# Design Modification of Flight Information Display System Simulator Based on Web Using Text To Speech at Aviation Polytechnic of Surabaya

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***ABSTRACT***

The limited learning facilities at the Surabaya Aviation Polytechnic have resulted in the understanding and operation of the Flight Information Display System (FIDS) remaining largely theoretical, with minimal practical application. This condition creates a gap between the practical competencies required by students and the available learning resources, highlighting the academic urgency for more interactive and applicable learning media. This study aims to design and develop a web-based FIDS simulator integrated with a Text to Speech (TTS) feature, providing not only visual information but also audio outputs similar to real airport systems. The development process employed the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) using Visual Studio Code and XAMPP. System evaluation included white box and black box testing to assess functionality, as well as validation by media experts (3 lecturers) and users (30 students) through a usability questionnaire. The results demonstrated that all system functions operated as designed, while the validation process produced an average usability score of 87.6%, placing it in the "highly usable" category. The findings indicate that the web-based FIDS simulator with TTS integration successfully enhances interactivity and provides a learning experience that closely simulates real operational conditions. Scientifically, this study contributes to the development of simulation-based learning media in aviation vocational education and may serve as a reference for similar system development in other aviation institutions. Practically, the system can be implemented both as an independent learning tool and as an integrated laboratory resource, supporting students in achieving competencies more effectively.

***Keywords:*** FIDS, Text to Speech, Simulator, Web, ADDIE

## 1. INTRODUCTION

The the flight information display system (FIDS) is a core component of modern airport operations, responsible for presenting structured and real-time data such as flight numbers, destinations, departure and arrival times, and flight statuses. beyond serving passenger convenience, fids ensures smooth coordination among airport staff, air traffic controllers, and airline operators. in recent decades, global trends have shown that international airports increasingly integrate fids with text to speech (tts) technology to deliver automated voice announcements. this integration enhances operational efficiency and service quality, as demonstrated by major airports such as changi (sin) and heathrow (lhr), where flight information is delivered both visually and audibly in a timely, consistent, and error-free manner.

In the educational context of the surabaya aviation polytechnic, particularly the d3 air navigation engineering program, the airport information systems course aims to equip cadets with both theoretical knowledge and practical skills in managing and operating fids. however, existing training facilities remain limited, relying on conventional, hardware-based simulators that are offline and lack tts capabilities. as a result, cadets are unable to experience the flexibility, scalability, and realism provided by modern, web-based systems currently deployed in actual airport environments [1].

From the perspective of prior research, fids-related studies have largely emphasized technical

implementation. Study developed a raspberry pi–based fids integrated with a public address system (PAS) [2], but its offline nature and lack of indonesian tts limited its relevance in education. study [3] designed a wireless pas and fids integration with multilingual tts for operational airports, yet its infrastructure complexity rendered it impractical for classroom use. study [4] proposed a web-based fids with improved user interface and user experience (ui/ux), but without audio integration, which reduced realism in simulation. consequently, a research gap exists in the form of a web-based fids simulator integrated with indonesian tts, specifically tailored to aviation vocational training needs.

Furthermore, from a learning theory perspective, the integration of visual text and audio in a fids simulator aligns with multimedia learning theory and dual coding theory, both of which highlight that information presented through dual channels (visual and auditory) significantly enhances comprehension and retention. therefore, the development of a web-based fids simulator with tts not only addresses technical limitations but also strengthens pedagogical effectiveness in aviation education.

In response to these gaps, this study designs and develops a web-based fids simulator with indonesian tts integration, specifically tailored for academic use at surabaya aviation polytechnic. the simulator replicates airport operations by displaying real-time flight schedules while automatically reading updates aloud. an admin panel allows instructors to manage flight data dynamically, enabling realistic training scenarios. with accessibility through any browser within a local network, the system offers a flexible, interactive, and contextually relevant learning medium [5].

The scientific contribution of this study lies in the development of a web-based simulation platform integrated with indonesian tts for aviation vocational education—an area that has received little attention in existing literature. this research not only provides a practical solution to laboratory limitations but also enriches academic discourse on leveraging multimedia technology to enhance learning effectiveness in air navigation training.

The admin panel allows instructors to manage flight data dynamically, enabling the creation of realistic training scenarios. by making the simulator accessible through any browser within the local network, the system promotes flexible, engaging, and contextually accurate learning experiences. ultimately, this study contributes to aviation education by providing an affordable, adaptable, and realistic fids simulation platform. it not only enhances cadets' understanding of airport information systems but also aligns with the technological standards and operational demands of the modern aviation industry [6].

