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Development of a Web-Based Electronic Data Capture Monitoring System Using the PIECES and Waterfall Models

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Abstract

The development of digital transactions has driven the need for more accurate and easily monitored Electronic Data Capture (EDC) devices to support payment processes in the retail and distribution sectors. However, the manual and unintegrated EDC monitoring mechanism leads to data inconsistencies, delays in operational information, and low device traceability throughout its lifecycle. This research develops a real-time, web-based EDC population monitoring system to improve device management efficiency and operational data quality. The needs analysis was conducted using the PIECES framework, while the development process adopted the Waterfall model, encompassing analysis, design, implementation, and testing. The resulting system supports device registration, distribution monitoring, activation tracking, mutation recording, and device closure. Test results show significant improvements in data accuracy, reporting speed, and monitoring process effectiveness compared to manual methods. These findings contribute to the literature on enterprise digital asset management and demonstrate that a structured development approach can optimize the EDC device monitoring process in large-scale retail networks.

Keywords: Electronic Data Capture; Web-Based Monitoring; System Development; PIECES Framework; Waterfall Model.

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Introduction

The increasingly rapid development of digital technology has strengthened the role of Electronic Data Capture (EDC) devices as the main means of facilitating non-cash transactions in various sectors, especially retail and distribution (Mahendra, 2019; Arifa et al., 2024)Electronic Data Capture (EDC) is an electronic device used to process non-cash payments via debit cards, credit cards, or digital wallets (Rif'ah, 2019; Tazkiyyaturrohmah, 2018; Triwardhani, 2025; Danuri, 2019)The EDC work process begins by reading data from a card or digital payment device, then sending the data to the banking network for authorization and transaction settlement (Fernaldo & Sani, 2023; IH Putra, 2024; Reza, 2017; Senja, 2025; Kartoma et al., 2024).

As the adoption of digital payments expands, EDC has become a crucial technology in speeding up transaction processes and reducing reliance on cash, particularly in the retail and public service sectors (Evi, 2023; Puspitasari, 2025)This is increasingly relevant for large companies like PT Indomarco Prismatama Makassar Branch, which operates a vast distribution network with EDC devices spread across numerous sales locations. This situation demands an accurate, integrated, and reliable device monitoring system to ensure optimal performance for each device.

However, the EDC population monitoring system currently used is still manual and semi-automatic, so it is not capable of providing real-time data (FM Putra et al., 2023). System inintegration causes the flow of information to be slow, the device tracking process to be difficult, and the risk of data recording errors to be high (Irdana et al., 2019)This condition has a direct impact on delays in the decision-making process, particularly regarding reporting, moving, repairing, or replacing devices experiencing technical problems (Lahallo, 2022)(Nasution et al., 2019; Rahmadana, 2021).

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To address these issues, an integrated, web-based EDC population monitoring system is required that can provide real-time data updates. The local server-based system allows for instant data exchange between users and servers within an organization's internal environment (Adani, 2025; Dahana, 2024; Dewaweb, 2025)This approach is widely used for internal monitoring needs that require full control over data to keep it secure without relying on the public internet (Dirgantara, 2025; Fitrotirrahman, 2023; Ideya, 2023).

In the process of developing web-based systems, utilizing local servers and MySQL databases is a commonly applied approach (Quzania et al., 2020; Shanty et al., 2023). The use of local servers provides flexibility in managing infrastructure and data security and supports development within the Company's internal environment (Novitasari et al., 2023). According to Parlika et al. (2020), integration between MySQL and local servers over an internal network allows PHP applications to access data effectively without dependence on external servers, thus supporting real-time data provision. In this study, the system development used the PIECES analysis method, which encompasses Performance, Information, Economics, Control, Efficiency, and Service aspects, to comprehensively identify system requirements. The system was then developed using the Waterfall model, which provides structured development stages from analysis to final testing.

The development of this real-time web-based monitoring system is expected to help PT Indomarco Prismatama Makassar Branch manage EDC devices more effectively, reduce delays in identifying technical issues, and provide accurate and timely operational information. Although previous research on EDC has been conducted, most have focused solely on transaction, risk, or device performance aspects. Research examining end-to-end monitoring, from device registration, distribution, usage, relocation, to operational closure, remains very limited. Therefore, this study proposes a device lifecycle-based EDC monitoring platform by utilizing the PIECES framework as the basis for requirements analysis and the Waterfall model as a guideline for system development. The main objective of this study is to design and implement an EDC monitoring system capable of supporting continuous monitoring, structured recording of device movements, and minimizing manual recording errors so that the credibility of operational data can be increased.

