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Risk Identification of the Implementation Runway Maintenance Works At Sam Ratulangi Manado Airport

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Abstract
Sam Ratulangi is an international airport located in the city of Manado, North Sulawesi Province. The airport which is managed by PT. Angkasa Pura I is capable of receiving loads from Boeing 737 series aircraft and Air Bus A320 Series. Periodic maintenance is carried out to maintain the capability of the existing runway. One of the maintenance currently being carried out is the project "Overlay Runway 18-36 at Sam Ratulangi Airport – Manado".
This study was conducted with the aim of identifying risk factors in the project "Overlay Runway 18-36 at Manado's Sam Ratulangi Airport" related to aviation accidents and to find out the dominant risk conditions that arise in the work method "Overlay Runway 18-36 at Sam Airport. Ratulangi – Manado" related to aviation accident.
The research method used is a mixture of qualitative and quantitative methods. Collecting data in this study in the form of primary data (interviews and distributing questionnaires) and secondary data (study of literature). The data obtained were analyzed statistically with the help of the Statistical Program for Social Science (SPSS) application, then the validity was tested using the Pearson Correlation testing technique, reliability testing was done with Cronbach's Alpha testing technique, qualitative risk analysis, quantitative risk analysis and risk category analysis. The results of the analysis are presented by grouping risks into high, medium and low categories.
The results of the research and analysis carried out can be stated (1) The risks that exist in the work method "Overlay Runway Work 18-36 at Sam Ratulangi Airport - Manado" related to aviation accidents were initially summarized as 62 risk factors, after being validated again by experts , tested the validity and reliability of the obtained as many as 43 definite risk factors. (2) After the analysis, it was found that from the 43 risk factors there were 12 risk factors that were included in the high risk category. Where the 3 highest risk factors are "poor quality of work" being at the "overlay" stage of work, "the final result of asphalting/connection of the runway is not smooth" is in the "overlay" stage of work and "poor quality of work" is in the "painting" stage of work. mark". It can be concluded that the implementation of runway maintenance at Manado's Sam Ratulangi Airport has 43 high risk factors that must be addressed immediately, in order to prevent in-flight accidents related to construction work at Manado's Sam Ratulangi Airport.
Keywords: *airport, runway, work method, project, risk*

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I. Introduction

Background

The runway is one of the important facilities in the take off / landing of aircraft, because in this area the aircraft will try to gain lift through collaboration between the area wing passengers, density of fluid (air) with aircraft speed and supported by a runway in good condition. Unsuitable runway conditions will hamper the speed of the aircraft, causing the aircraft to lose lift and thrust, which in turn will result in the aircraft not being able to fly. Sam Ratulangi International Airport (IATA: MDC, ICAO: WAMM), is an airport located in North Sulawesi, 13 kilometers (8.1 miles) northeast of the city of Manado. Sam Ratulangi Airport is capable of receiving loads from Boeing 737 series and Air Bus A320 series aircraft, but regular maintenance must be carried out in order to maintain the capability of the existing runway. One of the treatments being carried out at this time is "Overlay Runway Work 18-36 at Sam Ratulangi Airport – Manado".

Runway maintenance work (overlay) is usually carried out by research on materials, costs and experts, but currently no one has researched on the work methods used in order to avoid the risks that may occur in the runway maintenance work. By doing risk modeling on the work method, it will make it easier to manage work, avoid risks and maximize the time allotted to do overlay activities. From the author's analysis, it is necessary to have risk modeling for work methods and the best preparation of risk assessments for the 18-36 runway overlay work at Sam Ratulangi Airport - Manado".

Formulation of the problem.
Methods of Work Overlay Runway 18-36 at Sam Ratulangi Airport - Manado has not been carried out a risk assessment related to aviation accidents, so:
1. What are the risks involved in the work method of "Overlay Runway Work 18-
36 at Sam Ratulangi Airport – Manado"?
2. What are the dominant risks involved in overlaying the runway at Sam Ratulangi International Airport, Manado?

Scope of problem
Limitations of the problem in the preparation of this research are:
1. Risk analysis is only reviewed on the method
"Overlay Runway Work 18-36 at Sam Ratulangi Airport – Manado" on aviation accidents.

2. For survey respondents to be conducted at the supervisor level and above.
3. The risk model is only for all risks classified as high risk.

Research purposes
Writing this thesis aims to:
1. Knowing about all the risk factors that arise in the work method "Overlay Runway 18-36 work at Sam Ratulangi Airport – Manado"
2. Knowing the dominant risk conditions
appears in the work method "Overlay Runway Work 18-36 at Sam Ratulangi Airport – Manado"

Benefits of research
This writing is expected to be useful for:
1. Theory
Build and reproduce risk data on the methods used for runway overlay work, especially at airports in the world.

2. Practice
With the risk data from existing work methods, it is hoped that the right choice of method will be created in cases that arise in existing airport development or maintenance projects.
3. Organization
It is expected to provide additional contributions for project implementers in terms of risks in construction projects or airport maintenance.

II. Airport Literature Review

An airport is an area on land and/or a seaport with certain boundaries that is used as a place for aircraft, in addition to landing and taking off, as well as a place for boarding and dropping passengers, loading and unloading goods, and a place for intra and intermodal transportation, which is equipped with safety and security facilities. flights, as well as basic facilities and other supporting facilities (Law No. 1, 2009).

Table 1. Airports and facilities

Airport Facilities
A. Airside (Airside) 1. Runway / runway 2. Taxiway / take-off 3. Apron / parking lot
B. Landside 1. Passenger terminal building 2. Cargo terminal building 3. Operation building 4. Airport support facilities

Source: Sartono, 2016

Airport components must be planned in such a way as to allow "movement" from one component to another properly (Sartono et al, 2016). The airport is divided into 2 sides, namely the land side and the air side. The air side itself is divided into 3 major groups, namely the Runway Component, Taxiway Component and the Apron Gate Component (FAA, 1976).

