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Optimizing Logistics: Developing An Efficient Tracking and Delivery System for Automotive Spare Parts

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a r t i c l e i n f o

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a b s t r a c t

In the automotive spare parts industry, efficient supply chain management is the backbone of operational success. Amidst this complex ecosystem, companies face challenges in delivering fast, reliable, and competitive services, accommodating a constantly evolving consumer base with discerning preferences and rising expectations. This article aims to identify challenges in developing tracking and delivery scheduling applications for the automotive spare parts industry and improve system performance by introducing effective solutions. The research adopts a system development approach using the Waterfall method to produce a responsive and user-friendly web application, followed by functional testing using Black Box and evaluation using the System Usability Scale (SUS). Development of the tracking and delivery scheduling application using the Waterfall method resulted in a reliable and responsive application, with all system functionalities running smoothly. SUS testing indicated that the application has a good level of usability, with an average score of 77.5 out of 100. This study successfully provides relevant and efficient technological solutions to overcome operational barriers in the automotive spare parts industry, with the potential to enhance customer satisfaction and solidify the company's position as a pioneer in the automotive aftermarket sector. However, further improvements in application usability can be achieved through future iterations guided by user feedback and additional usability testing.

a b s t r a k

Dalam industri suku cadang otomotif, manajemen rantai pasokan yang efisien merupakan tulang punggung keberhasilan operasional. Di tengah ekosistem yang kompleks ini, perusahaan menghadapi tantangan dalam memberikan layanan yang cepat, andal, dan kompetitif, mengakomodasi basis konsumen yang terus berkembang dengan preferensi yang cerdas dan ekspektasi yang meningkat. Artikel ini bertujuan untuk mengidentifikasi tantangan dalam mengembangkan aplikasi pelacakan dan penjadwalan pengiriman untuk industri suku cadang otomotif dan meningkatkan kinerja sistem dengan memperkenalkan solusi yang efektif. Penelitian ini menggunakan pendekatan pengembangan sistem dengan metode Waterfall sehingga menghasilkan aplikasi web yang responsive dan user-friendly, dilanjutkan dengan pengujian fungsional menggunakan Black Box dan evaluasi menggunakan System Usability Scale (SUS). Pengembangan aplikasi pelacakan dan penjadwalan pengiriman dengan metode Waterfall menghasilkan aplikasi yang handal dan responsif, serta seluruh fungsionalitas sistem berjalan dengan lancar. Pengujian SUS menunjukkan bahwa aplikasi memiliki tingkat kegunaan yang baik, dengan skor rata-rata 77,5 dari 100. Penelitian ini berhasil memberikan solusi teknologi yang relevan dan efisien untuk mengatasi hambatan operasional di industri suku cadang otomotif, yang berpotensi meningkatkan kepuasan pelanggan. dan memantapkan posisi perusahaan sebagai pionir di sektor aftermarket otomotif. Namun, peningkatan lebih lanjut dalam kegunaan aplikasi dapat dicapai melalui iterasi di masa depan yang dipandu oleh umpan balik pengguna dan pengujian kegunaan tambahan.

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1. Introduction

In the automotive spare parts industry, the dynamics of efficient supply chain management serve as the backbone of operational success. Within this intricate ecosystem, companies face the relentless pursuit of delivering services that are not just fast and reliable but also competitively priced, catering to an ever-evolving consumer base characterized by discerning preferences and heightened expectations [1]. As the automotive sector continues to experience exponential growth, propelled further by the advent of e-commerce platforms, automotive spare parts companies find themselves at the nexus of an increasingly demanding landscape, necessitating agile strategies to meet burgeoning demand while ensuring operational efficiency and cost-effectiveness [2]. The multifaceted nature of the supply chain in this industry demands meticulous attention across various touchpoints, spanning procurement, warehousing, distribution, and ultimately, customer delivery. Each juncture presents its unique set of challenges, underscoring the criticality of seamless coordination and meticulous oversight to mitigate risks and ensure optimal performance [3]. Any disruption or delay along this intricate journey not only jeopardizes customer satisfaction but also erodes brand credibility, underscoring the imperative for companies to fortify their operational infrastructure with robust tracking and delivery management mechanisms [4]. In response to these challenges, the development and implementation of sophisticated tracking and delivery schedule applications emerge as imperative strategic initiatives for automotive spare parts companies.