## 2. METHODS

This research followed the ADDIE instructional design framework, which consists of five sequential stages: Analysis, Design, Development, Implementation, and Evaluation. The model was chosen for its structured approach in developing educational media and its emphasis on iterative improvement [7].

Ghjhjh This research applied the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), selected for its systematic framework and flexibility in refining instructional media [8]. During the development phase, the FIDS simulator was designed as a web-based application running on a local server using XAMPP 8.2.0 (Apache, PHP, and MySQL). Coding and interface design were carried out in Visual Studio Code, supported by the Bootstrap framework for responsive user interface development. The system was developed and tested on a computer with the following specifications: Intel Core i5-1135G7 processor, 8 GB DDR4 RAM, 512 GB SSD storage, and Windows 10 Pro 64-bit operating system. The primary browser used for testing was the latest stable version of Google Chrome.

Architecturally, the system adopts a client-server model. Instructors manage flight data through an admin panel connected to a MySQL database, while cadets access the FIDS interface via a browser within the local network. Updated flight information is not only displayed visually on the screen but also automatically announced using the Indonesian Text to Speech (TTS) module. The communication flow follows this sequence: admin input → database storage → user interface display → audio output through TTS. With this design, the simulator replicates the operational functions of modern airport FIDS.

System evaluation was carried out in two stages. First, functional testing employed white box testing to validate program logic and black box testing to ensure that user-facing functions performed as intended. Second, usability evaluation involved three media experts as validators and 30 cadets from the D3 Air Navigation Engineering program as respondents. The evaluation instrument was a Likert-scale questionnaire, adapted from the System Usability Scale (SUS), covering indicators such as ease of use, interactivity, and realism. Data from the questionnaires were analyzed using descriptive statistics, with mean scores converted into feasibility categories. Based on the criteria a score of ≥ 85% was classified as "highly usable" [9].

1. Analysis

At this stage, researchers identified problems through interviews with lecturers teaching Airport Information Systems, laboratory technicians, and classroom observations. The analysis results indicate that the FIDS system currently in use is still based on local hardware (Raspberry Pi), does not support remote access, and lacks automatic audio features. Additionally, students face difficulties in understanding the FIDS operation process directly due to limited practical facilities. These findings serve as the basis for designing a flexible, interactive web-based system equipped with Indonesian Text-to-Speech (TTS) features [10].

2. Design

Based on the analysis results, a system design was developed that includes user interface design, database structure, system workflow (flowchart), and determination of the technology to be used. Visual Studio Code was selected as the code editor, XAMPP as the local server, and the JavaScript SpeechSynthesis API as the TTS implementation. At this stage, an admin dashboard was also designed for flight data management and a user view page to display departure and arrival information [11].

3. Development

This stage is the realization of the design into a functional product. Researchers developed the website using a combination of PHP, HTML, CSS, and JavaScript programming languages, and integrated TTS features. Initial testing (unit testing) was conducted to ensure that each component, such as login, data input, and voice reading, functioned according to specifications. This process is iterative, whereby any bugs or discrepancies found are immediately corrected before moving on to the implementation stage.

4. Implementation

The simulator was deployed in the Surabaya Aviation Polytechnic laboratory. The server hosted the application for access by multiple devices connected to the local network. During training sessions, instructors updated flight data in the admin dashboard while cadets observed changes in the main display and listened to automatic announcements. This real-time interaction allowed for scenario-based training and immediate feedback.

5. Evaluation

The evaluation was conducted using two approaches: technical testing and user validation. Technical testing used the White Box method to examine program logic and the Black Box method to test functions from the user's perspective. User and expert validation was conducted using a Likert scale questionnaire to assess aspects of appearance, functionality, ease of use, and relevance to learning needs. The evaluation results were used to make final revisions before the system was declared ready for use [12].

