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The Influence of Human Factor and Runway Quality on the Aircraft Accidents in Indonesia

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Abstract

The aim of this study is to know the influence of *human factor* and *runway quality* on the aircraft accidents of commercial flights in Indonesia. This study uses survey method with the sample as many as 100 pilots taken in a sampling quota way. Data analysis uses descriptive statistics and correlation inferential statistics and regression. The result of this study indicates a negative and significant influence of human factor on the aircraft accidents, a negative and significant influence of runway quality on the aircraft accidents, and a negative and significant influence of human factor and runway quality simultaneously on the aircraft accidents. The study gives benefit of the importance to keep doing and maintaining continuous improvements on the qualities of human factor and runway at the most optimum level in order to reduce the number of aircraft accidents in Indonesia.

Keywords: Aircraft accident**,** human factor, and runway quality.

Introduction

Based on the statistics in transportation industry, air transport is the safest mode of transportation up to now, where the aspects of flight safety and security are internationally regulated in a tight way by International Civil Aviation Organization (ICAO) Annex 1 to Annex 19 which is universally also regulated by every country. In Indonesia, civil aviation is regulated in the Civil Aviation Safety Regulations (CASR) Part 1 to 830 as well as various circulars of other civil aviation safety regulations.

Based on the data of accidents published by the National Transportation Safety Committee or *Komite Nasional Keselamatan Transportasi* (KNKT) of the

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Republic of Indonesia in the end of 2014, there have been 201 aircraft accidents since 2007 until 2014 in two categories: 95 accidents and 106 serious incidents. Based on the data, there is an increase of accident numbers experienced by airlines in Indonesia, where in 2007 the number of flight accidents is 21 and in 2014 the number drastically increases to become 30 accidents.

Based on the investigation report of KNKT's sub-committee of flight accident investigation, the percentage of the predicted factors causing flight accidents during 2007-2016 respectively are as follows: human factor (62.26%), technical factor (21.79%), environment (10.89%), and facilities (5.06%). Based on KNKT's investigation report, human factor is the dominant factor causing the flight accidents in Indonesia.

In this study, the research on aircraft accidents is limited to the accidents in the runway area, namely *runway excursion* and *runway incursion*. Runway excursion is an aircraft accident in the stage of landing or takeoff and due to something the aircraft goes out of the runway. Whereas *runway incursion* is an aircraft accident in the runway in the stage of landing or takeoff caused by something (vehicle/person) entering the runway without permission or by animal entering the runway undetected by the airport management.

The accidents in the runway area are categorized into two: 78 runway excursions and 6 runway incursions. The data shows aircraft accidents in the type of operation in accordance with AOC 121 as many as 48, AOC 135 as many as 18, AOC 91 as

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http://proceedings.itltrisakti.ac.id/index.php/atlr

many as 7, PSC 141 as many as 10 and others as many as 1, as mentioned in the following table.

Table 1. Data of Aircraft Accidents by the Type of Operation

NO.	YEAR	RUNWAY SAFETY		TYPE OF OPERATIONS				
		EXCURSION	INCURSION	AOC 121	AOC 135	AOC 91	PSC 141	OTHERS
1	2007	6	0	4	1	-	-	1
2	2008	6	1	4	2	-	1	-
3	2009	6	0	4	2	-	-	-
4	2010	8	1	6	2	-	1	-
5	2011	16	0	12	-	1	3	-
6	2012	11	1	9	2	-	1	-
7	2013	15	3	7	7	2	2	-
8	2014	10	0	2	2	4	2	-
TOTAL		78	6	48	18	7	10	1

Source: KNKT 2015

Aircraft accident happens not because of a single factor but several factors influenced by *human factor* and *runway quality*.

Human factor means the human activity facing the working situation influenced by the factors outside work ability, including physical and psychological factors, environmental factors, internal factors, and situational factors. There are also some factors which influence the relationship between man and machine, between procedures as well as regulations and environment, and between one man and another (Reason 1990).

The research problems are formulated as follows: (1) Does *human factor* influence the accident of scheduled commercial aircrafts? (2) Does *runway quality* influence the accident of scheduled commercial aircrafts?, and (3) Do *human factor* and

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http://proceedings.itltrisakti.ac.id/index.php/atlr

runway quality simultaneously influence the accident of scheduled commercial aircrafts?

