Langit Biru: Jurnal Ilmiah Aviasi Vol. 18 No. 1 February 2025 Page. 44 : 53
ISSN (p) 1979-1534 ISSN (e) 2745-8695

AUTOMATED SYSTEM DESIGN FOR SENDING *ARRIVAL MESSAGES* AT BACKUP FACILITIES IN JAKARTA AIR TRAFFIC SERVICE CENTER

Muhammad Caesar Akbar[(1)], Hairul Amren[(2)], Surya Tri Saputra[(3)], Yuda Abimanyu[(4)]
[1,2,4]Politeknik Penerbangan Medan, [3]Politeknik Penerbangan Indonesia Curug
[1]mhdcaesar@poltekbangmedan.ac.id, [2]hairul.amren@yahoo.com, [3]suryaatc@gmail.com , [4]abimanyu.yda@gmail.com
coresponding: [1]mhdcaesar@poltekbangmedan.ac.id

Received :	Revised :	Accepted :
23 December 2024	14 February 2025	06 March 2025

Abstract: This research is urgent to ensure that the Arrival Message Engine, which is separate from the Main ATC System, can send ATS Messages automatically. This was deemed necessary to do immediately to back up a bug in the Main ATC System, which caused several Arrival Messages not to be sent. The method used is the research and development method, meaning it is a scientific way to research, design, and test the validity of the product that has been created. Research and development has four levels: researching without testing, testing without researching, researching and testing to develop existing products, and researching and testing to create new products. A product has been produced in the form of an arrival message delivery automation system that automatically sends arrival message data to the AFTN message network and can run well per the user needs assessment in this research. This system allows ATC personnel to reduce the time spent on manually sending arrival messages, enabling them to concentrate on more critical tasks such as air traffic monitoring. The implementation of this system can also enhance the accuracy of message delivery and minimize the risk of human error. It was proven from the design validation results that the test results were 100% and categorized as very feasible, as well as from the system test results using the Black Box method. As a continuation of this research, a warning and monitoring system for sending ATS messages is needed when a failure or anomaly occurs in the main system. It is hoped that this research can be considered for use in operations as an alternative facility so that it can support activities related to handling ATS messages or flight data processing systems in flight navigation operations.

Keywords: Arrival Message, ATS, AFTN Message, Automation, Flight data Processing System

Introduction

Airplanes are the most important part of air transportation. As a milestone in air transportation, aircraft movements have their characteristics, so studies can be carried out on this. Airline traffic flow refers to the number of aircraft passing a certain point or route in one unit of time (Zhang et al., 2020). The flow of aviation traffic is regulated in a process, namely flight navigation services. In the process, several supporting variables are needed so that the objectives of this service can be achieved, including flight data and information.

In the process, each aircraft requires some news to be broadcast, from preparing the flight plan to the aircraft's arrival. These news are called ATS Messages. In ATS Messages, aircraft movements can be identified so that flight navigation services can be provided. To determine the movement of an incoming aircraft, the Arrival Message, which is part of the ATS Message, is used to notify that the aircraft has arrived.

DOI: https://doi.org/10.54147/langitbiru.v18i01

ARR messages must be sent immediately after a flight lands. The ATS Unit from the arrival airport is the unit that is obliged to send the ARR message according to what is regulated in handling ATS messages in ICAO Document Doc.4444 (ICAO, 2018). So, sending an ARR message to the ATS Unit at the arriving airport after a flight has taken off is mandatory.

Apart from providing information on the arrival of an aircraft, ARR Messages are also used as follow-up information. This advanced information can be used to update requests and calculations in the Air Traffic Flow Management (ATFM) process, and other information can be used to support flight navigation service operations. ARR messages are also usually used as a Key Performance Indicator (KPI) of an AirNav Indonesia branch related to optimizing the flight information provided. What is no less important is that the ARR message is also used as an evidence variable in billing Air Navigation charges to airlines. With the growth in aviation traffic volume, aviation automation facilities have always been developed to improve the capabilities of air traffic controller (ATC) officers over the last few decades (Zakaria et al., 2022). Automation has increased the capabilities of flight navigation systems, thereby reducing the workload of flight navigation personnel. Much attention has been devoted to developing advanced automation technologies in the past decade (Wang et al., 2021). This research focuses on addressing the specific challenge of automating arrival message delivery at Jakarta Air Traffic Service Center.

