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Development of Material Requisition System Application Using Rapid Application Development Methodology in Fast-Moving Consumer Goods Companies

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Abstract— Efficient material requisition and tracking are essential for manufacturing operations, particularly in high-volume production environments. Currently, at a Consumer Goods manufacturer in Cikarang, Indonesia, the material requisition process is based on a non-standard request process through WhatsApp communication, lacks real-time tracking visibility, and requires manual data entry into the ERP system, leading to an average processing time of 9,122 seconds for material requests and 8,681 seconds for material returns. This research aims to develop a centralized Material Requisition System that is integrated with the existing company ERP system, while enhancing real-time material tracking and monitoring. The system is developed using the Rapid Application Development (RAD) methodology, Business Process Analysis (BPA), and an impact-effort matrix, incorporating problem mapping and field observations, as well as user interviews, to ensure alignment with operational requirements. The implemented system demonstrated a 49% reduction in material request processing time, decreasing from 9,122 seconds to 4,675 seconds, and a 75% reduction in material return processing time, reducing from 8,681 seconds to 2,189 seconds. The system eliminated manual data entry into the ERP system and provided end-to-end visibility of materials tracking across the material requisition process. These results highlight the effectiveness of automated and integrated systems in improving operational efficiency within FMCG manufacturing.

Keywords— Material Requisition; Material Tracking Visibility; Rapid Application Development; ERP System; System Integration; Operational Efficiency; Business Process Analysis.

I. INTRODUCTION

Manufacturing industries are faced with intense competition and must continuously improve performance to enhance productivity [1] [2] significantly in a multinational Fast Moving Company Goods (FMCG) as a key player in the global economy due to the rapid consumption of products every day [3]. The Consumer Goods manufacturer located in Cikarang, Indonesia, has quite a high operational complexity. There are three production technologies, including moulded, extruded, and cup cone, operated through 17 production lines. This factory can produce up to 100,000 pieces of product per daily shift. Efficient material requisition and tracking are crucial for managing delays in material supply within the production line, which can be caused by additional material requirements resulting from machine breakdowns, preparation for the next production cycle, changeovers, and oversupply. Currently, the material requisition process is based on a non-standard request process. WhatsApp communication lacks real-time visibility, making it difficult to track the location and status of materials [4]. Additionally, the administrator must manually input requests from WhatsApp into the Enterprise Resource Planning (ERP) system, resulting in production delays while waiting for the transfer order to be processed by the ERP system. It also results in inaccuracies in inventory and production data [5] and carries security risks because WhatsApp is designed for handling critical industrial data [6][7].

Despite ERP implementation, the existing system does not fully address the specific needs of real-time requirements in the FMCG environment. Several studies have explored digital transformation in materials management [8]. Although effective in improving supplier communication, the system did not provide real-time integration with ERP systems. Similarly, [9] proposed a First-in, First-out (FIFO)-based raw material control system in the food manufacturing industry. This system provided efficiency in stock management but was not designed to handle dynamic and real-time material requisition processes. Meanwhile, highlighted the benefits of integrating Material Requirements Planning (MRP) with Enterprise Resource Planning (ERP) systems, particularly in strategic material requirements planning [10].

However, this approach did not focus on the direct material requisition process that is tactical and responsive to field needs, especially in the context of high-volume FMCG production. This comparison reveals that no previous research has specifically developed a material requisition system that is directly integrated with an ERP, supports real-time tracking, and is tailored to the dynamic and complex FMCG operational environment. Therefore, this research introduces a novel approach by developing a centralized ERP-based material request system that enables automatic data synchronization, digital approval, and end-to-end real-time request monitoring across departments. This approach is expected to address the operational efficiency and data accuracy issues that have not been adequately addressed in previous studies.

The proposed system will be developed using the RAD model due to the project's limited scope focusing only on the material requisition process in Raw Material Storage-Sub Store to Production Hall area, the limited time of research, and the urgency to deploy within a short timeframe during peak

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operations from WE 23 until WE 26 at Line A and Line B during peak season, and this method is suitable for user-driven during the implementation [11] Additionally, Business Process Analysis (BPA) helps understand the flow of the material requisition process. It identifies processes that need improvement [12].

A. Literature Review

Several literature reviews support this research using the RAD model, as illustrated in Fig.1.