These technological solutions empower companies with real-time visibility into the movement of goods, facilitating granular insights from vendor procurement to warehouse inventory management and from distribution logistics to final customer delivery [5]. By harnessing the power of data analytics and predictive algorithms, companies can proactively identify potential bottlenecks, anticipate supply chain disruptions, and deploy preemptive measures to forestall adverse impacts on delivery timelines [6]. Furthermore, the adoption of these innovative applications augments customer-centricity by affording end consumers the agency to track the status of their orders autonomously. Through intuitive interfaces and seamless user experiences, customers gain unprecedented transparency into the delivery process, fostering trust and instilling confidence in the brand's commitment to delivering on promises [7]. Such enhanced engagement not only cultivates brand loyalty but also serves as a catalyst for positive word-of-mouth referrals, amplifying the company's market and competitive positioning [8].

Moreover, the strategic integration of tracking and delivery schedule applications within the operational framework engenders a virtuous cycle of continuous improvement. By leveraging insights gleaned from analytics-driven performance metrics, companies can iteratively refine their supply chain strategies, optimize resource allocation, and streamline processes to enhance operational efficiency and drive cost savings. This relentless pursuit of operational excellence not only fortifies the company's competitive edge but also positions it as an industry leader at the vanguard of innovation and customer-centricity. Within the dynamic landscape of the automotive spare parts industry, the strategic imperative of embracing technological innovation to augment supply chain efficiency and enhance customer experiences cannot be overstated. By leveraging sophisticated tracking and delivery schedule applications, companies can navigate the complexities of the modern marketplace with agility and precision, delivering unparalleled value to customers while cementing their position as trailblazers in the automotive aftermarket sector.

2. Research Method

This research focuses on the development of tracking and delivery schedule applications for the shipment of goods from vendors to warehouses. Based on this, the research consists of stages as illustrated in Figure 1.

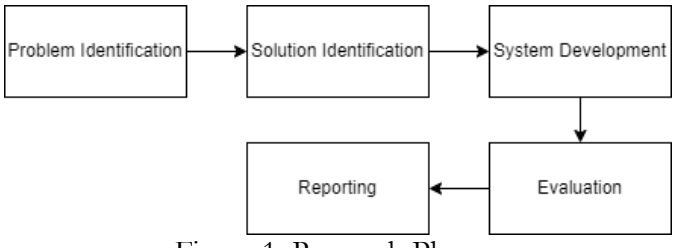


Figure 1. Research Phases

1) Problem Identification
   Problem identification aims to pinpoint challenges encountered during software development and find tailored solutions to enhance performance [9]. This crucial stage facilitates addressing issues effectively, ensuring performance software development process [10].
2) Solution Identification
   Solution identification involves crafting tailored responses to the challenges uncovered during the software development process [11]. Once the problems are identified, the focus shifts towards devising effective strategies and techniques to mitigate these issues and improve overall performance [12, 13].
3) System Development
   The system development stage aims to determine detailed specifications of information system components such as humans, hardware, software, and other information products, aligned with the analysis phase. In system design, methodologies like the Waterfall method are employed for systematic development [14]. This stage involves translating the conceptual framework established during analysis into tangible components and functionalities [15]. Detailed planning and design are crucial to ensure that the system meets the identified requirements and addresses the underlying challenges effectively [16]. By adhering to structured methodologies like Waterfall, teams can proceed through development systematically, minimizing risks and optimizing outcomes.
4) Evaluation
   The evaluation stage follows system development, where the tested application is implemented for the target users and made accessible to the public. This allows for an assessment of the application's usability, often conducted using the System Usability Scale (SUS) method [17]. SUS serves as a measurement tool to gauge the usability of a product [18]. By employing SUS, the effectiveness, efficiency, and overall user satisfaction with the application can be quantitatively evaluated. This stage is crucial for identifying areas of improvement and refining the application to better meet user needs and expectations.

The stages of system development using the waterfall method. The following are the stages of the waterfall method for system development [19].

