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Factors That Affecting Pilot Performance And Aircraft Accident Using Partial Least Square (Pls)

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***Abstract**: Air transport are held when there is an interaction between the human factor with the other factors, as well as aircraft accidents occur due to the interaction between the human factor and the other factors causing accidents. Based on this background, the objective of this research is to examination the condition of aviation operations which consisted of phases of time, phase of flight, terrain condition, and weather on the occurrence of aircraft accidents directly and also influence on the pilot itself in this case is the effect on performance that could cause aircraft accidents indirectly. The research analysis is using Partial Least Square (PLS) method. The result of the study shows that, H1 (phases of time with performance), H4 (phase of flight with accident), H5 (terrain condition with performance), H7 (weather with performance) and H8 (weather with accident) proved has positive and significant effects. Meanwhile H3 (phase of flight with performance), H6 (terrain condition with accident) and H9 (performance with accident) has negative relations and no significant effects, while H2 (phases of time with accident) has positive relations but not significant effects.*
***Keyword**: Aircraft Accident, Performance, Partial Least Square*

I. Introduction

One of the problems that face in the world of aviation is the increasing of aircraft accident frequency. Increased accidents can be an indicator for operational readiness of the flight. Air transport are held when there is an interaction between the human factor with the other factors, as well as aircraft accidents occur due to the interaction between the human factor and the other factors causing accidents.

Some studies that discuss the influence of external factors that could affect the occurrence of an aircraft accident had been done in previous studies, including the influence of the weather, the location, phase of flight, type of aircraft, and the flight conditions that could affect the occurrence of aircraft accidents caused by human.

The relationship between the effect of weather toward aircraft accident is supported by research conducted by Saleem and Kleiner (2005); Wong, et.al. (2006); Jarboe, (2005); Batt and O'Hare, (2005); Coyne, et.al. (2001); Capobianco and Lee, (2001); Goh and Wiegmann, (2002); Li, et.al. (2009); Wiegman, et.al, (2002); Burian, et.al. (2000); and Bustamante, et.al. (2005). The result shows that there is a significant correlation between the weather conditions with the occurrence of an aicraft accident, it because the aircraft is the mode that is very dependent on weather conditions, either take-off or in a cruise, the weather conditions greatly affect the operation of the aircraft. In addition, flight operating conditions (IMC or VFR) in order the influence of the weather that could lead to accidents have also been carried out by Jarboe, (2005); Batt and O'Hare, (2005); and Coyne, et.al. (2001), empirically show that the operation of the flight (IMC or VFR), influence the occurrence of aircraft accidents.

Meanwhile, empirical studies that discusses the effect of the terrain condition of an area toward aircraft accident performed by Rebok, et.al. (2009); Grabowski, et.al. (2002); Changchun and Dongdong, (2012); Li and Kearney, (2000); Grabowski, et.al. (2002); Li, et.al. (2009); and Ayres, et.al. (2012), revealed that the location of an area have a significant effect on the occurrence of an aircraft accident. This is because there are differences in the each surface of area, there is allowing similarlyof a difference in an area of potential accidents with each other.

While the factor of time is also allegedly linked to the occurrence of an aircraft accident, it was stated by a study conducted by Sungkawaningtyas, (2007); De Mello, et.al. (2008); Li, et.al. (2009); Rosekind, et.al. (2006); Goode (2003); Tvaryanas and MacPherson, (2009); Pruchniki, et.al. (2010); Conway, et.al. (2005); and Saleem and Kleiner (2005).

The relationship between the phase of flight with aircraft accident is supported by research conducted by Wignjosoebroto and Zaini, (2007); Schvaneveldt (2000); and Tiabtiamrat, et.al, (2009), the result shows that the aircraft accident was also influenced by the phase of flight an aircraft, because the phase of flight is the stage of flying of an aircraft from take-off until the next landing so the possibility of accidents at this stage is large enough.

This study is intended to fill a gap of previous research that can complement and improve it, research gap to be filled are, if previous research mostly examine the relationship between the various factors that can affect humans in this case the pilot toward occurence of an accident, so in this study in addition to discussing the factors that may result in an accident directly also to examine indirectly, in this case going through the mediating variable, there is pilot performance with the aircraft accidents.

Based on this background, the objective of this research is to examines the condition of aviation operations which consisted of phases of time, phase of flight, terrain condition, and weather on the occurrence of aircraft accidents directly and also influence on the pilot itself in this case is the effect on performance that could cause aircraft accidents indirectly.

II. Materials And Method

In this study a tool for solve the problem is using Structural Equation Modelling (SEM) based variance with the approach of Partial Least Square (PLS). Partial least squares (PLS) is a method for constructing predictive models when the factors are many and highly collinear. Note that the emphasis is on predicting the responses and not necessarily on trying to understand the underlying relationship between the variables. For example, PLS is not usually appropriate for screening out factors that have a negligible effect on the response. However, when prediction is the goal and there is no practical need to limit the number of measured factors, PLS can be a useful tool. In the PLS method, a model was built are contain two essential components, there are, structure model and parameters model. The structure model illustrates the schematic relationship between variables. Meanwhile parameters model inform or influence the nature of the relationship between these variables. The expected result is a significant relationship or real path coefficient value (ρ) between latent variables (aircraft accident) and manifest variables consist of pilot performance, phases of time, phase of flight, terrain condition, and weather. The same is expected for the latent variables of pilot performance with manifest variables: phases of time, phase of flight, terrain condition, and weather.