Several new functions have emerged, resulting in advances in traffic control activities that were previously unavailable (Bestugin et al., 2020). In ATS units that have used the ATC Automation System to provide flight navigation services, the process of managing and sending ARR messages is carried out automatically by the ATC Automation System. However, in operational implementation at the Jakarta Air Traffic Service Center, the existing ATC Automation System needs fixing in the form of bugs so that it can only produce ARR messages occasionally.

This can lead to inconsistencies in the processing of required flight information and impact flight navigation operations.

For example, the ATC Automation System and Jakarta Air Traffic System have yet to send ARR messages several times, causing several problems. Among the issues that arise if an ARR message is not sent are:

1. There needs to be initial information regarding flights that have landed by the parties in need, especially the airport of arrival.
2. In some ATC Automation Systems, the flight plan will not stop automatically, resulting in a buildup of data on the main operational server.
3. Some adjacent countries cannot estimate and calculate traffic flow because the ATFM System requires ARR messages as further information
4. The Air Navigation Charge billing process will be hampered because there is no evidence variable.

In previous research, an engine was created that could process Arrival Messages. Arrival Message data comes from the application server by processing data from the ATC System JATSC server so that Arrival Message news is created, which is ready to be used if the Arrival message cannot be sent automatically by the ATC System JATSC. However, the implementation still involves human intervention to copy the Arrival Message.

This results in an increase in workload for flight navigation personnel on duty. Plus, the number of ARR messages at JATSC is enormous. So, the potential for format errors and non-delivery is huge if sent manually. Therefore, this research will be designed so that the system can automatically send Arrival Message news to the system.

Based on the background description above, the author wants to create a system design that can automatically send ARR messages whose data requirements are taken from the automatic

ATS Message engine. Therefore, the author raised this research titled "Design of an Automation System for Arrival Message Delivery at Backup Facilities in Jakarta Air Traffic Service Center."The introductory section provides the background of the problem, problem formulation, problem limitations, objectives and benefits of the research briefly. The introduction should contain the development of previous research (state of the art) to compare with current research thereby highlighting a gap between the theory or results of previous research and the current or expected situation.

Literature Review

Recent studies have highlighted the importance of automation in air traffic control systems. (Sharma et al., 2022) emphasized that optimization and automation of ATC systems can significantly reduce human error and improve efficiency. Similarly, (Wang et al., 2021) discussed the impact of automation on air traffic controllers' behaviors, noting that automated systems can reduce workload and enhance decision-making processes.

Furthermore, the integration of advanced technologies such as blockchain in air traffic management has been explored by (Lu et al., 2022). Their study proposed a blockchain-based security framework for cyber-physical systems in air traffic management, which could enhance data integrity and security in ATS message delivery systems.

The importance of data-driven approaches in air traffic management has also been highlighted by (Zhang et al., 2020). Their research demonstrated how data-driven analysis could improve the understanding of chaotic characteristics in air traffic flow, which is crucial for optimizing ATC operations.

Method

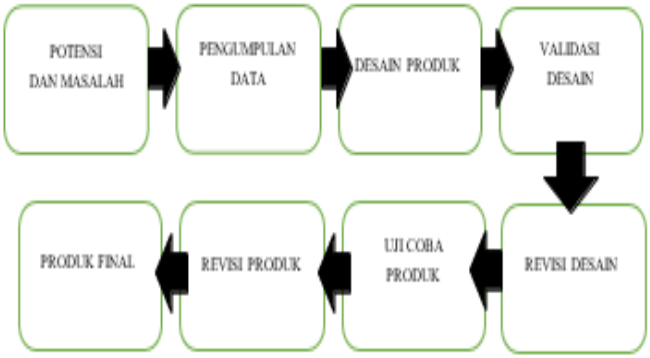
The research and development method is a scientific way to research, design, and test the validity of products that have been created. Research and development have four levels: researching without testing, testing without researching, researching and testing to develop existing products, researching and testing in creating new products. Or according to the following picture:

Figure 1. Research Level

In this research, the author used level 4 research. Namely, research to produce a product design and test the feasibility of the product. Data was collected through documentation study at the Jakarta Air Traffic Service Center, unstructured interviews with aviation professionals, and questionnaires. The data collected was then analyzed using methods appropriate to each type of

data, including percentage calculations for questionnaire data and qualitative analysis for interview data.

