Journal of Information Technology, computer science and Electrical Engineering (JITCSE)
Vol. 1, No. 1, The 1st ICANEAT 2023
ISSN: 3046-3900, DOI: 10.61306/jitcse.v1i1.10

Utilization Of Automation In Providing Flight Information At The Aerodrome Control Tower Unit

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***Abstract*— This journal discusses the analysis of automation needs for the Air Traffic Controller (ATC) in the Aerodrome Control Tower unit in providing information to improve air traffic services for aerodrome traffic. The research was conducted by analyzing data and information obtained from ATC and air operators. Besides that, it also analyzes problems in the field that hinder the efficiency of the process of providing information from ATC to air operators (pilots). The analytical method used is SWOT analysis by considering internal and external factors to develop an effective strategy. The results of the study show that the existence of automation is significantly needed to increase the time efficiency of ATC in providing flight information. With automation, the provision of information can be carried out quickly and accurately to increase efficiency and safety in air traffic services. Therefore, this journal provides useful insights into improving the quality of ATC services by utilizing automation technology.**

Keywords*— *Air Traffic Controller, Automation, Flight Information

I. INTRODUCTION

The Aerodrome Control Tower is a unit established to provide air traffic guidance services to aircraft transiting in the aerodrome traffic. Aerodrome traffic refers to all aircraft transiting in the maneuvering area and all aircraft flying in the vicinity of an airport [1]. The maneuvering area consists of runways and taxiways but excludes the apron [2]. Aircraft flying in the vicinity of an airport means aircraft flying in or out of the aerodrome traffic circuit [1]. The aerodrome traffic circuit can be understood as the flight path pattern that aircraft will use on the runway for landing or take-off.[3]

Automation is a component necessary to enhance productivity, increase efficiency, and aid operational flight personnel in focusing on their tasks while avoiding or minimizing errors [4].

In essence, Air Traffic Controllers (ATCs) must provide information and clearances to aircraft under their control (within the aerodrome traffic) to achieve safe, orderly, and smooth air traffic flow [1]. The provision of flight information should be rapid and optimal. The delivery of flight information to users of aviation navigation services should be supported by good and balanced facilities and infrastructure [5].

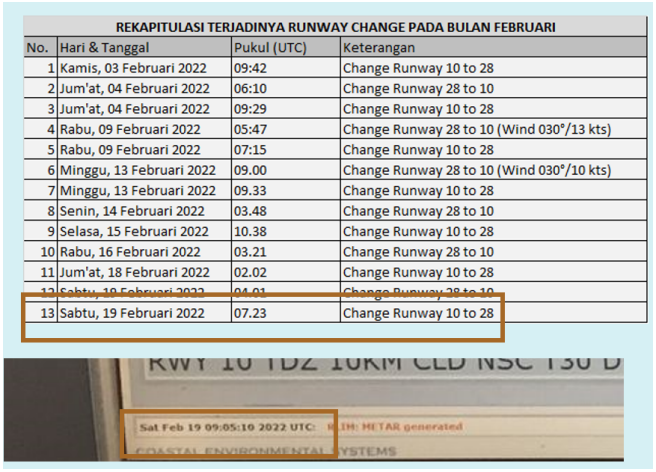
Flight information is crucial information that an Air Traffic Controller (ATC) is obligated to provide to pilots. This information supports the smooth provision of air traffic services. As stated in Annex 11 Chapter 2, which outlines the 5 Objectives of Air Traffic Services, point 4 is to "Provide advice and information useful for the safe and efficient conduct of flights" [6].

Not only does this discuss crucial flight information that needs to be known by ATC, but flight checklists are also an essential aspect that needs to be provided for ATC. This is because, without the existence of a checklist, there would be no reminder for controllers regarding the tasks that need to be carried out for the smooth operation of air traffic services. This opens up the possibility of human errors, which can result in jeopardizing flight safety and even leading to aviation accidents.