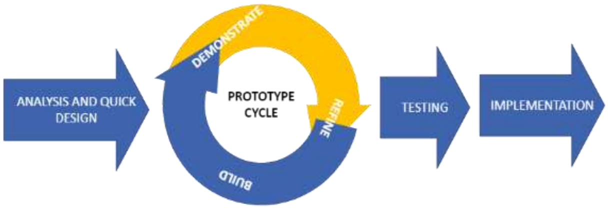

Fig.1. RAD Model

1) Material Requisition: A material requisition serves as the basis for material procurement, supporting operations and production within a business or manufacturing process. This function identifies material needs, such as raw materials, packaging, or other supporting goods, including the type of material based on the quantity and timing of the material requirement 13]. The material requisition process is pivotal in ensuring the smooth operation of the supply chain, as the availability of materials directly impacts the efficient production and timely distribution of products in time-sensitive companies 14]. Operations in a project or production line are usually allocated for material procurement. Therefore, an efficient and structured procurement system is needed to minimize waste and ensure the sustainability of the production process [8].

2) System Integration and Real-time Visibility: Integrating the material requisition system with the ERP system allows FMCG companies to achieve real-time visibility by utilizing order transfer and goods movement data [15]. The system can display real-time information such as material location and delivery status. In this way, companies can optimize material flow and increase efficiency [16].

3) Rapid Application Development (RAD): RAD is a software development model that emphasizes a short development cycle [11][17]. Fig.1 shows the process or stages involved in the RAD model. It is divided into four stages, including the Quick Design Build, Demonstrate, Refine, and Launch/Completion phases[18]. Recent developments in software engineering have demonstrated the increasing relevance of the RAD model when combined with modern development platforms. A recent study [19] introduces the RE4NCD framework, which illustrates how RAD principles can be effectively applied in a no-code environment to accelerate development cycles and enhance stakeholder collaboration. The framework supports rapid prototyping, user feedback, and rapid iteration, which aligns with dynamic project requirements. While RAD is applied in a general software development context, the study extends the RAD approach to a more specific and demanding environment: the fast-paced and operationally complex FMCG sector. Integrating RAD with business process analysis and ERP system synchronization, it addresses real-time material demand challenges.

4) Microsoft PowerApps: Power Apps is a service, connector, and data platform that provides a fast development environment for building custom applications tailored to business needs. Using Power Apps enables businesses to design simple mobile apps or web apps without requiring a deep understanding of programming fundamentals. Users can quickly create custom business applications that connect to data stored on the underlying data platform (Microsoft Dataverse) or across various online and on-premises data sources (such as SharePoint, Microsoft 365, Dynamics 365, SQL Server, and so on). With PowerApps, company employees can create applications similar to those in Microsoft Office. PowerApps provides a variety of design templates that can be customized to meet specific needs. The apps that PowerApps generates are also not platform-limited. The manufacturing process does involve a personal computer (PC), but the result can be an iOS, Android, or Windows Phone application. The distribution process only includes a link, and users can collaborate with other employees [20].

5) Flowchart: The flowchart illustrates the steps, sequences, and decisions in a process within a system. Flowcharts use symbols to show activities, conditions, and logical flows. The primary function of flowcharts is to document, plan, and communicate complex processes into diagrams [21]. Flowcharts are created using standard symbols that have their meanings.

6) Business Process Analysis: Business process analysis, the first key to total cost management, is a fundamental technique for understanding, analyzing, and improving business unit performance. The business unit as a collection of processes rather than a collection of individual functions [12]. Apart from focusing on customer satisfaction, this technique also aims to shorten waiting times and minimize costs. The analysis begins with developing a business process model, creating an activity definition, and then conducting a process value analysis to make an improvement plan [22].

7) Impact-Effort Matrix: The Impact and Effort Matrix quadrant in Fig.2 serves as a decision-making aid to prioritize projects and manage time more efficiently. It can be applied to groups of ideas, strategies, and projects to evaluate and prioritize them based on the effort required and potential positive benefits. Lean Six Sigma teams utilize the matrix to make informed decisions when faced with various options for solving business problems [23]. This matrix is often used to set project priorities at the start of a project. Reference [24] indicates that the Effort Impact Matrix helps companies determine which activities to focus on and which can be ignored. Each company has a limited number of resources that

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can be allocated to a project, so the matrix is the key to optimizing the use of these resources.

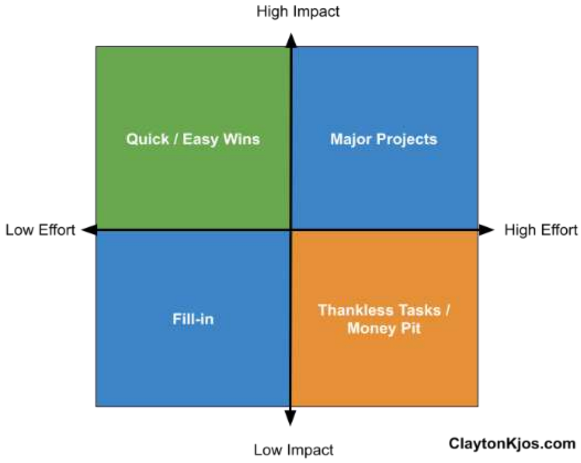

Fig.2. Impact-Effort Matrix

II. Research Methodology

This research uses the RAD model. Fig.3 shows the RAD approach for the research and development of the application.