Method of collecting data



1. Data reduction

Data processing is used to extract the essence of the data collected during the data collection stage to take only the important parts. According to Miles and Huberman (Sugiyono, 2019), namely data reduction, data display, and verification.

The author carried out data reduction at the needs assessment stage to get the essence of unstructured interviews with aviation communications managers, ATFM and ATS System Managers, and ATS System Specialists. The sample size for the needs assessment stage included 10 participants. While this provided valuable insights, the generalizability of the findings may be limited due to the specific context and relatively small sample. Future research could involve a larger and more diverse sample to enhance the external validity of the results."

2. Data Analysis

a. Analysis of Expert Validity Questionnaire Data

Expert validity questionnaire data will be analyzed using the Rating Scale.

No	Keterangan	Skor
1.	Sangat baik	4
2.	Cukup baik	3
3.	Kurang baik	2
4.	Sangat tidak baik	1

The percentage calculation from the data that has been obtained is processed using the following formula:

$$P = \frac{\Sigma R}{N} \times 100\%$$

Information :

P: Score percentage

∑ : Number of answers given by the validator

N : Maximum score

Data analysis method

1. Documentation study

Carried out at the initial data collection stage for design materials to be carried out. At this stage, the author collects data from the Jakarta Air Traffic Service Center for the data needed in the design.This involved reviewing existing documentation, such as procedure manuals and system specifications, to understand the current processes and system requirements. Data collected included process workflows and system requirements.

2. Unstructured interviews

Interviews were used as a data collection method in the author's research. Interviews were conducted several times. Namely, interviews are conducted to determine the needs of users or users in the field regarding what kind of design is needed to meet aviation traffic service needs. Participants for the need assessment interviews were selected based on their experience and expertise in air traffic management and ATS message handling at the Jakarta Air Traffic Service Center. This ensured that the elicited requirements were grounded in practical knowledge and operational needs.

3. Questionnaire (questionnaire)

A questionnaire is a method of collecting data with concrete or definite values. By using a questionnaire, a design you want to try can be assessed for its effectiveness and feasibility before it becomes a final product

Discussion

The product design in this research uses the **Change Data Capture (CDC)** approach. CDC is an innovative approach to data integration based on identifying, capturing, and transmitting changes made by source data. By processing only the changes, CDC makes the data integration process more efficient and reduces costs by reducing latency (Zhang et al., 2020). CDC must be integrated with ETL (Extract, Transform, Load) tools to make the ETL process efficient. Integrating CDC with existing ETL tools provides an integrated approach to reducing the amount of information sent while minimizing resource requirements and maximizing speed and efficiency (Lu et al., 2022).

The CDC model used in this research is the CDC Pull Model, where the ETL tool periodically requests data changes. The scenario created only captures and transfers changing data.

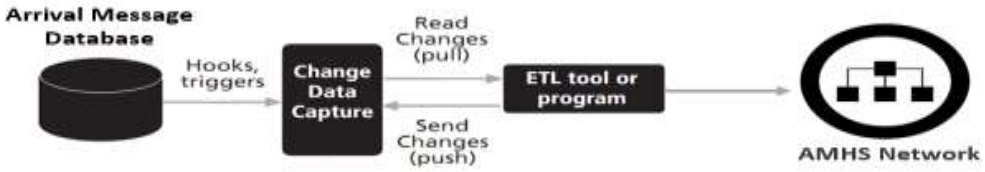


Figure 3. Integration CDC in ETL

1. System Sequence Diagram

Sequence diagrams describe interactions between objects over a certain period. Because interaction patterns vary from stage to stage, each sequence diagram only shows interactions related to a specific use case. Sequence diagrams can describe a pattern of interaction from one system to another so that it can produce the output the user wants. So that the goals of making the application can be achieved. The Sequence diagram of this automatic ATS message engine is shown in the following image.