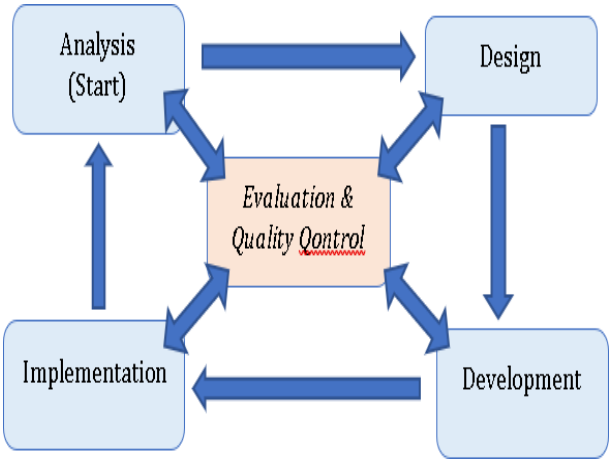


**Figure 1** Research Flowchart

Based on Figure 1, it can be concluded that the system development process follows a cycle involving several main stages, namely *Analysis (Start)*, *Design*, *Development*, and *Implementation*. These four stages are interconnected continuously and supported by the *Evaluation & Quality Control* process that takes place at each stage to ensure system quality. This model emphasizes the importance of continuous evaluation in order to minimize errors from the early stages and maintain the quality of the final outcome. Thus, the cycle can be categorized as an iterative and quality-oriented system development approach (Figure 1).

## 3. RESULTS AND DISCUSSION

This chapter presents the main findings of the research, interpreting the results, comparing them with relevant literature, and discussing their significance in the context of existing theories. The purpose of this section is to highlight the achievements of the study, explain their importance, and show their relevance to previous work. The development process followed the ADDIE model, consisting of five stage Analysis, Design, Development, Implementation, and Evaluation.

1. Analysis

The first stage of the ADDIE model focused on identifying the learning needs and operational gaps in the existing FIDS training facilities at Surabaya Aviation Polytechnic. Field observations and discussions with instructors revealed that the current FIDS simulator was hardware-based, offline, and lacked the ability to produce automated audio announcements in the Indonesian language. Such limitations reduced the realism and interactivity of the training process,

preventing cadets from experiencing scenarios similar to those in operational airports.

Previous studies have indicated that realistic simulations can significantly improve learners' comprehension and retention of operational procedures [13]. In the context of airport information systems, integrating visual and auditory channels is essential to mimic real-world conditions [14]. Therefore, the analysis concluded that a web-based FIDS simulator with integrated Text-to-Speech (TTS) would enhance accessibility, interactivity, and realism in training.

2. Design

Based on the identified needs, the design stage established the system architecture and functional specifications. The simulator was designed with two core modules. (1) The User Display Module, showing real-time departure and arrival schedules with fields for flight number, origin/destination, scheduled time, and status and (2) The Admin Management Module, enabling instructors to input, update, or delete flight information and trigger audio announcements. The database design was implemented in MySQL, while HTML, CSS, and JavaScript were used for the user interface, ensuring responsive design for multi-device compatibility [15]. The TTS functionality was planned using the Web Speech API, which has been recognized for its low-latency performance in browser-based applications [16]. A structured UI/UX layout was developed to facilitate intuitive navigation and efficient data entry.


**Figure 2** Display website

Based on Figure 2, the interface of the flight information system is shown, displaying two main menus: *Departure* and *Arrival*. These menus serve as the primary access points for users to obtain information on flight departures and arrivals. The design represents a simple yet effective concept in presenting flight data, making it easier for users to access the information they need. Thus, this interface supports the main function of the flight information system, which is to provide fast, clear, and easily understandable information (Figure 2).

3. Development

The development stage involved translating the design into a functional system. Using Visual Studio Code as the main development environment, the front-end was coded in HTML and CSS, while JavaScript handled dynamic content updates and TTS activation. The back-end was developed in PHP, connecting to a MySQL database hosted on a local server via XAMPP.

During coding, relevant libraries and APIs were integrated to handle data exchange between the admin module and the display module in real time. Following best practices in web-based simulator development, attention was given to minimizing server load and ensuring stable multi-user access. The TTS feature was configured to announce flight updates automatically whenever data changes occurred in the database. Early functional tests confirmed that the modules communicated seamlessly and that TTS announcements were triggered without noticeable delays [17].


**Figure 3** Display Home

Based on Figure 3, the main page of the web-based *Flight Information Display System (FIDS)* developed at Politeknik Penerbangan Surabaya is displayed. This page highlights the institutional identity while also providing an initial overview of the system's main function as a provider of flight information. The simple and informative design of the main page serves as the primary entry point for users to access the features of FIDS. Thus, this interface reflects the integration between institutional identity and the function of the flight information system (Figure 3).