Pavement

The runway is designed based on several objectives and must meet the main criteria, namely being able to withstand the weight of the aircraft without any damage, the surface must be stable and smooth, free from dust and foreign particles, able to distribute the aircraft load evenly without damaging the subsoil layer of the soil or the term is not easy to sink, and able to prevent damage or erosion of the subsoil layer of the soil from infiltration of rain or dew (www.aripsusanto.com, 2019).

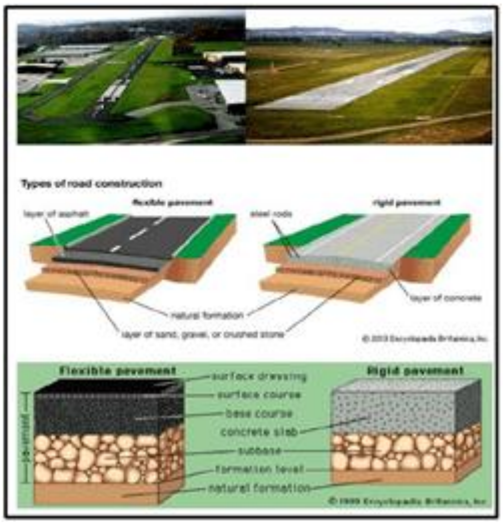

Figure 3. Difference between Rigid Pavement and Flexible Pavement

Pavement is an infrastructure consisting of several layers with different strength and bearing capacity. In general, pavement construction is divided into 2 types, namely: flexible pavement and rigid pavement. Pavement made from a mixture of asphalt and aggregate, laid on a surface of high quality granular material is called flexible pavement, while pavement made from slab concrete slab (Portland Cement Concrete) is called rigid pavement (KP 94 Tahun 2015)..

Risk Management

The definition of risk is the possibility of something happening that will have an impact on the target, measured in terms of consequences and possibilities. What is meant by the consequence is the result of a second that is expressed qualitatively and quantitatively, which is a lost, loss, or gain.

Table 2. Characteristics and examples of levels of uncertainty

LEVEL OF UNCERTAINTY	CHARACTERISTICS	EXAMPLE
None (Definitely)	Results Can Be Predicted With Certainty	Natural law
Uncertainty Objective	Results Identifiable And Probability Known	Game Card Dice
Uncertainty Subjective	Outcome Identifiable but Probability Unknown	Fire, Car Accident, Investment
Very Uncertain	Unidentifiable Result and Unknown Probability	Exploration Space

Source: Hanafi, 2016

Risk management is an integral part of the process that aims to identify potential risks associated with a project and respond to those risks. It includes activities aimed at maximizing the consequences associated with positive events and generating the impact of negative events. The risk management process is as follows (AS/NZA, 1999):

1. Plan Risk Management - the process of determining how to approach and plan risk management activities on the project.
2. Identification Risk – the process of determining risks affecting the project and documenting their characteristics or properties.
3. Qualitative Risk Analysis – Process prioritizing risks for further analysis or assessing and combining the probability of occurrence and impact of each risk.
4. Quantitative Risk Analysis – the process of analyzing according to the rules of the number of effects of the identified risks on the overall project objectives.
5. Plan Risk Response – the process of developing options and actions to enhance opportunities and reduce threats to objectives.
6. Monitoring and Control Risk – the process of implementing the Risk Response Plan, tracing the identified risks, monitoring remaining risks, identifying new risks, implementing the risk response plan, and evaluating its effectiveness throughout project implementation.

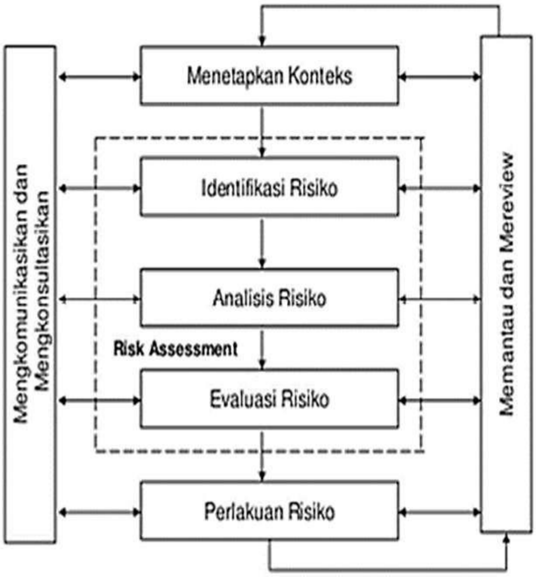

Figure 4. Risk Management Process (Australian Standard, 1999)

Qualitative drug assessment for projects according to PMBOK standards is shown in the table below.

Table 3. Qualitative Impact Assessment SCALE

SCALE	RELATIVELY	RESULT ASSESSMENT
0,05	Very Low	The accident frequency rate is very small, no impact on the schedule.
0,10	Low	Accident frequency rate < 5%, small impact, need attention to project work.
0,20	Moderate	Accident frequency rate of 5-10%, moderate impact, needs to be handled at any time.
0,40	High	Accident frequency rate of 10-20%, big impact, needs to be handled thoroughly
0,80	Very High	Accident frequency rate > 20%, very big impact.

Source: PMBOX, 2008

Edi (2007) in his book describes the level of risk qualitatively divided into five ranking categorizations which are described in the qualitative risk level matrix table below.

Table 4. Matrix of Risk Levels

LIKELYHOOD	AKIBAT				
	Tidak Penting	Minor	Medium	Major	Malapetaka
	1	2	3	4	5
Sangat Besar (A)	T	T	E	E	E
Besar (B)	M	T	T	E	E
Sedang (C)	R	M	T	E	E
Kecil (D)	R	R	M	T	E
Sangat Kecil (E)	R	R	M	T	T

Sumber : Edi, 2007

Description :
- E : Extreme risk, requires detailed observation, handling must be at the leadership level
- T : High risk, needs to be handled by
project manager
- M : moderate risk, routine risk, handled directly at the project level
- R : Low risk, routine risk, there is a budget project implementation

The evaluation of the risk of a project depends on:

1) The probability of occurrence of the risk and the frequency of occurrence,
2) The impact of the risk
3) In comparing project options and the various risks associated with it, a risk index is often used, where:

Risk Index = Frequency x Impact

The probability or frequency measurement table in accordance with the Australian/new zealand Risk Management Standard (AS 4360) is as follows:

Table 5. Probability Measurement

A	Very High	Always happens in every condition
B	High	Often occurs in every condition
C	Medium	Occurs under certain conditions
D	Low	Sometimes it happens under certain conditions
E	Very Low	Rarely occurs, there are only certain conditions

Source: Junanto, 2007

After the Risk is identified, the next stage namely measuring the level of existing Risk. With this measurement step, we can apply the priority scale of the risks faced. Hanafi (2016) draws a matrix of frequency and significance as shown in the figure below.