Literature Review

Human Factor

The definition of *human factor* in this context refers to the opinion of the experts studying human factor and flight accident such as Gaol (2014), Gambardella, Panico, and Velentini (2013), Salim and Karyawati (2013), Amalberti, Partai, Valot and Wibaux (1998), Chappell (1994), Wiegman and Shappel (2009), Christensen, Topmiller and Gill (1988), and Reason (1997).

Based on the experts' opinion, it can be concluded that *human factor* is someone's knowledge, skill, and ability that can be used to provide professional services. *Human factor* reflects a company's collective abilities to find the best solution based on the knowledge owned by the individuals in the company. In this context, *human factor* is an individual capacity to act in various organizational situations with the indicators of employees' knowledge, skill, competence, and attitude.

Runway Quality

The definition of runway or runway quality refers to the opinion of Horonjeff and McKelvey (1994) as well as Sandhyavitri and Taufik (2005).

According to Horonjeff and McKelvey (1994), the runway system of an airport consists of structural pavement, shoulder, blast pad, runway end safety area. To build a runway in an airport, the things that should be taken into account are length, number, width, distance to the taxiway and the wind direction.

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http://proceedings.itltrisakti.ac.id/index.php/atlr

According to Sandhyavitri and Taufik (2005), an airport is divided into two main parts, namely: (1) *land side*; Land side and air side are connected with the transition area or interface which is called terminal. *Land side* is the zone supporting the flight activities including loading and discharging, maintenance, and providing facilities for flight. The facilities of land side include: terminal yard (*curb*), entrance, and parking area. (2) *air side*; *Air side* is the zone directly related to the aircraft movement. The facilities of air side include: runway, taxiway, and apron.

Runway quality is the total characteristics of a certain rectangular area at an airport on the land or water used for aircraft landing and take off which support the ability to fulfill the need which is measured based on the indicators of structural pavement, shoulder, blast pad, runway safety area, and extended runway safety area which area absolutely needed by aircrafts. The length of runway usually depends on the size of aircraft being served.

Aircraft Accident

The definition of aircraft accident refers to the opinion of Suma'mur (2009) and ICAO (2010) which essentially can be synthesized that aircraft accident is an unpredicted occurence, initially unexpected which disrupt the process of an activity that has been set up and can cause loss for human beings and properties, with the indicators: human factor, mechanical factor, and environmental factor.

A relevant study concerning the influence of human factor on aircraft accident is carried out by Wiegmann and Shappell (2001) entitled *A Human Error Analysis of*

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Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

Commercial Aviation Accidents Using the Human Factors Analysis and Classification System (HFACS). The result of their study indicates that the commercial flight accidents are caused by human factor. The result of that study strengthens the empirical evidence that human factor significantly influences the aircraft accidents.

Study concerning the influence of runway problem on the aircraft accidents has been carried out among others by Taylor and Godley (2009) entitled *Runway Excursions: Part 2-Minimising The Likelihood and Consequences of Runway Excursions An Australian Perspective.* This study is done in Australia and the result indicates that most aircrafts stop at 1,000 feet from the end of runway and in the edge of runway/extended runway. Risk control is the most important way to reduce the possibility and consequence of runway problem. The study strengthens the empirical evidence that runway quality significantly influences the aircraft accidents.

Research Method

The method of research used is survey with questionnaire as the instrument of data collection. Data analysis includes descriptive statistical analysis, classic assumption test (requirements for analysis), and parametric (inferential) statistical analysis. The data is processed using SPSS software version 22.

This study takes all the national airlines in Indonesia providing scheduled commercial flight that operate in Soekarno-Hatta international airport as the analysis unit. The observation unit is the captain pilots and the research sample is

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http://proceedings.itltrisakti.ac.id/index.php/atlr

determined by *quota sampling* as many as 100 pilots of various airlines in Indonesia providing scheduled commercial flight with the aircraft category over 30 passengers (AOC 121). The sample taking is done through *accidental sampling* and the survey is done in October and November 2016.

