

Research on Early Warning Method of Air Traffic Control Unsafe Incidents

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Abstract

With the increasing number of flight flights and the increasingly crowded air traffic conditions, the air traffic management industry is facing enormous security pressure. In this paper, the method of air traffic control unsafe event warning is studied, the basic principle of air traffic control unsafe event warning system is analyzed, and the guiding idea and function of air traffic control unsafe event warning system are described. Finally, from the four aspects of people, equipment, environment and management, the early warning index system of air traffic control unsafe events is constructed, and the meanings and measurement methods of each index are put forward.

Keywords

Air Traffic Management; Unsafe Events; Warning Method; Index System.

1. INTRODUCTION

Safety is the basis to ensure the continuous and rapid growth of civil aviation. Air traffic management system is an important component of civil aviation system. Air traffic management plays an important role in ensuring civil aviation safety. With the rapid development of the aviation industry, more and more attention has been paid to the issue of aviation safety. How to prevent air accidents in the future and to minimize the rate of air accidents is an everlasting topic in the civil aviation industry. Air traffic control is an important part of civil aviation industry. Its main task is to effectively maintain and promote air traffic safety, maintain air traffic order, and ensure the unimpeded air traffic. It plays a crucial role in improving the overall competitiveness of China's civil aviation industry. The safe, reliable and efficient operation of air traffic control system provides the basic guarantee for the orderly and rapid development of civil aviation. Due to the increase in the number of aircraft and the limited airspace resources, some drawbacks in air traffic control safety gradually appear, resulting in the absolute number of air traffic control unsafe events showing an upward trend in recent years.

In the field of civil aviation abroad, the United States and European aviation industry took the lead in absorbing the early warning management ideas [1-3]. The most intuitive is the study of airborne environmental early warning. The development and application of a large number of early warning hardware systems have greatly promoted the level of aviation safety, such as the Airborne Collision Avoidance System (ACAS), Quick Access Recorder (QAR), Low Level Wind Shear Alert System, GPWS, Ground Proximity Warning System, etc.

The focus of traditional air traffic control safety management is on the analysis and handling of air traffic control unsafe events that have occurred. It belongs to passive handling of unsafe events and lacks active prevention ideas. The mode of air traffic control safety management

must change from post-management to pre-management, which is an urgent task to improve the ability of air traffic control system to prevent accidents. The study on Civil Aviation early warning management has just started and started, and has not yet carried out a comprehensive and detailed study on the causes of aviation disasters, the organizational mechanism of disaster early warning system and the methods of warning technology. The results of these studies have played an important reference and support role in enriching the theory of air traffic control safety risk management.

2. BASIC PRINCIPLES OF AIR TRAFFIC CONTROL UNSAFE EVENT WARNING SYSTEM

2.1. Guidelines for Early Warning Management of Unsafe Air Traffic Control Incidents

Establish an air traffic control unsafe event early warning system to monitor, diagnose, warn and pre-control the causes of air traffic control unsafe events, so as to ensure that air traffic control command is in a reasonable and efficient security state.

The early warning itself is a kind of information, mainly reflected in the need for certain information as the basis for the early warning, and information analysis, inference and transformation. The early warning process must also constantly update the information to achieve information collection. The final output of the early warning is the alert information and countermeasure suggestion information. For the early warning management of air traffic control unsafe events, information must be grasped, processed and transformed so that the original information can be transformed into useful information for decision-making [4].

2.2. Functions of the Air Traffic Control Unsafe Event Warning System

The early warning mechanism of the air traffic control unsafe event warning system includes warning function, corrective function and immune function. A new error prevention and correction mechanism based on alert, correction and immunity.

2.2.1 Warning Function

The warning function is a function to monitor, identify, diagnose and warn the early signs and incentives of unsafe events in air traffic control. It establishes boundaries for possible errors in the air traffic control system, identifies and warns all kinds of possible disaster symptoms and incidents to ensure the safety and effective condition of the system.

2.2.2 Corrective Function

It is a function to actively pre-control and correct the adverse development trend of unsafe or unsafe event symptoms of air traffic control, and to ensure the air traffic control system is in a safe state.

2.2.3 Immune Function

Immune function is a function that directs predictions, rapid identification and effective strategies for disasters or inducements of the same nature. It can accurately predict and quickly use normative means to avoid or effectively stop errors that have occurred in the past or the same error environment in the management process.

