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Development of a Color Analysis Print Cashier System at the Penjilidan Express Tulungagung Using Laravel Framework with the Scrum Framework

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Keywords

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Abstract

The manual and subjective process of determining color printing costs and recording sales transactions at Penjilidan Express, which resulted in inconsistent pricing, recording errors, and reduced operational efficiency. This research focuses on developing a web-based cashier system equipped with a Print Color Analysis feature to support more objective and consistent printing cost estimation and streamline transaction management. The system was developed using the Scrum framework and implemented with the Laravel framework based on the Model-View-Controller (MVC) architecture. The Print Color Analysis feature calculates the percentage of RGB/CMYK color composition from digital files in JPG, PNG, and PDF formats to automatically estimate printing costs. The developed system was evaluated through Black Box Testing across seven core functional features. The results demonstrated that every tested feature performed as expected, achieving a 100% success rate and confirming that the system fulfilled all predefined functional requirements.The developed system is expected to improve the consistency of printing cost calculations, streamline transaction processing, and minimize the risk of errors in sales data recording. Therefore, the proposed system can serve as an effective solution to support operational efficiency, pricing transparency, and business digitalization in printing service companies.

1. Introduction

The development of science and information technology has had a significant impact on various sectors, including industry and the service sector. The presence of computers and the internet as key digital tools of the 21st century has transformed the way people work, communicate, and manage data. The use of this technology has been proven to increase efficiency and productivity, particularly in economic activities such as information management, online communication, and job search. This demonstrates that information technology plays a role not only as a tool but also as a complete transformation of interaction patterns and work systems in society [1][2][3][4].

These developments have also impacted the printing process, which is now shifting from analog methods like offset printing to digital systems based on computers and networks. This transformation allows printing services to be performed online, from uploading to printing documents, thereby increasing efficiency and personalizing services. Printing is no longer solely focused on physical production, but has become part of a digital ecosystem that supports the industry's sustainability[5][6].

However, in practice, Tulungagung Express Binding Printing still faces various operational challenges, particularly in calculating color printing prices. The costing process is still done manually based on subjective employee estimates of document color percentages, resulting in pricing inconsistencies. This situation has the potential to cause losses for the printing company and customer dissatisfaction. Furthermore, manual transaction recording increases the risk of data errors and hinders efficient report management. [7] [8] . In system development, conventional methods such as Waterfall, Prototype, and Rapid Application Development (RAD) have limitations, such as a lack of flexibility to changing needs, dependence on user feedback, and the potential for sacrificing system quality. [9][10][11][12][13][14]. Therefore, this study proposes the use of the Scrum method which is iterative, flexible, and adaptive to changes in user needs, and is able to improve team collaboration and system quality. [15] [16].

Based on these problems, this study aims to design and test the functionality of a web-based Print Color Analysis cashier system using the Laravel framework with a Model–View–Controller (MVC) architecture. This system is expected to be able to automate printing cost calculations based on color analysis and improve the efficiency and accuracy of transaction processes at the Tulungagung Express Binding Printing Company.

2. Research Method

The development approach applied in this research is the Scrum framework, which is an iterative and incremental software development method executed through a series of sprint cycles. Scrum was selected because system requirements may change dynamically throughout the development process, making a flexible approach necessary to accommodate evolving user needs. This framework consists of several structured phases, including the product backlog, sprint planning, sprint backlog, sprint execution, daily scrum meetings, sprint review, and sprint retrospective. Each of these stages contributes to a well-organized workflow, improves collaboration between developers and stakeholders, and supports continuous system evaluation and refinement. The results of this study show that the implementation of Scrum facilitates the development of a system that aligns with user requirements while also increasing the efficiency of both development and testing activities. [17].

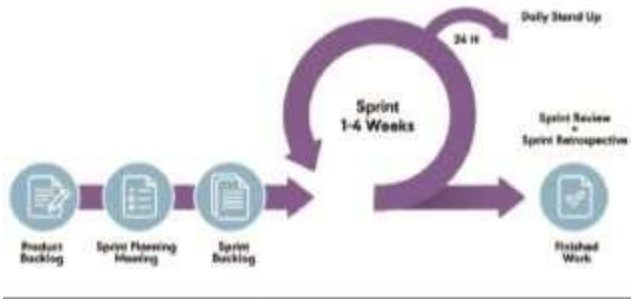

Figure 1. Scrum Development Method Flow.