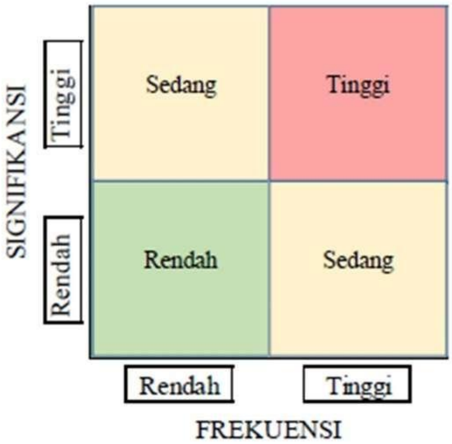

Figure 5. Matrix of Frequency and Significance

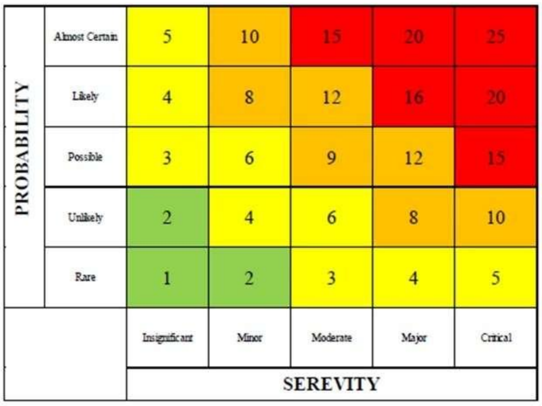

Figure 6. Risk Map

Risk Map is a mapping of the risks that will appear in an activity. Usually given a value of 1 for the lowest scale to 5 for the highest scale with coloring from green to red (minor, moderate, major, and critical) depending on the collaboration between probability and risk.

III. Research Methodology

Data

The achievement of writing this thesis requires supporting data that must be collected, including the project work method obtained from the Method of Working Plan (MOWP). Overlay Runway 18-36 at Sam Ratulangi Airport Manado and project work risk data obtained from interviews and data collection in the form of questionnaires for all existing respondents.

Place and time of research

The research took place at Sam Ratulangi Airport, Manado. The reason for taking the location is because Sam Ratulangi Airport Manado is one of the international airports in Indonesia which is temporarily carrying out runway maintenance activities, namely "Overlay Runway Work 18-36 at Sam Ratulangi Airport Manado" with the time of data collection being carried out in the contract period from 2018 to with 2019.

Research Material

In completing this research, appropriate research methods are needed. research method is a scientific way to obtain data with specific purposes and uses. The scientific method means that this research activity is based on rational, empirical and systematic scientific characteristics (Sugiono 2003).

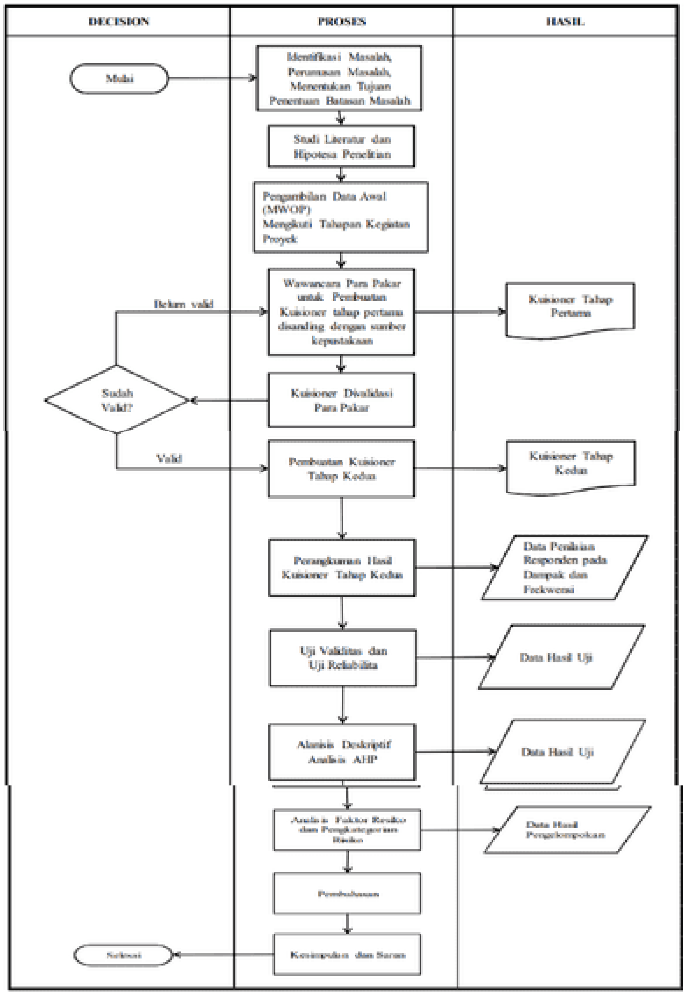

Figure 7. Research Flowchart

Research Variable

In this study, the variables are the risks related to aviation accidents contained in each stage of the work of the maintenance work method runway on “Runway Overlay Work 18-36 at Sam Ratulangi Airport, Manado".

Research Instruments

In this research, data collection is done by distributing questionnaires that have been validated by experts to all respondents.

