The Influence of Weather Factors on Flight Punctuality at Sultan Babullah Airport, Ternate

Bintang Rika W. [1], Yuyun Suprapto[2], and Fatmawati[3]

bintangR47@gmail.com

ABSTRACT

This study aims to determine the extent to which weather conditions affect flight punctuality at Sultan Babullah Airport in Ternate. Punctuality serves as a key indicator of service quality and operational performance for both airports and airlines. Adverse weather factors such as heavy rain, strong winds, and low visibility often lead to delays. The research employed a quantitative approach with a descriptive-analytical method, involving 71 respondents from airlines, BMKG, and airport staff. Data were analyzed using simple linear regression. The results revealed that weather particularly wind speed and rainfall has a significant impact on delays. The study recommends enhancing inter-unit coordination, utilizing more accurate weather data, and implementing extreme weather mitigation strategies to support smoother flight operations.

Keywords: *Weather condition, Punctuality of Flights, Delay, Sultan Babullah Airports, Quantitative Analysis*

1. INTRODUCTION

Sultan Babullah Airport, located in Ternate, plays a vital role as the primary air transportation gateway in the North Maluku region. With the increasing frequency of flights for both domestic travel and logistical distribution, on-time performance has become a critical indicator for assessing service quality and the airport's operational efficiency. Punctual flight schedules not only impact passenger satisfaction but also contribute to the overall efficiency of airline operations.

One of the main challenges in maintaining flight punctuality is adverse weather conditions, such as heavy rainfall, low visibility, and strong winds, which can lead to delays, cancellations, or diversions for safety reasons. Sultan Babullah Airport frequently faces extreme weather due to its location in a tropical region. Unstable winds and high rainfall often disrupt takeoffs and landings, especially since the airport operates with only a single runway. Therefore, responsive operational management is essential to minimize the impact of weather on flight punctuality.

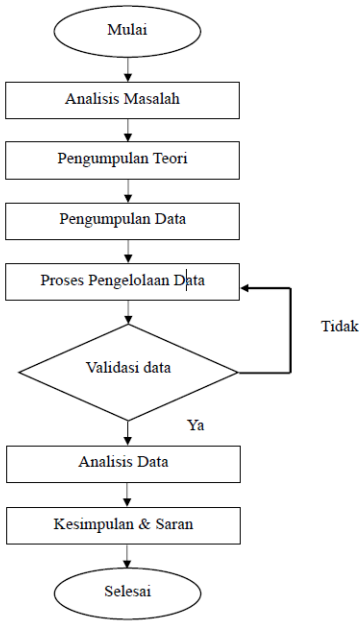
During the research period, several flights experienced delays due to weather conditions. For instance, on November 10, 2024, flight JT-786 on the Ternate-Makassar route was delayed by 2 hours and 15 minutes due to heavy rain, which reduced visibility to 750 meters below the safe landing threshold. A similar incident occurred on December 5, 2024, when Wings Air flight IW-1172 was forced to circle in the air for 50 minutes before being diverted to Pattimura Airport in Ambon due to strong winds reaching 27 knots, exceeding the safe landing limit for an ATR 72 aircraft. On January 18, 2025, flight ID-6346 from Jakarta to Ternate was delayed by 1 hour and 20 minutes at Soekarno-Hatta Airport because of severe weather in Ternate, which disrupted aircraft rotation. As a result, the connecting flight to Sorong was also delayed by 1 hour and 35 minutes.

Research indicates that temperature and air pressure significantly impact an aircraft's lift capability, with their combined effect reaching 99.99% [1]. Temperature has the greatest influence in March and September, while air pressure fluctuates throughout the year. Meanwhile, according to Antara, heavy rain and strong winds in Ternate have caused flight delays at Sultan Babullah

Airport, such as two flights from Jakarta and Makassar that were delayed by approximately 15 minutes. These findings highlight the substantial impact of weather on flight punctuality at Sultan Babullah Airport. Therefore, mitigation strategies are needed, including improved coordination, the use of advanced navigation systems, and timely dissemination of information to reduce weather-related delays. Studying the impact of weather on flight schedules is essential to help airport management develop effective mitigation strategies based on weather variables such as rainfall, visibility, air pressure, and wind.