The stages applied in this research consist of the following five steps:

a) Product Backlog

The Product Backlog phase was conducted by researchers through interviews and direct observation with the Penjilidan Express Manager to identify the system's proposed requirements, including both functional and non-functional specifications. The requirements gathering process focused on understanding existing

business processes, transaction recording procedures, and manual calculations of color printing costs. Based on the information gathered, a prioritized list of system requirements was compiled, including user authentication, product management, customer management, cashier transaction processing, print color analysis, sales reporting, and file upload functionality. The primary artifact produced during this phase was a Product Backlog document containing feature descriptions, priority levels, and implementation objectives. This document served as the basis for sprint planning and guided the development process throughout the project.

b) Sprint Planning

The Sprint Planning phase was conducted by the researcher in collaboration with the Penjilihan Express manager to determine the scope and priority of system development based on the approved Product Backlog. During this phase, backlog items were reviewed and grouped into several development sprints according to their priority and implementation complexity. The researcher also designed the system workflow and prepared supporting models, including use case diagrams, activity diagrams, and a database structure that included user entities, products, transactions, and print color analysis. Next, development tasks were allocated to sprints 1, 2, and 3, including user authentication, cashier transaction processing, file upload management, print color analysis, and sales reporting features. Each sprint was assigned a specific development target and estimated completion time to ensure that the implementation process remained structured and aligned with stakeholder requirements. The key artifacts produced during this phase were the Sprint Backlog, a system design model, and a sprint schedule, which were used to guide subsequent development activities.

c) Sprint Backlog

During the Sprint Backlog phase, researchers transform selected Product Backlog items into detailed development tasks that can be completed within each sprint. In collaboration with stakeholders, researchers prioritize implementation and define the technical activities required for each feature. Selected backlog items include user authentication, cashier transaction processing, print color analysis, file upload, and sales reporting. Each feature is broken down into smaller, measurable development tasks, such as database creation, user interface development, business logic implementation, and feature testing. These tasks are then assigned completion times and organized according to the objectives of each sprint. The primary artifact produced during this phase is the Sprint Backlog document, which lists development tasks, priorities, an implementation schedule, and sprint goals. This document serves as a guide for monitoring the progress of system development.

d) Sprint

During the Sprint phase, researchers implemented the tasks defined in the Sprint Backlog through a series of iterative development cycles. The system was developed using the Laravel framework, with Laragon as the local development environment and MySQL as the database management system. Each sprint focused on delivering a set of functional features according to planned priorities and objectives. Development activities included database implementation, user interface design, business logic programming, and feature integration. The implemented functionality included user authentication, product management, cashier transaction processing, document upload, print color analysis, and sales reporting. At the end of each sprint, completed features were tested to ensure they functioned according to defined requirements before proceeding to the next sprint. The key artifacts produced during this phase included the database schema, source code modules, user interface components, and functional system features. The iterative nature of the sprint process enabled continuous improvement based on stakeholder feedback, ensuring that the developed system remained aligned with operational needs at Penjilidan Express.

e) Sprint Review and Retrospective

The Sprint Review and Sprint Retrospective are carried out at the conclusion of each sprint, involving the researcher as the developer and the owner of Penjilidan Express as the primary stakeholder. In the Sprint Review session, the researcher presents the implemented system features, which include user

authentication, cashier transaction processing, print color analysis, document uploading, and sales reporting functionalities. During this stage, feedback from the stakeholder related to system performance, usability, and business requirements is gathered and recorded to ensure the developed features align with operational needs.

After the Sprint Review, a Sprint Retrospective is held to assess the overall effectiveness of the development process. The researcher evaluates the issues encountered during implementation, identifies factors that influenced development progress, and defines improvement actions for subsequent sprints. The outputs of this phase include documented stakeholder feedback, revision records, recommendations for feature improvements, and a sprint evaluation report.

3. Result and Discussions

3.1 Product Backlog

In developing a cashier system using the Scrum method, the first step is to compile a product backlog based on requirements obtained through observation and interviews. The product backlog for the cashier system is shown in Table 1.