Result And Discussion

Analysis Requirements Test

Based on the calculation using Kolmogorov-Smirnov formula, the result is obtained as shown in the following table:

Table 2. Summary of Normality Test Result

DESCRIPTION	STATISTICAL TEST RESULT
$X_1 \rightarrow Y$	
Statistical Test	0.062
Asymp. Sig.	0.200
$X_2 \rightarrow Y$	
Statistical Test	0.070
Asymp. Sig.	0.200
X_1 and $X_2 \rightarrow Y$	
Statistical Test	0.068
Asymp. Sig.	0.200

From the table above it is seen that in the normality test for the variable of *human factor* (X_1) toward aircraft accident (Y) the *statistical test* is found 0.062 with the value of *asymp. sig* 0.200 > 0.05, so it has normally-distributed residual. For the variable of *runway quality* (X_2) toward aircraft accident (Y) the *statistical test* is found 0.070 with the value of *asymp. sig* 0.200 > 0.05, so it has normally-distributed residual. And for the variable of *human factor* (X_1) and *runway quality*

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http://proceedings.itltrisakti.ac.id/index.php/atlr

(X_2) toward aircraft accident (Y) the *statistical test* is found 0.068 with the value of *asymp. sig* 0.200 > 0.05, so it has normally-distributed residual.

Hypothesis Test

The following is the description of statistical calculation with regression analysis to test the research hypotheses.

1. **The Influence of Human Factor on Aircraft Accident**

Based on the simple regressive calculation concerning the influence of *human factor* on aircraft accident, constant (a) is obtained 62.729 and regression coefficient (b) = -0.319. Based on that value, regression equation can be made $\hat{Y}= 62.729 – 0.319X_1$. The result of significance and linearity tests on the equation are presented in the following ANAVA table:

Table 3 ANAVA Table of Significance and Regression Linearity Tests

$\hat{Y}= 62.729 – 0.319X_1$

Source of Variation	dk	JK	RJK	$F_{calculation}$	F_{table}	
					$\alpha = 0.05$	$\alpha = 0.01$
Total	100	2.544.164				
Regression (a)	1	2.543.184				
Regression (b/a)	1	255.757	255.757	34.628**	3.96	6.90
Residual (S)	98	723.803	7.386			
Deviation (TC)	18	129.292	7.183	0.967^{ns}	1.79	2.17
Error (G)	80	594.512	7.431			

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

Notes:

** = *Regression equation is very significant (F_{cal} =34.628 > F_{table}= 6.90) at α = 0.01*

^{ns}= *Not significant, so the regression is linear (F_{cal} = 0.421 < F_{table}=2.15) at α = 0.01*

JK = Number of Squares

dk = Degree of freedom

RJK = Average number of squares

The calculation indicates that the influence of *human factor* on aircraft accident shown by the regression equation $\hat{Y} = 62.729 - 0.319X_1$ is very significant. This is seen from the value of F_{cal} (34.628) > F_{table} at α = 0.01 (6.90). In regression linearity test, the value of F_{cal} is obtained 0.967, whereas the value of F_{table} at α = 0.01 with numerator dk 18 and denominator dk 80 is 2.17. therefore, the value of $F_{cal} < F_{table}$, thus the regression equation of aircraft accident over *human factor* is linear.

Based on the table of significance test and regression linearity test, it can be concluded that the regression equation $\hat{Y} = 62.729 + -0.319X_1$ is very significant and linear. The value of constant in the equation indicates that when the variable of *human factor* has score -0.319 then aircraft accident has score 62.729. meanwhile, the regression coefficient means that every increase of one score in *human factor* will be followed by the decrease of -0.319 in aircraft accident score at the constant of 62.729. The influence of *human factor* on aircraft accident based on the obtained regression equation can be illustrated as follows.