Survey to collect required data in this research was conducted by distributing questionnaires to be filled by the respondent in accordance with the characteristics of the population, in this case the civilian aircraft pilot that operate scheduled aircraft (Aircraft Operations Certificated (AOC) 121). The sample size was 260 respondents pilot.

III. Results And Discussion

Data analysis was performed using LVPLS that will produce measurement model (outer model) and structural model (inner model). There are two endogenous variables (Pilot performance and accident), and four exogenous variables and acts as the independent variables (phases of the time, phase of flight, terrain condition, and weather). The effect of the relationship between variables is positive and significant estimated, the conseptual model can be illustrated as in Figure 1.

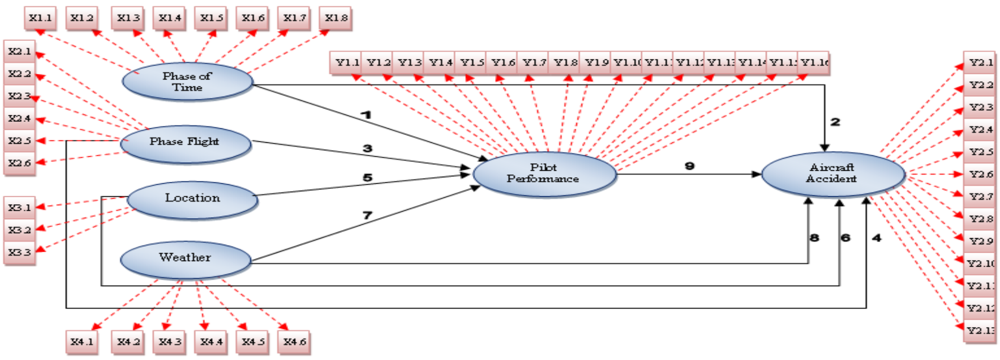

Figure 1. Proposed hyphothetical model

Table 1. the hyphotheses of relationships between model variables

H1. There is a positive & significant relationship between phases of time wiih pilot performance.
H2. There is a positive & significant relationship between phases of time with aircraft accident.
H3. There is a positive & significant relationship between phase of flight with pilot perfomance.
H4. There is a positive & significant relationship between phase of flight with aircraft accident.
H5. There is a positive & significant relationship between terrain condition with pilot perfomance.
H6. There is a positive & significant relationship between terrain condition with aircraft accident.
H7. There is a positive & significant relationship between weather with pilot perfomance.
H8. There is a positive & significant relationship between weather with aircraft accident.
H9. There is a positive & significant relationship between pilot perfomance with aircraft accident.

Table 2. Exogenous and endogenous variable

	Variable	Indicator
Exogenous	Phases of time	mornng (X1.1), afternoon (X1.2), night (X1.3), early morning (X1.4), weekend (X1.5), weekday (X2.6), peak season (X1.7), non-peak season (1.8)
	Phase of flight	take off (X2.1), climb (X2.2), cruise (X2.3), descent (X2.4), approach (X2.5), landing (X2.6)
	Terrain	plateau (X3.1), Mountainous (X3.2), relatively flat (X3.3)
	Weather	wind (X4.1), visibility (X4.2), pressure (X4.3), cloud (X4.4), temperature (X4.5), ceiling (X4.5)
Endogenous	Performance	flight hour (Y1.1), rating type (Y1.2), work (Y1.3), comunication (Y1.4), training (Y1.5), problem solving (Y1.6), health (Y1.7), fare (Y1.8), benefit income (Y1.9), responsibility (Y1.10), workload (Y1.11), carrer (Y1.12), SOP (Y1.13), SMS (Y1.14), facility & human resources (Y1.15), promotion (Y1.16)
	Accident	human (Y2.1), age (Y2.2), total flight hour (Y2.3), gender (Y2.4), rating type (Y2.5), IQ (Y2.6), education leve; (Y2.7), fatigue (Y2.8), ageing aircraft (Y2.9), engine of aircraft (Y1.10), type of aircraft (Y2.11), company policy (Y2.12), gap experience (Y2.13)

IV. Data Analysis

Partial Least Square (PLS) modeling was used to test and analyze the hypothesized relationship of the research model in Figure. 1. PLS aims to examine the inter-related relationships simultaneous between a set of posited constructs, each of which is measured by one more observed item. PLS involves the analysis of two models: a measurement or factor analysis model (outer model) and structural model (inner model). The measurement model specifies the relationships between the observed measures and their underlying construct, with the constructs allowed to inter-correlate. The structural model specifies the posited causal relationships among the constructs.

a. Measurement outer model

A preliminary evaluation of the measurement model is validating item. Validity examination was conducted to determine the extent to which the instrument's ability to measure things that are to be measured. It can be seen from the loading factor value. Loading factor value below 0,5 will be dropped from the model. From processing there are two indicators that dropped from the model because it has a loading factor value below 0,5, so the remaining 50 indicators that meet the criteria.