4. Implementation

The simulator was deployed in the Surabaya Aviation Polytechnic laboratory for controlled testing. The local server hosted the application, and multiple devices accessed it simultaneously to simulate real-world operational conditions. Instructors entered and modified flight information via the admin dashboard, while cadets observed live updates on the display module, accompanied by automated TTS announcements.

This setup mirrored actual airport workflows, where operational staff update FIDS in real time and passengers receive immediate visual and audio information. According to multimedia learning theory, combining visual and auditory channels can significantly enhance

understanding, a benefit observed during implementation as cadets responded positively to the immersive experience.

Table 1 White Box Testing

| No. | Feature Tested | Aspect Evaluated | Test Result Description | Status |
|---|---|---|---|---|
| 1. | Admin Login | Validation of login logic (SQL query) | Successfully accessed when input is valid, failed when input is incorrect | Passed |
| 2. | Flight Data Input | Logic for storing data into the database | Data stored without errors | Passed |
| 3. | Edit Data | Logic for updating data | Data successfully updated | Passed |
| 4. | Text-to-Speech | Execution of JavaScript speech Synthesis function | Voice output generated according to the text provided | Passed |
| 5. | Data Display | Looping and SQL SELECT query | Data displayed correctly | Passed |

On the Table 1 presents the results of white-box testing conducted on the web-based Flight Information Display System (FIDS) simulator integrated with Text-to-Speech functionality. The black-box testing approach focuses on evaluating system functionality from the user's perspective, without examining internal code or logic. The Admin Login feature was tested for proper validation of SQL-based login queries. The system successfully granted access when valid credentials were provided and correctly rejected invalid inputs, indicating robust input validation. For Flight Data Input, the test confirmed that new flight schedules were stored in the MySQL database without generating any errors. The Edit Data feature demonstrated accurate update functionality, with modifications to flight schedules reflected immediatelyin the database [18].

The Text-to-Speech feature was verified by executing the JavaScript speechSynthesis API. The system produced clear and accurate voice output matching the provided text, confirming proper integration between the web application and browser-based speech synthesis capabilities. Lastly, the Data and incorrectly formatted inputs.

Display module was evaluated for correct execution of looping and SQL SELECT queries. The displayed information matched the database records precisely, ensuring that end-users receive up-to-date and accurate flight information [19]. The results indicate that all tested features functioned according to their intended design, with each component passing the white-box testing phase successfully. This confirms that the developed system meets the functional requirements set during the design stage and is ready for operational use in an instructional setting.

This testing method validates the system's behavior by comparing the actual outputs with the expected results for various user interaction scenarios, without analyzing the underlying source code [20]. The Admin Login feature was tested using both valid and invalid credential combinations. The system correctly granted access to valid users and rejected invalid inputs, ensuring secure authentication in line with standard web application security practices. The Flight Data Entry function was evaluated with complete, empty,

**Table 2.** Black Box Testing

| No. | Feature Tested | Aspect Evaluated | Test Result Description | Status |
|---|---|---|---|---|
| 1. | Admin Login | Input a combination of valid and invalid credentials | Login successful if valid, denied if invalid | Passed |
| 2. | Flight Data Entry | Input complete, empty, and incorrectly formatted data | Valid: data stored; Invalid: data rejected | Passed |
| 3. | Page Navigation | Click navigation menu | Successfully redirected to the corresponding page | Passed |
| 4. | Text-to-Speech | Click voice button | Information read aloud clearly | Passed |

| | | | | |
|---|---|---|---|---|
| 5. | Flight Data Display | Open main user page | Data displayed accurately according to database entries | Passed |
| 6. | Logout | Click logout button | Successfully returned to the login page | Passed |

Based on Table 2, the testing results of the *Flight Information Display System (FIDS)* demonstrate in detail that every feature of the system has been evaluated thoroughly and all of them successfully passed the testing process. The first feature, *Admin Login*, was tested using a combination of valid and invalid credentials. The outcome showed that the system successfully granted access only to valid credentials and consistently denied invalid attempts, proving that the login security mechanism works reliably. The second feature, *Flight Data Entry*, was evaluated by inputting data that was complete, empty, and incorrectly formatted. The system stored the data correctly only when the input was valid, while invalid or incomplete data was automatically rejected, ensuring that data integrity within the database is well-maintained. The third feature, *Page Navigation*, was tested by clicking on different navigation menus, and the result showed that users were consistently redirected to the correct corresponding pages, which indicates that the navigation system is functional and user-friendly. The fourth feature, *Text-to-Speech*, was evaluated by clicking the voice button, and the test results confirmed that the system was able to read aloud the flight information clearly and understandably, enhancing accessibility for users. The fifth feature, *Flight Data Display*, was tested on the main user page, where the data displayed was proven to be accurate and consistent with the entries stored in the database, which demonstrates the reliability of the system in presenting information [21]. Finally, the sixth feature, *Logout*, was tested by clicking the logout button, and the system successfully redirected users back to the login page, ensuring proper session management and security. Overall, the comprehensive results of this testing process clearly indicate that the FIDS system is functioning as expected, with all features meeting their requirements in terms of security, data validation, navigation, accessibility, information display, and user session management. These outcomes highlight that the system is both reliable and effective, ready to be implemented in a real operational environment to support flight information services.

