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Statistics and analysis of civil aviation incidents in Indonesia from 2007 to 2017

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Abstract: The statistical analysis of aviation safety information can provide effective support for flight risk control and safety early warning. This article collects and sorts out the civil aviation incident information in Indonesia from 2007 to 2017, analyzes its occurrence time, stage, type, aircraft type, etc., and uses statistical analysis to summarize the main reasons and the main causes of unsafe civil aviation incidents in Indonesia Then use SPSS to analyze the reliability of the causes of unsafe incidents in each year to prove the availability of the data, and then perform correlation analysis to obtain relevant data, and finally use principal component analysis to obtain the most influential factor. And learn lessons. In this way, our country's airports in special geographic locations and climatic conditions will be paid more attention to, and it will serve as a warning and preventive effect on airlines with frequent unsafe incidents of the same type.

1. Introduction

Indonesia is located in southeast Asia, across the equator, numerous islands, because the land transportation is inconvenient, so air transportation occupies an important position. Indonesia is an important potential export market for China's aviation industry. By analyzing the safety situation of its aviation industry, it can provide reference for the safety of civil aviation operation and the export development of China's aviation industry.

Indonesia's economy had been slowed to develop after the second World War, when the fifth president Megawati came to power in 2001 and implemented a series of reforms, and the economy began to improve. At that time, because of the poor economic foundation, Indonesia's airlines were mostly humble, and their aircraft were dilapidated. In the meantime, personnel is in shortage, and supervision is not in place. The planes destroyed in the accidents one after another.

Since 2008, Indonesia's aviation authorities had made a major effort to clean up civil aviation safety. After the crackdown, Indonesia's aviation safety situation had improved, western countries have lifted the ban on Indonesian airlines. There are still occasional accidents, but at least the fleet has been updated, and there are fewer fatalities due to mechanical accidents than before.

In this paper, 52 civil aviation incidents with investigation reports occurred in Indonesia from 2007 to 2017 were analyzed, with the main data from ASN[12] and the official website of the International Civil Aviation Organization (ICAO)[13]. Luo Xiaoli[6], Jiang Lan[3], Liu Yuxing[7], and Du Hongbing[1] conducted a statistical analysis of civil aviation incidents in recent years, and put forward constructive suggestions, which are of reference significance for this article. Based on the classified statistics of civil aviation incidents in Indonesia from 2007 to 2017 according to the time of occurrence, flight stages, the types of events, aircraft involved, this paper analyzes the deep causes of the incidents and makes statistics on their occurrence frequency, so as to put forward suggestions and measures for the causes. At the same time, it also provides corresponding improvement measures for the similar situation encountered in the development of China's civil aviation industry.

2. Brief description of SPSS

2.1 Pearson Correlation Coefficient Method

Pearson correlation coefficient, also called Pearson product-moment correlation coefficient, PPMCC or PCCs for short, It evolved from a similar but slightly different idea put forward by Francis Galton in the 1880s. It is a statistical method to accurately measure the close relationship between two variables. Its value is between - 1 and 1. It is widely used in signal analysis, risk prediction and so on.

The size of Pearson correlation coefficient can reflect the strength of linear correlation between two variables. When the variables $X=[x1,x2,\ldots,xn]^T$ and $Y=[y1,y2,\ldots,yn]^T$ are determined, the expression of Pearson correlation coefficient:

$$r = \frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2\sum_{i=1}^{n}(y_i-\bar{y})^2}} \quad (1)$$

In equation (1) is the Pearson correlation coefficient, $\bar{x}$ and $\bar{y}$ are the average values of each data in variables x and y respectively. The size of $|r|$ determines the correlation degree of two groups of variables. generally, when $|r| \geq 0.8$, it means that the two variables are highly correlated; When $0.5 \leq |r| < 0.8$, it indicates that the two variables are moderately correlated; When $0.3 \leq |r| < 0.5$, it indicates that the two variables are low correlation;fg When $|r| < 0.3$, there is almost no linear correlation between the two variables.

2.2 Principal Component Analysis

Principal component analysis, also known as principal component analysis, is a mathematical transformation method. In the process of extracting principal components, it reduces the dimension, classifies and merges multiple indicators, and finally produces a few independent comprehensive indicators, which makes them retain the comprehensive information of original variables from different dimensions as much as possible, It is a method with the least information loss. In the research process of the actual subject, in order to comprehensively and effectively analyze the problem, many related factors are often proposed, and each factor reflects the subject information to varying degrees. As a basic statistical research method, it has a wide range of applications. It is not only applied to population statistics, but also plays an irreplaceable role in mathematical modeling, molecular dynamics simulation and other disciplines. According to the principle that the total variance in the transformation is unchanged, the principal components are extracted successively by comparing the variance of each index. Usually, the component index with characteristic root greater than 1 is used as the principal component. Two to three principal components can be extracted from multiple indicators, and the extracted principal components will also be used in the next data analysis.