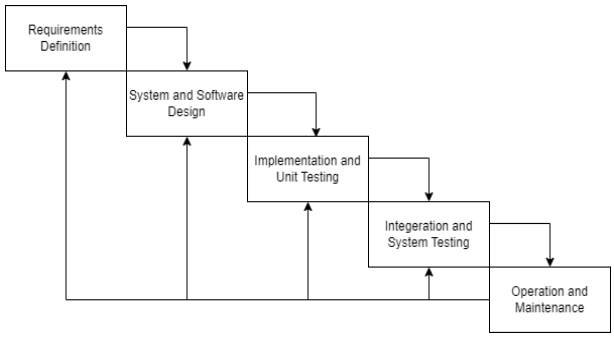


Figure 2. Waterfall Development

Here is the explanation of the system development method stages in Figure 2:

a) *Requirements Definition*
   This stage is essential for a deeper understanding of the system's needs and users, as well as obtaining user input regarding the desired system [20].
b) *System and Software Design*
   This stage involves determining the specifications required from the previous stages to be implemented in the development design [21].
c) *Implementation and Unit Testing*
   This stage entails software development and conducting tests and checks on the functionality of the system that has been created [22].
d) *Implementation and System Testing*
   This stage is the process of converting designs into an effectively functioning system with the application of software, hardware, and related steps. System testing is the verification and validation process of the system involving testing functionality, performance, security, and compliance with predefined requirements before implementation [23].
e) *Operation and Maintenance*
   This stage is an advanced phase to bring together all developed units to be integrated into the overall system [24]. To test the functionality of this application, a Black Box method is required. Black Box testing is performed to observe the input and output results of the application without knowing the application's code structure [23].

3. Result and Discussion

Initially, a use case diagram will be crafted to establish the application flow as depicted in Figure 3, ensuring structured and efficient system development. A use case diagram is a visual representation of the interaction between users (actors) and the system to be developed, depicting the system's functions and usage scenarios within a software system [25].

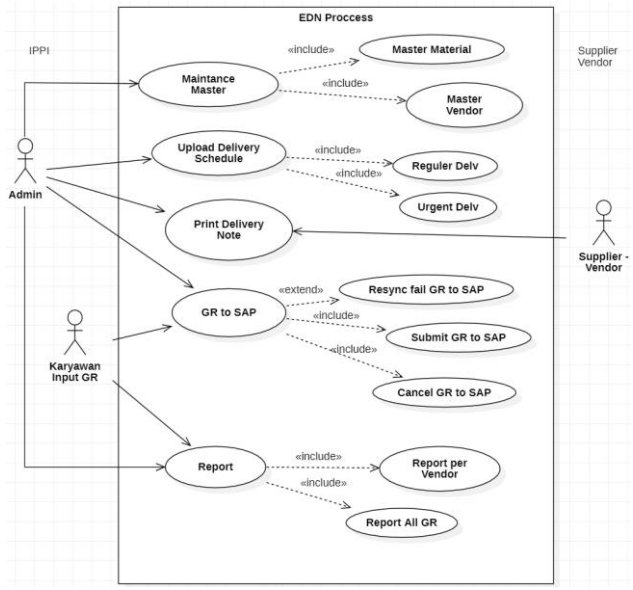


Figure 3. Use Case Diagram

There are 3 main actors in the system, each with their respective roles: Admin, GR Input Employee, and Supplier (Vendor). The Admin is responsible for managing master data, uploading delivery schedules, printing delivery notes, performing Good Receive (GR) to SAP, and generating reports. In this regard, the Admin is the actor with the highest privileges in the system, allowing access to almost all functions. The GR Input Employee is tasked with the GR process to SAP and generating reports. This actor is responsible for handling various processes related to GR. Meanwhile, the Supplier only has access to the Print Delivery Note process, where they can add delivery schedule data to the system for further processing by the Admin. There are several main process flows within the system. In detail, one can observe the process flows depicted in the following flowcharts for the Delivery Schedule, Print Delivery Note, and GR to SAP processes in Figures 4, 5, and 6.