The next review is to see the reliability of the construct. Reliability of a tools that shows the stability and consistency of an instrument to measure a concept or variable (Cooper & Schindler, 2008). There are two methods to review the reliability, there are Cronbach's alpha and composite reliability. Cronbach's alpha measures the lower limit reliability value of a construct, while the composite reliability measures the actual value of a construct. Between the two method, composite reliability is considered better in estimating the internal consistency of a construct (Salisbury, et.al, 2002 in Abdillah, 2008). According Hartono (2008), the criteria of Cronbach's alpha reliability value can be divided into three categories, there are: low (< 5,0); sufficient (0,5-0,6); and high (0,7 to 0,8). In this study, the construct is expressed reliable if it has value and the composite reliability or Cronbach's alpha is 0,7. Based on the results of data examination, it shows that for the whole construct composite reliability value is > 0,7, while there is Cronbach's alpha reliability value less than 0,7, which is the location (0,661076). However, when used in composite reliability method, reliability construct value its above 0,70. Thus, the data used in this study met the criteria of reliability, consistency and accuracy in measuring the concept were built.

b. Measurement inner model

Assessing the inner model is a look at how much power the exogenous variables or endogenous variables that are independent contribute to endogenous variables that are dependent on the model of this research by looking at the value of R^2 in each of the endogenous variables. According Hartono (2009) R^2 value was used to measure the degree of variation of the change of independent variables on the dependent variable. Thus, the higher R^2 value the better the prediction model predicts the proposed research.

Table 3. R-square value

Construct	R-square	Galat variable
Phases of time	-	-
Phase of flight	-	-
Terrain condition	-	-
Weather	-	-
Performance	0,440	0,560*
Accident	0,739	0,261

Source: Data processing with LVPLS, 2015 Description: * $Ó = 1- (R_1^2).....(R_n^2)$; $Ó = 1 – 0,440$

Table 3 above, shows that more than 40 percent (44%) the variance (R^2 = 0,44) of performance is explained by phases of time, phase of flight, terrain condition and weather. In other words, the amount of performance error is 0,56, or 56% pilot performance is influenced by other variables outside the model proposed. Meanwhile, from empirical results show that more than 70 percent of variance (R^2 = 0,739) of accident is explained in together by phases of time, phase of flight, terrain condition, weather, and performance, and the rest influenced or explained by other variables. In other words, the amount of accidents error is 0,261 or 26,1% accident are influenced by other variables. Phases of time, phase of flight, terrain condition and weather construct does not have a R^2 value as an independent variable in our model.

Examination and Hyphotheses Discussion

To examines the hypothesis that proposed in this study can be done by showing the significance level and the coefficient parameter (ρ) between latent variables. Therefore, the direction of this hypothesis in the model was a positive relationship, so the test will be used one-tailed test (Hartono, 2009). Hartono (2009) continues that confident level is widely used is 95% and 99%, or alpha 5% and 1% with t table 1,64 and 2,33 for one-tailed test, while for confidence level 90% or alpha 10% for one-tailed test with t-table 1,28 are considered marginal.

This research is positive directional, so that the examination is using one-tailed test with t-statistic value is 1,64 and with confidence coefficient 95% or probability of conviction that a value will be tested with an alpha of 5%. To determine the suitability of the proposed model in a population can be seen the value of the relationship between one variable to another variable or coefficient parameter (ρ) value by looking the Entire Sample Estimate value and t-statistics value from the output of LVPLS as an expression level of significance of the relationship between the variables with other variables.

Table 4. Inner weight

	Entire Sample Estimate	Mean of Sub sample	Standard Error	T- Statistic
Time->Performance	0,117	0,1137	0,0547	2,1405
Time->Accident	0,003	0,0349	0,0301	0,0998
P. Flight-> Performance	-0,69	-0,6953	0,1277	-5,4052
P. Flight-> Accident	0,333	0,3244	0,078	4,2711
Terrain-> Performance	0,661	0,6231	0,1578	4,1901
Terrain-> Accident	-0,031	-0,0511	0,0385	-0,8052
Weather-> Performance	0,584	0,6341	0,2504	2,3321
Weather-> Accident	0,625	0,6448	0,0694	9,0084
Performance-> Accident	-0,179	-0,1872	0,053	-3,3756

Source: Data processing with LVPLS, 2015

All test results were generated by the PLS is to look at the t-statistic. T-statistic resulting from original sample value divided by the standard error. The test results revealed a significant effect if the t statistic > t table. T table is certainly by looking the confidence level value. In this case if the confidence level is 95%, the t table 1,64 (one-tailed test). These values were compared with t-statistic produced by the PLS. The rho (ρ) value is in addition has a positive there is also a negative. A negative value is the resistor value and a correction variable. The influence of these variables are not always positive as desirable in concept, but it can be negative. This situation can not be avoided in a real situation, as many occur at several theories

The following is an explanation of the test and hypotheses verification that have been made in this research.