This situation is elaborated in Document 9806, the Human Factor Manual, in Chapter 1, point 1.2.4, which states, "Given the diversity of factors potentially affecting human performance, not surprisingly, human error has been recognized as a major factor in virtually all aviation accidents and incidents since the beginning of aviation. Understanding the context for human error then remains one of aviation's biggest challenges. If the reasons why human error can be understood, better strategies can be developed for avoiding

errors, and controlling and recovering safely from them. The study of Human Factors is fundamental to understanding the context in which normal, healthy, qualified, well-equipped, and motivated personnel commit human errors some of which are fatal." [7]

This is one of the data from the observation that shows the human error that happens due to no checklist, so several step steps that need to be done are missed/forgotten when the Runway Change happens which is changing the Runway in Use inside the AWOS. Based on the observation this case happens in the figure below:



REKAPITULASI TERJADINYA RUNWAY CHANGE PADA BULAN FEBRUARI

No.	Hari & Tanggal	Pukul (UTC)	Keterangan
1	Kamis, 03 Februari 2022	09:42	Change Runway 10 to 28
2	Jum'at, 04 Februari 2022	06:10	Change Runway 28 to 10
3	Jum'at, 04 Februari 2022	09:29	Change Runway 10 to 28
4	Rabu, 09 Februari 2022	05:47	Change Runway 28 to 10 (Wind 030°/13 kts)
5	Rabu, 09 Februari 2022	07:15	Change Runway 10 to 28
6	Minggu, 13 Februari 2022	09.00	Change Runway 28 to 10 (Wind 030°/10 kts)
7	Minggu, 13 Februari 2022	09.33	Change Runway 10 to 28
8	Senin, 14 Februari 2022	03.48	Change Runway 28 to 10
9	Selasa, 15 Februari 2022	10.38	Change Runway 10 to 28
10	Rabu, 16 Februari 2022	03.21	Change Runway 28 to 10
11	Jum'at, 18 Februari 2022	02.02	Change Runway 10 to 28
12	Sabtu, 19 Februari 2022	04.01	Change Runway 28 to 10
13	Sabtu, 19 Februari 2022	07.23	Change Runway 10 to 28

Fig 1. Runway Change Data and the AWOS Date

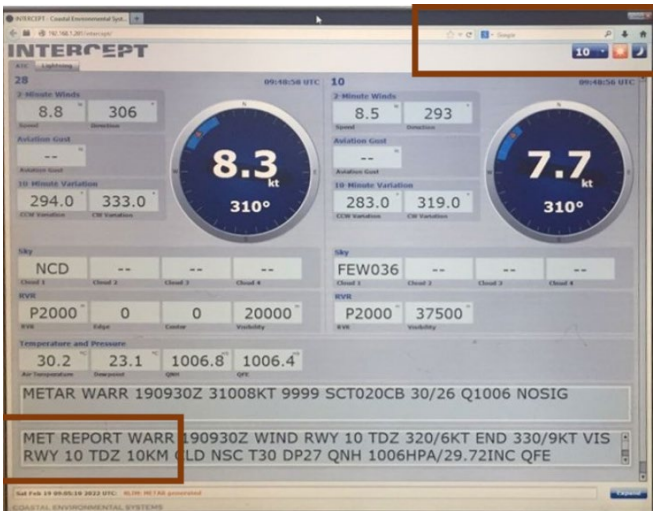


Fig 2. Human Error Case in which the Runway in Use still not changed into 28 by the ATC

ICAO Document 9806 emphasizes that human errors are the primary factors contributing to aviation accidents. Therefore, preventing human errors is of utmost importance. Based on this explanation, it is evident that the presence of flight information data and checklists is highly crucial and necessary.[8]

However, the current condition of flight navigation information services is not yet optimal. The problem is that important information and checklist items crucial to the smooth provision of flight navigation services are quite challenging for ATCs to access and locate. The platforms used to provide flight navigation information are still conventional, using paper media. In other words, the current platforms are not effective and efficient, thus hindering the information provision process by ATCs to pilots. At present, the process of providing flight information by ATCs is not fast and optimal due to the hindrance caused by inaccessible flight information platforms.