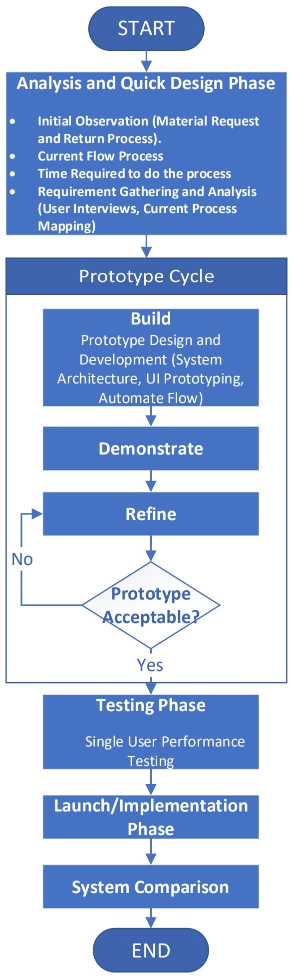

Fig.3. Research Framework

A. Initial Observation

The first step is to observe and document the material request and return process. This includes understanding the current workflow, identifying system bottlenecks and inefficiencies, and observing how the process works. This can help identify key problem areas and form the basis for gathering system requirements and suggestions for improvement.

B. Analysis and Quick Design

Following initial observations, user interviews are conducted, and data from the ongoing process are analyzed. During this phase, tools such as process flowcharts, effort, and impact matrix ensure functionality meets user expectations [25]. The goal is to thoroughly understand the system requirements and define the scope and requirements that will drive the design and prototyping phases.

C. Prototype/Design Cycle (Build, Demonstrate, Refine)

During this phase, the system architecture is sketched, and a prototype is developed. It includes designing the user interface (UI) for operators and material handlers. The process is iterative, focusing on automation and integration to optimize workflows. A prototype is created to visualize and test the proposed system design before it is implemented.

Once the prototype is developed, its acceptance level is determined. The prototype will be tested to ensure that it meets the requirements. If the prototype does not completely meet the user's requirements and expectations, the process returns to the design and prototyping stage for further refinement. This feedback ensures that the final application meets the user's needs. Once the test prototype is accepted, single-user performance testing is performed. This testing evaluates the system's release readiness by simulating real-world conditions and gathering user feedback. Based on this feedback, necessary adjustments have been made to improve the system's functionality and performance.

D. Testing Phase

After testing and making necessary modifications, the system is implemented. It includes implementing the system in a testing environment and providing required documentation, such as system implementation documentation.

E. Implementation

The system is now fully operational and available for operators and material handlers. For each improved process, the implementation will display the results or output of the process; therefore, we can determine that the improvement has an impact that can be used as an example for calculating cycle time reduction.

Cycle time reduction is an important metric used in this study to measure the efficiency gains achieved through the implementation of the proposed system. This study's cycle refers to the total time required to process material requests and return activities. It is crucial in FMCG manufacturing environments where speed and accuracy of material handling significantly impact production continuity and accountability.

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Next, it is necessary to determine the total time required for the time reduction process, which involves calculating the duration of the previous process, including the time it takes to complete a task from start to finish [26]. Equation (1) is for calculating the Cycle Time Reduction.

$$CTR = \frac{Previous\ Lead\ Time - New\ Lead\ Time}{Previous\ Lead\ Time}\ x\ 100\% \qquad (1)$$

F. System Comparison

In this final stage, a comparison is made between the old process flow and the new system to specifically evaluate the differences in query processing, traceability, and integration with automation. This comparison highlights the improvements achieved with the new system and demonstrates the benefits of transitioning from a manual process to an automated solution.

III. RESULT AND DISCUSSION

A. Initial Observation

In this step, production loss data is collected through field observations, analysis of the time required for each process stage, and examination of the overall process flow. The data and observations indicate several problems that may arise from events such as machine breakdown, changeover, next cycle, and oversupply, including inaccurate material data in the ERP system, miscommunication between teams, redundancy, manual data entry, and a lack of visibility in the process.