Interpretation of hyphotheses one

Hyphotheses one (H1) proposed in this research is the phases of time has positive and significant effect on the pilot performance. It is mean that the phases of time is used as a predictor of pilot performance. Based on test results using PLS method, there is a positive and significant relationship between phases of time with pilot performance, with a coefficient parameters (ρ) is 0,117. This can be evidenced by looking at the t-statistic greater than 1,64 with a confidence level of 95% or alpha 5%, which is equal to 2,1405. Thus, the hypothesis one of this study statistically supported and accepted. In other words, show that the phases of time factors can affect a pilot's performance, because in the world of aviation is known a cycle of passengers flow, there is peak season which usually take a place during the school holidays, year end holiday, eid holiday and weekend holiday. Another cycle of passengers flows is non peak season which usually held in January and August-November. There is also peak traffic hour which starts from 06.00 until 21.00 pm, that it all can affect a pilot's performance in carrying out their duties.

There has been no research that studies the relationship between phases of time and performance by using PLS. However, there has been some bivariate and multivariate research which analyzed the relationship beteween phases of time and performance indicators, with the results is appropiate or not appropiate to these study.

The results are appropiate with Saleem and Kleiner (2005) research. The research were conducted to determine the effects of time and weather conditions on the workload, performance and situation awareness of pilot. The Results of the analysis shows that there was no correlation between the condition of flight operations conducted at night and during good or bad weather with the possibility of accidents occurence, but there is a difference to the performance, situation awareness and workload of the pilot.

Interpretation of hyphotheses two

Hyphotheses two (H2) proposed in this research is the phases of time has positive and significant effect on the aircraft accident. These hyphotheses shows that the phases of time is used as a predictor of aircraft accident. Based on test results using PLS method, there is a positive relationship but not significant between phases of time with aircraft accident. It is based on the results of tests in which obtained coefficient parameter (ρ) value is 0.003 and the t-statistics value under 1,64 with a confidence level of 95% or alpha 5%, which is equal to 0,0998. Thus, hypothesis two in this study is not supported statistically and rejected. This illustrates that the phases of time does not affect the occurrence of an aircraft accident. In other words, the occurrence of an aircraft accident can occur anytime without knowing the time, it can be happen in morning, noon, and evening. An accident in aviation is an occurrence that emergence can be unpredictable and inevitable. The process of the incident can be described as being joined together in every trip, but hidden and will appear suddenly at the time one or several determining factors in the occurrence of other safety conditions of negligent or did not fully follow the rules that should be met and implemented.

There has been no research that studies the relationship between phases of time and aircraft accident by using PLS. However, there has been some bivariate and multivariate research which analyzed the relationship beteween phases of time and aircraft accident indicators, with the results is appropiate or not appropiate to these study.

Results of this study are not in accordance with the study conducted on similar research, the study was conduct in Brazil that to provide an analysis of the periods of the day in which pilots working for a commercial airline presented major errors. The result of the study shows that the according to airline flight schedules in Brazil, 35% of flights take place in the morning period, 32% in the afternoon, 26% at night, and 7% in the early morning. Data showed that the risk of errors increased by almost 50% in the early morning relative to the morning period (ratio of 1:1.46). For the period of the afternoon, the ratio was 1:1.04 and for the night a ratio of 1:1.05 was found. These results showed that the period of the early morning represented a greater risk of attention problems and fatigue. (De Mello, et.al, 2008). Incompatibility results of this study with previous research that has been done is because the study used a different methods of analysis and also difference state of respondent.

Incompatibility results of this study with the results of research that was reviewed also found in a study conducted by Goode (2003), the study is concern in the aviation community that pilot schedules can lead to fatigue and increased chance of an aviation accident. The result of the study shows that the proportion of accidents associated with pilots having longer duty periods is higher than the proportion of longer duty periods for all pilots. The analysis also suggests that establishing limits on duty time for commercial pilots would reduce risk. Such a rule is likely to be expensive and could substantially influence the commercial airlines. In return, there is likely to be a reduction in the risk of commercial aviation accidents due to pilot fatigue. The same study on flight time schedule and aircraft accident was also carried out by Rosekind et.al. (2006). The result of the research shows that there are significant relationship between fatique that occure aircraft accident with flight time schedulling.

However, these findings are consistent with research was conduct by Saleem and Kleiner (2005). The research were conducted to determine the effects of time and weather conditions on the workload, performance and situation awareness of pilot. The Results of the analysis shows that there was no correlation between the condition of flight operations conducted at night and during good or bad weather with the possibility of accidents occurence, but there is a difference to the performance, situation awareness and workload of the pilot.

Interpretation of hyphotheses three

Hyphotheses three (H3) proposed in this research is the phase of flight has positive and significant effect on the pilot performance. These hyphotheses shows that the phases of flight is used as a predictor of pilot performance. From the analysis using LVPLS by selecting a reflective measurement model shows that the relationship between the phase of flight with performance has negative directional and had no significant effect (for a 5% error level, one tailed test). This can be seen from the t-statistic is -5,4052, which is smaller than 1,64 with a confidence level of 95% or alpha 5%, and the coefficient parameter (ρ) of -0,69, which means phase of flight is correction variable to pilot performance. Thus, hypothesis three in this study is not supported statistically and rejected. This illustrates that the phase of flight does not affect the occurrence of pilot performance.