3. Event statistics and analysis

3.1 Analysis by Occurrence time and Quantity of events

3.1.1 Analysis by Year and Quantity of Events

According to the year of the accident, the number of accidents occurred in 2011 was 11, accounting for 21.15%. Followed by 8 cases in 2013, accounting for 15.38%; 7 in 2015, accounting for 13.46%; In 2009, 6 cases occurred, accounting for 11.54%; In 2008, there were 5 cases, accounting for 9.62%; 3 cases occurred in 2014, 2016 and 2017, accounting for 5.77% each; The least number of incidents occurred in 2007, 2010 and 2012, with two incidents each accounting for 3.85%. The year-number ratio of events is shown in Figure 1.

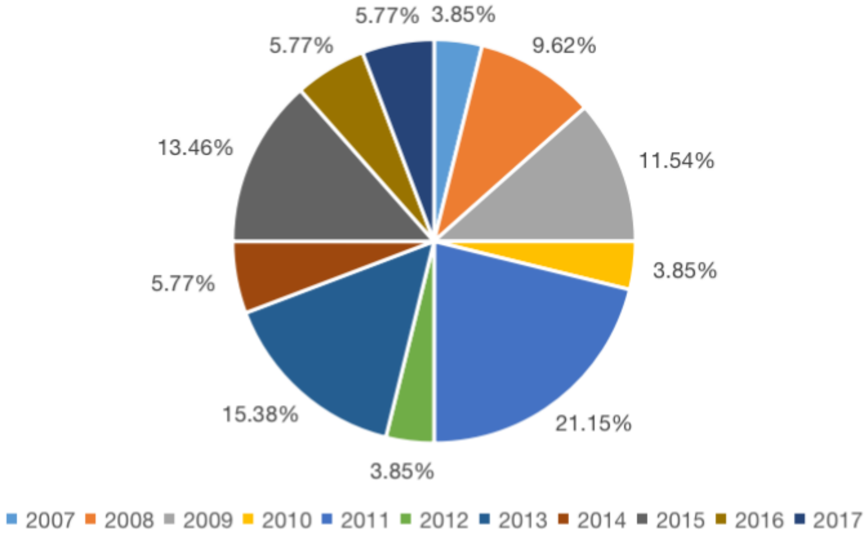

Figure 1: Pie chart of event year – ratio

As shown in Figure 2., the two-year rolling average of Indonesia's civil aviation flight from 2007 to 2017 (taking a year as a cycle, the average number of incidents in the adjacent two years is drawn as the dotted line in Figure 2) shows a wave advance, but the overall trend is downward, indicating that Indonesia's civil aviation flight safety has improved since 2011.

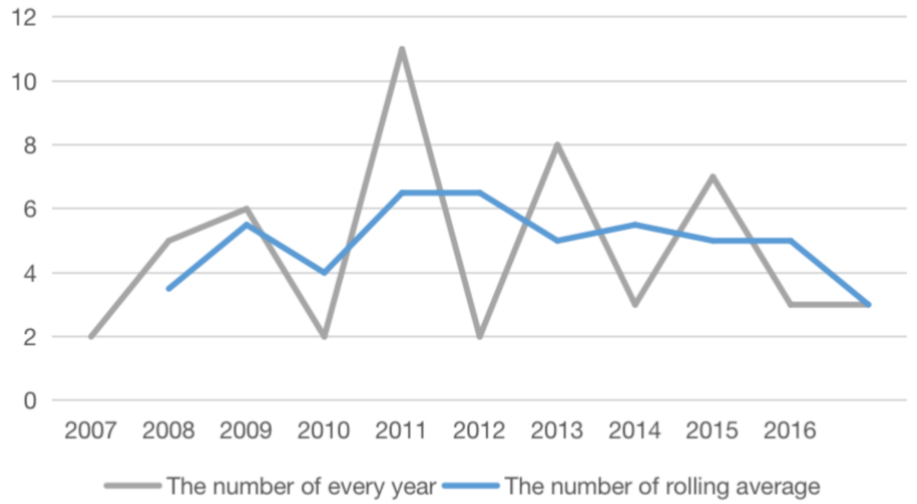

Figure 2: Line chart of rolling average in two years

3.1.2 Analysis by quarter and quantity of events

According to the quarterly statistics of Indonesia's civil aviation incidents, the fourth quarter has the largest number of incidents, with 22 incidents in total, accounting for 42.31%. The first quarter was followed by 12 cases, accounting for 23.08%. In the third quarter, 10 cases occurred, accounting for 19.23%; Eight cases occurred in the second quarter, accounting for 15.38%. Quarter of event occurrence - quantity shown in Figure 3.