1) Problem Mapping: Problem mapping is a structured approach to analyzing problems and finding the relationship between the problem and its solution. Before conducting further research, Table I is used to define the problem and determine the scope and objectives of problem mapping.

TABLE I
PROBLEM MAPPING

Problem Definition	Problem Manifestation	Objective
No system can organize and manage the material Requisition process in a way that meets corporate and centralized data security standards.	Consumer Goods manufacturer Cikarang, Indonesia, operators, and team leaders have difficulty tracking. Making material requests through the WhatsApp process can be challenging if the messages accumulate in the chat group.	Develop a centralized and secure platform to facilitate easy tracking and management of material requisitions through an internal platform (Inaccessible without permission).
Inefficient data synchronization to the ERP System	Manual data entry for material requisitions leads to delays and time-consuming processes, which hinder the collection of real-time data.	Implement seamless integration with the proposed system to automate and synchronize data to the ERP in real-time.
No standardized approval system for material requests and returns.	The current process leads to bypassed approval and results in no evidence or history of accountability for material requisitions.	Implement a mandatory approval layer within the system to enforce standardized processes and ensure proper authorization.
Data is not easily accessible, cannot be stored for long-term use, and is not centralized.	If needed, no historical data can be stored periodically (still retrieved from the stop line and Spreadsheet data from the RMS Supervisor that still needs to be sorted manually).	Historical data in a database that can be stored periodically and long-term for future analysis

2) Current Process: The current process flowchart indicates several potential problems. Fig.4 and Fig.5 visualize the current process and display several results. First, there is redundancy, especially in the multi-level material request process and repetitive manual data input. Second, the lack of visibility and control makes it challenging to monitor the status of requests and material availability in real-time. Third, the manual and multi-level process is prone to human error in data input and team communication. Furthermore, the use of WhatsApp for notifications exacerbates this issue. The lack of formality and documentation can cause essential notifications to be missed or deleted, potentially leading to problems.

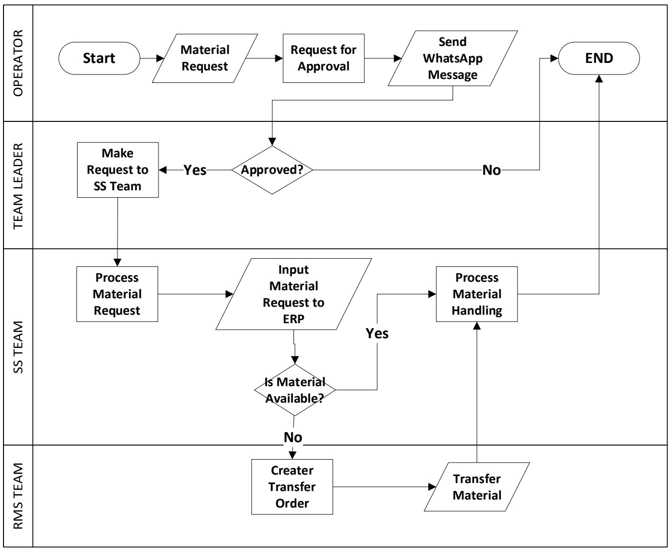

Fig.4. Current Material Request Process Flowchart

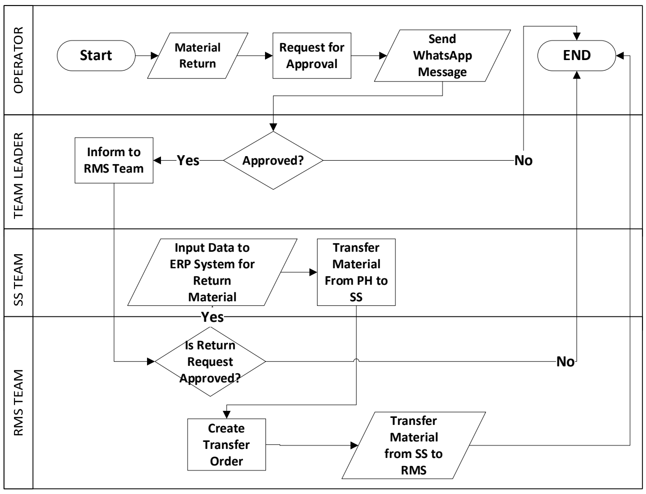

Fig.5. Current Material Return Process Flowchart

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3) Time Required in Material Request: In the observation and data processing process on WE 23 to WE 26, which was carried out on both lines, namely Line A, the average time required for the Material Request process was 8773 seconds or 146 minutes, while on Line B it took 8232 seconds or 137 minutes. Therefore, the average time required to process material requests on Lines A and B on WE 23 to 26 is 8503 seconds, or 142 minutes, or 2.3 hours. Table II is used to indicate the overall average time for material requests.