Furthermore, based on similar studies that have been conducted, several findings have been identified. These findings demonstrate the magnitude and significance of the role of automation in assisting flight personnel, especially ATCs.

Research results indicate that the utilization of automation significantly eases the work of ATCs in performing their main tasks based on the 5 Objectives of Air Traffic Services in Annex 11 Chapter 2. The primary tasks of ATCs, based on the 5 Objectives of Air Traffic Services, can be summarized as preventing collisions or ensuring flight safety, creating an efficient and orderly traffic flow, and providing flight information useful for flight safety [6].

Based on several reviewed journals, one of them explains that the use of automation can support the effectiveness and efficiency of flight navigation services. For instance, with the utilization of automation such as Electronic Flight Progress Strips (E-Strips), ATCs are facilitated in effectively managing the main tasks to create an efficient and orderly traffic flow by easily recording flight data on E-Strips [9].

Another similar journal also states that the use of automation can aid ATCs in their task of collision prevention. The presence of navigation aids like surveillance systems based on automation (e.g., ADS-B) and the implementation of human-automation relationships assist ATCs in their duty to prevent collisions or ensure flight safety [4].

Another similar journal discusses that flight information is crucial for ATCs to provide to ensure flight safety and efficient traffic flow. In other words, ATCs' primary tasks of ensuring flight safety and creating an efficient and orderly traffic flow can be achieved through the effective provision of flight information. An example from a similar study is the provision of atmospheric meteorological conditions using automation to aid ATCs in providing meteorological information to high-flying aircraft in a specific atmospheric region [10]. The study explains that the use of automation effectively assists both pilots and ATCs in providing useful information for flight safety.

This present study will differ from the aforementioned similar studies, as it will focus on the utilization of automation that aids ATCs in the Aerodrome Control Tower unit in

providing flight information to aerodrome traffic (all aircraft transiting in the maneuvering area and all aircraft flying in the vicinity of an airport).

The accurate and timely provision of air traffic information by ATCs in the Aerodrome Control Tower unit is a critical component in maintaining flight safety and efficiency. Air Traffic Controllers (ATCs) must provide accurate flight information for all departing and arriving aircraft to prevent accidents and incidents and ensure smooth operations on the runway.

In recent decades, advancements in automation technology have brought significant changes to the aviation industry, including air traffic control. The utilization of automation in providing flight information by ATCs has become an area of interest for scientists and aviation practitioners.

The purpose of this study is to describe and analyze the utilization of automation in the process of providing flight information by ATCs to enhance air traffic services in the Aerodrome Control Tower. We will discuss relevant automation concepts, utilized technologies, and expected benefits from the implementation of automation systems in providing air traffic information at the Aerodrome Control Tower unit of Perum LPPNPI Surabaya Branch.

II. METHODOLOGY

In this study, the author utilized a qualitative research methodology. This decision stems from the focus of the study, which is to examine the quality of ATC efficiency in providing flight information to pilots. This research falls under the category of exploratory research, where the author aims to explore the development of new technology or automation that can enhance the quality of ATC efficiency in delivering flight information to pilots.

There are a variety of methods of data collection in qualitative research, including observations, textual or visual analysis, and interviews (individual or group) [11]. For this study, the data collection methods employed were surveys, document analysis, and observations. As for data analysis, the SWOT analysis method was employed, which aids in assessing the most appropriate strategies considering both internal and external factors.

A. Data Collecting

The data collection method employed in this study involves surveys and observations. The survey method used, more specifically, is through interviews. In these interviews, the author directly interviewed 10 active ATCs or controllers from the Aerodrome Control Tower unit at Perum LPPNPI Surabaya Branch. This choice was made because active ATCs or controllers in that tower unit directly experience the inefficiencies and challenges in providing flight information to pilots.

Below are some question formats that the author posed to the relevant interviewees:

1. What are the crucial and mandatory flight information pieces that ATCs need to have available to provide them to pilots who require such information?
2. How is the current process of delivering flight information carried out?
3. What is the current platform used to provide flight information to ATCs for them to deliver to pilots?
4. Are there any challenges for ATCs in accessing flight information that is then communicated to pilots who need it? Why do these challenges arise?
5. Is a new platform needed to provide flight information to ATCs? What kind of new platform is envisioned?
6. Which ATCs at Airnav Juanda are capable of operating technology or automation?
7. Does Airnav Juanda possess adequate technological advancements and facilities that can support the implementation of new technology or automation?

