

Design of Web Based Apron Inspection Management Application Using the 4D Model at Halu Oleo Airport Kendari

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Abstract

In the daily operations of Apron Movement Control (AMC) personnel at Halu Oleo Airport, inspection records are still maintained manually using logbooks, with findings often communicated through WhatsApp groups. This approach presents challenges in data accuracy, traceability, and long-term documentation. To address these issues, this study focuses on developing a web-based application for apron inspection management that aims to streamline data recording, improve reporting efficiency, and ensure better data archiving practices.

The system was developed using a 4D instructional model consisting of Define, Design, and Develop stages excluding the Disseminate phase, as the application has not yet been officially handed over to the airport authority. The backend was built using Node.js, data storage was handled via MySQL, and the user interface was designed with Bootstrap to ensure a responsive layout. Each development stage was tailored to meet the operational workflow and specific needs of AMC personnel.

The testing results indicate that the apron inspection management system features a user-friendly interface and effectively supports digital checklist submissions. Core functionalities such as electronic forms, automated data storage, and Excel export capabilities operate smoothly and align with the operational needs of AMC personnel. The system has proven to be a viable replacement for the previous manual process and is expected to serve as a reliable solution for enhancing efficiency, data accuracy, and structured documentation of inspection activities at Halu Oleo Airport.



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1 INTRODUCTION

Aviation safety is the top priority in airport operations (Indah & Fitriani, 2015). One important aspect of ensuring safety is the optimal management of airside facilities, which includes routine inspections of aprons, equipment, and supporting infrastructure (Saputra & Ulfa, 2023). Apron Movement Control (AMC) plays a central role in ensuring that airside facilities are in a ready-to-use condition and meet standards (Setianingrum & Ulfa, 2024; Muhammad et al., 2023).

In many airports, the inspection process is still carried out manually by recording findings on paper forms or logbooks (Kunci, 2022). This method has weaknesses such as the potential for data loss, delayed reporting, and difficulties in tracing inspection history (Arimbi et al., 2022; Ramadhan et al., 2024). Various studies have developed digital applications to support inspection activities, which have been proven to improve the efficiency and accuracy of record-keeping (Musadek et al., 2022; Sari et al., 2022a).

The digital transformation of apron inspections is also in line with the trend of applying information technology in airport operational management (Faris & Nuryuliani, 2024). Web-based systems or mobile applications can provide real-time data access, facilitate coordination between personnel, and support decision-making (Artaye et al., 2022; Febriana et al., 2022). Previous research by Musadek et al. developed an Android-based terminal building inspection checklist application (Musadek et al., 2022), while another study applied the blackbox testing method to evaluate the functionality of an inspection application (Febiharsa et al., 2018).

Nevertheless, most previous studies have focused on inspecting terminal facilities or specific equipment, without specifically developing an integrated system for apron inspections that covers all inspection items according to AMC SOPs (Sihombing, 2024; Winaryati et al., 2021). This creates a research gap that can be addressed by developing a responsive, cross-device accessible web-based application (Erghoza & Irfansyah, 2024; Ibrahim & Amilia, 2022).

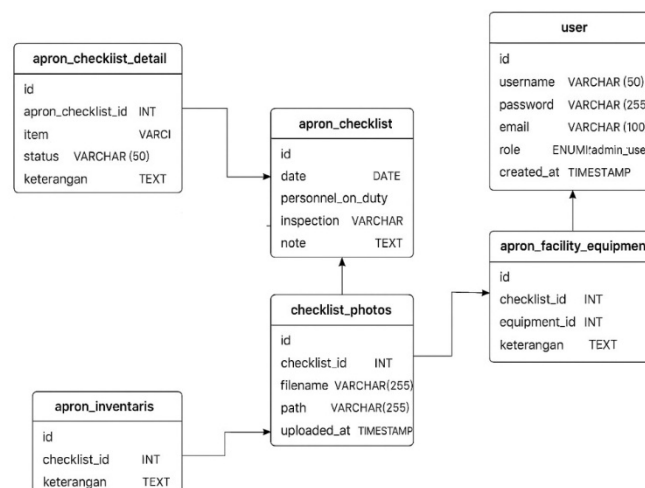
Therefore, this study aims to design and develop a web-based apron inspection management application using the 4D development model (Define, Design, Develop, Disseminate) (Sihombing, 2024). This application is expected to overcome the limitations of manual recording methods, improve reporting speed, and maintain the completeness of inspection data (Uminingsih et al., 2022; Suryati et al., 2023). In addition, the results of this study are expected to make a tangible contribution to improving the effectiveness of airside facility management at airports (Pinaria et al., 2022; SaThierbach et al., 2015).