TABLE II
PROBLEM LINE A AND B OVERALL AVG (S) MATERIAL REQUEST TIME REQUIRED

No	Line	Average Time (sec)
1	Line A	8773
2	Line B	8232
Overall Avg (s) Time		8503

4) Time Required in Material Return: In the observation and data processing process on WE 23 to WE 26, which was carried out on both lines, on Line A, the average time required for the Material Return process was 8720 seconds or 145 minutes, while on Line B it took 8643 seconds or 144 minutes. Therefore, the average time required to carry out the material return process on Lines A and B at WE 23 to 26 is 8,682 seconds, or approximately 145 minutes, or 2 hours and 25 minutes. Table III is used to point out the overall average time for the material return process. Based on this data, there is an opportunity to reduce the lead time in the material request and return process.

TABLE III
PROBLEM LINE A AND B OVERALL AVG (S) MATERIAL RETURN TIME REQUIRED

No	Line	Average Time (sec)
1	Line A	8720
2	Line B	8643
Overall Avg (s) Time		8682

B. Analysis and Quick Design

1) User Requirements: Table IV presents the extracted information from users interviewed about the system's final output. For this system, the users that will be interviewed are the warehouse supervisor and management.

TABLE IV
USER REQUIREMENT

User	Requirement
Warehouse Supervisor	The operator can request and return the material from the operation tablet in the production line.
Warehouse Supervisor	The system must automatically sync and return the material request to the ERP system immediately after approval.
Warehouse Supervisor	The system can adjust the quantity requested and return based on the Transfer Order Process in the ERP System.
Warehouse Supervisor	The system can automatically notify the Material Handler of any material requests or returns.
Warehouse Supervisor	The system can automatically notify the Team Leader, RMS Team, and SS Team and comply with the approval layer for every request made by the operator.
Warehouse Supervisor	The system can store the log-book for historical data to facilitate future research and provide a preview to monitor the process's performance and condition.

2) Impact-Effort Matrix: The next step is to prioritize the features developed in the new application. The main features to be developed are PowerApps for making requests and tracking Materials (used by MH, Operator, RMS Team, and SS Team) on an operation tablet, auto-data sync with the ERP System, generating historical reporting to a spreadsheet, and QR Scanning for easily inputting the Material/Lot ID Number. Fig.6 and Table V show the impact-effort matrix used to map the feature and determine its justification and priority for development.

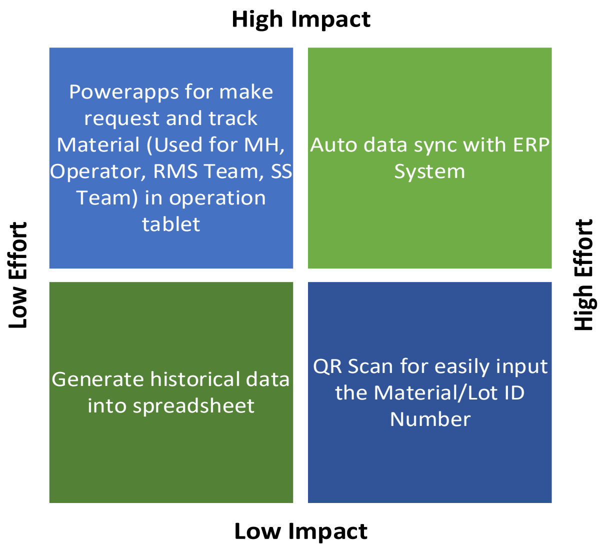

Fig.6. Impact-Effort Matrix Material Requisition Application

TABLE V
IMPACT-EFFORT FEATURE MATRIX

Feature	Justification	Impact	Effort
PowerApps for making requests and tracking Material (Used for MH, Operator, RMS Team, SS Team) in an operational tablet	This is the core feature needed to address the issues of inefficient processes and to replace non-formal communication channels for material call-offs.	High	High
Auto data sync with ERP System	The ERP system needs to be updated immediately to ensure the material is available in storage and in the system.	High	Low
QR/Barcode Scan for easily inputting the Material/Lot ID Number	Additional features will help operators input the ID by scanning the Barcode.	Low	High
Generate historical reporting to the spreadsheet.	This feature is nice to have but not necessary because the user can already see the report from the PowerApps database (data-verse)	Low	Low

C. Design/Prototype and Development

1) Proposed System Architecture: All required requests for materials will be created in PowerApps, and the data will be stored in the database feature within PowerApps. Additionally, PowerApps includes a customized connector that functions as

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an ERP System Integrator to synchronize data between the database in PowerApps and the ERP System. Operators, administrators, and management can access the platform, and it enhances the efficiency of the request, approval, and reporting processes. Fig.7 illustrates the proposed system architecture.