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

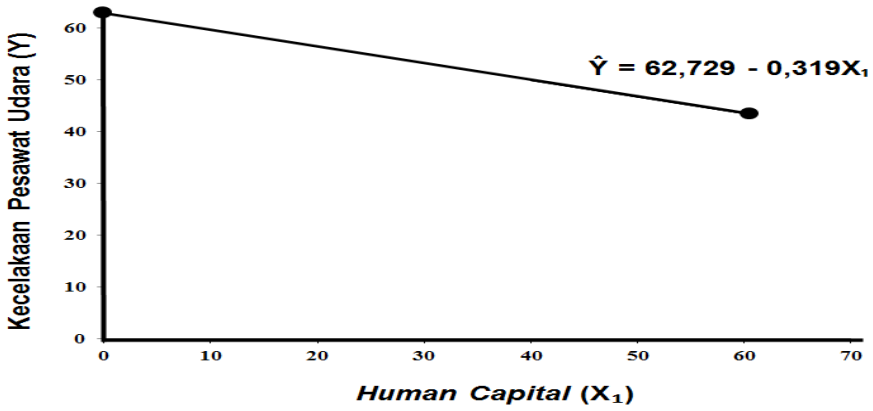

Figure 1. Regressive Line of Human Factor's Influence on Aircraft Accident

The strength of the correlation between *human factor* and aircraft accident can be seen from the coefficien of correlation. The calculation of the coefficient of correlation and t test can be seen in Table 4.

Table 4. Significance Test of the Coefficient of Correlation and t Test between Human Factor and Aircraft Accident

Number of Sample (n)	**Coefficient of Correlation** (r_{y1})	**Coefficient of Determination** (r_{y1}^2)	**$T_{calculation}$**	**T_{table}**	**t_{table}**
				α = 0.05	**α = 0.01**
100	0.511	0.261	-5.885**	1.660	2.364

Notes:

** = the coefficient of correlation is very unsginificant *(T_{cal} = -5.885 < F_{table} = 2.364) at* α = *0.01*

From the calculation it is seen that the coefficient of correlation is 0.511. This indicates that the correlation between human factor and aircraft accident is categorized moderate. Significance test on the correlation finds the t_{cal} = -5.885 < t_{table} = 2.364 at α = 0.01, so H_i is rejected and H_o is accepted. Thus, the coefficient

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

of correlation between human factor and aircraft accident (r_{y1}) 0.511 is negatively significant. It means there is a negative and very significant influence of human factor on aircraft accident.

The coefficient of determination (r_{y1}^2) = 0.261 means 26.1% variation of aircraft accident can be explained by the variation of human factor through the regression equation $\hat{Y} = 62.729 + -0.319X_1$.

2. The Influence of Runway Quality on Aircraft Accident

Based on the calculation of simple regression on the influence of runway quality on aircraft accident, the constant (a) is found 63.072 and coefficient of regression (b) = -0.321. Based on that value, regression equation $\hat{Y}= 63{,}072 - 0{,}321X_2$ can be made. The result of significance test and linearity on the regression equation is presented in the following ANAVA Table:

Table 5. ANAVA Table of Significance and Regression Linearity Tests

$\hat{Y}= 63.072 – 0.321X_2$

Source of Variation	dk	JK	RJK	$F_{calculation}$	F_{table}	
					$\alpha = 0.05$	$\alpha = 0.01$
Total	100	2.634.721				
Regression (a)	1	2.633.742				
Regression (b/a)	1	223.385	223.385	28.951**	3.96	6.90
Residual (S)	98	756,175	7,716			
Deviation (TC)	17	120,845	7,109	$0{,}906^{ns}$	1,79	2,20
Error (G)	81	635,329	7,844			

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

Notes:

*** = Regression equation is very significant (F_{cal} =28.951 > F_{table} = 6.90) at α = 0.01*

^{ns}= Not significant, so the regression is linear (F_{cal} = 0.906 < F_{table} =2.20) at α = 0.01

JK= Number of squares

dk = Degree of freedom

RJK = Average number of squares

The result of the above calculation indicates that the influence of runway quality on aircraft accident shown by the regression equation $\hat{Y} = 63.072 - 0.321X_2$ is very significant. This is seen from the value of F_{cal} (28.951) > F_{table} at α = 0.01 (6.90). In the regression linearity test, the value of F_{cal} is found 0.906, whereas the value of F_{table} at α = 0.01 with numerator dk 17 and denominator dk 81 is 2.20. Therefore, the value of $F_{cal} < F_{table}$, so the regression equation for aircraft accident over the runway quality is linear.

Based on the above table, it can be concluded that the regression equation $\hat{Y} = 63.072 - 0.321X_2$ is very significant and linear. The value of constant in the equation shows that when the variable of runway quality has score -0.321 then aircraft accident has score 63.072. The coefficient of regression means that every increase of one score in runway quality will be followed by the decreasing score of -0.321 in aircraft accident at the constant of 63.072. The correlation between runway quality and aircraft accident based on the regression equation can be illustrated in the following figure.