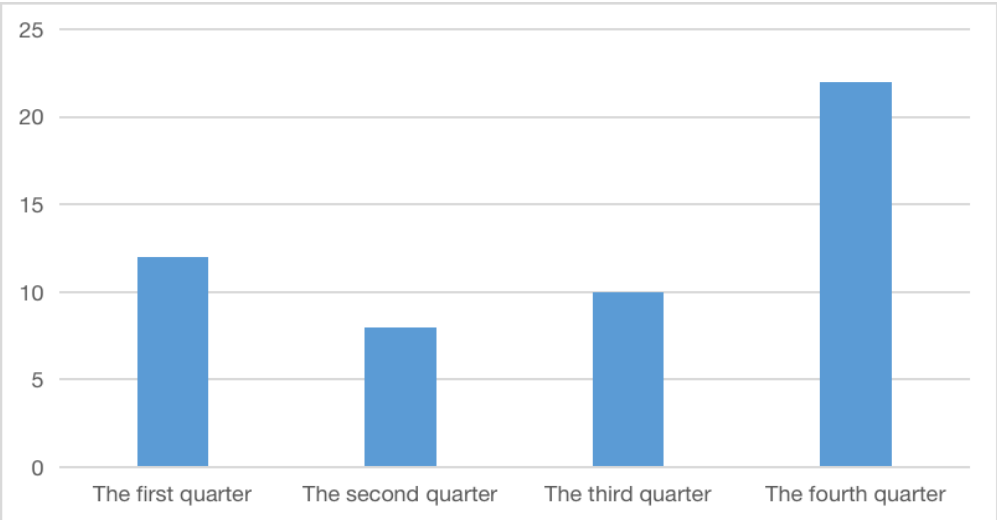

Figure 3: Histogram of events by quarter and by number

In the first quarter, 8 incidents occurred in February, accounting for 15.38%. The number of monthly incidents in the second quarter was average and lower. In the third quarter, 7 incidents occurred in August, accounting for 13.46%. In the fourth quarter, there were 9 incidents in October and December, accounting for 17.31% respectively. Month of occurrence - numbers are shown in Figure 4.

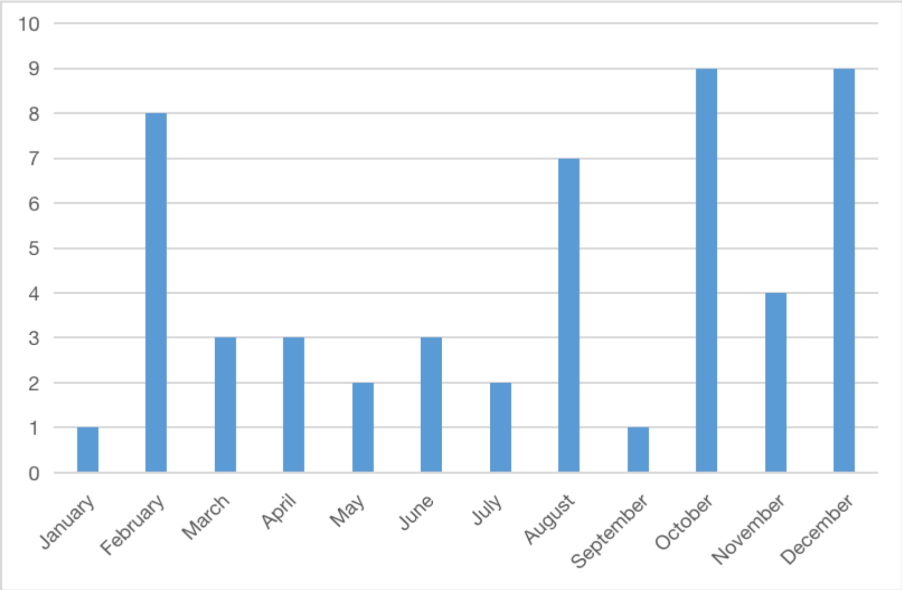

Figure 4: Month - number bar chart of events

Indonesia does not have a spring, summer, fall and winter, but a rainy season and a dry season. Indonesia's rainy season is generally from November to April of the following year. The north is affected by the northern hemisphere monsoon, and precipitation is abundant from July to September.

The south is affected by the southern Hemisphere monsoon, and precipitation is abundant in December, January and February. As can be seen from the number of unsafe incidents in Figure 4, bad weather will increase the difficulty of flying and have a bad impact on the psychological aspects of pilots.

3.2 Analysis by event occurrence stage and quantity

According to the statistics of event stages, the landing stage in Indonesia had the largest number of incidents, accounting for 31, accounting for 59.62%. The number of incidents occurred in the take-off phase was 8, accounting for 15.38%. The number of incidents in the cruise phase was 6, accounting for 11.54%; The number of incidents in the approach phase was 5, accounting for 9.62%; The number of events in the descent phase is 0. See Figure 5 for the phase - number ratio of events.

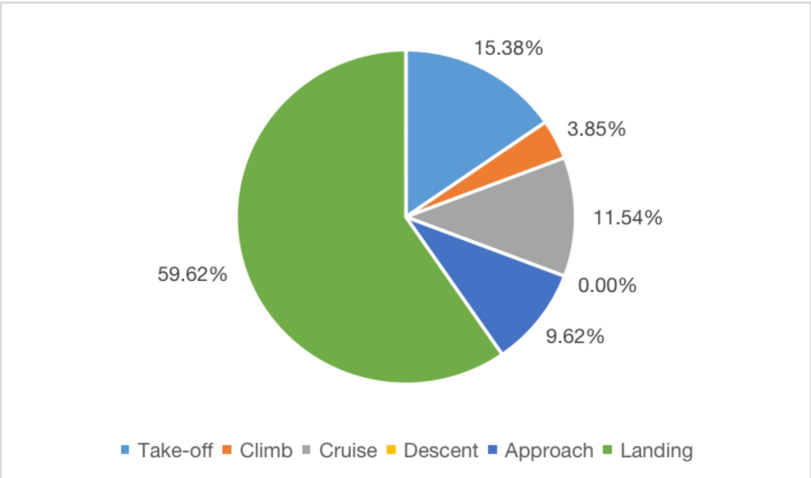

Figure 5: Pie chart of phase - number of events

In the six stages of flight, take-off and landing are the two most prone to accidents, especially the landing, which is a test of pilots' ability, but also the most unsafe stage.