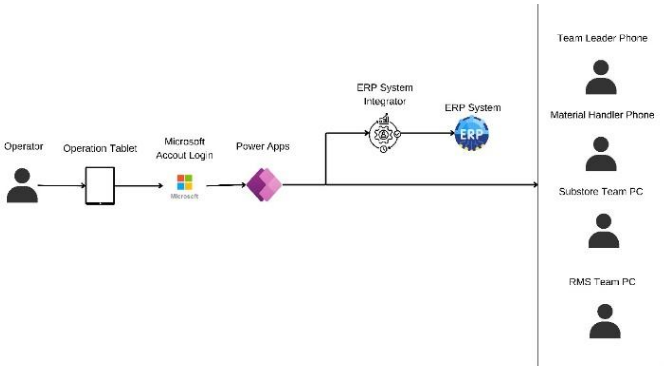

Fig.7. Proposed System Architecture

2) Application Design: This system will utilize a user interface (UI) that is intuitive and easy for operators to use. This system will be divided into three distinct segments based on user roles and device types. The operator will use the tablet in each line to make requests and return materials, and team leaders or approvers who have gained access to the company's account can use their respective mobile devices to approve. The application design was performed through three iterations, as shown in Table VI.

TABLE VI
APPLICATION ITERATIONS

Iteration	New Feature	Enhance Feature
Iteration 1	1) Operator Operations Tablet UI 2) Team Leader/Approver/Material Handler Mobile UI 3) QR/Barcode Scanner UI 4) Automation Flow for ERP System	
Iteration 2	1) RMS, SS, Supervisor UI 2) Data Export to Spreadsheet	Automation Flow for ERP System and Spreadsheet
Iteration 3	A Glance Dashboard UI	

D. Testing

1) Single-User Performance Test: A single-user performance test evaluates the speed, responsiveness, and stability of a user's device, network, software program, or device under a specific workload [27]. The primary objective of performance testing is to identify and eliminate software application performance bottlenecks, thereby contributing to ensuring the quality of software. Network type, use location, and user role will all be covered in the test. User A uses a computer connected to the company cable network, with access to the RMS and RMS Admin systems. User B, on the other hand, utilizes a mobile phone connected to the company Wi-Fi network, performing tasks related to SS and working as a Material Handler. User C operates a tablet connected to the company's Wi-Fi network while working on the production floor as an Operator. Lastly, User D relies on a mobile phone with cellular data while working as a Team Leader in the office. In terms of performance, where 0 indicates "Not Applicable," 1 means "Not running," 2 represents "Slowly Running," and 3 signifies "Quickly Running." These ratings are used to assess the status of the systems or devices used by the respective users.

TABLE VII
RUNNING CAPABILITY TESTING

Action/User	A	B	C	D
Request Material	3	2	3	2
A Glance Dashboard	3	2	2	1
Approve the Request	3	3	3	2
Receive Material	3	3	3	2
Receive notification	3	3	3	3
QR Scan for Material Track	0	3	3	3
Total	15	16	17	13

The test uses 1-3 points for each feature to measure, and the measurement results are used in Table VII to determine the total running capability test score. User D has the lowest score of 13 (User gives 1 score to view the daily overview of material requisition on the glance dashboard because they are using a mobile phone with limited signal and cellular data). User C, with the highest score of 17, can be concluded to have the best performance in User A conditions, and the system will run optimally in User A, C, and D conditions.

Each feature successfully ran with good results. Table VIII is used to determine in detail whether the implemented features are functioning properly. The problems that occur during the application's use will be identified in Table IX. After testing the application in this phase, the system will be ready to enter the implementation stage and be approved by the user.

