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A Grey System Study of Air Accidents from the Perspective of Human Factors

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Abstract

This study took Grey System theory to probe the accidents / incidents of aircraft within the period of its service. The analysis classified the essence of mishap records by Content Analysis into and six major human error types that include skill-based level, rule-based level, knowledge-based level, communication-based level, judgment-based level and leadership-based level.

The objective of this study is to evaluate the nature of human error and understands potential elements that harm pilot, crew and aviation organization. The constrains of data quantity and the uncertainty of mishap level distribution lead the traditional statistic method fail to handle the variables and relationships among variables effectively. The relational analysis of Grey System has been used for this purpose to address the factors that influence the aviation safety. The essence of Grey System theory, which doesn't need huge data quantity and specific distribution pattern, successfully processed seven failures of flying mishap to reach their relational coefficients. The results reveal that skill-based level has the most detrimental effect on the aviation, while machine failure also shows a strong effect. Suggestions are also discussed on the prevention of these factors in order to improve aviation safety.

Keywords: Aviation Safety; Human Factor; Content Analysis; Crew Resource Management; Grey System
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1. Introduction

Safety is a part of, or even the core of, aviation. There would be no aviation industry if there is no flight safety [1]. Therefore, safety is continuously pursued in the aviation activities. During the early stage, "Blood Priority" was based on some traumatic events that have to occur in order true changes took place, and the further redundant fail-free designs were generated. All these efforts are pursued to reduce aircraft accident rate and casualty rate [2].

When accident causes are examined, a major issue in aviation safety always remains human error [3]. First related study was conducted by a German civil aviation engineer Meier Muller in 1940. Muller found that human factor took up

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more than seventy percent on the aircraft accidents and incidents [4]. Sixty years later, all of aircraft accident statistics conducted by the International Civil Aviation Organization (ICAO), aircraft manufacturers, civil aviation authorities of different nations, and human factor specialists still reveal that about 72% to 80% of all accidents in modern cause of human factor while mechanical factor commercial aviation are attributed to the takes up 12%-18% and environmental factor takes up 5%-10% [3,5-8].

In general, human factors studies human capabilities, system analysis and design, process control and automation, skill acquisition, information processing and display, operator workload, and task-induced stress, human-computer interaction, environmental effects on performance, and accident prevention [5]. If interpreted narrowly, human factor is often considered synonymous with crew resource management (CRM) or maintenance resource management (MRM)[6].

According to a previous report [7], in past twenty years up to 1997, there were one hundred and eighty-one aircraft crashed; there were two hundred and nineteen aircraft damaged and by average eleven aircrafts per year. These above mishaps caused one hundred and twenty-two pilots dead, five persons severely injured and twenty-seven slightly injured. In which human errors occupied about 60% in the distinguished accidents.

2. The Systematic Methodology

2.1. *Content Analysis*

Content analysis is a research tool used to determine the presence of certain words or concepts within texts or sets of texts. Researchers quantify and analyze the presence, meanings and relationships of such words and concepts, then make inferences about the messages within the texts [8]. At the early stage, content analysis was focused on the information of mess media, especially on those written form information published on newspapers or magazines [9]. With the evolution of the analysis method, the content analysis has not only applied to other social and human sciences but also become one of the major methods on data analysis [1,10,11]

Table 1: The grey relational coefficients and grades.

γ0i(k)	γ01	γ02	γ03
K=1	0.6478	0.6478	0.75992
K=2	0.73757	0.60234	0.73529
K=3	0.839	0.5508	0.75153
K=4	0.74195	0.5508	0.75153
K=5	0.56575	0.33333	0.36333
K=6	0.70633	0.79845	0.80724
K=7	0.80395	0.94495	0.77951
K=8	0.89611	0.78626	0.98552
K=9	0.96156	0.78626	0.78626
K=10	0.88034	0.88034	0.8691
Grey relational grade	0.79822	0.71649	0.78084

Table 1 shows the calculated grey relational coefficients and grades , where γ01 stands for personnel factor; γ02 stands for group factor; andγ03 stands for mechanical factor. As shown in Table 6, the value of grey relational grade of major mishaps caused by personnel factor, group factor, and mechanical factor were 0.79822, 0.71649 and 0.78084. From high to low of the value, the grey relational series was formed by personnel factor＞mechanical factor＞group factor. This result implies that personnel factor was the most detrimental cause for the number of major mishaps. Mechanical factor was followed up next by a similar value and the last was group factor.

3. Results and Discussion

Among three hundred and ninety four mishaps records, There were one hundred and twenty six major mishaps which were specified through content analysis. As shown in Table 3, 50.1% was specified as serious accident while 24.4% was specified as minor accident and 25.5% was specified as incident.

Through content analysis, the central cause factor in major mishaps was generally revealed (see Figure 1). Specifically, 67.1% of major mishaps was attributed to human error. Mechanical failure took up 27.8% and was the second in the sequence of volume fraction. Finally, environmental factors, were rarely reported that caused only 5.1% in the events. The above results are apparently consistent with the tendency reported by civil aviation [12] and other military aviation [13].

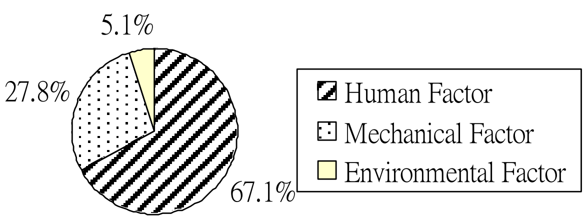

Figure 1: The volume fraction of central cause factor in major mishaps.

4. Conclusions

1. The pilots were under the maximum stress at the stage of cruise/airspace. Therefore, a high frequency of major mishap was happened at this stage (42.3%) whereas the stages of take-off and landing showed a relatively low frequency (24.3%) comparing to civil aviation.
2. After weighted with serious accident, minor accident and incident, the grey relational series of major mishap at the stage of cruise/airspace is Skill ＞Machine ＞ Knowledge ＞Leadership ＞ Rule ＞ Judgment ＞ Communication.

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