The author's rationale behind choosing and designing these questions is to understand the current condition of the ATC process of accessing flight information that is subsequently provided to pilots in need. The process of providing flight information by ATC to pilots needs to be re-evaluated. The factors hindering this process and the root causes of these obstacles need to be analyzed from the perspectives of ATCs or active controllers in the tower unit who directly experience the impact of these challenges.

In addition to using the survey method, the author also employed the data collection method of observation. The observation method used in this study is direct observation as an insider. This decision was made because the author has also experienced being an active controller in that tower unit and has directly felt the impact of the challenges present.

B. Data Analysis

The author employed a qualitative data analysis method to uncover findings in this study. Before discovering a new solution to the existing problem, the author utilized qualitative data analysis with the SWOT analysis method. The SWOT Matrix is a step that must be taken to determine strengths and weaknesses as well as to deal with the opportunities and threats encountered [12].

Based on the SWOT analysis, appropriate strategies can be derived to address the existing issues. The results obtained from the SWOT analysis method, as utilized in the research

by Freddy Rangkuti, will serve as a reference for uncovering new findings in this study.

SWOT stands for Strengths, Weaknesses, Opportunities, and Threats. SWOT analysis is a strategic planning technique for businesses or projects. This method considers internal and external factors to formulate effective business strategies. In each SWOT matrix, the components can be easily interpreted as follows:

1) Strengths
   - ➢ Positive (+) aspects originating from within or internal factors.
2) Weaknesses
   - ➢ Negative (-) aspects originating from within or internal factors.
3) Opportunities
   - ➢ Positive (+) aspects originating from outside or external factors.
4) Threats
   - ➢ Negative (-) aspects originating from outside or external factors.

The methodology of employing the SWOT analysis method, as outlined by Freddy Rangkuti, involves the cross-matching of SWOT components. This process yields appropriate strategies for each intersection of SWOT components. A brief overview of this process can be observed in the diagram below.

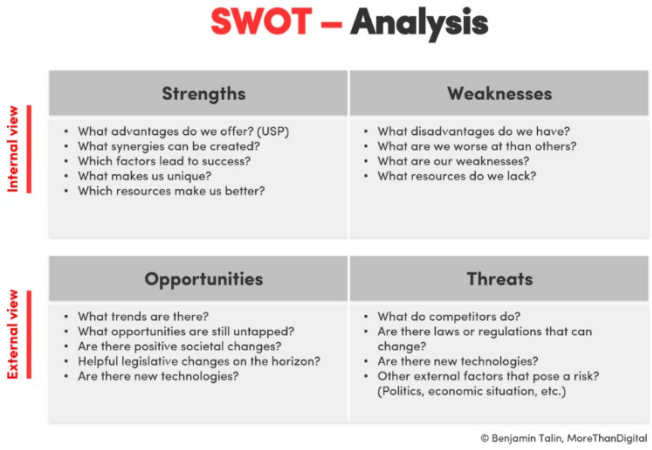


Fig 3. Table of SWOT Analysis Formula

III. RESULT (RESEARCH FINDINGS)

Flight information and checklists are crucial pieces of knowledge that an Air Traffic Controller (ATC) needs to be aware of and acquire. For instance, consider the checklist outlining the necessary steps during a Runway Change (Runway Change Checklist). This checklist is an essential resource for an ATC [13].

Another example pertains to critical information that an ATC, particularly in the Aerodrome Control Tower unit, must be aware of. For instance, knowing the remaining TORA (Take-Off Run Available) when a pilot requests take-off from an intersection taxiway. Essentially, this information is vital because, according to Doc.4444, when providing take-off clearance via an intersection, the ATC must also communicate the remaining TORA. Similarly, the presence of other important information and checklists is crucial for the seamless provision of air traffic services by an Air Traffic Controller (ATC) [14].