2. RESEARCH METHOD

In writing the Final Project titled The Influence of Weather Factors on Flight Punctuality at Sultan Babullah Airport, the author employed a quantitative research method:



Research Design

2.1. Research Variables

In concept, a research variable refers to an attribute or characteristic found in a specific subject, object, or activity that exhibits varying values and becomes the central focus of study for analysis and conclusion. Variables are essential components of any research, as their presence is fundamental to the research process. However, many researchers find it challenging to grasp the core concept of variables and their different types. This confusion often leads to numerous questions, highlighting the importance of a clear and comprehensive understanding of variables[2].

2.2. population, sample, Research Object

2.2.1. Population

The population in this study consists of 250 individuals from airlines operating at Sultan Babullah Class II Airport in Ternate, including employees of Lion Air, Batik Air, Wings Air, as well as airport operational staff such as AMC, ground handling, ATC, and BMKG personnel. Population is defined as a group with specific characteristics that serve as the basis for drawing research conclusions.

2.2.2. Sample

A sample is a representation of the population used when the population size is too large to study in its entirety. This research involved 71 respondents, consisting of airline employees and operational staff at Sultan Babullah Airport, a number considered statistically representative[3].

2.2.3. Research Object

This study focuses on flight punctuality at Sultan Babullah Airport in Ternate, which is influenced by weather conditions. Data were collected through direct observation and questionnaires distributed to three airlines (Lion Air, Batik Air, and Wings Air), airport operational staff, and BMKG personnel to assess the impact of weather on flight schedules.

2.3. Data Collection Techniques and Research Instruments

2.3.1. Observation

Observation is a data collection method involving direct monitoring by researchers to obtain necessary information[4]. Note that it is conducted in natural settings for deeper insights, though it can be time-consuming and costly[5]. In this study, observation was used to directly monitor weather conditions and flight schedules at Sultan Babullah Airport, focusing on factors like rainfall and wind speed based on meteorological station reports[6]. Flight delay data were obtained from airlines and airport authorities to ensure accurate primary data and verify secondary sources.

2.3.2. Documentation

Documentation is a form of recorded evidence that holds legal validity and can be accounted for (Tung Palan). It includes observable materials such as written records, photos, videos, audio recordings, and other stored data (Thyredot). In this study, documentation involved photos taken with a mobile phone and screenshots from the Flight Radar app. These visual records served as data sources to address the research question on the impact of weather on flight punctuality at Sultan Babullah

Airport, referring to the Ministry of Transportation Regulation No. PM 89 of 2015.

2.3.3. Literature Study

Literature review is a systematic process of searching, reviewing, and organizing written sources to build the theoretical foundation of a study. Used multiple linear regression to predict rainfall based on temperature, humidity, air pressure, and wind speed, with data from BMKG Semarang (2015–2017), finding that these variables explained 25.5% of rainfall variation. Examined flight delays at Lion Air, identifying bad weather especially rain and fog as key factors, and recommended improved coordination, weather forecasting technology, and rescheduling to reduce delays[7].

2.3.4. Questionnaire

A questionnaire is a data collection tool consisting of a systematically arranged set of questions, designed to gather responses in both quantitative and qualitative forms[4]. This instrument can be distributed either in person or online to reach a broad range of respondents.

2.3.5. Research Instrument

The assessment of research variables used the Likert Scale, developed by Rensis Likert in 1932 to measure respondents' attitudes or tendencies toward statements. Respondents indicate their level of agreement, though it's often misunderstood as the scale itself rather than its response format

2.3.6. Test Instrument Data

Instrument testing was conducted using statistical software. The questionnaire data were analyzed through simple linear regression to examine the effect of one independent variable on one dependent variable. Prior to this, validity and reliability tests were carried out to ensure the accuracy and consistency of the data.

2.3.7. Data Analysis Techniques

This Final Project adopts a descriptive quantitative approach, utilizing numerical data to describe phenomena based on direct observation. Data were collected through documentation, field notes, and relevant sources, and then analyzed using the Likert Scale to explain the impact of weather on flight punctuality at Sultan Babullah Airport in Ternate.