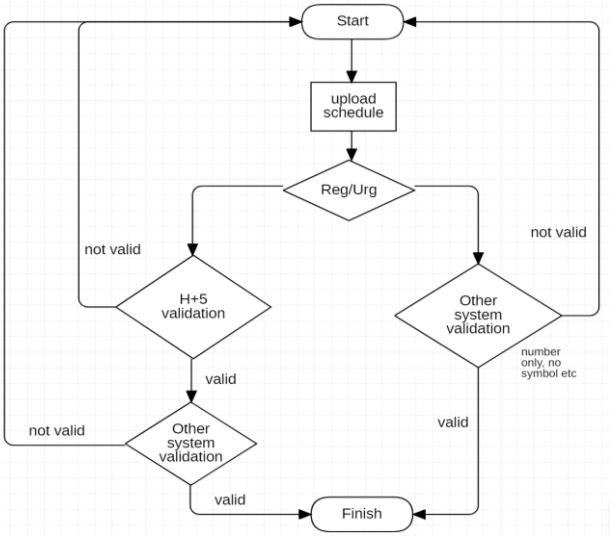


Figure 4. Flow Chart of Delivery Schedule

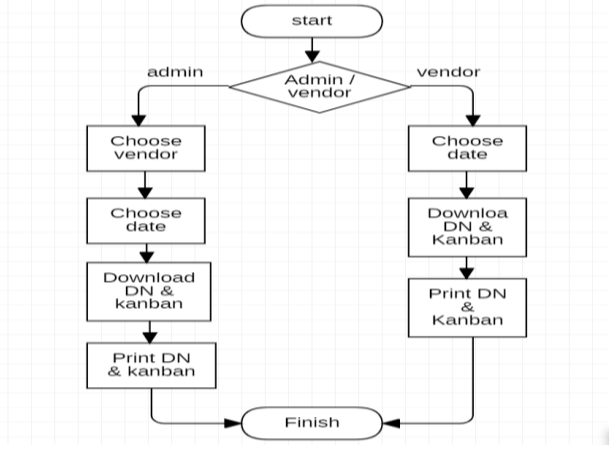


Figure 5. Flow Chart of Print Delivery Note

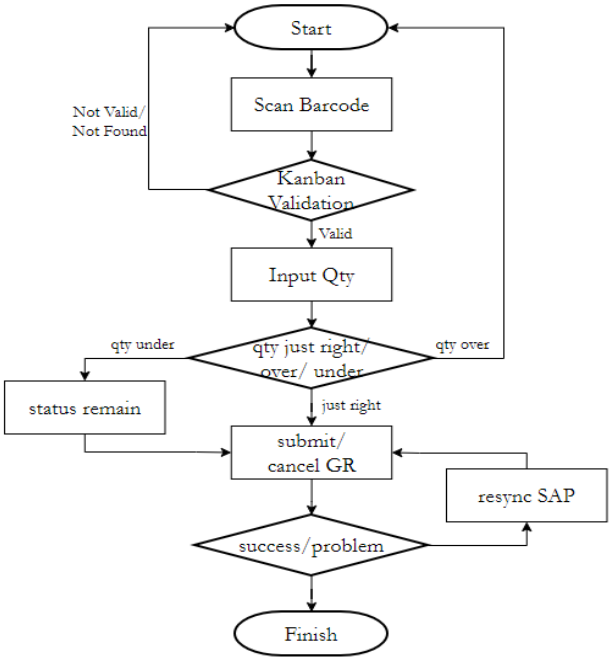


Figure 6. Flow Chart of GR to SAP

The development of the system using the Waterfall method resulted in a web-based application. This application is built with a responsive interface, catering to user needs for easy accessibility and usability [26, 27]. Upon the initial access of the web application, users will be directed to the login page, as depicted in Figure 7. On this page, users are required to input credentials, including a username and password. Registration buttons are not provided as the application is intended for specific use and credentials can only be obtained by being registered by an admin within the application.

Figure 7. Login Page

Upon successful login, users are redirected to the main page. The main page of the application includes announcements and user dashboards. To access all menus, users can refer to the sidebar on the left-hand side, as illustrated in Figure 8. Users can click on a menu item, and the system will navigate to the intended menu page.

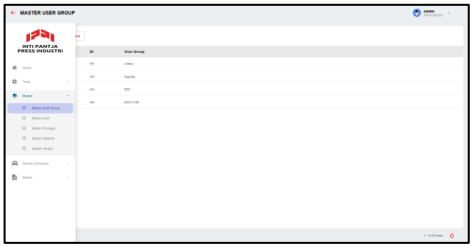


Figure 8. Sidebar Menu

To access the My Account page, users can click on the Tools menu group, then select the My Account menu. On the My Account page, users can view account details containing user ID, name, password, user group, and initial vendor, as shown in Figure 9. Additionally, users can update specific data such as name and password, then click the Submit button to save the changes.

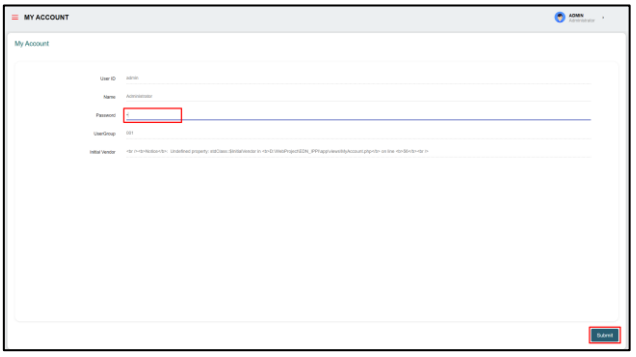


Figure 9. My Account Page

System admins can register new users within the system. Each user to be registered is assigned a specific role within the system. To create a new role, admins can click on the Master menu group, then select the Master User Group menu. On this page, admins can manage user group data, including group ID and user group name, as seen in Figure 10.