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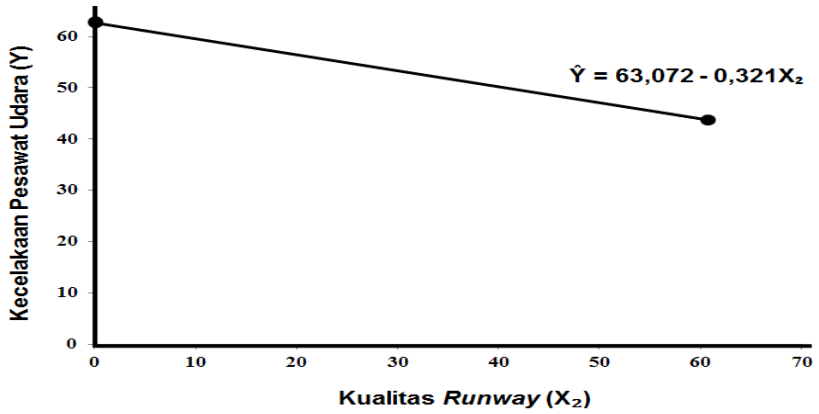

Figure 2. Regression Line of the Correlation between Runway Quality and Aircraft Accident

The strength of the correlation between runway quality and aircraft accident can be seen from the coefficient of correlation. The calculation result of the coefficient of correlation and t test can be seen in the following table.

Table 6. Significance Test on the Coefficient of Correlation and t Test between Runway Quality and Aircraft Accident

Number of Samples (n)	**Coefficient of Correlation** (r_{y2})	**Coefficient of Determination** (r_{y2}^2)	**$T_{calculation}$**	**T_{table}**	**t_{table}**
				α = 0.05	**α = 0.01**
100	0,478	0,228	-5,381**	1,660	2,364

Note:

** = *Coefficient of correlation is very unsignificant (T_{cal} = -5.381 < F_{table} = 2.364) at α = 0.01*

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Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

From the above calculation it is seen that the coefficient of correlation is 0.478. This indicates that the correlation between runway quality and aircraft accident is categorized moderate. The significance test on that correlation finds t_{cal} = -5.381 < t_{table} = 2.364 at α = 0.01, so H_i is rejected and H_o is accepted. Thus, the coefficient of correlation between runway quality and aircraft accident (r_{y2}) is 0.478, very significantly negative. It means there is a negative and very significant influence of runway quality on aircraft accident.

The result of the coefficient of determination (r_{y2}^2) = 0.228, meaning that 22.8% of aircraft accident variation can be explained by runway quality variation through the regression equation $\hat{Y} = 63.072 + -0.321X_2$.

3. The Influence of Human Factor and Runway Quality Simultaneously on Aircraft Accident

From the multi-regression calculation concerning the influence of human factor and runway quality simultaneously on aircraft accident, it has been found the constant (a) 62.966, coefficient of regression direction for human factor (b_1) = -0.294 and coefficient of regression direction for runway quality (b_2) = -0.030. Thus, from the influence of human factor and runway quality simultaneously on aircraft accident it is found the regression equation $\hat{Y} = 62.966 – 0.294X_1 – 0.030X_2$. The calculation result of significance test on the regression equation is presented in the following table.

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

Table 7. ANAVA Table of Significance Test on the Regression Equation $\hat{Y} = 62.966 - 0.294X_1 - 0.030X_2$

Source of Variance	dk	JK	RJK	$F_{calculation}$	F_{table}	
					α =0.05	α =0.01
Total	1	979.560				
Regression b	2	256.042	128.021	17.163**	3.11	4.83
Residual (S)	97	723.518	7.459			

Notes:

** = *Regression is very significant ($F_{cal} = 17.163 > F_{table} = 4.83$) at $\alpha = 0.01$*

JK = Number of squares

Dk = Degree of freedom

RJK = Average number of squares

Based on the table of significance test on the regression equation above, it can be concluded that the multi-regression equation $\hat{Y} = 62.966 - 0.294X_1 - 0.030X_2$ is very significant. The conclusion is based on the value of F_{cal} (17.163) > F_{table} (4.83) at $\alpha = 0.01$.

The result of calculation concerning the influence of human factor and runway quality simultaneoulsy on aircraft accident is indicated by $R_{y.12} = 0.511$. The significance test of the coefficient of multiple correlation can be seen in the following table.