3. RESULT AND DISCUSSION

3.1. Obsevation Result

Flights at Sultan Babullah Airport in Ternate often experience delays, particularly during the rainy season or under extreme weather conditions such as heavy rain, strong winds, and fog that reduce visibility. Based on the researcher's observation of flight schedules, several delays and cancellations were identified as being caused by bad weather. This highlights that weather remains a major obstacle to maintaining flight punctuality at the airport. Operational reports also show fluctuations in on-time performance (OTP), especially during months with high rainfall. This situation is worsened by the limited number of parking stands at the airport, making it difficult to manage multiple delayed aircraft simultaneously.

3.2. Questionnaire

This study employed a questionnaire method to collect data on the impact of weather conditions on flight schedule punctuality at Sultan Babullah Airport in Ternate. The questionnaire was distributed to 71 respondents, including personnel from three airlines Lion Air, Batik Air, and Wings Air as well as airport operational staff and BMKG personnel. Responses were evaluated using a five-point Likert scale: Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), and Strongly Disagree (SD).

3.3. Data Collection and Processing

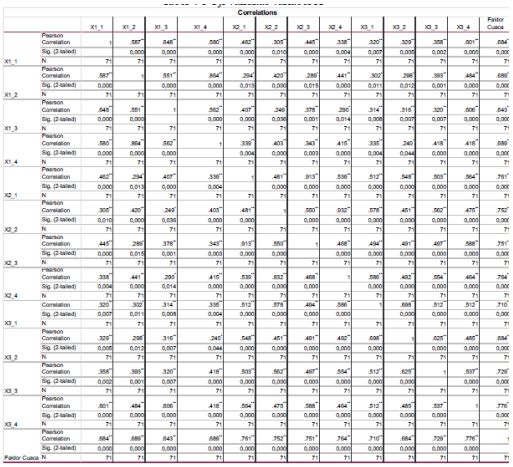
In this study, the researcher used a questionnaire to collect data on the impact of weather on flight punctuality at Sultan Babullah Airport in Ternate. The questionnaire was distributed online via Google Forms to 71 respondents, including 15 from Lion Air, 15 from Batik Air, 10 from Wings Air, and 21 airport operational staff—comprising 5 AMC (Apron Movement Control) personnel, 9 from ATC (Air Traffic Control), and 7 from Ground Handling. Additionally, 10 respondents were from BMKG. Each respondent provided one answer per statement, with the questionnaire containing five items for each variable, all weighted equally in the assessment.

3.4. Data Analysis

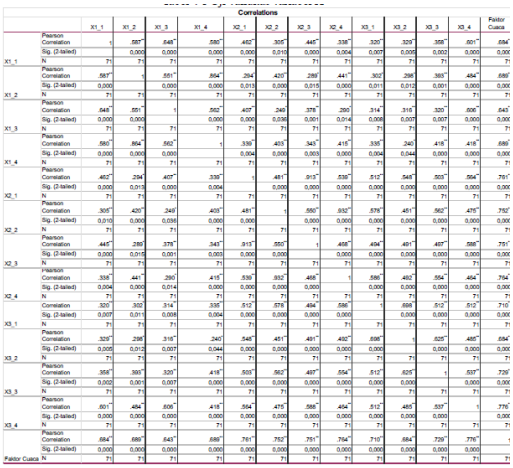
3.4.1. Validation Test

The validity test was conducted using IBM SPSS Statistics 27. An instrument is considered valid if the calculated r-value exceeds the r-table value, which is determined based on the total number of respondents, totaling 71 individuals.

Variable X Validation Test



Variable Y Validation Test



1. For X variable:
   a. If R count > R table then the statement item is declared valid

      0,684 > 0,194 (valid)

      0,689 > 0,194 (valid)

   b. If Sig value < 0,005 then the statement item is declared valid

      0,000 < 0,005 (valid)

      0,000 < 0,005 (valid)

2. For Y variable:
   a. If R count > R table then the statement item is declared valid

      0,799 < 0,005 (valid)

      0,784 < 0,194 (valid)

   b. If Sig value < 0,005 then the statement item is declared valid

      0,000 < 0,005 (valid)

3.4.2. Reability Test

For reability test result in table X:

Reability Test Table X

X		
Reliability Statistics		
Cronbach's alpha	*Cronbach's alpha Based on Standardized Items*	*N of Items*
0,915	0,915	12

Reability Test Table Y

Y		
Reliability Statistics		
Cronbach's alpha	*Cronbach's alpha Based on Standardized Items*	*N of Items*
0,875	0,876	8

3.4.3. Hypothesis Test

The hypothesis test was conducted using IBM SPSS Statistics 27 for Windows. This analysis aims to assess the level of relationship between variable X and variable Y.