Method

This community service activity was implemented using a participatory technology transfer approach that involved active collaboration between the implementation team and the industrial partner, namely PT Indomarco Prismatama Makassar Branch. This approach was chosen to ensure that the developed technological solutions were truly relevant to the partner's operational needs and could be implemented sustainably. In the initial stage, a situation analysis was conducted through in-depth interviews, direct observation, and operational document review to map the problems of monitoring Electronic Data Capture (EDC) devices, which had been carried out manually. The needs identification process was analyzed using the PIECES framework, which helps map aspects of performance, information, economy, efficiency, control, and services that require improvement.

Based on the initial analysis, the community service team designed and developed a web-based EDC monitoring system as a technology solution tailored to the partner's needs. The system development process followed the Waterfall model, which consists of analysis, design, implementation, and testing. The design included database architecture, user interface design, and the formulation of core modules such as device registration, distribution monitoring, activation tracking, mutation recording, and device shutdown. The implementation was carried out using the PHP programming language and a MySQL database installed on the partner's local server. After implementation, the system was tested through functional tests and simulations of real-world scenarios with partner staff to ensure the system was ready for full use, before finally undergoing the maintenance phase, which consisted of repairs and enhancements after the limited-scale trial (Agency, 2024; Borecky et al., 2016; Meilinaeka, 2023; Senarath, 2021; Tekno, 2021).

The next stage is training and mentoring for partner staff as a core part of the community service process. Training covers system usage, understanding new workflows, data input procedures, and introducing initial troubleshooting mechanisms. Mentoring is provided during the adaptation period to ensure that partners fully master the implemented technology and are able to operate it independently. After the system is operational, a comprehensive evaluation is conducted through interviews, observation sheets, user satisfaction forms, and documentation analysis to assess implementation effectiveness, data quality improvements, and device monitoring efficiency. All data are analyzed

qualitatively using a descriptive approach and the PIECES framework to assess differences in conditions before and after implementation.

The results of the evaluative analysis were used as a basis for refining the system and developing further recommendations for technology development and improving the quality of partner services. With this structured and participatory approach, community service activities not only produced solutions tailored to the context of partner needs but also made a tangible contribution by increasing human resource capacity and strengthening the overall EDC device management system. After the system was deployed on an operational scale, a comprehensive evaluation was conducted through interviews, field observations, process documentation, and user satisfaction forms to assess improvements in work efficiency and data reliability after implementation. The analysis was conducted qualitatively using a descriptive approach and the PIECES framework to compare conditions before and after system implementation.

Results and Discussion

The designed web-based EDC population monitoring system has been successfully implemented and tested on a limited basis within the operational environment of PT Indomarco Prismatama, Makassar Branch. This system aims to improve the effectiveness of EDC unit management and tracking in a faster, more efficient, and systematic manner. The implementation results are outlined based on the system's primary functions as follows:

Figure 1. Login page

The login page shown in Figure 1 is the main gateway to the system, designed to ensure security and authorise access only for authorised parties. On this page, users are required to enter credentials in the form of a username and password according to the account that has been provided. For example, certain user levels, such as Operational Manager (OM), have a special account format like OMJKT1. The authentication process involves validating the entered data, and the system will adjust access rights based on the user level. If authentication is successful, the user will be directed to the main page (dashboard) to continue activities according to their role. Meanwhile, if an error occurs in data input, the system will display a notification or warning to prevent unauthorised access. Thus, the login page serves not only as an access control but also as an initial mechanism for maintaining the system's security and integrity.