Table 1. Cashier System Product Backlog

ID	Penjilidan Express Cashier System Backlog Items
1	Displays the login page
2	Displays the Document color analysis feature page for automatic color print price calculation.
3	Displaying the Cashier Calculation/Calculation Feature
4	Features file upload (PDF/JPG/PNG) for color analysis
5	Displays stock management of stationery and supporting materials
6	Displays the Minimum Stock Notification feature
7	Displays the Logout Page

The product backlog presented in Table 1 reflects the core operational needs identified during the observation and interview phase, with particular emphasis on the Document Color Analysis feature (item 2) and file upload capability (item 4), as these directly address the primary problem of subjective and inconsistent print pricing at Penjilidan Express. The prioritization of authentication and cashier features alongside stock management indicates that the system was designed not merely as a pricing tool, but as an integrated operational platform.

3.2 Sprint Planning

Sprint planning is a stage that includes activities to determine sprint goals and prepare an estimated schedule or time allocation needed to complete each activity on time according to the established plan. [18] . The estimated schedule or time allocation required to complete the design and feature development activities for the Cashier System can be seen in Table 2.

Table 2. Cashier System Sprint Planning

No	Description of Activities	Work Estimate	Total	Sprint Plan
1	System requirements analysis based on interview and observation results	2 days		
2	System flow design (Use Case, Activity Diagram)	4 days		
3	Database design (ERD & table relations)	4 days	2 Weeks	1st Sprint
4	Interface (UI) design of login page & dashboard	2 days		
5	Implementation of login feature	2 days		
6	Product CRUD implementation	3 days		
7	Implementation of cashier transaction features	3 days	3 Weeks	2nd

No	Description of Activities	Work Estimate	Total	Sprint Plan
8	Implementation of document file upload feature	2 days		Sprint
9	Implementation of the Print Color Analysis feature	3 days		
10	Implementation X`of automatic print price calculation	4 days		
11	Implementation of transaction reports (daily & monthly)	3 days		
12	Black Box Testing (Testing each feature)	3 days		
13	System improvements based on test results	5 days	2 Weeks	3rd Sprint
14	Deployment & handover of the system to stakeholders	3 days		

As shown in Table 2, the nine planned activities were distributed across three sprints spanning approximately seven weeks in total. This allocation prioritized foundational elements — system analysis, flow design, and database structure — in the first sprint, ensuring that subsequent implementation of the Print Color Analysis and transaction features in Sprint 2 was built upon a validated technical foundation. This sequencing reduced the risk of rework during later development stages.

3.3 Sprint Backlog

The Sprint Backlog consists of selected Product Backlog items that have been prioritized for completion within a sprint, accompanied by task planning and functional estimations to ensure the successful delivery of the intended product[19][20]. The following is table 3 which contains the Sprint Backlog.

Table 3. Cashier System Sprint Backlog

ID	Description of Activities	Task	Work Estimate
1	Create a design (plan) for the main feature workflow, database structure, and interface/display on the Print Color Analysis Cashier System	Create a flowchart diagram of the main features of the Print Color Analysis Cashier System	2 Days
		Create a use case diagram of the main features of the Print Color Analysis Cashier System	1 Day
		Create an activity diagram of the main features of the Print Color Analysis Cashier System	2 Days
		Creating a sequence diagram of the main features of the Print Color Analysis Cashier System	3 Days
		Creating a database design (CDM and PDM)	4 Days
		Create an interface/display design	2 Days
		Total Work Estimate	14 Days

Table 3 details the technical breakdown of Sprint 1 tasks, totaling 14 days of estimated work. The inclusion of four distinct diagram types (flowchart, use case, activity, and sequence diagrams) prior to database design reflects a design-first approach intended to minimize ambiguity before implementation began.

Table 4. Cashier System Sprint Backlog

ID	Description of Activities	Task	Work Estimate
1	Developing (implementing) the main features of the Print Color Analysis Cashier System	Implementing Admin and Cashier Login features	2 Days
		Implementing the Cashier Calculation feature	3 Days
		Implementing the Print Color Analysis feature	5 Days
		Implementing the Calculate Income feature	3 Days
		Integrating features with database	4 Days
		Total Work Estimate	14 Days

Table 4 shows that Sprint 2 focused on implementing the core functional modules, with the Print Color Analysis feature requiring the longest estimated duration (5 days) among all tasks. This reflects the relative technical complexity of the color-extraction logic compared to standard CRUD-based features such as login and income calculation.