Hypothesis Test Table

Correlations				
			Faktor Cuaca	Ketepatan Waktu
Spearman's rho	Faktor Cuaca	*Correlation Coefficient*	1,000	.887**
		Sig. (2-tailed)		0,000
		N	71	71
	Ketepatan Waktu	*Correlation Coefficient*	.887**	1,000
		Sig. (2-tailed)	0,000	
		N	71	71

Therefore, if the significance value (Sig) is less than 0.005, it can be concluded that there is a relationship between weather factors and flight punctuality at Sultan Babullah Airport in Ternate. Based on the results, the Sig value for variables X and Y is below 0.005, indicating a statistically significant relationship between the two.

3.4.4. Simple Linear Regression

Simple linear regression analysis was used to evaluate the effect of weather factors on flight punctuality at Sultan Babullah Airport in Ternate. After confirming a linear relationship through a linearity test, the average data of variables X and Y were analyzed using IBM SPSS Statistics 27.

Hypothesis Test Table

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.894[a]	.799	.796	1.574

The simple linear regression model indicates that weather factors have a highly significant impact on flight punctuality, accounting for 79.9% of the variability in on-time performance.

3.4.5. T Test (Partial)

The regression results were analyzed using a t-test (partial). The output from this test is presented as follows.

T Test Table

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2,111	1,693		1,247	0,217
	Faktor Cuaca	0,541	0,033	0,894	16,566	0,000
a. Dependent Variable: Ketepatan Waktu						
	Persamaan Regresi					
	Y = a + bx					
	Y = 2,111 + 0,541X					

The t-test is used to determine the significant partial effect of weather factors on flight punctuality at Sultan Babullah Airport in Ternate, based on the regression results shown in the "Coefficients" table.

- The calculated t value is 16,566
- Sig Value (p-value) is 0,000
- The t-table value (with df = 69 and $\alpha = 0.05$) is 1.66660
- The regression coefficient (B) for the weather factor is 0.541
- The constant (a) is 2.111

Based on the results of the analysis, the following simple linear regression equation was obtained:

$$\mathbf{Y = a + bX}$$

$$\mathbf{Y = 2{,}111 + 0{,}541X}$$

The equation indicates that for every one-unit increase in the weather variable (X), flight punctuality (Y) increases by 0.541, assuming other variables remain constant. This finding confirms that weather plays a significant role in influencing flight timeliness or delays, highlighting the importance of effective weather management and accurate meteorological information to ensure smooth operations at Sultan Babullah Airport in Ternate.

This study aims to determine the extent to which weather conditions affect flight schedule punctuality at Sultan Babullah Airport in Ternate. The results of a simple linear regression analysis indicate that weather has a significant impact on flight delays. This finding is supported by the t-test results, where the calculated t-value of 16.566 exceeds the critical t-value of 1.66660, and the significance value of 0.000 is less than 0.05. Therefore, the alternative hypothesis (H_1) is accepted, and the null hypothesis (H_0) is rejected.

The regression equation Y = 2.111 + 0.541X indicates that for every one-unit increase in the weather variable (X), there is a corresponding increase of 0.541 units in flight delays (Y), assuming other variables remain constant. This suggests a strong positive relationship between adverse weather conditions and flight departure delays.

The weather factors analyzed include rainfall, wind speed, and extreme conditions such as storms and fog—all of which were identified as major causes of delays. Direct observations support this, including instances of heavy rain causing flight delays of over two hours and flight diversions due to strong winds.

Based on questionnaires distributed to 71 respondents—including airline staff, airport operations personnel, and BMKG officers—the majority agreed that severe weather significantly affects departure and arrival processes, particularly in ground handling and operational decision-making. For example, heavy rain slows down boarding and refueling procedures and requires additional safety measures.

The impact of delays is not only experienced by passengers but also affects aircraft rotation, subsequent flight schedules, and overall operational efficiency. Therefore, improved mitigation systems and more

integrated cross-unit coordination are necessary to handle rapidly changing weather conditions.

