Southeast University, 2021. DOI: 10.27014/d.cnki.gdnau.2021.002069. (In Chinese).