3.3 Event Type - Quantity Analysis

According to the statistics of event types, running off the runway was followed by 20 cases, accounting for 38.46%. Heavy landing occurred in 3 cases, accounting for 5.77%; There were 2 cases of aircraft crashing into a mountain, wheels falling off, controlled flight crash, runway incursion and landing gear not down, accounting for 3.85% respectively. Each of the other types of events occurs once, accounting for 1.92% respectively. Event types - Number see Table 1. The event type-number ratio is shown in Figure 6.

Table 1: Event type – quantity

Event type	off the runway	heavy landing	aircraft crashing into a mountain	wheels falling off	controlled flight crash	runway incursion	landing gear not down	other	total
quantity	20	3	2	2	2	2	2	19	52

Type / Year	ground service	flight crew	regulation	environment	mechanics	machinery	Total
2007	1	1					2
2008		2			1	2	5
2009		2			2	2	6
2010						2	2
2011		7		2	1	1	11
2012		2					2
2013	1	6	1				8
2014	1	1			1		3
2015		4		2		1	7
2016		1	1			1	3
2017		2				1	3
Total	3	28	2	4	5	10	52

Figure 6: Bar chart of the number of incidents with the type involved

3.4 Analysis by Boeing 737 model involved and quantity

According to the analysis of Boeing 737 aircraft involved, B737-400 aircraft was the most involved in 7 cases, accounting for 28.00%. The second was B737-300 aircraft, involved 6 cases, accounting for 24.00%. B737-800 and B737-900 were both involved in 4 cases, accounting for 16% respectively.

B737-200 and B737-500 were both involved in 2 cases, accounting for 8.00% respectively. See Figure 7 for more details. The proportion is shown in Figure 8.

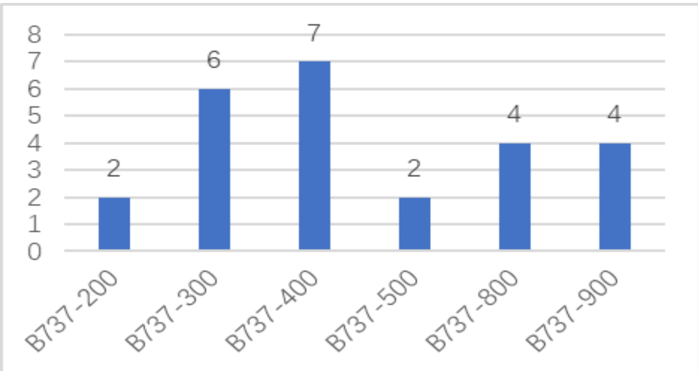

Figure 7: Bar chart of Boeing 737 models involved – number

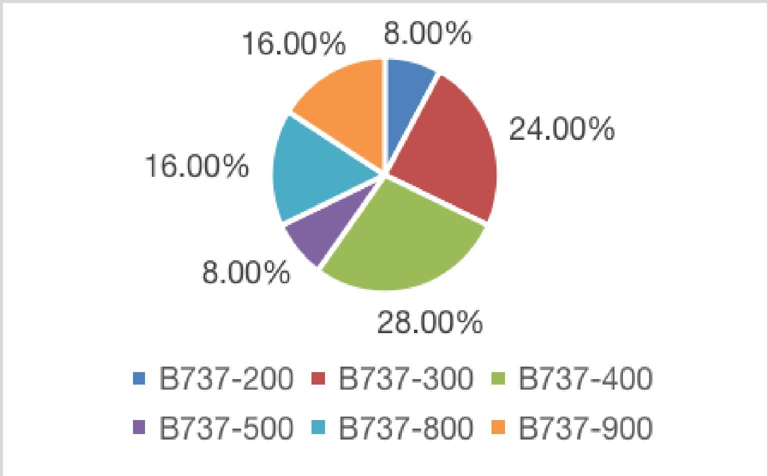

Figure 8: Boeing 737 models involved - Pie chart of number of units

Table 2: Airline - Event cause

airlines	ground service	Figureht crew	regulation	environment	mechanics	machinery	total
Deraya		1					1
Nusantara Buana		1					1
SMAC						1	1
Wings Air	1	1					2
Batik Air		1	1				2
MASwings						1	1
Merpati Nusantara Airlines		5			2	2	9
Aviastar		1					1
Cardig Air				1			1
KalStar Aviation		1					1
Condor Flugdienst		1			1		2
Lion Air	1	2				2	5
Srivijaya Air		5				1	6
Trigana Air		1				1	2
Lion Airlines		1		2			3
Adam Air		1					1
AirAsia		2	1		1	1	5
Garuda Indonesia Airline	1	4		1	1	1	8
total	3	28	2	4	5	10	52

3.5 Airlines - event causes analysis

3.5.1 Analysis by number of airline-events

As show in Table 2, according to the statistics of event causes, the number of incidents caused by flight crew is the most, with 28 cases in total, accounting for 53.85%. The number of incidents caused by mechanical reasons was the second, with 10 cases in total, accounting for 19.23%. There are 5 cases caused by maintenance, accounting for 9.62%; There are 4 cases caused by environment, accounting for 7.69%; There were 3 cases caused by local service, accounting for 5.77%; And there are 2 cases due to regulation, accounting for 3.85%.