The questionnaire column filled out by the respondents is an assessment column related to the project and knowing about aviation safety. All data in this study consisted of primary data and secondary data

Data collection

Data collection techniques in research

This is done by means of a survey. All data were taken from the results of interviews and filling out questionnaires for the supervisory level teams that

Data analysis

In this analysis, the processed data are all data obtained from the distribution of the respondents' questionnaire data. Further analysis was carried out with statistical data assisted by the application of the Statistical Program for Social Science (SPSS) version 22.

IV. Results And Discussion

Research result

1. Data Collection

The type of data used in this study is secondary data obtained from several existing sources and primary data obtained from the results of questionnaires and interviews.

Table 6. Profile of Questionnaire Respondents

No	**Name**	**Position**	Experience (years)	Graduate
1	Pakar A	Safety Manager PT. Angkasa Pura 1 Internasional Sam Ratulangi	8	S2
2	Pakar B	Non Terminal Airside Technician Manager	4	S1
3	Pakar C	Sam Ratulangi Inspektur Bandar Udara Kantor Otoritas Bandar Udara Wilayah VIII	30	S1

Table 7. Profile and Number of Respondents

No	Uraian	Jumlah Responden
1	Safety Tim PT. Angkasa Pura 1 Bandar Udara Internasional Sam Ratulangi Manado	5
2	Non Termilan Airside Technician Tim Bandara Internasional Sam Ratulangi Manado	7
3	Kantor Otoritas Bandar Udara Wilayah VIII Manado	6

2. Data Analysis

- The first stage of data analysis is carried out by distributing the first stage of questionnaires to the experts, where the experts will fill out answers about the question of whether or not the variable is influential existing risks and coupled with filling in responses, corrections, input, addition or subtraction on each initial variable whose opinion was asked for. The results of the first stage of the questionnaire that were assessed by experts show that all variables that have been arranged are considered impact on flight safety.

Table 8. Recapitulation of Questionnaire Results The first stage

Variabel	Pakar A	Pakar B	Pakar C	Hasil
X1	✓	✓	✓	OK
X2	✓	✓	✓	OK
X3	✓	✓	✓	OK
X4	✓	✓	✓	OK
X5	✓	✓	✓	OK
X6	✓	✓	✓	OK
X7	✓	✓	✓	OK
X8	✓	✓	✓	OK
X9	✓	✓	✓	OK
X10	✓	✓	✓	OK
X11	✓	✓	✓	OK
X12	✓	✓	✓	OK
X13	✓	✓	✓	OK
X14	✓	✓	✓	OK
X15	✓	✓	✓	OK
X16	✓	✓	✓	OK
X17	✓	✓	✓	OK
X18	✓	✓	✓	OK
X19	✓	✓	✓	OK
X20	✓	✓	✓	OK
X21	✓	✓	✓	OK
X22	✓	✓	✓	OK
X23	✓	✓	✓	OK
X24	✓	✓	✓	OK
X25	✓	✓	✓	OK
X26	✓	✓	✓	OK
X27	✓	✓	✓	OK
X28	✓	✓	✓	OK
X29	✓	✓	✓	OK
X30	✓	✓	✓	OK
X31	✓	✓	✓	OK
X32	✓	✓	✓	OK
X33	✓	✓	✓	OK

X34	✓	✓	✓	OK
X35	✓	✓	✓	OK
X36	✓	✓	✓	OK
X37	✓	✓	✓	OK
X38	✓	✓	✓	OK
X39	✓	✓	✓	OK
X40	✓	✓	✓	OK
X41	✓	✓	✓	OK
X42	✓	✓	✓	OK
X43	✓	✓	✓	OK
X44	✓	✓	✓	OK
X45	✓	✓	✓	OK
X46	✓	✓	✓	OK
X47	✓	✓	✓	OK
X48	✓	✓	✓	OK
X49	✓	✓	✓	OK
X50	✓	✓	✓	OK
X51	✓	✓	✓	OK
X52	✓	✓	✓	OK
X53	✓	✓	✓	OK
X54	✓	✓	✓	OK
X55	✓	✓	✓	OK
X56	✓	✓	✓	OK
X57	✓	✓	✓	OK
X58	✓	✓	✓	OK
X59	✓	✓	✓	OK
X60	✓	✓	✓	OK
X61	✓	✓	✓	OK
X62	✓	✓	✓	OK

- The second stage of data analysis was carried out by how to distribute the second stage of the questionnaire on the respondents, where the respondents will fill out answers about the question of the value of impact and frequency any existing risk variables.

Validity test is done by assessing Pearson correlation. Valid or not the data can be seen by comparing Pearson values correlation of the data with the table, which is as follows:

- If r count is positive or r count > r table, then the variable is considered valid.
- If r count is negative or r count < r table, then the variable is considered invalid. If the data is not considered valid then it will not be used in further analysis. The calculation of the value of r is done with the help of the SPS program.

Table 9. Calculation of Data Validity
Frequency and impact

	Frekuensi			Dampak		
	r Hitung	r Tabel	Hasil	r Hitung	r Tabel	Hasil
X1	.936**	0.468	Valid	-.183	0.468	Tidak Valid
X2	.106	0.468	Tidak Valid	.708**	0.468	Valid
X3	.918	0.468	Valid	.445	0.468	Tidak Valid
X4	.664	0.468	Valid	.840**	0.468	Valid
X5	.690**	0.468	Valid	.693**	0.468	Valid
X6	.262	0.468	Tidak Valid	.945**	0.468	Valid
X7	.664**	0.468	Valid	.959**	0.468	Valid
X8	.937**	0.468	Tidak Valid	.940**	0.468	Valid
X9	.387	0.468	Tidak Valid	.959**	0.468	Valid
X10	.955**	0.468	Valid	.959**	0.468	Valid
X11	.941**	0.468	Valid	.971**	0.468	Valid
X12	.179	0.468	Tidak Valid	.938**	0.468	Valid
X13	.112	0.468	Tidak Valid	.970**	0.468	Valid
X14	.262	0.468	Tidak Valid	.944**	0.468	Valid
X15	.937**	0.468	Valid	.942**	0.468	Valid
X16	.262	0.468	Tidak Valid	.897**	0.468	Valid
X17	.262	0.468	Tidak Valid	.927**	0.468	Valid