TABLE VIII
RUNNING DETAILS

Condition	Feature	Platform	Results
The request will notify the approver and ring their notification bell.	Material Request and Return	Microsoft PowerApps	OK
Users can access the glance dashboard to view the daily overview of material requisitions.	A glance dashboard	Microsoft PowerApps	OK
The data is synced between Dataverse and the ERP System.	Automated Flow	Microsoft PowerApps, ERP System	OK
The approver can approve the request and change the status of the request from "Waiting for Approval" to "On Process."	Approval Layer	Microsoft PowerApps	OK

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Condition	Feature	Platform	Results
Users can bulk scan the material using the device camera to change the track state.	QR Scan	Microsoft PowerApps	OK

TABLE IX
TROUBLESHOOT

Action	Problem	Solution
Accessing the application		
User A, B, C, D	N/A	N/A
Material Request		
User B	The process is slightly slow because the user is mobile and uses the company Wi-Fi, and sometimes there are blank spots (with or without a low Wi-Fi signal).	Use hybrid Wi-Fi and cellular data.
User D	The process is slightly slower because the user is using cellular data in the office.	Use hybrid Wi-Fi and cellular data.
Glance Dashboard		
User B, D	The data slowly shows	Use hybrid Wi-Fi and cellular
User C	The data slowly shows.	Use the 5GHz Wi-Fi and the SSID specifically provided for operation devices by the company.
Approve the Request		
User D	The approval for one-click takes 5-10 seconds	Use hybrid Wi-Fi and cellular
QR Scan Material Track		
User A	N/A	N/A

E. Implementation

Fig.8 and Fig.9 show the Material Request UI and Material Return UI, where users can click "Next Cycle" to automatically create a material request based on the current SKU or Batch product and return the material. Users can also request manual updates if there is a machine breakdown or material change. In Fig. 10, if the material is defective, the user can use a QR or barcode scanner to identify the issue. The dashboard display makes it straightforward for users to see a summary of lines that are actively running.

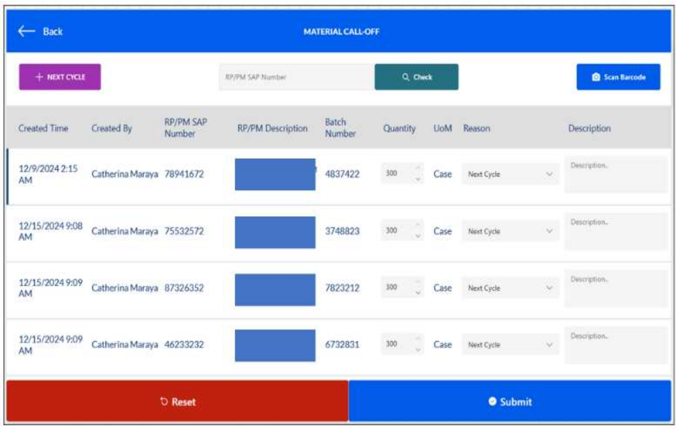

Fig.8. Material Request

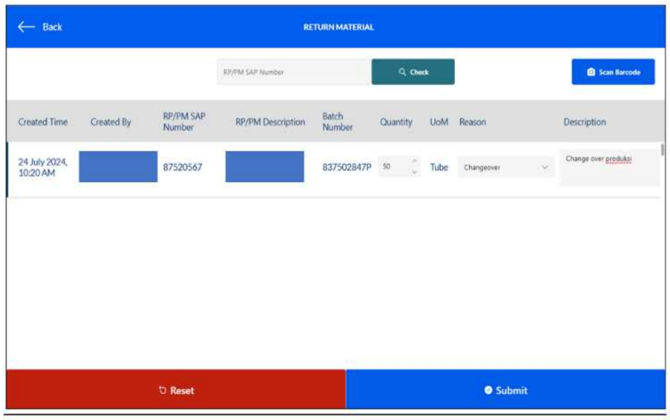

Fig.9. Material Return

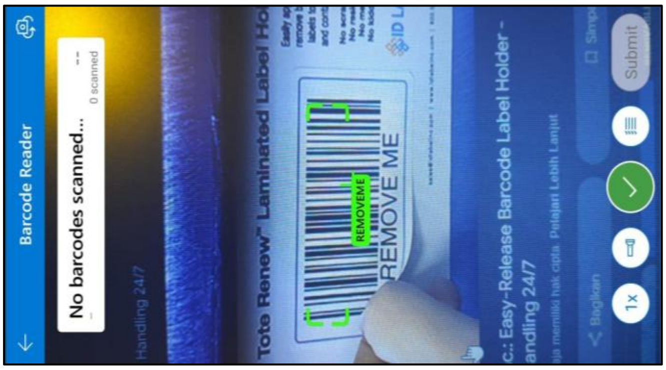

Fig.10. QR/Barcode Scanner UI

Fig. 11 shows the approval notification received via a mobile device for a manual material request. This notification informs the user that the authorized party has approved the manually submitted material request. This feature enables users to receive request status updates directly and quickly via their mobile devices, without needing to open the system on a computer manually.