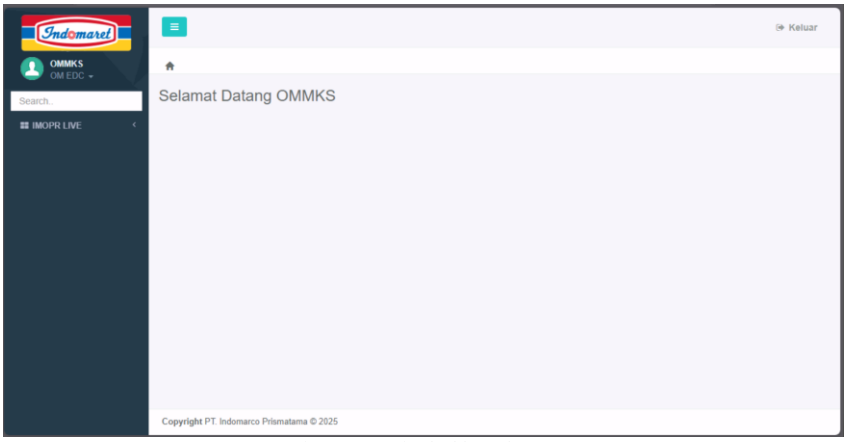

Figure 2. Main dashboard page

In Figure 2, the main dashboard page displayed after the user successfully logs in serves as an information centre and the main gateway to system navigation. On this page, users can immediately obtain a summary of essential data related to EDC devices, such as the total number of registered devices, the operational status of devices categorised as active, inactive, and closed, and information regarding the last system update date. Furthermore, the dashboard is also equipped with quick access to key modules, including Data Collection, Delivery, Activation, Closing, and EDC Transfers. The presence of this feature makes it easier for users to understand the overall condition and distribution of EDC devices in their respective work areas. Thus, the dashboard not only serves as the initial system display but also becomes a strategic instrument that supports the efficiency of EDC device management by presenting concise, clear, and easily accessible information.

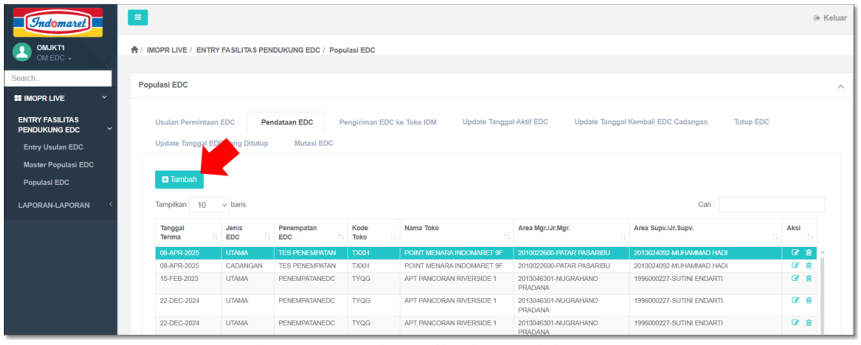

Figure 3. EDC data collection module page

In Figure 3, the EDC data module page functions as an initial recording medium for newly received EDC devices or those to be distributed to various destination locations. At this stage, users are required to input a number of important information, including the date of device receipt, the type of device classified as primary or backup EDC, the location of the store placement or destination, and the relevant store code. In addition, this module also facilitates the recording of detailed banking information such as the Merchant Identification Number (MID), Terminal Identification Number (TID), and the name of the bank integrated with the device. All entered data is automatically stored in the system database, so it can be used as a primary reference to support the monitoring, management, and evaluation of EDC devices in the next operational phase. Thus, this data module plays a strategic role in ensuring that each EDC device is accurately and systematically documented to ensure smooth distribution and monitoring in the field.

Figure 4. EDC delivery page

In Figure 4, the EDC delivery page serves to record and document the device distribution process from the branch to the destination store after the data collection stage is complete. In this module, users need to complete several steps, namely searching for the MID/TID of the registered device, entering the actual delivery date, and saving this information into the system. This feature allows the device handover process to be digitally documented, thereby increasing data accuracy while strengthening logistics tracking aspects. With this mechanism, companies can ensure transparency and efficiency in the EDC device distribution flow, while minimising the potential for recording errors that often occur with manual methods.