Interpretation of hyphotheses four

Hyphotheses four (H4) proposed in this research is the phase of flight has positive and significant effect on the aircraft accident. It is mean that the phases of flight is used as a predictor of aircraft accident. There is a positive and significant relationship between phases of flight with aircraft accident, with a coefficient parameters (ρ) is 0,333. This can be evidenced by looking at the t-statistic greater than 1,64 with a confidence level of 95% or alpha 5%, which is equal to 4,2711. Thus, the hypothesis four of this study statistically supported and accepted. In other words, show that the phases of flight can affect the occurrence of aircraft accident.

There has been no research that studies the relationship between phase of flight and pilot performance by using PLS. However, there has been some bivariate and multivariate research which analyzed the relationship beteween phase of flight and pilot performance indicators, with the results is appropiate or not appropiate to these study.

The results consistent with Tiabtiamrat et.al. (2009) research. The result of reseach shows that the phase of flight on the Boeing 737 has a significant effect on the occurrence of a an aircraft accident, but this is not related to the number of victims affected, where data of accidents involving Boeing aircraft was taken from 1967 to 2006.

This result finding is also consistent with Cardi et.al. (2012) research, which indicates that the landing phase which includes approach and landing phase it self has a high value and significant impact on the occurrence of an accident compared with the take off and climb phase. In his research also found that the results for the approach phase, the highest accident which occurred before the runway (88%), while for the landing phase, the highest accident occurred after the runway (46%).

Similar results were found in research was conduct by Schvaneveldt et.al. (2000). The result of study found that among the phase of flight in the operation of aircraft, takeoff, approach and landing have a high workload value during normal conditions of operation of the aircraft. In the study also found that aircraft accidents often occur in takeoff, approach and landing phase.

While the research conducted by Wignjosoebroto and Zaini (2007), which discusses the relationship between the phase of flight with the occurrence of accidents are represented by the workload variable also proved that the phase of flight give a significant impact on the workload of pilots that can affect the safety of operation flight, the study also compared between the pilots who operate different types of aircraft (Fokker 28 and Boeing 737).

This consistency suggests that the phase of flight may influence the occurrence of aircraft accident, it because aircraft accidents can occur at the stage of operation of the aircraft, start from taxiing, take-off, climb, cruise, and a landing stage which starts from the descent, approach, touch down until the aircraft stopped on the apron of the destination airport. Among the further phases in flight operations, take off and landing phase is the most critical and dangerous in flight operations, it is possible due to the fact that the take off and landing is the phase that occurs near the ground, resulting in a greater risk in the safety aspect. Moreover, at this stage there are also many replacement aircraft operation procedure to be performed by the pilot so that the risk of error can increase.

Interpretation of hyphotheses five

Hyphotheses five (H5) proposed in this research is the terrain condition has positive and significant effect on the pilot performance. It is mean that terrain condition on the flight route and the airport is used as a predictor of pilot performance. Based on test results using PLS method, there is a positive and significant relationship between terrain condition with pilot performance, with a coefficient parameters (ρ) is 0,661. This can be evidenced by looking at the t-statistic greater than 1,64 with a confidence level of 95% or alpha 5%, which is equal to 4,1901, Thus, the hypothesis five of this study statistically supported and accepted. In other words, show that the terrain condition or refer to the surface of the earth containing naturally occuring features such as mountains, hills, ridges, valley, bodies of water, permanent ice and snow, and excluding obstacles, can affect the pilot performance.

Interpretation of hyphotheses six

Hyphotheses six (H6) proposed in this research is the terrain condition has positive and significant effect on the aircraft accident. It is mean that terrain condition on the flight route and the airport is used as a predictor of aircraft accident. The result of the anayzed shows that the relationship between terrain condition with aircraft accident has negative directional and had no significant effect (for a 5% error level, one tailed test). This can be seen from the t-statistic is -0,8052, which is smaller than 1,64 with a confidence level of 95% or alpha 5%, and the coefficient parameter (ρ) of -0,031, which means terrain condition is correction variable to aircraft accident.

Thus, hypothesis six in this study is not supported statistically and rejected. This illustrates that the terrain condition does not affect the occurrence of an aircraft accident.

There has been no research that studies the relationship between terrain condition and aircraft accident by using PLS. However, there has been some bivariate and multivariate research which analyzed the relationship beteween terrain condition and aircraft accident indicators, with the results is appropiate or not appropiate to these study.

The results of this study are not incompatibility with the study was conducted on similar research. Changchun and Dongdong (2012), in his research that uses gray incident analysis methods to examine the areas most prone to accidents in China, it is found that the area of Southeast China that have a highlands terrain condition have a high relevance for the occurance of aircraft accident, and the research also found that high terrain areas can affect humans in this means is pilot to perform actions that led to human error. Besides effect on human error, high terrain area also storing the potential danger posed by the animals in this case birds, because of the results of the research found that the cause of the accident in that area was also caused by birds (birds strike).