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

Table 8. Significance Test on the Coefficient of Corelation of the Influence of Human Factor and Runway Quality Simultaneously on Aircraft Accident

Number of Observations (n)	Coefficient of Correlation ($r_{y.12}$)	Coefficient of Determination ($r_{y.12}^2$)	$F_{calculation}$	F_{table}	
				α= 0.05	α= 0.01
100	0.511	0.261	17.163**	3.94	6.90

Note:

** *Coefficient of correlation is very significant (F_{cal} = 17.163 > F_{table} = 6.90) at α = 0.01*

The coefficient of correlation shows the influence of human factor and runway quality smultanoeiuly on aircraft accident amounting 0.511. The coefficient of correlation shows a strong correlation, so the better human factor and runway quality, the lower the degree of aircraft accident will be. From the calculation in the significance test of the coefficient of multiple correlation it is found the value of F_{cal} = 17.163 > F_{table} = 6.90 at α = 0.01, so that it can be concluded that the influence of human factor and runway quality simultaneously on aircraft accident with the coefficient of correlation ($R_{y.12}$) = 0.511 is very significant. Thus, there is a negative and very significant influence of human factor and runway quality simultaneously on aircraft accident.

From that coefficient of correlation, the coefficient of determination can be known as 0.261 or the variation of coefficient of determination amounting 26.1%. It

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http://proceedings.itltrisakti.ac.id/index.php/atlr

means 26.1% of the variation of aircraft accident can be explained by human factor and runway quality through the regression equation $\hat{Y} = 62.966 – 0.294X_1 – 0.030X_2$.

Discussion

The result of this study empirically proves that human factor negatively and very significantly influences aircraft accident. This finding signalizes that human factor is very vital to flight, especially to reduce the risk of aircraft accident. Human factor is an individual capacity to act in various organizational situations which is reflected in the employees' knowledge, skills, competence, and attitude. When all the potential resources are well contributed to the viability of aviation organizations, then this can minimize the aircraft accident, that is an unpredicted occurence, initially unexpected which disrupts the process of an activity that has been set up and can cause loss for human beings and properties due to human factor, mechanical factor, and environmental factor. Research by Wiegmann and Shappell (2001) shows that the accidents of commercial flight are caused by human factor. Thus, this finding conforms and strengthens the previous research as well as asserts the empirical evidence that human factor negatively influences aircraft accidents, especially scheduled commercial aircrafts.

The result of this study also proves empirically that runway quality negatively and very significantly influences the accidents of scheduled commercial aircrafts. This finding signalizes that runway quality is very vital to flights, especially to reduce the risk of aircraft accident. Runway quality is the total characteristics of a certain

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Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

rectangular area at an airport in the land or water used for aircraft landing and takeoff, which is manifestated in structural pavement, shoulder, blast pad, runway safety area, and extended safety area. When the runway quality is good, it will reduce the risk of aircraft accident. Aircraft accident is an unpredicted occurence, initially unexpected which disrupts the process of an activity that has been set up and can cause loss for human beings and properties due to human factor, mechanical factor, and environmental factor. Research by Taylor and Godley (2009) shows that the condition of runway influences aircraft accidents. So, this finding conforms and strengthens the previous research as well as asserts the empirical evidence that runway quality negatively influences aircraft accidents, especially scheduled commercial aircrafts.

In addition, the result of this research proves empirically that human factor and runway quality negatively and very significantly influences aircraft accidents. This finding signalizes that human factor and runway quality are very vital to flights, especially to reduce the risk of aircraft accident. If in a same time human factor and runway quality are in good conditions and are sufficient, then this can minimize the risk of aircraft accident. So, this finding strengthens the previous research as well as asserts the empirical evidence that human factor and runway quality negatively influences aircraft accidents, especially scheduled commercial aircrafts.

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Advances in Transportation and Logistics Research
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Conclusions

1. Human factor negatively and very significantly influences aircraft accidents. This finding indicates that improvements in human factor will reduce aircraft accidents.
2. Runway quality negatively and very significantly influences aircraft accidents. This finding indicates that improvements in runway quality will reduce aircraft accidents.
3. Simultaneously, human factor and runway quality negatively and very significantly influences aircraft accidents. This finding indicates that improvements in human factor and runway quality will reduce aircraft accidents.

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