Hence, there arises a need for a platform that can provide such essential information and checklists comprehensively, in real-time, and with easy accessibility. However, the challenge in reality is that the crucial information and checklists supporting smooth air traffic services are often difficult to access and locate. At Juanda International Airport in Surabaya, this vital information and checklists are presented in the form of paper documents affixed to the control desk. The following provides an overview of the platform used to deliver information and checklists at Airnav Juanda Surabaya:

Fig 4. Layout of Control Desk

The current platform, as depicted in the image above, is not suitable for housing the crucial information and checklists that support the smooth provision of air traffic services. It can be analyzed that several issues arise from the current paper-based platform affixed under the control desk. The problems that emerge include the following:

1) Disruption of the control desk's neatness, which serves as an ATC's workspace.
   - ➢ As can be observed from the image above, the appearance and aesthetic of the paper attachments can be quite disruptive.
2) Ineffectiveness in facilitating the seamless provision of air traffic services.
   - ➢ With a platform like the one shown above, it is evident that ATCs will face difficulty in obtaining the information they require. An ATC must remember and search for the location of the paper containing the necessary information. However, when an ATC is controlling ongoing

air traffic, quick access to information and communication to pilots is crucial.

3) Lack of accessibility

Fig 5. Illustration of Density on Control Desk Resulting in Inaccessible Flight Information

- The placement of essential flight information and checklist documents on the control desk leads to complexities. Since the control desk area is a space that cannot be tampered with to avoid disruption to ATC activities, and it's already filled with necessary items for traffic management, accessing important flight information and checklists becomes cumbersome. Objects must be moved or lifted from the control desk to locate and access the needed information.

4) Inefficiency and Lack of updatability

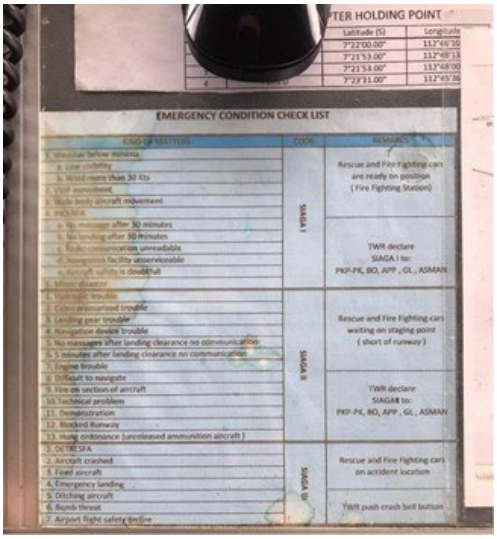


Fig 6. Paper Exposed to Water

- Considering its medium, which is paper, the current approach is not efficient. It involves acquiring paper, printing the required information, and then dealing with the complexity of placing it under a plastic sheet on the control desk. Furthermore, there's the possibility of the paper being lost or easily damaged, as depicted in the image above. Additionally, using this inefficient paper-based approach often results in delays in replacing important information or procedures with the latest updates.

Based on the aforementioned issues, it can be concluded that a new platform is required. The result of these research findings shows us that we need a platform that is paperless, accessible, and more efficient.

IV. DISCUSSION

To find an appropriate solution to the issues at hand, it's essential to analyze the data that has been collected and structured into a problem, as explained above. Based on a journal about strategic planning, some techniques can be used to analyze the best solution, and one example is the Improved SWOT Analysis [15]

The analysis method employed in this study is SWOT analysis, wherein we determine the SWOT components first and then cross-reference them to arrive at suitable strategies. The SWOT analysis is a strategic tool employed in organizational planning and management. It proves valuable in constructing both organizational and competitive strategies with great effectiveness. [16]

Specifically, when addressing the issues related to checklists and flight information, the SWOT components can be outlined as follows:

1) *Strengths (S)*
   a) Airnav Juanda International Airport already possesses the necessary content, checklists, and crucial information required to facilitate air traffic services.

b) Airnav Juanda International Airport has skilled and technologically adept human resources.

c) The airport's IT experts and SOP teams can design and generate important content for the smooth provision of air traffic services.