X18	.254	0.468	Tidak Valid	.952**	0.468	Valid
X19	.941**	0.468	Valid	.966**	0.468	Valid
X20	.180	0.468	Tidak Valid	.923**	0.468	Valid
X21	.579*	0.468	Valid	.883**	0.468	Valid
X22	.973**	0.468	Valid	.762**	0.468	Valid
X23	.502*	0.468	Valid	.876**	0.468	Valid
X24	.875**	0.468	Valid	.899**	0.468	Valid
X25	.875**	0.468	Valid	.827**	0.468	Valid
X26	.387	0.468	Tidak Valid	.823**	0.468	Valid
X27	.628**	0.468	Valid	.987**	0.468	Valid
X28	.664**	0.468	Valid	.919**	0.468	Valid
X29	-.180	0.468	Tidak Valid	.948**	0.468	Valid
X30	.664**	0.468	Valid	.919**	0.468	Valid
X31	.614**	0.468	Valid	.867**	0.468	Valid
X32	.937**	0.468	Valid	.972**	0.468	Valid
X33	.640**	0.468	Valid	.922**	0.468	Valid
X34	.628**	0.468	Valid	.890**	0.468	Valid
X35	.254	0.468	Tidak Valid	.741**	0.468	Valid
X36	.664**	0.468	Valid	.844**	0.468	Valid
X37	-.112	0.468	Tidak Valid	.842**	0.468	Valid
X38	.915**	0.468	Valid	.623**	0.468	Valid
X39	.614**	0.468	Valid	.922**	0.468	Valid
X40	.738**	0.468	Valid	.954**	0.468	Valid
X41	.825**	0.468	Valid	.700**	0.468	Valid
X42	.673**	0.468	Valid	.966**	0.468	Valid
X43	.841**	0.468	Valid	.810**	0.468	Valid
X44	.690**	0.468	Valid	.907**	0.468	Valid
X45	.468	0.468	Tidak Valid	.877**	0.468	Valid
X46	.614**	0.468	Valid	.878**	0.468	Valid
X47	.664**	0.468	Valid	.890**	0.468	Valid
X48	.614**	0.468	Valid	.866**	0.468	Valid
X49	.944**	0.468	Valid	.890**	0.468	Valid
X50	.557*	0.468	Valid	.650**	0.468	Valid
X51	.841**	0.468	Valid	.625**	0.468	Valid
X52	.832**	0.468	Valid	.969**	0.468	Valid
X53	.865**	0.468	Valid	.866**	0.468	Valid
X54	.979**	0.468	Valid	.928**	0.468	Valid
X55	.772**	0.468	Valid	.943**	0.468	Valid
X56	.670**	0.468	Valid	.650**	0.468	Valid
X57	-.180	0.468	Tidak Valid	.890**	0.468	Valid
X58	.468	0.468	Tidak Valid	.904**	0.468	Valid
X59	.698**	0.468	Valid	.860**	0.468	Valid
X60	.894**	0.468	Valid	.903**	0.468	Valid
X61	.894**	0.468	Valid	.903**	0.468	Valid
X62	.890**	0.468	Valid	.903**	0.468	Valid

The value of r table with the number N=18 and Level of Significance=5% is worth 0.468 (can be seen on the r table in the appendix). While on the table above shows the value of r for X2, X6, X9, r table while X8, X29, X37 and X57 on impact data is negative, the same as X3 the impact data is still below the r table while X1 on the impact data is negative. Therefore, the 19 data are considered invalid and will then be removed from the data analysis process. Invalid risk details are:

X1 : No overlay job request completed according to the target at the stage of the job of making an overlay job request
X2 : The overlay job request was not approved at the stage of the overlay job request creation job
X3 : The overlay job request was not approved at the stage of the overlay job request creation job
X6 : Raw materials are lacking in stages
tools and materials preparation paving
X9 : No supporting tools/machines
X12 : Initial measurement of work is not
according to job request overlays on work stages initial measurement and tool mobilization
X13 : Initial measurement crossed the line the time specified in the stages initial measurement work and tool mobilization
X14 : Mobilization of tools/machines across borders the time specified in the stages initial measurement work and tool mobilization
X16 : Tools/machines do not pass through the designated area determined at the stage of work initial measurement and tool mobilization
X17 : Tool/machine over speed limit
at the stage of measurement work start and mobilization of tools
X18 : Tool/machine does not have standard equipment in stages initial measurement work and tool mobilization
X20 : Pre-cleaning crossed the line the time specified in the stages preliminary cleaning work
X26 : Tool/machine damaged during operation at the cutting job stage local "patching"
X29 : Coating is not done in asphalt coating work stages
X35 : Changes in field conditions in laying work stages, asphalt compaction and cleaning end
X37 : The number of HR is less in stages laying work, compaction asphalt and final cleaning
X45 : The number of HR is lacking in the stages of the runway light elevation work
X57 : Job competence does not match in the stage of testing work HWD and runway stray
X58 : Tool/machine damaged during operation at the stage of testing work HWD and runway slippage

The reliability test was carried out by looking at the value of the Vronbach alpha coefficient that came from data greater than 0.6. The Cronbach's alpha coefficient was calculated using the SPSS 22 program. The test results can be seen in table G and table H.

Table 10. Calculation of Frequency Reliability

Reliability Statistics

Cronbach's Alpha	N of Items
.971	62

Tabel 11. Perhitungan Reliabilitas Dampak

Reliability Statistics

Cronbach's Alpha	N of Items
.994	62

The value of the Cronbach alpha coefficient of the impact and risk frequency variable data is greater than 0.6 so that the instrument used to retrieve the data can be said to be reliable.
- Descriptive Analysis
The purpose of the descriptive analysis is to analyze the data based on the mean and mode values of the level of impact and frequency of risk derived from the respondent's data. The mean and mode values are obtained by first adding up all respondents' answers for the level of influence and frequency on each variable.