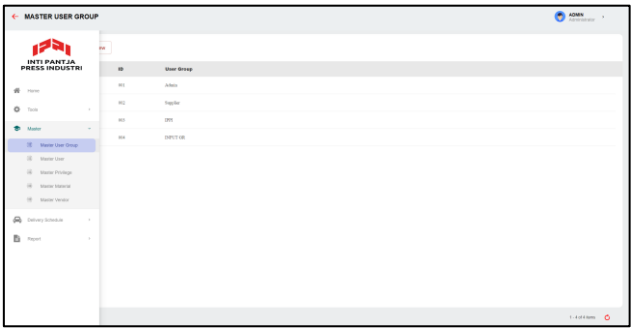


Figure 10. Master User Group Page

Once roles or user groups have been registered within the system, admins need to determine the privileges for each user group. Privileges include access to all menus within the application and operations that can be performed within each menu. The application's menus consist of Home, My Account, Master Material, Master Privilege, Master User, Master User Group, Master Vendor, Upload Monitoring Order Vendor, Delivery Number Vendor, Good Receive SAP, and Report Vendor. Operations that can be performed for each menu include Read, Add, Edit, and Delete. For a clearer view of the Master Privilege page, refer to Figure 11.

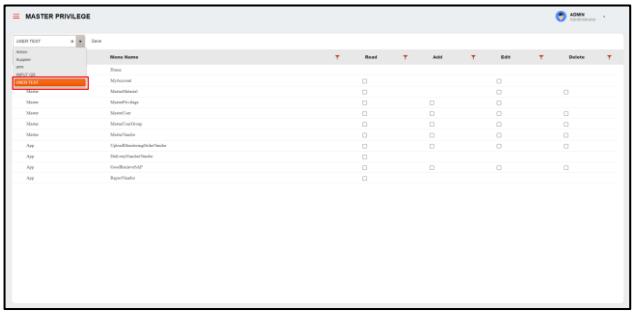


Figure 11. Master Privilege Page

After the admin has prepared all user roles within the application, they can begin registering new users within the system. To access the Master User page, admins can click on the Master menu group, then select the Master User menu, displaying a page as seen in Figure 12. The details required when adding new user data include User ID, User Name, Password, and Group ID. Vendor Code and Initial Vendor are optional. User ID is a unique identifier used to relate to various data within the system. User Name and Password are used as credentials for logging in. Vendor Code and Initial Vendor are only filled in if the user is a vendor.

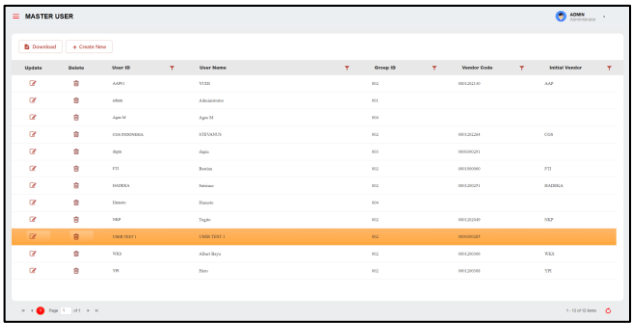
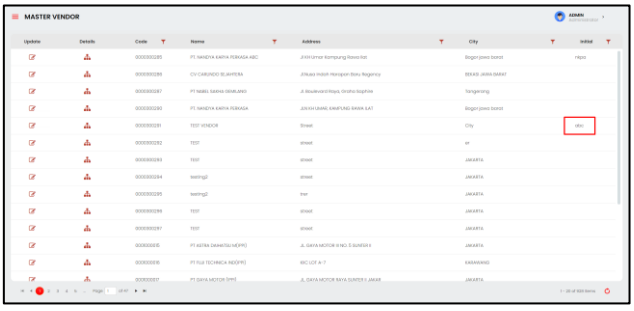


Figure 12. Master User Page

Vendor data management can be done through the Master Vendor menu, accessible by clicking on the Master menu group, then selecting the Master Vendor menu. Vendor data can be managed on this page, where each vendor has attributes such as Code, Name, Address, City, and Initial, as shown in Figure 13a. This page displays a list of master vendor data retrieved from SAP. Users can update the initial for each vendor listed, facilitating the user in creating delivery schedules based on the vendor's initial. This page also displays vendor details, including the supplier's organizational structure, as seen in Figure 13b. Users can update the supplier's organizational structure, and the email data input will be used by the system for automated emails to suppliers.