Table 5. Cashier System Sprint Backlog

ID	Description of Activities	Task	Work Estimate
1	Conduct testing, evaluation, and improvement of the Print Color Analysis Cashier System	Perform functional testing (black box testing)	3 Days
		Conduct validation testing	2 Days
		Performing bug fixes and system enhancements	5 Days
		Conduct system trials on users	4 Days
		Conducting evaluation of system test results	2 Days
		Total Work Estimate	14 Days

Sprint 3, as outlined in Table 5, was dedicated primarily to verification activities, with black box testing, validation testing, and bug fixing collectively accounting for 10 of the 14 estimated days. This allocation indicates that quality assurance was treated as a substantial development phase rather than a final formality, consistent with Scrum's emphasis on iterative refinement.

3.4 Sprint

3.4.1. Sprint 1

At this stage, the development team conducted system analysis and design based on the product backlog. The main feature workflow was modeled using a Use Case Diagram to describe user interactions with the system. In addition, an Entity Relationship Diagram (ERD) was created to design the database structure and define relationships between entities. These design artifacts served as a blueprint for the implementation of the cashier transaction and print price analysis features in the next sprint.

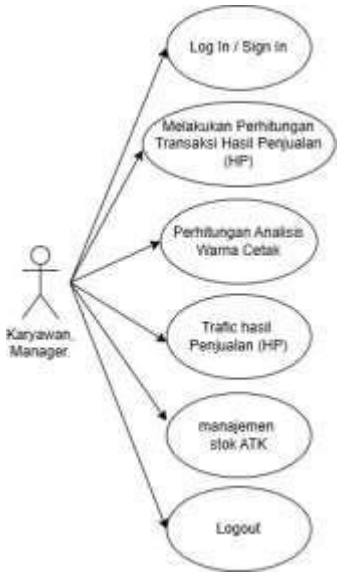

Figure 2. Cashier System Use Case Diagram

Figure 3. Entity Relationship Diagram (ERD) Cashier System

Figure 2 illustrates the interaction between the two primary actors — Admin and Cashier — and the system's core functions, including transaction processing, print color analysis, and reporting. Figure 3 presents the corresponding Entity Relationship Diagram, which defines the relationships between key entities such as users, products, transactions, and color analysis records. The alignment between these two diagrams ensured that each functional requirement identified in the use case model was supported by a corresponding data structure, reducing the likelihood of design inconsistencies during implementation.

Table 6. Sprint Review System

Design	Validator	Validator Criteria	Expected Results	Evaluation Results
Flowchart	Manager of Penjilidan Express	Suitability with business process requirements and system workflow completeness	The proposed flowchart serves as a graphical representation of the operational workflow for the cashier system's essential features, incorporating the functional requirements that were systematically identified and documented during the preliminary analysis.	Valid
Use Case Diagram	Manager of Penjilidan Express	Suitability of actors, system functions, and user requirements	The use case diagram illustrates the interactions between system actors and the primary functionalities of the Cashier System based on the requirements identified and documented during the initial analysis phase.	Valid
Activity Diagram	Manager of Penjilidan Express	Suitability of activity flow and business process sequence	The activity diagram design clearly illustrates the process flow/activities of the main features used by users in the Cashier System, in accordance with the needs documented initially.	Valid

Design	Validator	Validator Criteria	Expected Results	Evaluation Results
ERD	Manager of Penjilidan Express	Database structure completeness,entity relationships, and data requierements suitability	Entity Relationship Diagram (ERD) describes the structure of the Cashier System database which consists of entities, attributes,and relationships between entities according to the system	Valid
User Interface (UI)	Manager of Penjilidan Express	Usability,layout consistency, and with user needs suitability	The user interface describes the interface design/main page display of the Cashier System according to the needs that have been documented at the beginning	Valid

As shown in Table 6, all five design artifacts — the flowchart, use case diagram, activity diagram, ERD, and user interface — were validated as suitable ("Valid") by the Penjilidan Express manager against business process requirements. It should be noted that this validation was conducted by a single stakeholder acting as the primary domain expert; while this reflects direct end-user involvement consistent with Scrum's stakeholder-centered approach, future evaluation could benefit from multiple validators to strengthen the reliability of the assessment.

3.4.2. Sprint 2

In Sprint 2, the Log In/Sign In feature was developed and implemented to provide user authentication and secure access to the system. This functionality ensures that only authorized users can access and manage system data. In the same sprint, the Print Color Analysis feature was also developed to support automatic estimation of color printing costs based on document color composition. For JPG and PNG files, the system reads the image pixel data and extracts RGB values from each pixel. The proportion of colored and non-colored pixels is then calculated to determine the overall color composition of the document. For PDF files, each page is first converted into an image format before undergoing the same color analysis process. The system then extracts RGB values from the converted images and calculates the proportion of colored and non-colored pixels on each page. The analysis results are subsequently used as the basis for estimating printing costs, thereby reducing subjective price determination and improving pricing consistency.