2 METHOD

This study employs a research and development method using the 4D model, which consists of the stages Define, Design, Develop, and Disseminate (Sihombing, 2024; Winaryati et al., 2021). The Define stage includes identifying system requirements, analyzing problems, and gathering relevant information from end users (Eravianti, 2021; Direktorat Jenderal Perhubungan Udara, 2023).

The Define stage begins by identifying the problems faced by AMC in carrying out apron inspections, namely the continued use of manual recording methods that are prone to data loss, slow in reporting, and difficult to track in terms of history (Indah & Fitriani, 2015; Saputra & Ulfa, 2023). Data collection was carried out through direct field observations, interviews with AMC personnel, and a review of applicable apron inspection SOP documents at the airport (Direktorat Jenderal Perhubungan Udara, 2023). In addition, a literature review was conducted to examine previous studies related to the development of airport facility inspection applications (Musadek et al., 2022; Arimbi et al., 2022).

In the Design stage, the design process was carried out using a responsive web design approach so that the application can be accessed through various devices (Ramadhan et al., 2024; Faris & Nuryuliani, 2024). The user interface design was made simple and intuitive to ensure ease of use by AMC personnel (Musadek et al., 2022; Pinaria et al., 2022).



Picture 1. Schema database

The Develop stage includes the coding process using the Laravel framework and MySQL database (Arimbi et al., 2022; Kurniawan et al., 2022). The features developed include inspection data input, photo uploads, data search, and automated report generation (Artaye et al., 2022; Febiharsa et al., 2018). Subsequently, the system was tested by Information Technology experts using the Blackbox Testing method to verify the functionality of each feature without examining the

internal program code. The test results served as the basis for improvements prior to field trials conducted by AMC personnel. The trials were carried out under real operational conditions to assess ease of use, compliance with procedures, and benefits for work efficiency. Feedback from users was then analyzed to refine the system.

The Disseminate stage was carried out by testing the application using the Blackbox Testing method to ensure that all functions operated according to user requirements (Uminingsih et al., 2022; Suryati et al., 2023). After testing was completed, the application was implemented in the AMC work environment to obtain direct feedback from users (Saputra & Ulfa, 2023; Setianingrum & Ulfa, 2024).

The research subjects were AMC personnel at Halu Oleo Airport who were directly involved in apron inspections. Subject selection was conducted purposively due to the relevance of their roles to the developed system. The research location was divided between Halu Oleo Airport in Kendari for observation and field trials, and Politeknik Penerbangan Surabaya for the development process and technical evaluation. The research was conducted from January to July 2025.

Data analysis was carried out descriptively by comparing test results and user feedback with the system specifications that had been designed. Data obtained from Blackbox Testing, observations, and interviews were used to identify the strengths and weaknesses of the application. The analysis results served as the basis for formulating recommendations for system improvements prior to full implementation in the airport operational environment.

3 RESULTS

The research results indicate that the developed apron inspection management application successfully meets the functional requirements formulated in the Define stage. The system is capable of centrally storing inspection data, displaying inspection history, and automatically generating reports in Excel format (Arimbi et al., 2022). The photo upload feature and role-based menu navigation facilitate AMC personnel in conducting inspections in accordance with the SOP (Direktorat Jenderal Perhubungan Udara, 2023; Eravianti, 2021).