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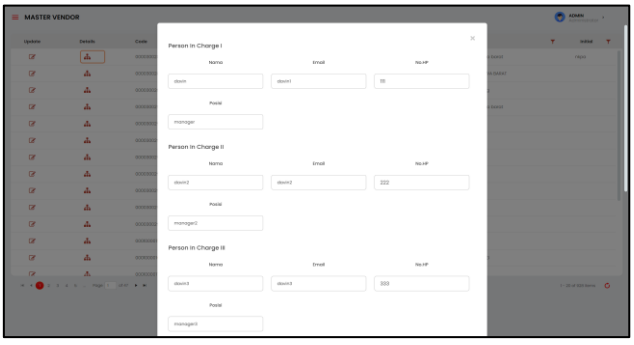
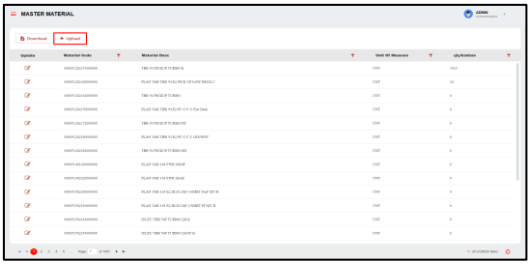


(b)

Figure 13. Master Vendor Page (a) Data List, (b) Organizational Structure Detail

Another page, the Master Material page, can be accessed by clicking on the Master menu group, then selecting Master Material. This page displays a list of master material data retrieved from SAP, as shown in Figure 14a. Users can update the quantity per kanban for each material listed by either uploading data collectively or updating data per material. To upload master material data, click the Upload button, then click Browse or Drag and Drop the material data file with the .xlsx file extension, as depicted in Figure 14b.



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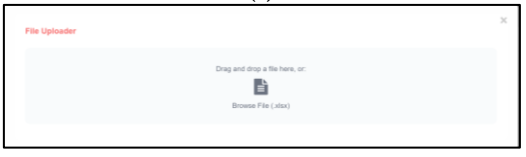
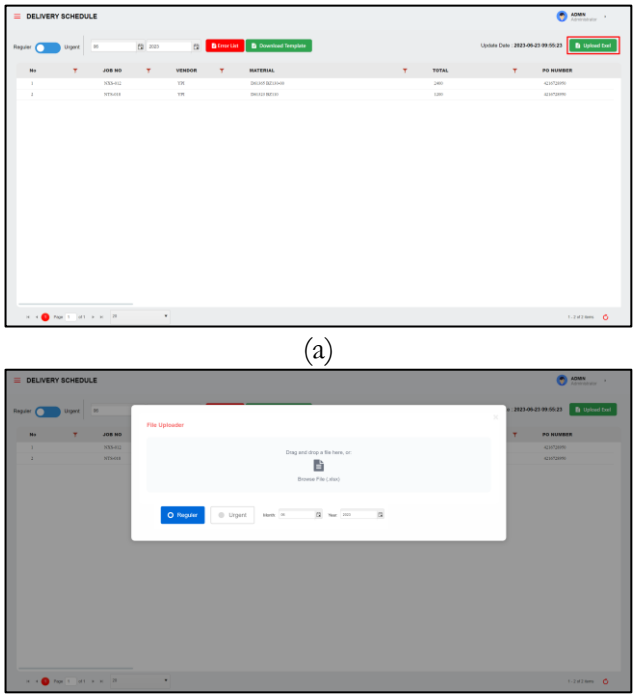


(b)

Figure 14. Master Material Page (a) Data List, (b) Excel Upload

Next is the Delivery Schedule page, accessible by clicking on the Delivery Schedule menu group, then selecting the Delivery Schedule menu. On this page, users can view a list of delivery schedules for regular and urgent purchase orders (POs), as shown in Figure 15a. Users can upload delivery schedules for supplier shipments. Before uploading a delivery schedule, users can download a template in the form of an .xlsx file provided by the system by clicking the Download Template button. After filling in the quantities for each date according to the total in the PO, users can then click the Upload Excel button, specifying whether it is Regular or Urgent, and enter the month and year, as seen in Figure 15b.