The reason of flight crew is the most important need to pay close attention to, and the evaluation of the job competence of flight crew needs to be strengthened.

3.5.2 Analysis by Cause and Number of Events

In Indonesia, the number of incidents of Merpati Nusantara Airlines is the most between 2007 and 2017, with 9 cases in total, accounting for 17.31%. Garuda Indonesia Airline is the second one, with 8 cases in total, accounting for 15.38%. Srivijaya Air, with 6 cases in total, accounting for 11.54%. Lion Air and AirAsia both accounted for 5 cases, with each accounting for 9.62%. Lion Airlines accounted for 3 cases, each accounting for 5.77%. Wings Air, Batik Air, Condor Flugdienst and Trigana Air both accounted for 2 cases, each accounting for 3.85%. The other airlines both accounted for one, and each accounting for 1.92%.

Indonesia Civil Aviation Authority in the initial stage of civil aviation development on the management of a considerable omission, leading to the airline management is also very lax. In the early stage of economic development, supervision and implementation were not well coordinated, resulting in frequent unsafe incidents. Merpati Nusantara Airlines, Garuda Indonesia Airline, Lion Air, Srivijaya Air and AirAsia because of management confusion at first, lead to the management lax of the unit and the civil aviation personnel. The flight crew is technically unqualified, even in physical quality substandard aircraft pilots, these situations directly lead to the occurrence of civil aviation unsafe incidents.

In this paper, the causes of accidents in different years are sorted out and the following Table is obtained. Kaiser Meyer Olkin and Bartlett spherical tests were performed to test whether the data were suitable for factor analysis.

KMO coefficient represents the ratio of correlation coefficient to partial correlation coefficient. When kmo is closer to 1, the data is more suitable for factor analysis. The KMO value is divided into four stages below. When the KMO value is below 0.5, it is considered not suitable for factor analysis; When the KMO value is 0.70-0.80, it is suitable for factor analysis; When KMO value is 0.80-0.90, it is more suitable; When the KMO value is 0.90-1.0, it indicates that it is very suitable. In addition, the smaller the Bartlett distribution coefficient, the stronger the independence between variables. When the Sig value of Bartlett test is less than 0.001, it indicates that the questionnaire data is suitable for factor analysis.

The KMO and Bartlett spherical test of the sphericity are shown in the table below:

Table 3: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.692
Bartlett's Test of Sphericity	Approx. Chi-Square	56.064
	df	15
	Sig.	0.000

According to the Table 3, the KMO value is 0.721, and the Bartlett sphere test result is 0.000, less than 0.001, indicating that this group of data has certain correlation and is suitable for factor analysis.(abcdef respectively represents ground service, flight crew, control, environment, maintenance and machinery.)

Table 4: Correlations

		a	b	c	d	e	f
a	Person Correlation	1	0.842**	0.656*	0.676*	0.816**	0.784**
	Sig.(2-tailed)		0.001	0.021	0.016	0.001	0.003
	N	12	12	12	12	12	12
b	Person Correlation	0.842**	1	0.398	0.795	0.805**	0.890**
	Sig.(2-tailed)	0.001		0.200	0.002	0.002	0.000
	N	12	12	12	12	12	12
c	Person Correlation	0.656*	0.398	1	0.557	0.556	0.480
	Sig.(2-tailed)	0.021	0.200		0.060	0.060	0.114
	N	12	12	12	12	12	12
d	Person Correlation	0.676*	0.795**	0.557	1	0.736**	0.749**
	Sig.(2-tailed)	0.016	0.002	0.060		0.006	0.005
	N	12	12	12	12	12	12
e	Person Correlation	0.816*	0.805**	0.556	0.736**	1	0.892**
	Sig.(2-tailed)	0.001	0.002	0.060	0.006		0.000
	N	12	12	12	12	12	12
f	Person Correlation	0.784**	0.890**	0.480	0.749**	0.892**	1
	Sig.(2-tailed)	0.003	0.000	0.114	0.005	0.000	
	N	12	12	12	12	12	12

1) A is highly correlated with b and e, b is highly correlated with e and f,and e is highly correlated with f.In order to further determine the correlation degree of the six groups of data, Pearson correlation analysis in spss26.0 is used to judge them, and the results are shown in the Figureure.

2) It can be seen from the Tbale 4 that among the six groups of data, ground service is highly correlated with flight crew and maintenance, flight crew is highly correlated with maintenance and machinery, and maintenance and machinery are highly correlated. The group with the greatest correlation is "maintenance and machinery" (the Pearson correlation coefficient is 0.892 at the confidence level of 99%), followed by "flight crew and machinery" (at the confidence level of 99%), The Pearson correlation coefficient is 0.890). Pearson correlation coefficient preliminarily determines five groups of relevant data, but it can not intuitively judge the redundant items in the system, so it is necessary to conduct factor analysis on the data to judge whether the dimension of the index can be reduced.