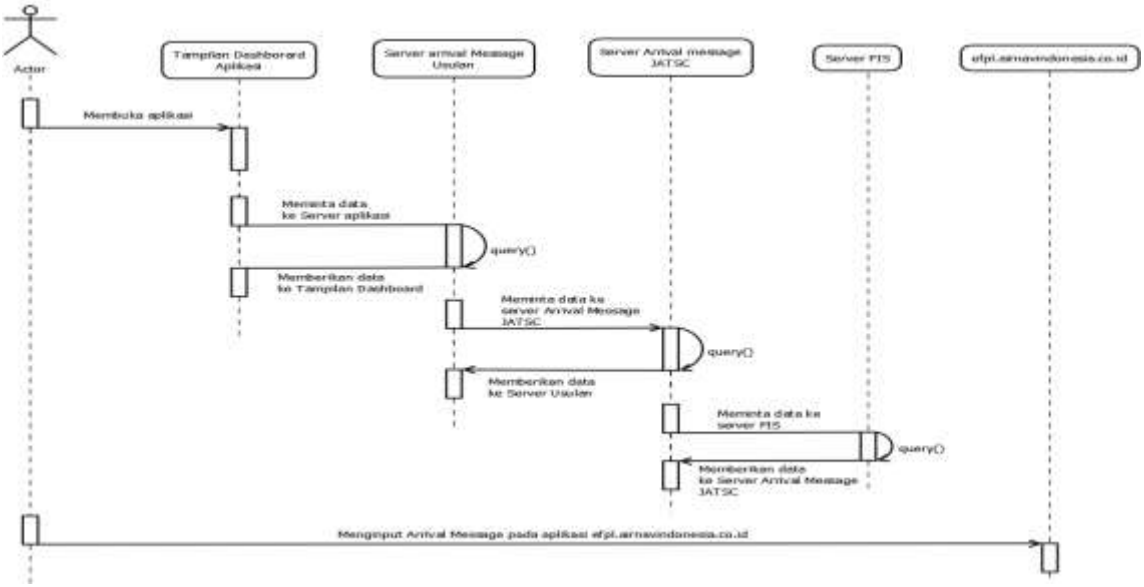


Figure 4. Sequence Diagram Automatic ATS Message Engine

2. The process of capturing data changes

The image below is a view of the application server. In this display, you can see the activity of the application server when retrieving data changes in the automatic ATS message engine. This display also shows server activity when data is provided to the application dashboard display. This process will continue until an indefinite time limit and will stop if there is a failure in the system, such as a power outage and other things that can cause system failure.

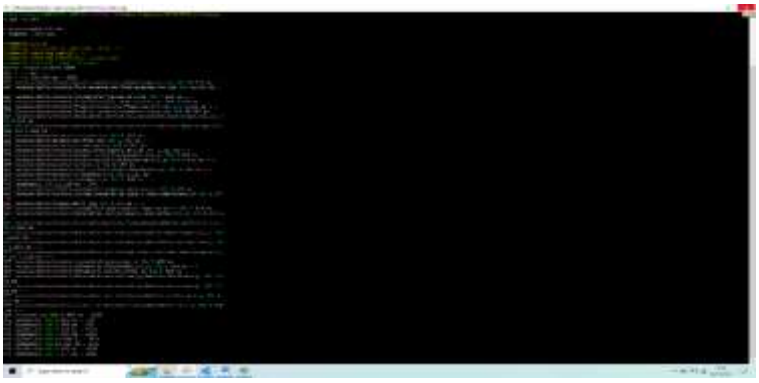


Figure 5. Process of Capturing Data Changes on the Server System

3. Automatic Arrival Message Production Process, Arrival Message Format Arrangement and Automatic Arrival Message Delivery Process.

The image below displays the application database opened with the Heidi SQL application. With the application, programmers can view the contents of the database in the form of tables. Because the original database file contains long text using the SQL programming language. Apart from that, programmers can give query commands to the database, such as update, delete, create and others, by typing these commands in the bottom line of the Heidi SQL application using the SQL programming language and syntax. The data that has been previously captured will be transferred to this database and will continue with the arrival message production process automatically in a format that is according to the applicable document requirements. Process of Capturing Data Changes on the Server System