Table 10. Risk Descriptive Analysis Results
For Frequency Level

X	Tingkat Frekuensi					Analisis Deskriptif	
	1	2	3	4	5	Modus	Mean
X4	17	1	0	0	0	1	1.06
X5	16	1	1	0	0	1	1.17
X7	17	1	0	0	0	1	1.06
X8	0	3	15	0	0	3	2.83
X10	15	0	2	1	0	1	1.39
X11	15	2	1	0	0	1	1.22
X15	15	3	0	0	0	1	1.17
X19	15	2	1	0	0	1	1.22
X21	15	1	0	2	0	1	1.39
X22	14	0	1	3	0	1	1.61
X23	1	16	0	1	0	2	2.06
X24	14	2	2	0	0	1	1.33
X25	14	2	2	0	0	1	1.33
X27	16	2	0	0	0	1	1.11
X28	17	1	0	0	0	1	1.06
X30	17	1	0	0	0	1	1.06
X31	0	16	2	0	0	2	2.11
X32	15	3	0	0	0	1	1.17
X33	15	3	0	0	0	1	1.17
X34	16	2	0	0	0	1	1.11
X36	0	17	0	1	0	2	2.11
X38	2	12	0	4	0	2	2.33
X39	0	16	2	0	0	2	2.11
X40	12	4	2	0	0	1	1.44
X41	3	12	0	3	0	2	2.17
X42	1	14	3	0	0	2	2.11
X43	15	1	2	0	0	1	1.28
X44	16	1	1	0	0	1	1.17
X46	16	0	0	2	0	1	1.33
X47	17	0	1	0	0	1	1.11
X48	16	0	2	0	0	1	1.22
X49	14	0	1	1	2	1	1.72
X50	1	15	0	0	2	2	2.28
X51	15	0	1	0	2	1	1.56
X52	14	1	3	0	0	1	1.39
X53	14	0	1	1	2	1	1.72
X54	14	1	3	0	0	1	1.39
X55	14	3	1	0	0	1	1.28
X56	16	0	1	1	0	1	1.28

Table 11. Risk Descriptive Analysis Results for Impact Level

X	Tingkat Dampak					Analisis Deskriptif	
	1	2	3	4	5	Modus	Mean
X4	1	2	3	5	7	1	3.83
X5	1	1	6	3	7	1	3.78
X7	4	0	1	6	7	1	3.67
X8	3	1	1	6	7	3	3.72
X10	4	0	2	5	7	1	3.61
X11	1	1	3	5	8	1	4.00
X15	3	1	1	6	7	1	3.72
X19	4	0	4	3	7	1	3.50
X21	0	1	2	8	7	1	4.17
X22	0	0	3	8	7	1	4.22
X23	1	0	3	6	8	2	4.11
X24	0	2	1	8	7	1	4.11
X25	0	2	2	7	7	1	4.06
X27	2	2	1	5	8	1	3.83
X28	0	2	1	7	8	1	4.17
X30	0	2	1	7	8	1	4.17
X31	0	2	5	2	9	2	4.00
X32	1	3	3	3	8	1	3.78

X33	1	0	4	4	9	1	4.11
X34	2	0	1	7	8	1	4.06
X36	0	3	4	3	8	2	3.89
X38	0	0	2	5	11	2	4.50
X39	1	2	2	4	9	2	4.00
X40	1	1	4	4	8	1	3.94
X41	1	0	2	4	11	2	4.33
X42	4	0	1	5	8	2	3.72
X43	3	0	4	10	1	1	3.33
X44	0	1	2	7	8	1	4.22
X46	2	1	2	4	9	1	3.94
X47	2	0	1	7	8	1	4.06
X48	1	0	2	7	8	1	4.17
X49	2	0	1	7	8	1	4.06
X50	1	0	2	14	1	2	3.78
X51	0	1	5	11	1	1	3.67
X52	1	3	2	4	8	1	3.83
X53	1	0	2	7	8	1	4.17
X54	0	1	6	3	8	1	4.00
X55	1	2	2	5	8	1	3.94
X56	1	0	2	14	1	1	3.78
X59	0	0	4	6	8	1	4.22
X60	0	2	4	4	8	1	4.00
X61	0	2	4	4	8	1	4.00
X62	0	2	4	4	8	1	4.00

- Analytical Hierarchy Process (AHP)
The data that has been tabulated with Descriptive Analysis is then analyzed using the AHP method starting with the normalization of the matrix, calculating the consistency of the matrix, the consistency of the hierarchy and the level of accuracy, then calculating the average value.

a. Pair Comparison
Matrix created for comparison in pairs, for each frequency and impact. Then continue with pairwise comparison so that obtained as many as 5 elements which compared. Below is given paired matrix for frequency and impact.

Table 12. Paired Matrix For Frequency and Impact

	Sangat Tinggi	Tinggi	Sedang	Rendah	Sangat Rendah
Sangat Tinggi	1.00	3.00	5.00	7.00	9.00
Tinggi	0.33	1.00	3.00	5.00	7.00
Sedang	0.20	0.33	1.00	3.00	5.00
Rendah	0.14	0.20	0.33	1.00	3.00
Sangat Rendah	0.11	0.14	0.20	0.33	1.00
Jumlah	**1.79**	**4.68**	**9.53**	**16.33**	**25.00**

b. Elemental Weight
The calculation of the element weights for each element in the matrix for both frequency and impact can be seen in the table below.

Table 13. Calculaton of Elemental Weights for Frequency

	Sangat Sering	Sering	Sedang	Jarang	Sangat Jarang	Jumlah	Prioritas	Presentase
Sangat Sering	0.560	0.642	0.524	0.429	0.360	2.514	0.503	100.00%
Sering	0.187	0.214	0.315	0.306	0.280	1.301	0.260	51.75%
Sedang	0.112	0.071	0.105	0.184	0.200	0.672	0.134	26.72%
Jarang	0.080	0.043	0.035	0.061	0.120	0.339	0.068	13.48%
Sangat Jarang	0.062	0.031	0.021	0.020	0.040	0.174	0.035	6.93%
Jumlah	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**5.00**		

Table 14. Frequency Element Weight

	Sangat Rendah	Rendah	Sedang	Tinggi	Sangat Tinggi
Bobot	0.069	0.135	0.267	0.518	1

The element weight calculation for the impact element is carried out in the same way as the frequency element weight calculation, which is shown in the table below.