These result incompatibility to the research was conduct by Grabowski et.al. (2002). In the research Geographic information systems and exploratory spatial analysis were used to describe the geographic characteristics of pilot fatality rates in 1983–1998 general aviation crashes within the continental United States. The result of the study shows that the 14,051 general aviation crashes studied, 31% were fatal. Seventy-four geographic areas were categorized as having low fatality rates and 53 as having high fatality rates. High-fatality-rate areas tended to be mountainous, such as the Rocky Mountains and the Appalachian region, whereas low-rate areas were relatively flat, such as the Great Plains.

Moreover, the result is also incompability with Li an Kearney (2000) research, the research was conduct to know the relationship of crash risk and mortality with respect to geographic area. The result of the study shows that the calculated United States crash rate is 8.9 crashes per 100,000 flight hours. The Alaskan and Northwest Mountain regions had the highest crash rates and fatal crash rates. It also shows that even when the amount of flying is controlled for, crash rates and fatal crash rates are highest in mountainous regions. Our results indicate that aviation safety in mountainous regions deserves more attention.

These result also incompatibility to the research was conduct by Grabowski et.al. (2002), This study examined the geographic patterns of pilot fatality rates in commuter and air taxi operations. The result of the study shows that the 1094 commuter and air taxi crashes studied, 25% resulted in a pilot fatality. A large geographic area with a pilot fatality rate of > or = 36% extended through portions of Michigan, Indiana, and Illinois. A relatively low fatality rate (< 15%) prevailed over an area extending from Texas to northwest Georgia. Crashes in high-rate areas were significantly more likely than crashes elsewhere to have occurred at night and during instrument meteorological conditions.

Incompatibility results of this research with the research that has been explored to the previous studies is due to difereence of analytical methods and data analysis used.

Interpretation of hyphotheses seven

Hyphotheses seven (H7) proposed in this research is the aviation weather has positive and significant effect on the pilot performance. It is mean that aviation weather is used as a predictor of pilot performance. Aviation weather is refers to the weather which dedicated to the aviation world. Weather information is given at any time during the aircraft planing the flight which will be adapted to the flight schedule. Weather information which given at the time of take off, cruise and landing includes some weather elemants, there are: wind condition, visibilty condition, pressure, cloud, ceiling and temperature.

From the analysis using LVPLS by selecting a reflective measurement model shows that there is a positive and significant relationship between weather with pilot performance, with a coefficient parameters (ρ) is 0,582. This can be evidenced by looking at the t-statistic greater than 1,64 with a confidence level of 95% or alpha 5%, which is equal to 2,3321. Thus, the hypothesis seven of this study statistically supported and accepted. In other words, show that the weather can affect the pilot performance in carrying out its duty to operate the aircraft. The result of this research was appropiate with Saleem and Kleiner (2005) research. The research were conducted to examine the effects of time and weather conditions on the workload, performance and situation awareness of pilot. The Results of the analysis shows that there was no correlation between the condition of flight operations conducted at night and during good or bad weather with the possibility of accidents occurence, but there is a difference to the performance, situation awareness and workload of the pilot.

Interpretation of hyphotheses eight

Hyphotheses eight (H8) proposed in this research is the aviation weather has positive and significant effect on the aircraft accident. It is mean that aviation weather is used as a predictor of aircraft accident. Based on test results using PLS method, there is a positive and significant relationship between weather with aircraft accident, with a coefficient parameters (ρ) is 0,625. This can be evidenced by looking at the t-statistic greater than 1,64 with a confidence level of 95% or alpha 5%, which is equal to 9,0884. Positive impact shows the directional influence, it is mean when there is a change the weather condition, the potential occurrence of an airplane accident will also increase. This is because, in modes of transportation, air transportation is the mode that is very dependent on weather conditions, either the aircraft will take off and on the cruise, weather phenomena which are beyond the control of human existence are often inserted into the factors which may be the cause of a accident. Thus, the hypothesis eight of this study statistically supported and accepted.

There has been no research that studies the relationship between aviation weather and aircraft accidnet by using PLS. However, there has been some bivariate and multivariate research which analyzed the relationship beteween aviation weather and aircarft accident indicators, with the results is appropiate or not appropiate to these study.

These result is appropiate with Capobianco and Lee (2001) research. This research discusses an analysis that was undertaken to identify the causes, contributing factors and associated issues of weather-related General Aviation (GA) accidents. Results suggest the most prevalent factors in fatal weather accidents are low ceiling (20%), fog (14%), wind (10%), and night (9%). Visual Flight Rule (VFR) to Instrument Meteorological Condition (IMC) flight and flight into adverse weather during the cruise phase are the most common probable causes of fatal weather accidents.