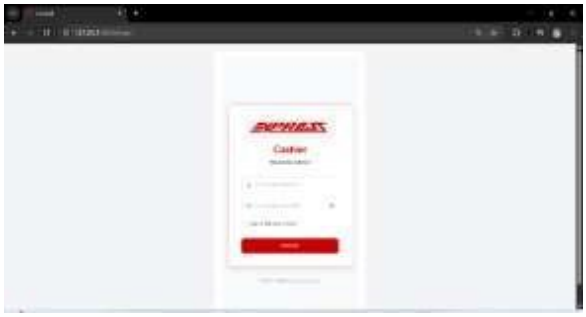

Figure 4. User Interface Log In/Sign In

Figure 5. Print Color Analysis User Interface

Figure 4 shows the login interface, which requires username and password credentials prior to granting access to the dashboard. Figure 5 presents the Print Color Analysis interface, where users upload a document file (PDF, JPG, or PNG) that is subsequently processed to extract RGB/CMYK color composition; the resulting percentage output directly informs the automated print cost calculation described in the Research Method section. The direct correspondence between this interface and Table 8 confirms that the feature functions as designed across all tested input scenarios.

Table 7. Black Box Testing of Login Features

Requirements/Features	Task	Test Case	Expected Results	Test Results
Log In / Sign In in feature	Log In / Sign In Feature	Enter the Username according to the PC name and Password	Admin successfully logged into the system and was directed to the Dashboard page	Pass
		Leave one of the Username or password blank	page The user failed to log in to the system and displayed the error message “These credentials do not match our records.”	Pass
		Entering an incorrect username and password.	The user failed to log in to the system and displayed the error message “Please fill out this	Pass
	Log Out / Sign Out Feature	Click the logout button while the session is active.	The user successfully exited the system and was redirected back to the log in/sign in page.	Pass

Table 7 confirms that the authentication feature correctly handled both valid and invalid input scenarios, including blank-field submission and incorrect credentials, with the system consistently returning appropriate error messages. The successful handling of edge cases — rather than only the "happy path" login scenario — indicates a reasonable level of robustness in the authentication module's error-handling logic.

Table 8. Black Box Testing Print color Analysis feature

Requirements/ Features	Task	Test Case	Expected Results	Test Results
Print Color Analysis	Upload File	User inputs values into the form	The system automatically adds to the lower balance (UB)	Pass
		Upload valid file	The system processes the file and displays the analysis results.	Pass
		Upload format is not appropriate	System rejects file or no response from system	Pass
		Click create new transaction	The system directs to the Upload File page	Pass

The results in Table 8 demonstrate that the Print Color Analysis feature correctly processed valid file uploads and appropriately rejected unsupported file formats. It is important to note that this testing verified functional behavior — i.e., whether the feature executes and responds as expected — rather than the numerical accuracy of the extracted RGB/CMYK values against a ground-truth reference. Future evaluation should therefore include accuracy testing that compares system-estimated color composition against manually measured or professionally calibrated print samples.

3.4.3. Sprint 3

In Sprint 3, a revenue calculation feature was developed and implemented to calculate daily earnings. Additionally, a sales summary feature was developed to make it easier for managers to monitor store finances.

Figure 6. User Interface Earnings Calculation Feature

Figure 7. User Interface Sales Summary Feature

Figure 6 displays the automated earnings calculation interface, which aggregates transaction data to compute daily revenue without manual recapitulation. Figure 7 shows the sales summary dashboard, which presents aggregated transaction and income data to support managerial monitoring. Together, these interfaces demonstrate how the system extends beyond individual transaction processing to provide managerial-level business insight, addressing the reporting inefficiencies noted in the introduction.

Table 9. Black Box Testing of Cashier Calculation Features

Requirements/ Features	Task	Test Case	Expected results	Test Results
Cashier Calculation	Feature	Input Data User inputs values into the form	The system automatically adds to the lower balance (UB)	Pass
	Calculate & Save	Click calculate & save	The system stores values in the database	Pass
	Dashboard	Click dashboard	The system directs to the dashboard page	Pass

Table 9 confirms that the cashier calculation feature correctly stored transaction values upon confirmation and routed users appropriately between the calculation form and dashboard, indicating stable data flow between the transaction and reporting modules.