5. Evaluation

The evaluation phase was carried out to verify both the technical performance and the pedagogical suitability of the developed web-based FIDS simulator with Indonesian Text-to-Speech (TTS) integration. This stage employed a combination of White Box Testing and Black Box Testing approaches to ensure comprehensive assessment [22]. White Box Testing focused on examining the internal program logic, database queries, and communication between modules. It confirmed that the system could accurately process administrator input, update the MySQL database, and execute TTS announcements without error or data loss, even when accessed by multiple devices concurrently. Black Box Testing, on the other hand, was conducted to evaluate the simulator from the end-user perspective. During these trials, instructors acted as administrators by modifying flight schedules, while cadets observed the corresponding real-time updates on the display module and listened to the automated announcements. The tests revealed that the TTS feature delivered clear and accurate pronunciation in Indonesian, with negligible latency between the data update and the audio output. Additionally, the display module consistently reflected accurate and synchronized information across different devices connected to the local network [23]. The evaluation also included expert validation from both subject matter specialists in airport operations and instructional media experts. Their feedback indicated that the simulator successfully addressed the shortcomings of previous training tools, particularly in terms of accessibility, interactivity, and operational realism. Compared to prior implementations of academic FIDS simulators this system demonstrated superior adaptability through its browser-based design, as well as enhanced inclusivity by incorporating localized TTS.

Overall, the evaluation confirmed that the simulator not only met its technical specifications but also fulfilled its intended role as an effective and engaging instructional medium in the context of aviation education. granted access to valid users and rejected invalid inputs, ensuring secure authentication in line with standard web application security practices. The Flight Data Entry function was evaluated with complete, empty, and incorrectly formatted inputs. The application successfully stored valid entries in the database and rejected invalid inputs, demonstrating effective form validation [24].

## 4. CONCLUSION

1. The design of a web-based Flight Information Display System (FIDS) simulator modification using

Text to Speech (TTS) was successfully completed by following a systematic system development process, namely through the ADDIE model approach (Analysis, Design, Development, Implementation, and Evaluation). The designed system is capable of processing flight schedule data and presenting it in an attractive visual format, complete with automatic reading features via TTS technology. This design is responsive, accessible via web-based devices, and allows users to input, update, and delete data flexibly through the admin page.

2. The feasibility level of the modified web-based FIDS simulator was assessed as good based on the results of functional testing and system quality testing. Based on the feasibility test results conducted on three groups of assessors, namely lecturers, field technicians, and students of the Surabaya Aviation Polytechnic, the web-based Flight Information Display System (FIDS) was declared VERY FEASIBLE for use. This is based on the results of the feasibility percentage calculation. The feasibility test results of the modified web-based FIDS system indicate the category "Highly Feasible," based on evaluations from three groups: 1) Lecturers: 75% (Highly Feasible) 2) Field technicians: 95% (Highly Feasible) 3) Students: 95% (Highly Feasible) The aspects evaluated include: display, feature suitability, accessibility, efficiency, effectiveness, security, and reliability. Based on the evaluation results of the Quality of Service (QoS) parameters, which include Throughput, Delay, Jitter, and Packet Loss, it can be concluded that the web-based Flight Information Display System (FIDS) with Text to Speech (TTS) features is at a very good level of suitability and is suitable for use. Testing shows that, based on ITU standards, the system demonstrates very good performance on the following QoS parameters: 1) Throughput: Maximum reaches 205 bps = Very good category 2) Delay (latency): Range 9 ms – 124 ms = Very good category 3) Jitter: Stable and small = Very good category (assumed based on system stability) 4) Packet Loss: 0% = Good category (no data loss).

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