Research was conduct by Wong et.al. (2006) also showed similar results with the results of this study. The aims of the study is to examine the relationship between accidents with weather seen from flight procedures by using (Instrument Meteorological Condition (IMC) and Visual Meteorological Condition (VMC) proceudre. The result of the study that using chi square test shows that the IMC or VMC flying conditions have a significant relationship to the occurrence of an aircraft accident. While using the RAIR (Relative Accident Involvement Ratios) test, found that IMC conditions have a great relationship to the occurrence of accidents compared with VMC conditions. The same result was found in the Jarboe (2005) research, which examines the relationship between accidents caused by weather through viewed from the flight operational procedures. The result of the study shows that approximately 88% of the aviation weather-related fatalities can be attributed to Operations in Instrument Meteorological Conditions (IMC).

Consistency of these results with the results of research that has been studied, suggesting that weather phenomena are beyond the control of human existence is often incorporated into the factors that may be the cause of a aircraft accident. Experience suggests that various aircraft accident that occurred in Indonesia and in the world often occur due to interference from weather. Weather disturbances that occur in nature is something that is natural and can no longer inevitable.

In addition to some of the research that has been previously described, there is also a study that does not comply with these results. This study is not in accordance with research conducted by Saleem and Kleiner (2005). The research were conducted to determine the effects of time and weather conditions on the workload, performance and situation awareness of pilot. The Results of the analysis shows that there was no correlation between the condition of flight operations conducted at night and during good or bad weather with the possibility of accidents occurence, but there is a difference to the performance, situation awareness and workload of the pilot.

Interpretation of hyphotheses nine

Hyphotheses nine (H9) proposed in this research is the pilot performance has positive and significant effect on the aircraft accident.. Based on the calculation above (Table 5), the relationship between pilot performance with aircraft accident has negative directional and had no significant effect (for a 5% error level, one tailed test). This can be seen from the t-statistic is -3,3756, which is smaller than 1,64 with a confidence level of 95% or alpha 5%, and the coefficient parameter (ρ) of -0179, which means pilot performance is correction variable to aircraft accident. Thus, hypothesis nine in this study is not supported statistically and rejected. This illustrates that the pilot performance does not affect the occurrence of an aircraft accident.

Hyphotheses Summary

The result of the research shows that H1, H4, H5, H7 and H8 proved positive and significant effects. While H3, H6 and H9 has negative and not significant effects, and H2 is positive but not significant effects. Summary results are presented in Table 3 as below:

Table 3. Hyphotheses examination results

Hyphotheses	Results	Explanation	Conclusion
H1: There is a positive & significant relationship between phases of time with performance	ρ = 0,117 t-statistic = 2,1405	Positive & significant	H1 is confirmed
H2: There is a positive & significant relationship between phases of time with accident	ρ = 0,003 t- statistic = 0,0998	Positive & no significant	H2 is rejected
H3: There is a positive & significant relationship between phase of flight with performance	ρ = -0,69 t- statistic= -5,4052	Negative & no significant	H3 is rejected
H4: There is a positive & significant relationship between phase of flight with accident	ρ = 0,333 t- statistic = 4,2711	Positive & significant	H4 is confirmed
H5: There is a positive & significant relationship between terrain with performance	ρ = 0,661 t- statistic = 4,1901	Positive & significant	H5 is confirmed
H6: There is a positive & significant relationship between terrain with accident	ρ = -0,031 t- statistic = -0,8052	Negative & no significant	H6 is rejected
H7: There is a positive & significant relationship between weather with performance	ρ = 0,584 t- statistic = 2,3321	Positive & significant	H7 is confirmed
H8: There is a positive & significant relationship between weather with accident	ρ = 0,625 t- statistic = 9,0084	Positive & significant	H8 is confirmed
H9: There is a positive & significant relationship between perfomance with accident	ρ = -0,179 t- statistic = -3,3756	Negative & no significant	H9 is rejected

Source: primary data processing

Direct and Indirect Relationship Examination

To determine the value of the direct, indirect, and total effects can be seen from the results of path analysis. Analysis of this pathway is a further development of the multiple regression analysis and bivariate, involving several exogenous and endogenous variables simultaneously, thus increasing testing of the variables that are positioned as the mediating variable (Ghozali, 2007).

Table 8. Direct, inderect and total effect

	Expected influence	Direct effects		Indirect effects	Total effects
		ρ value	t value *		
Performance (R^2=0,440)					
- Phases of Time	+	0,117	2,1405	----	0,117
- Phase of Flight	+	-0,690	-5,4052	----	-0,690
- Terrain	+	0,661	4,1901	----	0,661
- Weather	+	0,584	2,3321	----	0,584
Accdient (R^2=0,739)					
- Phases of Time	+	0,003	0,0998	-0,020	-0,017
- Phase of Flight	+	0,333	4,2711	0,124[1]	0,457
- Terrain	+	-0,031	-0,8052	-0,118	-0,149
- Weather	+	0,625	9,0084	-0,105	0,520
- Performance	+	-0,179	-3,3756	----	-0,179

Explanation:0,690 x (-0,179)=0,124; * t-table α 5%= 1,64

From the analysis above is obtained the direct relationship equations model between performance variable with phases of time, phase of flight, terrain condition and weather, as a mathematical equation below:

$Y_1= \alpha_1X_1 + \alpha_2X_2 + \alpha_3X_3 + \alpha_4X_4 + Ó_1$

Or

$Y_1= 0{,}117X_1-0{,}69X_2+0{,}661X_3+0{,}584X_4+ 0{,}560$

Explanation: Y_1= performance; X_1 = phases of time; X_2 = phase of flight; X_3 = terrain; X_4 = weather; $Ó_1$ = perfomance error

The equation can be read that the increase and decrease of performance, decisively influenced by the phases of time (0,117); terrain condition (0,661); and weather (0,584) and other variables outside the model, or can be translated into a simple sentence as follows:

1) Each phases of time increase of 1%, will improve the performance dimension of 0,117 or 11.7%, with assumption other variables in this model are fix.
2) Each phase of flight dimension increase of 1%, it would reduce the performance dimension of 0,69 or 69%, with assumption other variables in this model are fix. Phase of flight variable is become correction variable or inhibitors of the increase or decrease in performance variables, the negative sign indicates the relationship is not unidirectional.
3) Each terrain condition dimensions increase by 1%, will improve the performance dimension of 0,661 or 66,1%, with assumption other variables in this model are fix.

4) Each the weather dimensions increase by 1%, will improve the performance dimension of 0,584 or 58,4%, with assumption other variables in this model are fix.
5) The magnitude of the error value of performance is 0,560; or 56% performance is influenced by factors other variables in this model.

Meanwhile the direct relationship equations model between aircraft accident variable with phases of time, phase of flight, terrain condition, weather and performance, as a mathematical equation below:

$Y_2 = \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 Y_1 + Ó_2$

Or

$Y_2 = 0{,}003X_1 + 0{,}333X_2 – 0{,}031X_3 + 0{,}625X_4 – 0{,}179Y_1 + 0{,}261$

Explanation: Y_2 = accident; X_1 = phases of time; X_2 = phase of flight; X_3 = terrain; X_4 = weather; Y_1 = performance; $Ó_2$ = accident error

The equation can be read that the increase and decrease of accident, decisively influenced by the phases of time (0,003); phase of flight (0,333); and weather (0,625) and other variables outside the model, or can be translated into a simple sentence as follows

1) Each the phases of time dimensions increase by 1%, will improve the accident dimension of 0,003 or 0,3%, with assumption other variables in this model are fix.
2) Each the phase of flight dimensions increase by 1%, will improve the accident dimension of 0,333 or 33,3%, with assumption other variables in this model are fix.
3) Each terrain condition dimensions increase of 1%, it would reduce the accident dimension of 0,031 or 3,1%, with assumption other variables in this model are fix. Terrain condition variable is become correction variable or inhibitors of the increase or decrease in accident variables, the negative sign indicates the relationship is not unidirectional.
4) Each the weather dimensions increase by 1%, will improve the accident dimension of 0,625 or 62,5%, with assumption other variables in this model are fix.
5) Each performance dimensions increase of 1%, it would reduce the accident dimension of 0,179 or 17,9%, with assumption other variables in this model are fix. Performance variable is become correction variable or inhibitors of the increase or decrease in accident variables, the negative sign indicates the relationship is not unidirectional.
6) The magnitude of the error value of accident is 0,261; or 26,1% accident is influenced by factors other variables in this model.

The rho (ρ) value are produced is used for the basic material for assessing the magnitude of the direct and indirect affect that occurs in between variables and end on accident variables in the model. These variables are predictive variable for accident variable. By knowing the value of other variables that influence the accident variables other than the variables that exist in the model, it can thus be made in the final mathematical equation that models can be delivered as follows:

$Y_2 = ë_1 X_1 + ë_2 X_2 + ë_3 X_3 + ë_4 X_4 + Ó_3$

Or

$Y_2 = - 0{,}017\, X_1 + 0{,}457\, X_2 - 0{,}149\, X_3 + 0{,}520\, X_4 + 0{,}161$

Explanation Y_2 = accident; X_1 = phases of time; X_2 = phase of flight; X_3 = terrain; X_4 = weather; $Ó_3$ = total error

The equation can be read that the increase and decrease in accidents indirectly through intermediate variable (performance), decisively influenced by the phase of flight (0,457) and weather (0,520). Phases of time, terrain condition becomes correction variable (inhibitor) to increase or decrease the accident variables indirectly through intermediate variable (performance). The results also explained that the magnitude of the total error of 0,261 or 26,1% of accidents are influenced by factors other than phases of time, terrain condition, weather, phase of flight, and performance (which is not contained in the model or outside the model).

V. Conclusions

In this paper a structural equation model has been proposed in order to show the relationship model between phases of time, phase of flight, terrain condition, weather, pilot performance and aircraft accident. From the analysis data, the result shows that H1 (phases of time with performance), H4 (phase of flight with accident), H5 (terrain condition with performance), H7 (weather with performance) and H8 (weather with accident) proved has positive and significant effects. Meanwhile H3 (phase of flight with performance), H6 (terrain condition with accident) and H9 (performance with accident) has negative relations and no significant effects, while H2 (phases of time with accident) has positive relations but not significant effects.

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