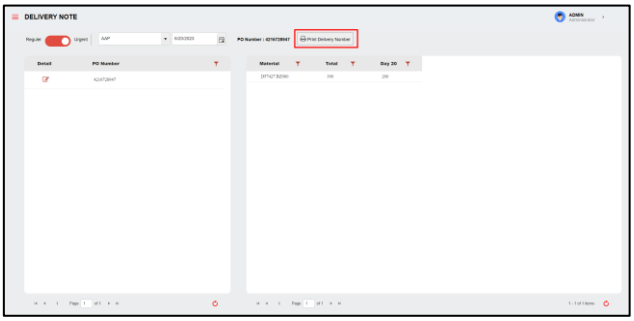


(a)

(b)

Figure 15. Delivery Schedule Page (a) Data List, (b) Excel Upload

To view and print delivery notes, users can access the page by clicking on the Delivery Schedule menu group, then selecting the Delivery Note menu. On this page, users can view and print delivery notes for regular and urgent deliveries. To display delivery note data, users can select the vendor and period to be displayed, then click on the detail button represented by an icon to view the delivery note details, as shown in Figure 16a. This page also provides a Print Delivery Number button to download a .zip file containing two files: the delivery note and Kanban. The delivery note contains comprehensive details including vendor information, delivery note number, date, list of materials, and other details in .pdf format, as shown in Figure 16b. The Kanban contains QR lists and other details related to the materials listed according to the number of Kanban specified in the delivery note. All Kanban lists are merged into one .pdf file, as shown in Figure 16c.



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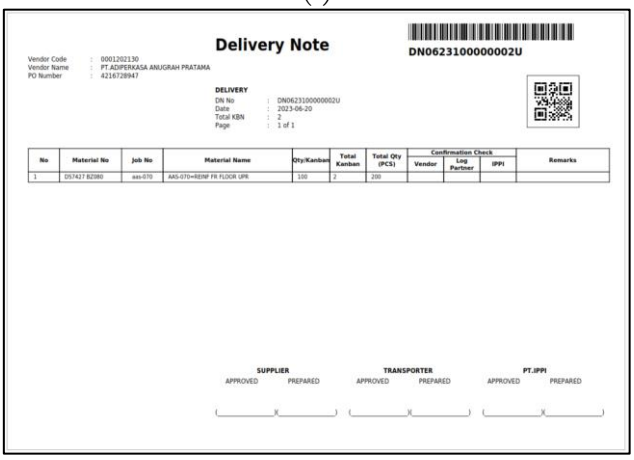

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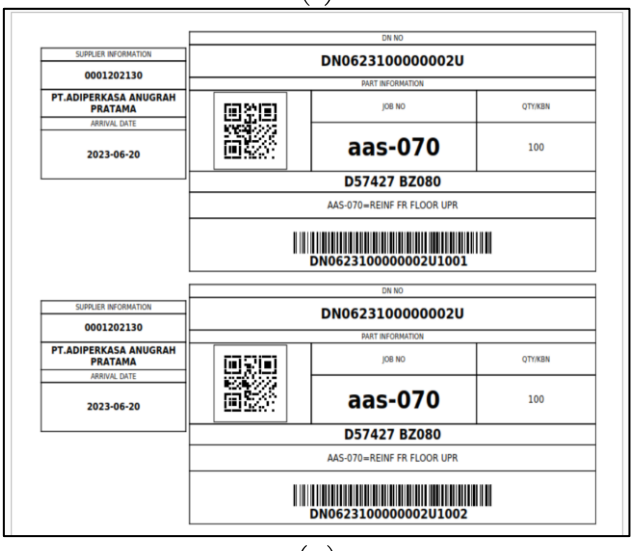
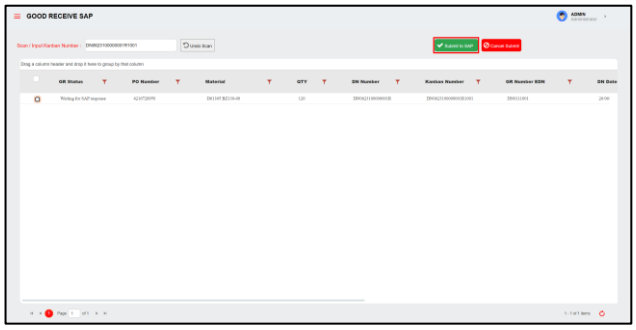