Table 10. Black Box Testing of the Sales Recap Feature

Requirements/ Features	Task	Test Case	Expected results	Test Results
Sales Summary Feature (HP)	Access the dashboard	User login with valid account	The system displays the dashboard page	Pass
		Access the dashboard after logging in	Data and dashboard components are displayed correctly according to the database.	Pass
	Display data	The dashboard displays summary data (e.g. total transactions / income)	Data appears according to the database	Pass
		There is no data in the the database	Dashboard still displays with empty value / 0	Pass

Requirements/ Features	Task	Test Case	Expected results	Test Results
	Menu navigation	Click on the other menu from the dashboard sidebar	The system moves to the selected page.	Pass
		Click refresh page	Dashboard data updated	Pass

As shown in Table 10, the sales recap feature consistently displayed accurate summary data — including total transactions and income — that matched underlying database records across all tested scenarios, including empty-data conditions. This confirms that the dashboard reliably reflects real-time database state rather than static or cached values, which is essential for managerial decision-making.

3.5 Review and Retrospective

After completing each sprint, a Sprint Review and Retrospective session was conducted involving the researcher as the developer and the owner of Penjilidan Express as the stakeholder. During the Sprint Review, the implemented features, including user authentication, cashier transaction processing, document upload, Print Color Analysis, and sales reporting, were demonstrated and evaluated. Feedback obtained from stakeholders was documented and used as a basis for improving system functionality and ensuring that the developed features aligned with operational requirements. Following the review process, a Sprint Retrospective was carried out to evaluate the effectiveness of the development activities and identify challenges encountered during implementation. The results of this evaluation were used to determine improvement strategies for subsequent iterations. After all planned sprints had been completed and the final system testing had been conducted, the web-based cashier system was considered ready for deployment and operational use at Penjilidan Express. Furthermore, the hosting process was prepared to facilitate system accessibility and support future development based on additional backlog items identified during actual system usage

Taken together, the findings presented across Tables 1–10 and Figures 1–7 demonstrate a consistent alignment between planning, implementation, and evaluation throughout the Scrum development cycle. The product backlog and sprint planning (Tables 1–2) established a clear prioritization of features centered on the Print Color Analysis capability, which was subsequently translated into detailed technical tasks across three sprints (Tables 3–5). The design artifacts produced in Sprint 1 (Figures 2–3) were validated by the primary stakeholder prior to implementation (Table 6), reducing the risk of misalignment between system design and actual business requirements. Functional testing conducted across Sprints 2 and 3 (Tables 7–10) further confirmed that each implemented feature — from authentication to automated print cost estimation and sales reporting — operated according to its intended specification, with all test cases achieving a "Pass" result. This end-to-end traceability, from initial requirement identification through to functional verification, indicates that the iterative and stakeholder-involved nature of the Scrum framework contributed meaningfully to the reliability of the final system. However, as noted in the discussion of individual tables, several aspects of this evaluation — including single-stakeholder validation and functional (rather than accuracy-based) testing of the color analysis output — represent methodological boundaries that should be addressed in future research.

The results demonstrate that the developed web-based cashier system successfully integrates transaction management, automated print cost estimation, and Print Color Analysis into a single platform. This integration streamlines operational processes by enabling users to upload documents, analyze color composition, calculate printing costs, process transactions, and generate reports within one system environment. Consequently, the system has the potential to reduce administrative workload and improve operational efficiency, and support faster and more consistent service delivery. These findings support previous studies showing that integrated information systems contribute to more effective business