3. PRINCIPLES FOR THE CONSTRUCTION OF EARLY WARNING INDICATOR SYSTEM FOR AIR TRAFFIC UNSAFE EVENTS

3.1. Selection Principle of Early Warning Indicators for Unsafe Air Traffic Control Events

The early warning index system of air traffic control unsafe events should include many aspects of system security to make it a system:

1. Relevance--To use the relativity principle of system theory to continuously analyze, and then, to design the early warning index system of unsafe air traffic control events in combination;
2. Hierarchy--index system should form a hierarchical functional group, which should be mutually adapted and consistent with each other, and should have a corresponding guiding role, that is, each upper level index should have a corresponding lower level index to adapt to it;
3. Integrity--not only should we pay attention to the internal connection of the whole index system of air traffic control unsafe event warning, but also to the overall functions and objectives;
4. The design of comprehensive--air traffic control unsafe event early warning index system needs not only indicators reflecting unsafe events, but also indicators reflecting hidden dangers, so that it can be more objective and comprehensive.

3.2. Selection Process of Early Warning Indicators for Air Traffic Control Unsafe Events

3.2.1 Risk Factor Analysis

Risk factors are the source and basis of the early warning indicators for unsafe air traffic control events. The early warning indicators must be obtained by decomposition, extraction, merge and synthesis after identifying the risk factors that affect the safety of air traffic control. Therefore, first of all, according to the objectives to be achieved in the management of air traffic control security risk, every station and department should search, dig and investigate the potential risk risks affecting safety, so as to understand the targets to be monitored, the form of monitoring, etc., and initially determine the early warning indicators.

3.2.2 Theoretical Verification

According to the guidelines and principles of index design, the designed early warning index is demonstrated, which has certain scientific basis.

3.2.3 Determining the Index System

According to the index initially determined by risk factor analysis, after consulting the controllers, managers and experts extensively, delete those indices that are not easy to operate and measure, further decompose the indices that overlap and cross each other, and properly integrate the indices that reflect the same problem and different dimensions, so as to form a scientific, rational and refined index system.

3.2.4 Revision of Index System

In order to make the identified indicators more reasonable, they should also be revised. The revisions are divided into two types: the first is pre-use revision, which refers the identified indicators to the leaders, academic authorities or experts for deliberation through expert consultation method, solicits opinions, modifies, supplements and improves the evaluation index system; the second is post-use revision, which is based on the effect of the air traffic control system after use, and so on, to make the content of early warning indicators more ideal and perfect.

4. CONSTRUCTION AND MEASURING METHOD OF EARLY WARNING INDICATOR SYSTEM FOR AIR TRAFFIC UNSAFE EVENTS

The selection of early warning index system for air traffic control unsafe events is based on the principles stated in the above chapters. The early warning index system of air traffic control unsafe events consists of four modules, including early warning index of actor factor, early warning index of equipment factor, early warning index of environment factor and early warning index of management factor, totally 22 indexes.

4.1. Early Warning Indicators of Actors

Early warning indicators of actor factors include: air traffic control illegal operation rate, air traffic control command error times, business assessment failure rate, improper handling times of special service, safety awareness, health level, etc [5].

Table 1. Meaning and measurement method of early warning index of actor factor

serial number	names of index	Meaning of indicators	method of measurement
1	Illegal operation rate	Standard degree, implementation of relevant laws and regulations, etc	Operation violation rate = (number of violations / total sorties) * 100%
2	Correct command ability	Accuracy, business level, security risks.	It is measured by counting the number of command errors of controllers
3	Business Assessment	ability level	Unqualified rate of business assessment = (number of unqualified Controllers / total number) X100%
4	Number of improper special handling	Ability to deal with special cases	According to the analysis of the duty log of the control room, the number of improper handling of special cases is measured
5	security awareness	Responsibility, the discovery of dangerous conflicts	Using the scoring method
6	health level	Physical and psychological status, ability to withstand high workload	Through regular physical and psychological examination

4.2. Monitoring Index of Equipment Factors

The early warning indicators of equipment factors include: unqualified equipment maintenance quality inspection, equipment failure rate, equipment maintenance error rate, technical standard oversight rate, etc.