3) Using the idea of dimensionality reduction, the principal component analysis of six event incentives is carried out to study the internal relationship of the original variable correlation matrix. Here, the maximum variance method is used to output the solution, and the interpretation results of the overall variance are shown in Table 3-4.

Table 5: Component Matrix

	Component					
	1	2	3	4	5	6
a	0.914	0.094	-0.265	-0.260	-0.105	-0.087
b	0.918	-0.306	0.002	-0.202	0.089	0.127
c	0.670	0.734	0.014	0.032	0.092	0.043
d	0.863	-0.025	0.495	-0.034	-0.079	-0.046
e	0.925	-0.077	-0.136	0.283	-0.190	0.054
f	0.927	-0.221	-0.076	0.182	0.213	-0.083
Extraction Method: Principal Component Analysis. a. 6 components extracted.						

According to the Table 5, four principal component factors are extracted from the 6 factors. According to the cumulative value, the cumulative contribution rate of these four factors is 97.456%. By comparing the percentage decline rate of the initial eigenvalues of the factors, it is concluded that four factors decline rapidly, namely a, b, e and f. therefore, it is appropriate to select these four factors, namely ground service, flight crew, maintenance and machinery. According to the analysis results, it is considered that these four factors are the main factors leading to the occurrence of flight unsafe events (The following conclusions are modified or supplemented). The total variance explained are shown in Table 6.

Among them, e and f are highly correlated, (the Pearson correlation coefficient is 0.892 at the confidence level of 99%). Changes in either part will have an impact on the other part. This also tells us that we should minimize the connection between the two in the process of safety management. The connection between these two aspects can improve product reliability in terms of hardware, provide appropriate education and training for maintenance personnel, and formulate assessment standards. These aspects can be controlled, thereby reducing the possibility of unsafe incidents. At the same time, b is highly correlated with a, e, and f, indicating that this factor has a greater impact on the three, and the human-related factors are dynamic and complex. We should not only pay attention to the physiological health of the pilots, but also pay attention to them. The inner psychological health makes the relationship with the other three factors controllable.

Table 6: Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.588	76.468	76.468	4.588	76.468	76.468	1.536	25.597	25.597
2	.696	11.606	88.074	.696	11.606	88.074	1.276	21.271	46.868
3	.339	5.656	93.730	.339	5.656	93.730	1.258	20.968	67.836
4	.224	3.726	97.456	.224	3.726	97.456	1.244	20.739	88.574
5	.115	1.921	99.377	.115	1.921	99.377	.628	10.465	99.039
6	.037	.623	100.000	.037	.623	100.000	.058	.961	100.000
Extraction Method: Principal Component Analysis.									

4. Conclusion

4.1 Human factors

4.1.1 Pilot

The aviation system is a complex socio-technical system built around air transportation services, including hardware, software, human, management, and environmental elements, among which humans are difficult to control[9], and human factors are the main reason for the unsafe events of civil aviation in the world. The main problems of Indonesian civil aviation pilots include: non-compliance with regulations, ineffective communication between pilots and controllers, poor physical condition of pilots, and pilots' failure to make pre flight preparations.

1) Non compliance with regulations. On February 21, 2007, the flight crew did not comply with some procedures published by Boeing. The flight crew did not respond to the alarms and warnings of the ground proximity warning system (GPWS); On August 27, 2008, the hydraulic system failed during the approach, but the pilot did not terminate the approach in time or review the flight plan again; On August 2, 2009, when the aircraft was flying below the minimum safe altitude, the pilot did not maintain visual flight procedures.

2) Invalid communication between pilot and controller. On December 17, 2008, the approach controller did not get a complete and detailed recitation that could clearly show that the pilot had understood and complied with all air traffic control instructions, and the pilot misinterpreted the information conveyed by the approach controller; On November 20, 2013, there was a deviation in the pilot's and controller's understanding of the holding point position of runway 27, and the taxiing instruction had not been clearly clarified. The instruction between the approach controller and the tower was not transmitted and the communication was invalid, resulting in the failure to confirm the go around instruction issued by Adi tower controller to the pilot.

3) The pilot's physical condition is not up to standard. On February 12, 2011, the pilot suffered from partial paralysis or paralysis of vestibular organs and tissues, and was unable to respond normally to three-dimensional motion or movement.

4) The pilot was not ready for the flight. On February 12, 2011, the pilot did not make good preparations for the flight test, and there was no flight test plan.

5) The pilot made a wrong decision. On September 29, 2011, the plane flew under visual flight rules, but both pilots agreed to fly into the clouds. As a result, the pilot lost situational awareness due to the loss of visual reference to the ground, and did not take corrective measures before hitting the ground or took corrective measures too late due to low visibility.

6) Pilot technical errors and mistakes. On December 26, 2011, the pilot used asymmetric backstepping, and there was no difference in N1 during the use of backstepping; Failure to follow the published standard procedures when using brake and reverse thrust correction direction control; On June 10, 2013, during the approach, the pilot chose to open the electromagnetic stop lock of the throttle lever, and the throttle lever was lifted from the mechanical stop groove of the throttle lever, but the pilot did not realize that the co-pilot inadvertently moved the throttle lever to the flight slow parking position; On December 28, 2014, the pilot made an incorrect correction to the abnormal attitude of the aircraft.