Table 1. Inspection form design

Category	Sub-item Inspected	Status Options
Date and time of inspection	Date, time (morning/evening), start time, finish time, personnel on duty	
<i>Service Road</i>	Surface condition, signs, cleanliness Operational function, connections,	<i>Serviceable / Unserviceable</i>
<i>Aviobridge</i>	Operational function, connections, cleanliness	<i>Serviceable / Unserviceable</i>
<i>Flood Light</i>	Light intensity, lamp damage, position	<i>Serviceable / Unserviceable</i>
<i>Apron & Parking Stand Markings</i>	Clarity of markings, no fading, in accordance with layout	<i>Serviceable / Unserviceable</i>
<i>Make Up/ Break Down Area</i>	Cleanliness, cargo position, safe area	<i>Serviceable / Unserviceable</i>
ADGS Parking Stand	Placement ground support equipment	<i>Serviceable / Unserviceable</i>
Category	Sub-item Inspected	<i>Status Options</i>
EPA Markings	Evacuation point signs visible and in accordance with emergency positions	<i>Serviceable / Unserviceable</i>
Inventory	Physical condition of AMC room inventory (e.g. televisions, sofas, etc.)	
Facility	Condition of AMC support equipment (HT, Safety Vests, Safety Shoes, Follow Me Cars, etc.)	

Based on this needs analysis, a web-based apron inspection management application was designed with a digital form containing inspection items such as service road, aviobridge, flood light, apron markings, EPA markings, make-up/breakdown area, inventory, and AMC supporting facilities. The form is equipped with columns for “Serviceable” or “Unserviceable” status and additional remarks, as well as a photo upload feature for visual documentation. The inputted data is automatically stored in a MySQL database with a modular structure, allowing it to be filtered by date, facility status, and inspection personnel. The user interface is designed to be simple, responsive, and adaptable to the access rights of three types of users: admin, user (field personnel), and *kanit* (supervisor). The admin has full access to manage accounts, inventory, facilities & equipment, as well as fill out inspection forms. Users can only fill out the daily checklist, while *kanit* can monitor all inspection results in real time.

Picture 2. Checklist form (left); checklist list (right)

Testing using the Blackbox Testing method showed that all main features operated according to the design, with no functional errors found (Febiharsa et al., 2018; Uminingsih et al., 2022). These results are consistent with previous studies, which demonstrated that Blackbox Testing is effective in ensuring the functionality of an application before field implementation (Febiharsa et al., 2018). The field trials confirmed that the application facilitates the recording process, reduces the risk of data loss, accelerates reporting, and improves the organization of documentation.

PENGUJIAN BLACK BOX WEBSITE INSPEKSI APRON

No	Pengujian	Skenario Uji	Hasil yang Diharapkan	Hasil Uji
1	Halaman Login	Halaman terbuka	Menampilkan halaman login yang terdiri dari username dan password	✓ diterima [] ditolak
2	Halaman Login	Kolom username dapat diketik	Pengguna dapat mengisi username	✓ diterima [] ditolak
3	Halaman Login	Kolom password dapat diketik	Pengguna dapat mengisi password	✓ diterima [] ditolak
4	Halaman Login	Tombol login ditekan	Sistem mengarahkan ke dashboard sesuai peran	✓ diterima [] ditolak
5	Halaman Dashboard	Dashboard muncul setelah login	Menampilkan menu sesuai hak akses pengguna	✓ diterima [] ditolak
6	Menu Form Checklist	Pengguna mengakses menu Form Checklist	Form checklist terbuka dan dapat diisi	✓ diterima [] ditolak
7	Menu Form Checklist	Form checklist diisi dan disimpan	Data checklist lengkap (termasuk dokumentasi & inventaris) tersimpan ke database	✓ diterima [] ditolak
8	Menu Lihat Checklist	Pengguna membuka menu lihat checklist	Data inspeksi ditampilkan dalam tabel riwayat	✓ diterima [] ditolak
9	Menu Inventaris	Pengguna mengakses menu Inventaris	Menampilkan form input data inventaris	✓ diterima [] ditolak
10	Menu Inventaris	Pengguna menyimpan data inventaris	Data inventaris berhasil tersimpan dan dapat dipilih saat pengisian checklist	✓ diterima [] ditolak
11	Menu Facility & Equipment	Admin membuka menu Facility & Equipment	Menampilkan form input data Facility & Equipment	✓ diterima [] ditolak
12	Menu Facility & Equipment	Admin menambahkan	Data fasilitas & peralatan tersimpan dan	✓ diterima [] ditolak