2) *Weaknesses (W)*

a) The medium used to present important information for air traffic services still relies on paper, affixed to the control desk, without leveraging available technological advancements.

b) Paper-based media is susceptible to damage, loss, and lack of updatability.

c) The placement of critical information on the control desk makes it challenging to locate, as it is often covered by various items.

3) *Opportunities (O)*

a) Rapid technological advancements in the Industry 4.0 era.

b) Availability of various application types to simplify the creation of an application.

c) Various devices exist that could serve as new platforms that are easier, more effective, and simpler.

4) *Threats (T)*

a) Insufficient attention was given to innovating and developing a new platform to present essential flight information and checklists.

b) Challenges associated with implementation during the current pandemic conditions.

c) Overcrowding of items within the tower, particularly on the control desk.

To derive suitable strategies for a problem, it's not a matter of simply creating or building something new. Rather, it requires analysis through the SWOT method. This involves considering the results of matrix cross-referencing: S-O for SO strategies, W-O for WO strategies, S-T for ST strategies, and W-T for WT strategies. [17][18]

Based on the cross-referenced SWOT matrix, the following strategies are formulated:

TABLE 1. SWOT ANALYSIS RESULTS

	STRENGTHS (S)	WEAKNESS (W)
OPPORTUNITIES (O)	SO Strategy: Deploying qualified and expert IT personnel to create digital content regarding flight checklists and information.	WO Strategy: Changing the presentation media of flight information by utilizing simple technology and devices.
THREATS (T)	ST Strategy: Harnessing the potential of human resources to contribute to implementing solutions within the existing limitations.	WT Strategy: Creating an innovation that can serve as a simple, accessible, and low-capital media.

Consequently, what is needed is a digital innovation that can encompass all checklists and flight information in a simpler and more accessible manner. This digital innovation takes the form of an application, such as the ACID (Aeronautical Checklist & Information Display) application created by the author. The ACID application is designed to encompass all checklist and vital flight information content produced by the skilled human resources of AirNav Juanda International Airport, Surabaya. Additionally, the expertise of the IT Manager can contribute to the evaluation and execution of this digital solution that harnesses the advancements in today's information technology. The utilization of technology is a highly recommended solution in this industry 4.0 era especially in Indonesia. [19]

The ACID (Aeronautical Checklist & Information Display) application is developed using the Visual Basic 2019 software. This application serves as a repository and display platform for checklists and critical flight information. Below is the interface of the ACID application, as designed by the author:

Fig 7. Application Appearance After Export

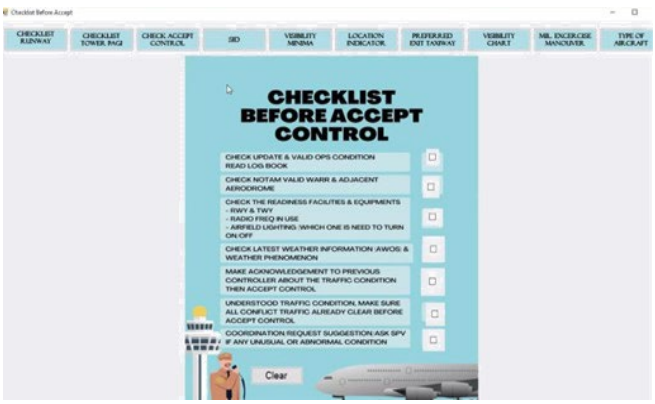


Fig 8. Design Model 2 of the Application

V. CONCLUSION

Juanda International Airport (Surabaya) is one of the busiest airports in Indonesia for both domestic and international flights. Air Traffic Controllers (ATC) rely on checklists and information provided by AirNav Juanda International Airport in paper form. This practice has led to issues such as inaccessible, inefficient, and non-updatable information. Therefore, the presence of a portable application containing the required information is crucial. The Aeronautical Checklist & Information Display (ACID) is a potential solution that can ensure smooth information distribution for ATC in implementing air traffic control procedures.

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