7) Unit resource allocation. Huang Zheng[11], Xu Shengping[4], Chen Shide[5] and others have

studied the relationship between crew resource management and flight safety, and proposed that the rational arrangement of crew resources is of great significance to improving flight safety. On October 2, 2008, both pilots focused on the inside of the cockpit and did not fully cross check the external situation; On September 29, 2011, due to the excessive authority gradient of the pilots, there was a lack of good crew cooperation, no reading of the checklist and no crew briefing; On February 3, 2015, the control power was exchanged twice at the key height, and there was no clear statement; The pilot who took over the control did not fully understand the flight status of the aircraft, thus endangering flight safety; On December 21, 2015, there was poor cooperation between the pilots and almost no cross inspection. During the approach, improper flight management led to the aircraft not fully setting the landing configuration, late grounding, high speed and low braking pressure.

4.1.2 Maintenance

1) Improper maintenance. On October 28, 2008, a fatigue crack on the axle of No. 1 main landing gear was not found, which was caused by a corroded hole in the connecting flange of the braking system; On October 30, 2009, the bearing of No. 2 main engine wheel failed because the axle nut was not installed with the correct torque. Under the condition of torque, it will inevitably lead to catastrophic bearing failure.

4.1.3 Cabin crew

1) Improper cabin emergency command. On October 15, 2017, the cabin crew put forward additional requirements to the passengers (especially the passengers who felt uncomfortable during pressure relief and emergency descent), which may increase the confusion in the cabin and the degree of panic of some passengers.

4.2 Mechanical factors

1) Mechanical and system failure. In the event on August 27, 2008, the hydraulic system failed and the generator driven by the left engine (JT8D) failed. On November 2, 2010, it was difficult for the thrust reverser and spoiler to open automatically. On February 12, 2011, the engine stopped.

2) The tire is damaged and burst. On April 12, 2007, the tire burst when it passed over a pointed object. The pointed object may be a concrete fragment. The tire burst causes the tire tread to fall off, and the concrete and / or tire fragments are damaged from the thickness direction of the flap and cause the rupture of the left rear flap.

3) Old connectors, corrosion, etc. On January 16, 2019, the failure of the left landing gear tire was caused by the failure of 4 of the 16 bolts installed due to fatigue cracks.

4.3 Environmental factor

1) Tropical monsoon climate. Indonesia is an archipelago country, located near the equator and surrounded by the ocean. The ocean surface temperature is very high, which forms a tropical monsoon climate. During the rainy season, the annual precipitation in some places exceeds 4000 mm, usually lasting more than 250 days a year[10]. Indonesia has no four seasons, but is divided into dry season and rainy season. The northern part is affected by the northern hemisphere monsoon, with abundant precipitation from July to September, and the southern part is affected by the southern hemisphere monsoon, with abundant precipitation in December, January and February.

2) Special mountain terrain. Many island airports in Indonesia are located in mountainous terrain. Due to complex terrain and changeable weather, pilots often need to switch between visual and instrument flight, which often leads to controllable flight collision or out of control accidents.

3) Foreign object intrusion on the runway. On April 12, 2007, a tire burst occurred when a tire passed over a pointed object. The pointed object may be a concrete fragment; A tire burst causes the tread to fall off. Concrete and / or tire debris damaged from the thickness of the flap and caused the left rear flap to rupture.

4.4 Management factors

1) Many flight incidents, such as August 27, 2008, July 18, 2010, November 2, 2010 and December 12, 2011, reflected the problems of inadequate training for crew and controllers, imperfect training system, inadequate review and low post level;

2) The flight incident on December 21, 2015 reflected the defects in crew resource management;

3) The flight incident on December 28, 2014 reflected defects in the supervision of maintenance personnel;

4) The incident on December 12, 2011 showed that the formulation of airline emergency procedures and emergency training for employees were not in place;

5) The incident on 11th June, 2014 showed that the airport does not pay enough attention to safety risk management, including the defects in the airport manual, inadequateness of vehicle management and runway management, and inadequateness of facilities management and maintenance;

6) The airworthiness quality system of the aircraft is not perfect and cannot meet the requirements of CASR135;

7) The Civil Aviation Administration has insufficient review and supervision of airline operations.

5. Suggestions for improving civil aviation safety in Indonesia

The unsafe incidents of Indonesian civil aviation are mainly the result of many factors, such as improper management, economic, social and geographical, etc. In the late 1990s, after decades of dictatorship, Indonesia opened its economy, aviation boomed, and it was almost unregulated in its early years. To improve civil aviation safety, first of all, the management should attach great importance to flight safety.