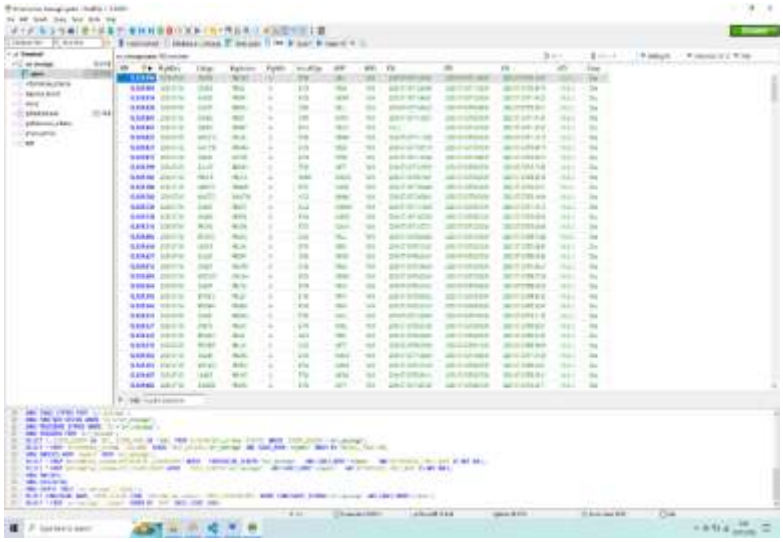


Figure 6. Database system

After the data is collected in the database, the arrival message production process continues automatically with a format that meets the applicable document requirements. This process is done by creating a script that executes the command to change the data collected in the database into arrival message text. This process will continue automatically when new data is captured in the database.

The image below shows the source code of the system being designed. The script created is a command to produce arrival messages automatically in a format that complies with the applicable document requirements. After the arrival message is produced, the script will order the arrival message to be sent automatically to the AFTN Message network. This system was created using the Javascript programming language. Javascript was chosen as the programming language for this system because Javascript is supported by many communities from all over the world. This makes it easier to develop the system in the future.

Apart from that, this system is also supported by database processing from Prisma, where the coding process uses the Javascript programming language. With Prisma, programmers can process databases so the system can use the database. This source code is displayed in the VS-code code editor application. With VS-code, developers are greatly helped in writing programming scripts when syntax errors occur. The process of debugging the program becomes easy because of the help

Figure 7. Source Code and Script System for sending arrival messages automatically

4. Arrival Delivery Automation System Dashboard Display Messages

The image below is a display of the system dashboard. On the system dashboard, the text of the arrival message that has been successfully produced automatically is displayed and immediately sent to the AFTN Message network. Before being displayed on the dashboard, this

arrival message data was first processed on the system server. The system server receives a lot of data. Therefore, the application server will sort out which data will be displayed or not displayed on the system dashboard. Then, after processing the data, it will be stored in the database and displayed on the application dashboard screen.

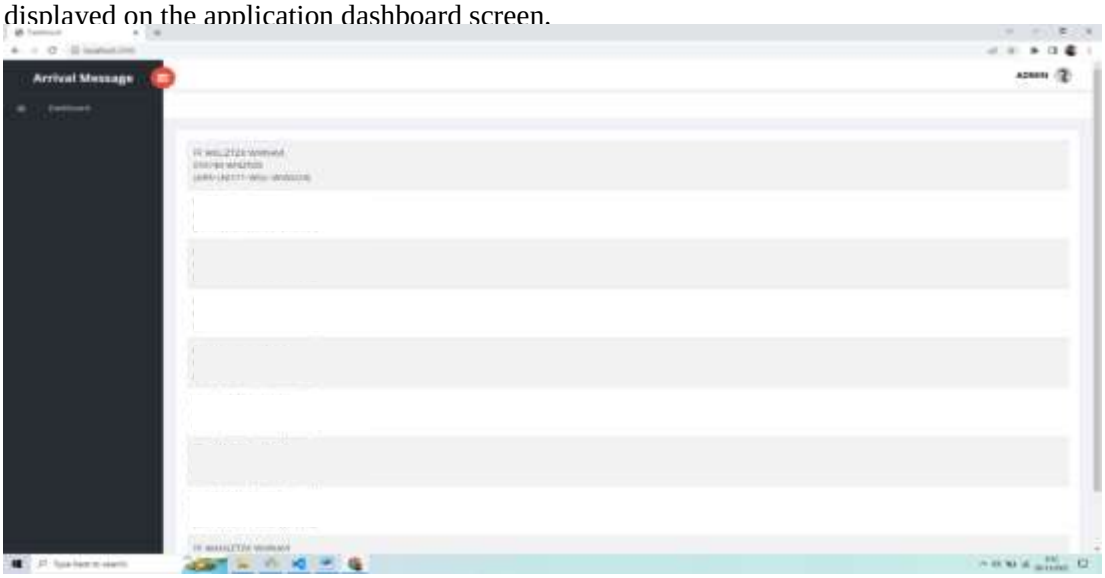


Figure 8. Arrival Message Delivery Automation System Design

5. Arrival Message Notification Dashboard Display on the ATS Message Network

The image below displays the arrival message notification dashboard on the AFTN message network/AMHS network. The system dashboard shows the arrival message text successfully sent automatically to the AFTN Message network. The new arrival message text will be green as a notification for the personnel on duty.