Table 15. Calculation of Elemental Weights for Impact

	Sangat Sering	Sering	Sedang	Jarang	Sangat Jarang	Jumlah	Prioritas	Presentase
Sangat Sering	0.560	0.642	0.524	0.429	0.360	2.514	0.503	100.00%
Sering	0.187	0.214	0.315	0.306	0.280	1.301	0.260	51.75%
Sedang	0.112	0.071	0.105	0.184	0.200	0.672	0.134	26.72%
Jarang	0.080	0.043	0.035	0.061	0.120	0.339	0.068	13.48%
Sangat Jarang	0.062	0.031	0.021	0.020	0.040	0.174	0.035	6.93%
Jumlah	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**5.00**		

Table 16. Weight of Impact Elements

	Sangat Rendah	Rendah	Sedang	Tinggi	Sangat Tinggi
Bobot	0.069	0.135	0.267	0.518	1

c. Matrix and Hierarchy Consistency Test

The weight matrix from the results of pairwise comparisons must have a diagonal of one value and be consistent. To test the consistency, the maximum eigen value (λmax) must be close to the number of elements (n) and the remaining eigen value is close to zero. Proof of the consistency of the paired matrix is carried out by dividing the elements in each column by the number of the corresponding column to obtain the following matrix.

0.560	0.642	0.524	0.429	0.360
0.187	0.214	0.315	0.306	0.280
0.112	0.071	0.105	0.184	0.200
0.080	0.043	0.035	0.061	0.120
0.062	0.031	0.021	0.020	0.040

Next, the average for each row is taken, namely 0.503; 0.260; 0.134; 0.068 and 0.035. Then the average column vector is multiplied by the original matrix, resulting in a value for each row, which is then divided again by the corresponding vector value.

1.00	3.00	5.00	7.00	9.00		0.503		2.74	:	0.503	=	5.46
0.33	1.00	3.00	5.00	7.00		0.260		1.41	:	0.260	=	5.43
0.20	0.33	1.00	3.00	5.00	X	0.134	=	0.70	:	0.134	=	5.20
0.14	0.20	0.33	1.00	3.00		0.068		0.34	:	0.068	=	5.03
0.11	0.14	0.20	0.33	1.00		0.035		0.18	:	0.035	=	5.09
										JUMLAH		26.21

The number of elements in the matrix (n) is 5, then max = 26.21/5 to get max of 5.24, thus because the value of max is close to the number of elements (n) in the matrix, namely 5 and the remaining egen value is 0.24 which means close to zero, then the matrix is consistent. Because the paired matrix values for frequency and impact are the same as the matrix values in table 28 and table 30, the results of this calculation are the same for impact and frequency, that is, each matrix is consistent.

Table 17. Random Value of Consistency Index

N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

To test the consistency of the hierarchy and the level of accuracy, for the impact and frequency with the number of elements in the matrix (n) is 5, the CRI for n=5 is according to the table 32 is 1.12, then CCI = (λmax – n) / (n – 1) so that the CCI is 0.061. furthermore because CRH = CCI/CRI, then CRH is quite small or below 10% means the hierarchy is consistent and the level of accuracy is high.

d. Average Impact Value and Frequency

After the matrix passes the consistency test, calculation can be seen in the following table:

Table 18. Average Frequency Value

X	Tingkat Frekuensi					Nilai Rata-rata Frekuensi
	0.069	0.135	0.267	0.518	1.000	
X4	17	1	0	0	0	0.0729
X5	16	1	1	0	0	0.0839
X7	17	1	0	0	0	0.0729
X8	0	3	15	0	0	0.2451
X10	15	0	2	1	0	0.1161
X11	15	2	1	0	0	0.0875
X15	15	3	0	0	0	0.0802
X19	15	2	1	0	0	0.0875
X21	15	1	0	2	0	0.1227
X22	14	0	1	3	0	0.1550
X23	1	16	0	1	0	0.1524
X24	14	2	2	0	0	0.0985
X25	14	2	2	0	0	0.0985
X27	16	2	0	0	0	0.0765
X28	17	1	0	0	0	0.0729
X30	17	1	0	0	0	0.0729
X31	0	16	2	0	0	0.1495
X32	15	3	0	0	0	0.0802
X33	15	3	0	0	0	0.0802
X34	16	2	0	0	0	0.0765
X36	0	17	0	1	0	0.1561
X38	2	12	0	4	0	0.2126
X39	0	16	2	0	0	0.1495
X40	12	4	2	0	0	0.1058
X41	3	12	0	3	0	0.1877
X42	1	14	3	0	0	0.1532
X43	15	1	2	0	0	0.0949
X44	16	1	1	0	0	0.0839
X46	16	0	0	2	0	0.1191
X47	17	0	1	0	0	0.0802
X48	16	0	2	0	0	0.0912
X49	14	0	1	1	2	0.2086
X50	1	15	0	0	2	0.2273
X51	15	0	1	0	2	0.1837
X52	14	1	3	0	0	0.1059
X53	14	0	1	1	2	0.2086
X54	14	1	3	0	0	0.1059
X55	14	3	1	0	0	0.0912
X56	16	0	1	1	0	0.1052
X59	16	1	0	1	0	0.0978
X60	15	2	0	1	0	0.1014
X61	15	2	0	1	0	0.1014
X62	14	2	1	1	0	0.1124