(c)

Figure 16. Delivery Note Page (a) Data List, (b) Delivery Note File, (c) Kanban File

The last page created is the Good Receive SAP page, accessible by clicking on the Delivery Schedule menu group, then selecting the Good Receive SAP menu. This page displays a list of GR SAP data, including GR Status, PO Number, Material, Qty, DN Number, Kanban Number, GR Number EDN, and DN Date, as shown in Figure 17a. To perform GR, users can scan or input the Kanban number into the system, prompting a dialog to enter the quantity, as shown in Figure 17b.

The last page created is the Good Receive SAP page, accessible by clicking on the Delivery Schedule menu group, then selecting the Good Receive SAP menu. This page displays a list of GR SAP data, including GR Status, PO Number, Material, Qty, DN Number, Kanban Number, GR Number EDN, and DN Date, as shown in Figure 17a. To perform GR, users can scan or input the Kanban number into the system, prompting a dialog to enter the quantity, as shown in Figure 17b.



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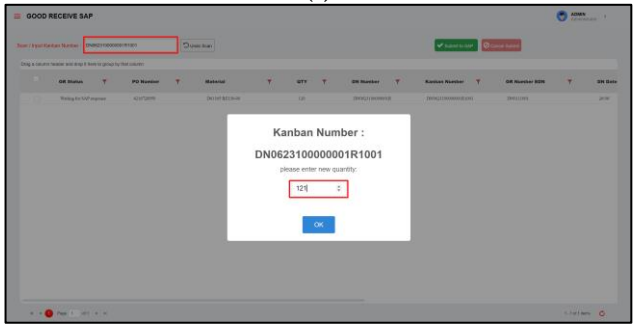

(b)

Figure 17. Good Receive SAP Page (a) Data List, (b) Scan Kanban Number

The development of this application involved functional testing using Black Box to identify any functions that are not functioning properly or bugs in this Tracking and Delivery system. The testing was manually conducted by the Developer comprehensively on each display and its functions. Testing was carried out using various types of input cases, and the output obtained still matched the expected results. Out of a total of 319 tests, all were valid, or 100% of the system's functionality was running smoothly and ready for implementation. In order to evaluate the usability of the developed system, testing was conducted using the System Usability Scale (SUS) method [28]. This method is utilized to measure the extent to which the system can be effectively and efficiently used by its users [8, 29]. The measurement process involved distributing questionnaires to a group of respondents, consisting of 20 prospective system users. The questionnaire used adhered to the template of the System Usability Scale itself, as seen in Table 2 for reference [28].

For each odd-numbered question, the score given by the respondent would be reduced by 1. This was done to correct scores and avoid potential assessment biases. As for even-numbered questions, the final score was obtained by subtracting the score given by the respondent from 5. Through these steps, individual scores for each question in the questionnaire were obtained. SUS scores were derived by summing up the scores from each processed question, and then multiplying the total by 2.5. These SUS scores serve as indicators of the system's usability, with higher scores indicating easier usability and greater user satisfaction [30]. From the 20 respondents, an average SUS score of 77.5 was obtained, categorized as grade scale B+ and described as good [31]. Thus, through data processing using the System Usability Scale method, we can gain a deeper understanding of the usability level of the developed system and provide guidance for future development and improvements.

4. Conclusion

This study effectively illustrates the significance of creating tracking and delivery scheduling apps within the automotive spare parts sector to tackle supply chain management hurdles. Its primary goal is to devise technological remedies that amplify operational efficacy and enhance customer satisfaction. By employing the Waterfall system development methodology, a user-friendly and responsive app has been developed, indicating its

ability to cater to user requirements. Thorough testing confirms the reliability and seamless functionality of the app, ensuring its effectiveness. In addition, the System Usability Scale (SUS) evaluation resulted in a grade B+, indicating a good level of usability for the developed application. Consequently, this study has successfully delivered a pertinent and efficient technological solution for addressing operational obstacles in the automotive spare parts industry, which could bolster the company's standing as a pioneer in the automotive aftermarket sector while augmenting customer contentment. However, while the app demonstrates effectiveness in addressing user needs and enhancing operational efficiency, there are still areas for improvement to further elevate the user experience. Therefore, future iterations and refinements guided by user feedback and usability testing could potentially enhance the application's usability and overall satisfaction.

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