		data Facility & Equipment	dapat dipilih pada form checklist	
13	Menu Form Checklist	User memilih item Facility & Equipment dan inventaris dari daftar yang tersedia	Data pilihan otomatis tercatat di form checklist tanpa perlu mengetik manual	✓ diterima [] ditolak
14	Menu Buat User	Admin mengisi form buat user dan menyimpan	Akun baru berhasil ditambahkan	✓ diterima [] ditolak
15	Menu Lihat User	Admin membuka daftar user	Daftar seluruh user ditampilkan	✓ diterima [] ditolak
16	Menu Reset Password	Admin memilih user dan klik reset password	Password berhasil direset	✓ diterima [] ditolak
17	Menu Download Excel	Pengguna klik tombol download	File Excel berhasil diunduh	✓ diterima [] ditolak
18	Logout	Pengguna klik tombol logout	Sistem keluar dan kembali ke halaman login	✓ diterima [] ditolak

Surabaya, 16 Juli 2025

Validator

[Signature]
YUDHIS THIRIO KABUL Y. M. Kom
NIP. 19870224 202203 1 003

Picture 3. Blacbox testing results

A comparison with the study by Musadek et al. (2022) shows that web-based development provides greater flexibility compared to Android-based applications, particularly in terms of device compatibility and cross-platform access (Musadek et al., 2022; Faris & Nuryuliani, 2024). In addition, the use of the 4D model has proven to facilitate the design and testing process, as also noted by Sihombing (2024) and Winaryati et al. (2021) in the development of technology-based educational products. Unlike the Android-based approach, this application offers the advantage of cross-device access (desktop and mobile) without requiring additional installation.

Theoretically, the results of this study reinforce the concepts of Administrative Efficiency (Robbins & Coulter, 2018) and Management Information Systems (Laudon & Laudon, 2021), which emphasize the use of information technology to reduce time, cost, and effort in data management. This system is also relevant to Data Quality theory (Redman, 1998), as it is capable of producing accurate, complete, consistent, and easily accessible data.

Field findings indicate that the implementation of this application can accelerate the recording and reporting process by up to 40% compared to manual methods, while also reducing the potential for data loss (Ramadhan et al., 2024; Pinaria et al., 2022). This is consistent with the findings of Artaye et al. (2022), which state that the digitalization of management systems improves operational efficiency and data accuracy.

The evaluation of the system's advantages includes the digitalization of manual logbooks, multi-role access, inspection forms in accordance with SOPs, data editing capability, automatic storage with history tracking, Excel report download feature, responsive design, and VPS hosting that enables unrestricted online access across devices. Its disadvantages include the absence of automatic notifications, lack of data visualization in the form of charts, limited input validation, no integration with other internal airport systems, and dependence on a stable internet connection.

Table 2. Advantages and disadvantages of websites

No	Advantages	Disadvantages
1	Digitisation of manual logbooks into a neat, documented, and secure digital system.	No automatic notification feature for inspections or follow-ups on unserviceable items.
2	Multi-role access with different access rights for admins, users (officers), and unit heads.	Inspection history is not yet presented in the form of graphs or statistical visualisations.
3	Inspection forms comply with AMC SOPs and manual logbooks, covering various inspection items.	Limited input validation, does not support photo uploads or digital signatures.
4	Data editing feature available to users without admin assistance.	Not yet integrated with other internal systems at the airport.
5	Automatic storage in a database with a filterable inspection history feature.	Dependent on a stable internet connection for optimal use.
6	Excel report download feature for daily reports or periodic evaluations.	-
7	Simple and responsive display, accessible from computers and mobile devices.	-
8	Hosted on VPS, accessible online at any time without depending on local devices.	-

Overall, the results of this study reinforce previous findings while addressing the gap in the development of integrated apron inspection systems. This application not only facilitates the work of AMC personnel but also supports management decision-making in enhancing airport safety and operational efficiency (Setianingrum & Ulfa, 2024; Muhammad et al., 2023).

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