Table 19. Average Impact Value

X	Tingkat Dampak					Nilai Rata-rata Frekuensi
	0.069	0.135	0.267	0.518	1.000	
X4	1	2	3	5	7	0.5960
X5	1	1	6	3	7	0.5755
X7	4	0	1	6	7	0.5916
X8	3	1	1	6	7	0.5953
X10	4	0	2	5	7	0.5777
X11	1	1	3	5	8	0.6441
X15	3	1	1	6	7	0.5953
X19	4	0	4	3	7	0.5499
X21	0	1	2	8	7	0.6561
X22	0	0	3	8	7	0.6634
X23	1	0	3	6	8	0.6653
X24	0	2	1	8	7	0.6487
X25	0	2	2	7	7	0.6348
X27	2	2	1	5	8	0.6257
X28	0	2	1	7	8	0.6755
X30	0	2	1	7	8	0.6755
X31	0	2	5	2	9	0.6467
X32	1	3	3	3	8	0.6015
X33	1	0	4	4	9	0.6782
X34	2	0	1	7	8	0.6683
X36	0	3	4	3	8	0.6125
X38	0	0	2	5	11	0.7846
X39	1	2	2	4	9	0.6635
X40	1	1	4	4	8	0.6302
X41	1	0	2	4	11	0.7597
X42	4	0	1	5	8	0.6184
X43	3	0	4	10	1	0.4140
X44	0	1	2	7	8	0.6829
X46	2	1	2	4	9	0.6599
X47	2	0	1	7	8	0.6683
X48	1	0	2	7	8	0.6792
X49	2	0	1	7	8	0.6683
X50	1	0	2	14	1	0.4916
X51	0	1	5	11	1	0.4535
X52	1	3	2	4	8	0.6155
X53	1	0	2	7	8	0.6792
X54	0	1	6	3	8	0.6273
X55	1	2	2	5	8	0.6367
X56	1	0	2	14	1	0.4916
X59	0	0	4	6	8	0.6763
X60	0	2	4	4	8	0.6338
X61	0	2	4	4	8	0.6338
X62	0	2	4	4	8	0.6338

- Risk Factor Value Analysis

After obtaining the average value of the impact and frequency of risk, the analysis is continued by looking for the value of the Risk Factor. The risk factor equation is defined as the multiplication between the magnitude of the risk impact and the probability
risk events, which are calculated from the following equation, namely:

$$FR = L + I - (L \times I)$$

with the understanding:

FR = Risk Factor, with Scale 0-1
L = Probability of risk event
I = the magnitude of the risk

The table recapitulation of values from the results of the calculation of risk factors for all risk variables or events is as follows:

Table 20. Value of Risk Factors

X	Nilai Rata-rata Frekuensi	Nilai Rata-rata Dampak	Faktor Risiko
X4	0.073	0.596	0.625
X5	0.084	0.576	0.611
X7	0.073	0.592	0.621
X8	0.245	0.595	0.694
X10	0.116	0.578	0.627
X11	0.088	0.644	0.675
X15	0.080	0.595	0.628
X19	0.088	0.550	0.589
X21	0.123	0.656	0.698
X22	0.155	0.663	0.716
X23	0.152	0.665	0.716

- Risk Category Analysis

This risk category is a way to determine risk categories into groups based on the level of risk. To determine the category of these variables, the risk categorization table refers to the RSNI (2006) as follows:

Table 22. Risk Categorization

Nilai FR	Kategori	Langkah Penanganan
> 0.7	Risiko Tinggi	Harus dilakukan penurunan ke tingkat yang lebih rendah
0.4 – 0.7	Risiko Sedang	Langkah perbaikan dibutuhkan dalam jangka waktu tertentu
< 0.4	Risiko Rendah	Langkah perbaikan bila mana memungkinkan

The summary of factor variables risks in the table below:

Table 23. Summary of Factor Variables

	Faktor Risiko					
	Tinggi		Sedang			
X	X38	X33	X31	X62	X32	X43
	X41	X46	X28	X36	X15	
	X53		X30	X60	X10	
	X49		X21	X61	X4	
	X23		X47	X25	X7	
	X22		X8	X55	X5	
	X39		X34	X40	X50	
	X44		X24	X54	X19	
	X48		X42	X52	X51	
	X59		X11	X27	X56	

V. Discussion

Based on the results of the previous data processing, it can be explained that the high risk category is 12 variables and the medium risk is 31 variables.

- Risk variables classified as high risk have values above 0.7 to 1.
- Risk variables classified as moderate risk have values between 0.4 to 0.7.
- The risk variable classified as moderate risk has a value between 0 to 0.4

Category data shows three risks top are:

- The risk of X38 is that the quality of the work is not good at work stage number 8, namely laying, compacting asphalt and final cleaning. This risk has a risk factor value of 0.830
- X41 risk is the final result of paving/connection of non-sloping runways at work stage number 8 namely laying, asphalt compaction and final cleaning. This risk has a risk factor value of 0.805
- X53 risk is poor quality of work good to be at work stage number 10, namely painting markings. This risk has a risk factor value of 0.746

VI. Conclusion

Based on the results of research and analysis that has been done, it can be concluded that:
1. The risks involved in the work method "Overlay Runway 18-36 work at Sam Ratulangi Airport - Manado" related to aviation accidents was initially summarized as many as 62 risk factors, after being validated again by experts, validity and reliability testing was carried out so that 43 definite risk factors were obtained.
2. After the analysis, it was found that from the 43 risk factors there were 12 risk factors that were included in the high risk category. Where the 3 highest risk factors are poor quality work at the stage of laying work, the final result of asphalting/connection of the runway is not sloping at the stage of laying work and poor quality work being at the stage of marking painting work

VII. Suggestion

Based on the research that has been done, the suggestions that can be
be delivered:

1) The high and moderate risks that arise in the work method "Overlay Runway Work 18-36 at Sam Ratulangi Airport – Manado" must be handled immediately, in order to prevent in-flight accidents related to construction work at the airport.

2) Comparison of risk modeling and risk assessment related to runway maintenance at airports that have different runway configurations and different work methods need to be carried out, so that it will bring up a general picture of risks in working methods in runway maintenance.

3) There needs to be a deeper understanding of contractors regarding the risks that arise in "Overlay Runway Work 18-36 at Sam Ratulangi Airport – Manado" in the aviation world.

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