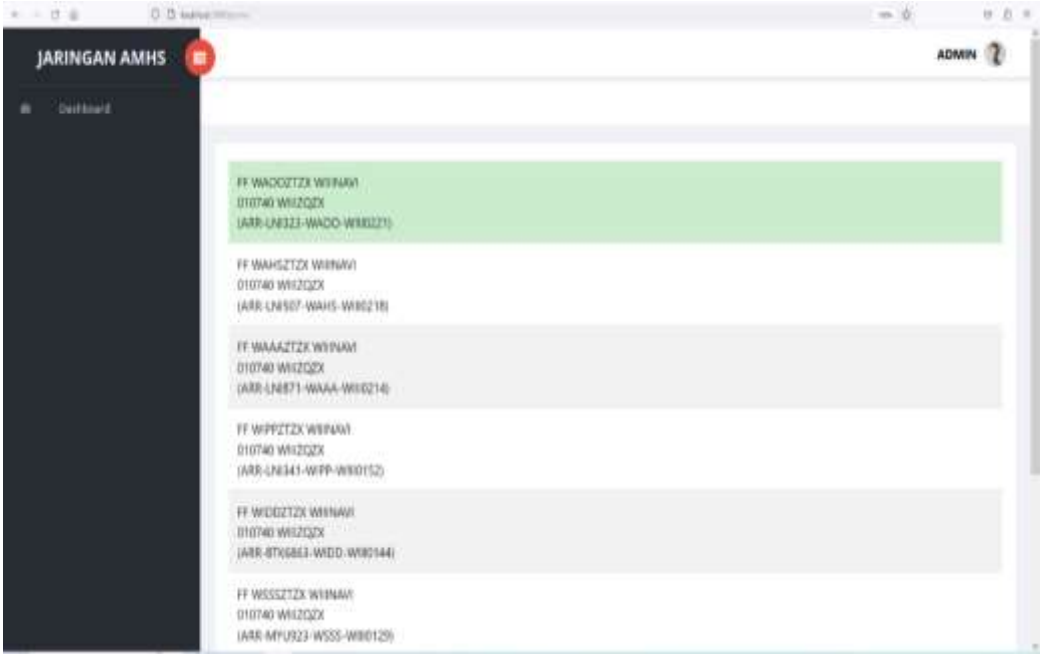


Figure 9. AFTN Message Network Notification Dashboard

Several dashboard displays above show that when the automatic arrival engine produces a new arrival message, it will immediately be sent automatically to the AFTN message network. When the AFTN Message dashboard receives new arrival message data, there will be a green sign in the arrival message column on the AFTN Message dashboard.

Conclusion

Based on the design, development, and implementation of the CDC, from the interviews with expert sources, 6 (six) points of operational requirements were obtained as a reference for designing an automation system for sending arrival messages. A product has been produced in the form of an arrival message delivery automation system that automatically sends arrival message data to the AFTN message network and can run well per the user needs assessment in this research. The resulting arrival message delivery automation system is good software; its quality has been tested and can meet user needs. It was proven from the design validation results that the test results were 100% and categorized as very feasible. The results of system testing using the Black Box method showed that the system could run well, with test results of 100% successful and by the requirements in the needs assessment. As a continuation of this research, a warning and monitoring system for sending ATS messages is needed when a failure or anomaly occurs in the main system. It is hoped that this research can be considered for use in operations as an alternative facility so that it can support activities related to handling ATS messages or flight data processing systems in flight navigation operations.

Bibliography

Abarca, R. M. (2021). Sugiyono (2019 : 147). *Nuevos Sistemas de Comunicación e Información*.