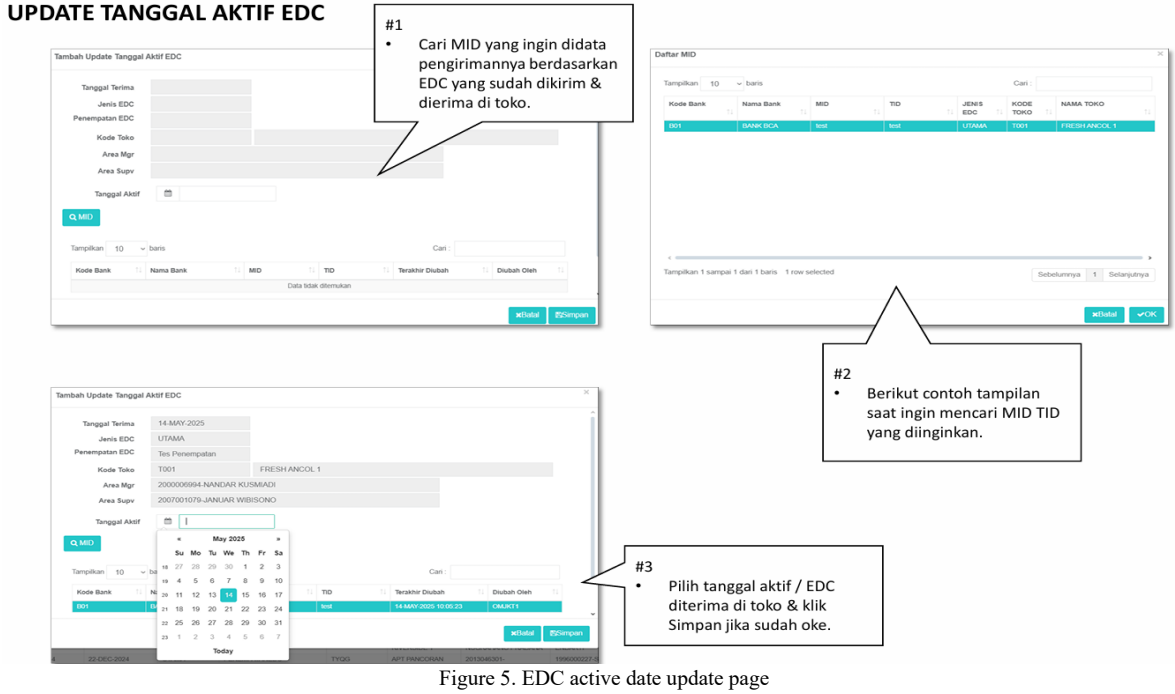

Figure 5. EDC active date update page

In Figure 5, the EDC activation date update page functions as an important feature in the system to record and update device activation data that has been received and is ready for use in stores. The update process is carried out in several stages, namely searching for the MID/TID of the related device, inputting the activation date, and saving the data so that it is officially recorded in the system. Information regarding this activation date plays a significant role as a marker for the start of the EDC device's operational period in the relevant store. With this feature, the system is able to provide accurate, structured, and well-documented records, thus facilitating monitoring of the device usage cycle while supporting transparency and accountability in EDC operational management.