Table 2. Meaning and measurement method of equipment early warning factor index

serial number	names of index	Meaning of indicators	method of measurement
1	Unqualified rate of equipment maintenance and quality inspection	Measuring equipment maintenance quality	Unqualified rate of equipment maintenance and quality inspection = (the number of unqualified inspection of important equipment / the total number of maintenance and quality inspection) * 100%
2	Equipment failure rate	Normal operation and support capacity of ATC equipment	Equipment failure rate = (number of equipment failures / total number of ground equipment) * 100%
3	Technical standards oversight rate	Implementation degree of safety supervision system, familiarity with technical standards and implementation strength	Failure rate of technical standards = (1. Number of violations of technical standards / number of illegal operations) * 100%
4	Equipment maintenance error rate	Equipment maintenance personnel's work engagement, compliance with work rules, maintenance technology, etc.	Equipment maintenance error rate = equipment maintenance failure times / total equipment maintenance times

4.3. Early Warning Indicators for Environmental Factors

The early warning indicators of environmental factors include five items: control business volume, on duty environment, bad weather during flight, flight delay, daily peak volume, etc.

Table 3. Meaning and measurement method of early warning index of environmental factors

Serial number	names of index	Meaning of indicators	method of measurement
1	Controlling traffic conditions	The impact of the increase of control operations on the work pressure of controllers	Using expert scoring method
2	On duty environment	On duty environment of controllers	Using expert scoring method
3	Severity of weathe	The flight is affected by weather conditions and their deterioration	By comparing the weather forecast information with the minimum standard of flight weather, the expert scoring method is used
4	Flight delay	Due to the flight delay, and because of the delay to the controller work pressure	Using expert scoring method
5	Daily peak volume	Control pressure during peak hours	It is measured by the per capita control sorties during the daily peak period

Table 4. Meaning and measurement method of early warning index of management factors

serial number	names of index	Meaning of indicators	method of measurement
1	Unreasonable organizational structure	Personnel's recognition of scientific and reasonable organizational structure, such as age structure, education structure, qualification structure, etc	According to the results of the expert scoring method
2	Frequency and intensity of departmental conflicts	Inter departmental relations	According to the results of the expert scoring method
3	Staff's dissatisfaction with organizational goals	Personnel's recognition of the scientificity, rationality and feasibility of the objectives set by the organization	Through anonymous questionnaire survey
4	Poor implementation of management standards	Implementation degree of safety management standards within the Department	Using expert scoring method
5	Failure rate of emergency drill of standby / emergency system	Whether the standby / emergency system has operation failure and drill failure during the drill	Failure rate of emergency drill of standby / emergency system=(number of failures / number of drills) * 100%
6	Group centrifugal force	Cohesion and morale of air traffic control personnel	Using the Group Cohesion Scale and factor scoring method
7	Information communication distortion rate	The status of internal safety related information communication within the organization (including errors, omissions, errors, obsolescence, etc.) in information dissemination	The staff in the Department discuss and calculate the approximate probability

4.4. Management Factor Warning Indicators

The early warning indicators of management factors include: irrational organization structure, frequency and intensity of department conflicts, people's disagreement with organizational goals, inadequate implementation of management norms, failure rate of emergency drills of standby/emergency systems, group centrifuge force, distortion rate of information communication, etc.

5. CONCLUSION

This paper studies the early warning methods of air traffic control unsafe events, aiming to prevent and correct the emergence and development of the inducing factors of air traffic control unsafe events, further reduce the accident rate, reduce the occurrence of civil aviation disasters, and promote the healthy development of civil aviation industry.

(1) This paper discusses the basic principles of the early warning system of air traffic control unsafe incidents. Firstly, it clarifies the guiding ideology of the early warning management system of air traffic control unsafe events, including information theory, cybernetics and decision theory. Then it introduces the functions of early warning system: warning function, correction function and immune function.

(2) According to the six principles of selecting the early warning indicators of air traffic control unsafe events, through risk factor analysis, theoretical verification, determination of index system and modified index selection process, a total of 22 air traffic control unsafe event early warning indicators are constructed from four aspects of human, equipment, environment and management, The meaning and measurement method of each index are discussed.

The innovative work of this paper is to conduct a comprehensive safety assessment on the early warning indicators of air traffic control unsafe events. Future research can put forward early warning strategies combined with control work practice, so as to prevent the occurrence of air traffic control unsafe events more effectively.

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