5.1 The civil aviation administration

Indonesia civil aviation administration should set up a sound, scientific and strict review system combining its national conditions, and enhance the supervision for airlines, check many items based on the established reasonable system including the responsibility of airlines are specific or not, the personnel of risk management qualification meets the requirements or not, the manual of procedure have operability or not, risk management procedures associated with other elements or not, the risk management program are consistent or not, the manual is in accordance with Indonesia's current situation or not, the manual is effective or not. Indonesia civil aviation administration need to collate the information of civil aviation safety on schedule, pay close attention on the airlines which cause more unsafe incidents, such as Merpati Nusantara Airlines, Garuda Indonesia Airline, Lion Air, Srivijaya Air and AirAsia, focus on the unsafe event type, such as blunt, wide runway, etc, and formulate the corresponding improvement measures, and draw up programs to train high-quality personnel.

5.2 Airlines

There are many enlightenments for airlines which reflected from the incidents of Svivijaya Air on 27th August, 2008, Lion Air on 2nd November, 2010 and AirAsia Indonesia on 28th December, 2014. Airlines shall formulate their safety and training rules, establish a serious institution of assessment, strengthen the training of flight crews, strengthen the safety education of employees, and enhance the safety awareness of employees according to the regulations issued by the civil aviation administration. Risk assessment factors should be quantified as far as possible, and evaluation standards should be unified at the company level. Establish and improve the reporting system, encourage employees to feedback the potential risks of aviation safety actively, and establish a self-inspection system. The two aviation incidents that occurred on 24th December, 2011 and 19th October, 2012, at Svivijaya Airlines alert airlines that they may learn to identify hazards, carries on many analysis including new system, the significant changes - job, internal and external unsafe incidents ,and analyze find safety problems-daily safety problems such as daily safety audit, evaluation, audit, employee reports, inspection, and analyze security problems- security information which found in daily safety information analysis, questionnaire method and other methods are the methods of identifying hazard sources. When airlines formulate security measures, they may reduce or not use "strengthen", "improve", "perfect" and other words as far as possible , can not formulate measures in the form of requirements , the security measures may have a specific purpose, number, degree, time to complete, etc, they must be operable. After the formation of measures, in addition to the follow-up verification of the implementation of measures, the effectiveness evaluation of measures should also be carried out in order to form a closed loop [8].

5.3 Airports

Combining with the system established by the bureau, we will strengthen the training of airport staff in connection with the environmental conditions of the respective airports, and optimize the airport's flight procedure design[2]. The aviation incident of Lion Air company which occurred on 6th August, 2013 warned airports to strengthen the inspection of the ground to prevent unsafe incidents which caused by objects. On rainy days, it is necessary to contact the air traffic control in time to report the road surface conditions, and then the air traffic control informs the flight crews in order to provides decision support to the flight crews. Contacts and cooperation with local governments, airlines and public transport companies should be strengthened.

6. Enlightenment to civil aviation safety of China

Since The reform of CAAC in March 2002, the civil aviation safety supervision organization structure of "two-level government and three-level management" has been formed. China has been adhering the principle of life safety and developing safety to develop the civil aviation.

1) The development of civil aviation safety in China is relatively stable compared with Indonesia, and civil aviation safety education is deeply rooted in people's heart. The omissions in Indonesian management inspire the management of civil aviation airlines of China in a sense that the purpose of protecting the life safety of passengers should be clear, the training of the crew should be comprehensive and strict, the assessment system should be serious, the management should be

changed infrequently if it is not necessary, and should be minimize the impact on the crew and employees if it is necessary.

2) Civil aviation of China must pay more attention to the airports with special terrain and climate, and strengthen the training of pilots which perform various special airport tasks. The pilots must fly with the flight rules strictly, airlines emphasize that the pilots must be diverted or go around under the bad weather conditions, put an end to luck, and if it is under the special weather, the airlines may reduce the requirements on punctuality.

3) Civil aviation of China may make full use of the effective information brought by the mandatory reporting system and voluntary reporting system, pay attention to the potential safety hazards, and the crews must discuss immediately to formulate measures and take improvement actions once the potential safety hazards are found.

4) The government and the Civil Aviation Administration of China shall formulate special assessment systems for airports and airlines with high incidence of incidents, deeply analyze the causes of incidents, enhance the frequency of inspection and focus on them. At present, the main cause of aviation incidents in China is human factors. For airlines with high incidence of human factor incidents, it is necessary to focus on monitoring. For those who frequently cause unsafe incidents, it is necessary to understand, analyze, interview or issue penalty notices. In addition, the root cause behind the human factor should be found out. If the reason is organizational management, the airline leaders should be reviewed. Most airports in China are managed by local governments, so it is necessary to strengthen the connection between airports and local governments, strengthen the connection between airlines, airports and governments, and strengthen the mutual supervision between airlines and airports. A comprehensive evaluation model of airline safety information management level can be established, and it can be evaluated regularly to ensure the effectiveness and reliability of information transmission[8].

5) As the pathfinder of China civil aircraft, Modern Ark 60 has good safety performance. Among 52 unsafe incidents in Indonesia from 2007 to 2017, there were only 3 unsafe incidents involving the Modern Ark 60, and the reasons were all human factors. Nevertheless, it still brought some negative effects to the Modern Ark 60. Later, China made some improvements to the Modern Ark 60 to improve the stability and comfort of the aircraft. Civil aviation insecurity incidents have a negative impact on aircraft more or less. What we need to do is not be satisfied with the existing state, but to build and transform a more comfortable and safer aircraft by combining man-machine safety technology on the basis of existing.

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