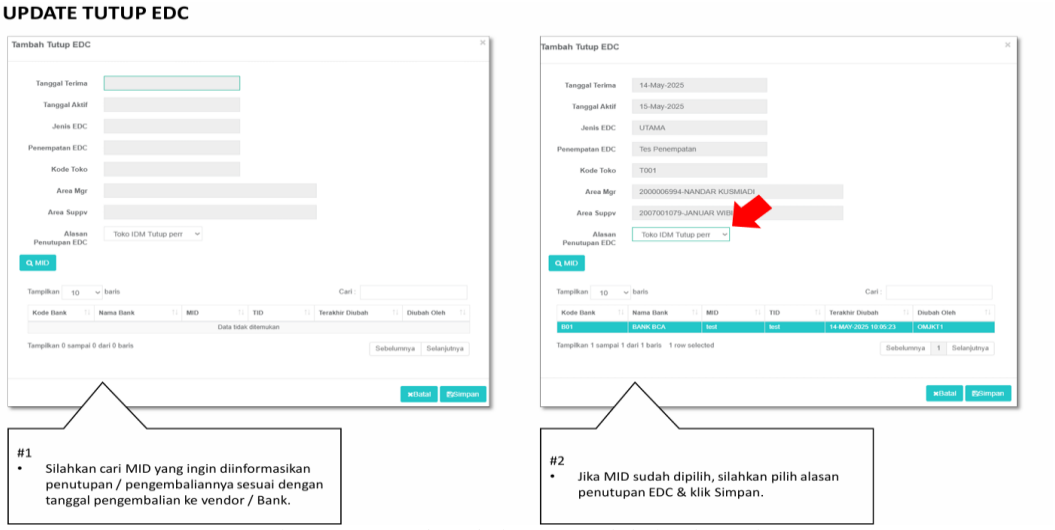

Figure 6. EDC update, closing page, and closing date update

In Figure 6, the EDC Close and Update Closing Date pages are provided to support the recording and management of EDC devices that must be deactivated under certain conditions, such as store closures, excess devices, or returns to vendors or banks. Through this module, users can systematically record important information such as the MID/TID of the returned device, the reason for closure, and the return date. In addition, if there is an input error or there is a change related to the closing date, the system also provides a revision feature through the Update Closed EDC Date, so that the stored data remains accurate and in accordance with actual conditions. This feature contributes to maintaining data consistency, increasing the efficiency of device management, and supporting a more transparent audit and monitoring process.

Figure 7. EDC mutation page

In Figure 7, the EDC Transfer page is a crucial component of the system that records the movement of EDC devices from one store to another without returning them to the branch, thus accelerating the distribution and utilization of available devices. The operational process involves inputting data from the originating and destination stores, determining the device based on the MID/TID, entering the effective date of the transfer, and saving the changes to document them in the system. This feature is highly relevant to operational needs in the field, especially when spare EDC devices are reused at different locations. Furthermore, recording transfers also provides benefits in strengthening the historical documentation of device movements between locations, which not only supports administrative transparency but also improves the accuracy of company asset monitoring.

The system evaluation was conducted using the PIECES framework to comprehensively assess the implementation impact. From a performance perspective, the system accelerates data input, search, and reporting, significantly reducing processing time compared to manual methods. This significantly increases operational staff productivity while reducing the risk of delays in decision-making. From an information perspective, the system provides more accurate, complete, and historically documented information, from device receipt, distribution, activation, transfer, and closure. This comprehensive historical data significantly assists the company in the audit and reconciliation process of the device population.

From the Economy aspect, the use of a local server and open source software (PHP and MySQL) makes this system cost-effective because it does not require additional licenses or dependence on third-party vendors. In the Control aspect, the user authentication mechanism and structured activity recording improve the company's ability to trace cases in the event of input errors or data discrepancies. Meanwhile, the Efficiency aspect also shows significant improvements because the system allows users to record and update device status quickly and consistently, without having to use error-prone manual forms. From the Service aspect, the system is able to provide fast information services to branches and head offices (HO/Regional), thus supporting the validation, reconciliation, and strategic decision-making processes related to EDC device management. Overall, the implementation results show that the developed system not only improves the accuracy and traceability of device data, but also improves operational efficiency and the quality of managerial decision-making. This contribution aligns with the research objectives described in the abstract, namely to produce a more accurate, responsive, and integrated web-based EDC monitoring system. These findings confirm that the structured development approach based on PIECES and the Waterfall model can improve the effectiveness of digital asset management in the large-scale retail industry.

Conclusions

Based on the design, implementation, and testing processes that have been carried out, this study concludes that the web-based Electronic Data Capture (EDC) population monitoring system has been successfully developed as a digital solution that is able to provide real-time, integrated, and easy-to-use device monitoring. This system has been able to accommodate all major workflows in EDC device management at PT Indomarco Prismatama Makassar Branch, starting from initial data recording, distribution process, activation, mutation between locations, to device closure. The integration of these modules produces more accurate, consistent data and has clear traceability throughout the device lifecycle, thus supporting the data reconciliation and validation process at the central level (HO/Regional) more effectively. The application of the PIECES framework in needs analysis has proven to provide a strong foundation for identifying weaknesses in the previous manual system and formulating targeted solutions. In addition to improving recording and reporting performance, this system also has a positive impact on operational efficiency, internal control, and the quality of information services. The implementation of the Waterfall development model also ensures a structured design process and results in a stable system that meets user needs. Overall, this research makes a significant contribution to strengthening digital asset management in the retail sector and demonstrates that a structured development approach based on PIECES and web technology can be an effective solution for improving data accuracy and the quality of operational decision-making.

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