operations through centralized information management and process automation [7] , [8] . Compared with conventional Point-of-Sale (POS) systems for printing services, which primarily focus on transaction recording, payment processing, and sales management, the proposed system introduces a Print Color Analysis feature that automatically estimates printing costs based on the actual color composition of uploaded documents. This feature represents the main contribution of the study because it extends the role of a cashier system beyond transaction processing by providing support for pricing decisions. Existing printing cashier systems generally rely on manual estimation of color usage, making the pricing process dependent on employee experience and subjective judgment [2] , [4] . Such practices may result in inconsistencies in pricing and increase the risk of human error. By automatically analyzing document color composition before calculating costs, the proposed system provides a more objective, transparent, and standardized pricing mechanism. The novelty of the proposed approach lies in the integration of digital color analysis and transaction management within a unified workflow. For JPG and PNG files, the system extracts RGB color information and calculates the proportions of colored and non-colored areas. PDF documents are converted into images before undergoing the same analysis process. The resulting color composition data are then directly utilized to estimate printing costs automatically. This approach reflects the growing adoption of digital technologies within printing businesses and demonstrates how document analysis can be incorporated into operational decision-making processes [5] . Unlike conventional approaches that separate cost estimation from transaction processing, the developed system combines both functions within a single platform, reducing repetitive tasks, minimizing data entry errors, and improving consistency between estimated costs and transaction records. The practical benefits of integrating transaction management and automated print cost estimation are particularly evident in workflow efficiency. In conventional printing services, employees typically estimate printing costs manually before recording transactions in a separate cashier application. This process increases processing time and creates opportunities for inconsistencies between cost calculations and transaction records. In contrast, the proposed system automatically transfers estimation results into the transaction module, eliminating redundant processes and reducing the possibility of human error. As a result, service delivery becomes more efficient, workflow management is simplified, and users experience a more streamlined operational process. Furthermore, the integration enhances pricing transparency and supports more accurate business records, which may contribute to improved employee productivity and customer experience [6] . The Black Box Testing results indicate that all functional requirements were successfully implemented, with every test case producing the expected output. These findings confirm the functional correctness of the system by demonstrating that all major features operate according to predefined specifications and user requirements. The successful validation of user authentication, transaction management, Print Color Analysis, automated cost estimation, and reporting functions indicates that the system can consistently perform its intended operations in a reliable manner. Similar findings have been reported in recent information system development studies, where successful functional testing serves as an important indicator of software quality and implementation readiness [20] . Furthermore, the testing outcomes provide evidence of the system's readiness for practical implementation. The successful interaction among all functional modules demonstrates that integrating multiple functionalities within a single platform does not compromise system stability or performance. Instead, the results indicate that the developed application can effectively support real-world printing service operations. From an operational perspective, the system is capable of assisting users in transaction processing, pricing determination, document analysis, and business reporting while maintaining data consistency and reliability. Therefore, the Black Box Testing results not only validate technical functionality but also provide confidence that the proposed system can deliver practical benefits when deployed in operational environments. The implementation of the Scrum framework also contributed significantly to the effectiveness of the development process. Through iterative development cycles, system requirements were continuously refined based on stakeholder feedback obtained during sprint planning, sprint reviews, and retrospectives. This approach enabled early identification of functional issues and facilitated incremental improvements throughout development. As a result, system features such as Print Color Analysis, automated print cost estimation, transaction management, and reporting could be evaluated and refined progressively before final deployment. The continuous feedback mechanism also improved communication between developers and stakeholders, ensuring that the final system aligned closely with operational requirements. These findings are consistent with Agile Requirements Engineering practices that emphasize continuous stakeholder involvement and iterative refinement of system requirements throughout the development process [17]. In

addition, previous studies have reported that Scrum improves development flexibility, stakeholder collaboration, and software quality through continuous feedback and incremental delivery [18], [19] . Therefore, Scrum played an important role in supporting system refinement and ensuring successful project outcomes. Despite these advantages, the developed system has several limitations. First, the Print Color Analysis feature currently supports only PDF, JPG, and PNG file formats. Second, print cost estimation is based solely on digital color composition and does not consider factors such as printer specifications, ink consumption efficiency, paper characteristics, or printing machine configurations that may affect actual printing costs. Third, the system evaluation was conducted only at Penjilidan Express, limiting the generalizability of the findings. Therefore, future research should incorporate machine learning-based color analysis, support additional file formats, evaluate the system in multiple printing businesses, and compare estimation accuracy across different printing technologies to improve the accuracy and applicability of the proposed system.

4. Conclusions and Future Works

This research successfully developed an Express Binding Cashier System using the Scrum framework to assist the transaction process and print price analysis based on document color composition automatically. The developed system is expected to improve service efficiency and accuracy relative to the previous manual process, especially in transaction calculations and printing price determination. The system was developed through multiple Scrum sprints, with each iteration evaluated in collaboration with stakeholders to ensure that both functional and non-functional requirements were successfully achieved. Future enhancements may include integrating machine learning-based color analysis to improve cost estimation accuracy, expanding support for additional file formats, evaluating the system across multiple printing businesses, and incorporating printer specifications and ink consumption factors into cost calculations.

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