Akbar, M. C. (2021). Hubungan Sistem Sosialisasi Prosedur Dengan Kualitas Pelayanan Pemanduan Lalu Lintas Penerbangan di Divisi Jakarta Area Control Center (ACC). *Langit Biru: Jurnal Ilmiah Aviasi*, *14*(02). doi: 10.54147/langitbiru.v14i02.480

Arikunto. (2019). *Arikunto Prosedur penelitian. Jakarta:Rineka Cipta*.

Bestugin, A. R., Eshenko, A. A., Filin, A. D., Plyasovskikh, A. P., Shatrakov, A. Y., & Shatrakov, Y. G. (2020). Purpose and Comparative Study of the Controllers of ATC Automated System Simulators. In Springer Aerospace Technology. doi: 10.1007/978-981-13-9386-0_3

Dou, X. (2020). Big data and smart aviation information management system. *Cogent Business and Management*, *7*(1). doi: 10.1080/23311975.2020.1766736

Ferduła, P., & Skorupski, J. (2018). The Influence of Errors in Visualization Systems on the Level of Safety Threat in Air Traffic. *Journal of Advanced Transportation*, *2018*. doi: 10.1155/2018/1034301

Harada, A., Ezaki, T., Wakayama, T., & Oka, K. (2018). Air Traffic Efficiency Analysis of Airliner Scheduled Flights Using Collaborative Actions for Renovation of Air Traffic Systems Open Data. *Journal of Advanced Transportation*, *2018*. doi: 10.1155/2018/2734763

ICAO. (2018). Procedures for Air Navigation Services (PANS) - Aircraft Operations - Volume I - (Doc 8168-1. In Procedures for Air Navigation Services: Vol. I (Issue November).

Li, R., Zhou, Z., Cheng, Y., & Wang, J. (2017). Failure Effects Evaluation for ATC Automation System. *Applied Computational Intelligence and Soft Computing*, *2017*. doi: 10.1155/2017/8304236

Lu, X., & Wu, Z. (2022). ATMChain: Blockchain-Based Security Framework for Cyber-Physics System in Air Traffic Management. *Security and Communication Networks*, *2022*. doi: 10.1155/2022/8542876

Narbuko, C., & Achmadi, A. (2017). Metodologi Penelitian (Jakarta: Bumi Aksara, 2013), Cet. *Ke-XIII*, *h*.

Paielli, R. A. (2018). Trajectory Specification Language for Air Traffic Control. *Journal of Advanced Transportation*, *2018*. doi: 10.1155/2018/7905140

Sentoso, M. H., & Ruseno, N. (2021). DEVELOPMENT AND ANALYSIS OF 2D FLIGHT PLANNING SEARCH ENGINE CONSIDERING FUSION OF SWIM DATA. *Angkasa: Jurnal Ilmiah Bidang Teknologi*, *13*(1). doi: 10.28989/angkasa.v13i1.941

Sharma, U., Astya, P., Baliyan, A., Krit, S., Jain, V., & Khan, M. Z. (2022). Advancing Computational Intelligence Techniques for Security Systems Design. In Advancing Computational Intelligence Techniques for Security Systems Design. doi: 10.1201/9781003229704

Sugiyono. (2019). variabel indepen. *Jurnal Akuntansi*, *51*(1).

Timotic, D., Netjasov, F., & Cicevic, S. (2020). Investigation of Relationship Between Trust in Automation and Human Personality Traits Among Air Traffic Controllers. *ICRAT 2020 (9th International Conference for Research in Air Transport)*.

Wang, Y., Hu, R., Lin, S., Schultz, M., & Delahaye, D. (2021). The impact of automation on air traffic controller's behaviors. *Aerospace*, *8*(9). doi: 10.3390/aerospace8090260

Yousefzadeh Aghdam, M., Kamel Tabbakh, S. R., Mahdavi Chabok, S. J., & kheyrabadi, M. (2021). Ontology generation for flight safety messages in air traffic management. *Journal of Big Data*, *8*(1). doi: 10.1186/s40537-021-00449-3

Zakaria, Z., & Lye, S. W. (2022). Unearthing Air Traffic Control Officer Strategies from Simulated Air Traffic Data. *Lecture Notes in Networks and Systems*, *319*. doi: 10.1007/978-3-030-85540-6_46

Zhang, Z., Zhang, A., Sun, C., Xiang, S., & Li, S. (2020). Data-Driven Analysis of the Chaotic Characteristics of Air Traffic Flow. *Journal of Advanced Transportation*, *2020*. doi: 10.1155/2020/8830731