Overall, the research findings highlight that weather is a critical factor that must be considered in flight operations, particularly to maintain punctuality and service quality at Sultan Babullah Airport in Ternate.

4. CONCLUSION AND RECOMMENDATION

From the explanation above, it can be concluded that.

1. Based on the research findings, it can be concluded that weather factors have a significant impact on flight punctuality at Sultan Babullah Airport in Ternate. Wind speed and rainfall were identified as the main causes of delays, supported by observational data and the majority of respondents who stated that adverse weather frequently hinders takeoff and landing operations.
2. The results of the simple linear regression analysis show a significance value of 0.000 (< 0.05) and a t-value of 16.566 (> t-table 1.66660), indicating that weather factors have a significant effect on delays. The regression equation Y = 2.111 + 0.541X suggests that each one-unit increase in weather factors leads to a 0.541-unit increase in flight delays.
3. Therefore, the alternative hypothesis (H_1) is accepted, and the null hypothesis (H_0) is rejected. Weather factors should be a key consideration in flight operations planning and management to ensure efficiency and on-time performance.

Based on the research results and conclusions above, the researcher provides several suggestions aimed at Babullah Ternate Airport to make adjustments, namely:

1. Increasing the number of parking stands to accommodate aircraft delays caused by weather or operational factors, preventing congestion when multiple flights experience similar disruptions.
2. Upgrading the weather monitoring systems to provide clearer and more accurate information compared to the previous equipment.
3. It is recommended that airport management and BMKG enhance the real-time weather information system to ensure greater accuracy. This improvement is crucial for enabling airlines and operational staff to make faster and more informed decisions when dealing with extreme weather changes that could cause flight delays.

REFERENCES

[1] “jurnal pengertian pengaruh”.

[2] “06. CALK 2019-3”.

[3] Millah Hayatul and Suryana Hamdiah, “360-Article Text-1011-1-10-20200715”.

[4] Z. Iba and A. Wardhana, “METODE PENELITIAN,” 2024.

[5] S. Romdona, Senja Junista, and Gunawan A, “TEKNIK PENGUMPULAN DATA: OBSERVASI, WAWANCARA DAN KUESIONER. 3(1), 39–47. ”.

[6] P. Biringkanae and R. R. Bunahri, “Literature Review Penggunaan Teknologi Kecerdasan Buatan dalam Penerbangan: Analisis Perkembangan Teknologi, Potensi Keamanan, dan Tantangan”, doi: 10.31933/jimt.v4i5.

[7] A. Luthfiarta, A. Febriyanto, H. Lestiawan, and W. Wicaksono, “Analisa Prakiraan Cuaca dengan Parameter Suhu, Kelembaban, Tekanan Udara, dan Kecepatan Angin Menggunakan Regresi Linear Berganda,” *JOINS (Journal of Information System)*, vol. 5, no. 1, pp. 10–17, May 2020, doi: 10.33633/joins.v5i1.2760.

[9] A. Pnueli, In transition from global to modular temporal reasoning about programs, in: K.R. Apt (Ed.), Logics and Models of Concurrent Systems, Springer, Berlin, Heidelberg, 1984, pp. 123–144. DOI: https://doi.org/10.1007/978-3-642-82453-1_5

[10] B. Meyer, Applying "Design by Contract", Computer 25(10) (1992) 40–51. DOI: https://doi.org/10.1109/2.161279

[11] S. Bensalem, M. Bogza, A. Legay, T.H. Nguyen, J. Sifakis, R. Yan, Incremental component-based construction and verification using invariants, in: Proceedings of the Conference on Formal Methods in Computer Aided Design (FMCAD), IEEE Press, Piscataway, NJ, 2010, pp. 257–256.

[12] H. Barringer, C.S. Pasareanu, D. Giannakopolou, Proof rules for automated compositional verification through learning, in Proc. of the 2nd International Workshop on Specification and Verification of Component Based Systems, 2003.

[13] M.G. Bobaru, C.S. Pasareanu, D. Giannakopoulou, Automated assume-guarantee reasoning by abstraction refinement, in: A. Gupta, S. Malik (Eds.), Proceedings of the Computer Aided Verification, Springer, Berlin, Heidelberg, 2008, pp. 135–148. DOI: https://doi.org/10.1007/978-3-540-70545-1_14