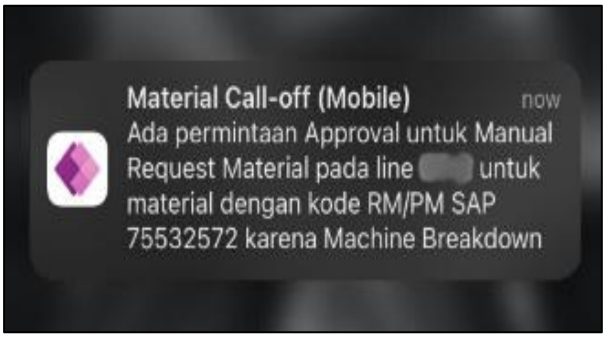

Fig.11. Approval Notification on Mobile Phone

In Fig. 12, users can see the number of queues and the number of requests being made. Fig. 13 supports decision-making with data orientation; each shift's data will be automatically generated into a spreadsheet. It will enable users to view historical data and support informed decisions related to improvement or audit [28].

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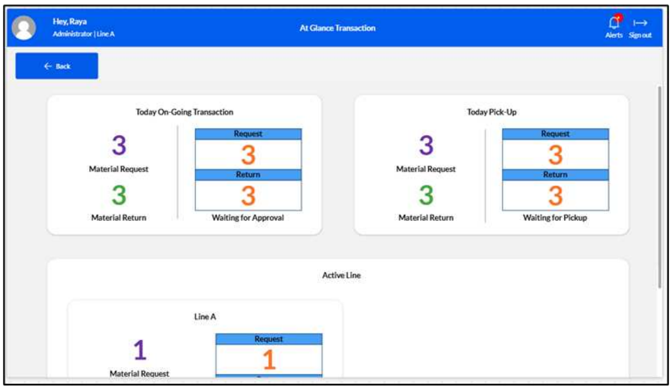
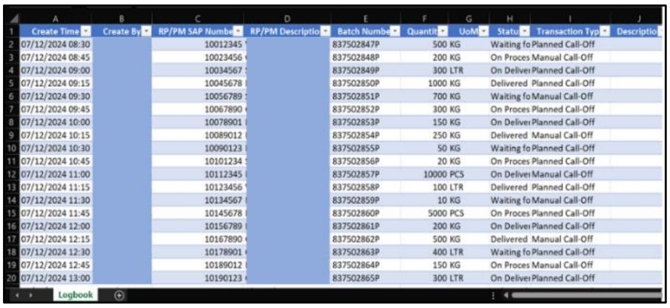


Fig.12. Glance Dashboard



Create Time	Create By	RP/PM SAP Numbe	RP/PM Descriptio	Batch Numbe	Quantit	UoM	Statu	Transaction Typ	Descriptio
07/12/2024 08:30		10012345		837502847P	500	KG	Waiting fo	Planned Call-Off	
07/12/2024 08:45		10023456		837502848P	200	KG	On Proces	Manual Call-Off	
07/12/2024 09:00		10034567		837502849P	300	LTR	On Delive	Planned Call-Off	
07/12/2024 09:15		10045678		837502850P	1000	KG	Delivered	Planned Call-Off	
07/12/2024 09:30		10056789		837502851P	700	KG	Waiting fo	Manual Call-Off	
07/12/2024 09:45		10067890		837502852P	300	KG	On Proces	Planned Call-Off	
07/12/2024 10:00		10078901		837502853P	150	KG	On Delive	Planned Call-Off	
07/12/2024 10:15		10089012		837502854P	250	KG	Delivered	Manual Call-Off	
07/12/2024 10:30		10090123		837502855P	50	KG	Waiting fo	Planned Call-Off	
07/12/2024 10:45		10101234		837502856P	20	KG	On Proces	Planned Call-Off	
07/12/2024 11:00		10112345		837502857P	10000	PCS	On Delive	Manual Call-Off	
07/12/2024 11:15		10123456		837502858P	100	LTR	Delivered	Planned Call-Off	
07/12/2024 11:30		10134567		837502859P	10	KG	Waiting fo	Manual Call-Off	
07/12/2024 11:45		10145678		837502860P	5000	PCS	On Proces	Planned Call-Off	
07/12/2024 12:00		10156789		837502861P	200	KG	On Delive	Planned Call-Off	
07/12/2024 12:15		10167890		837502862P	500	KG	Delivered	Manual Call-Off	
07/12/2024 12:30		10178901		837502863P	400	LTR	Waiting fo	Planned Call-Off	
07/12/2024 12:45		10189012		837502864P	150	KG	On Proces	Manual Call-Off	
07/12/2024 13:00		10190123		837502865P	300	LTR	On Delive	Planned Call-Off	

Logbook

Fig.13. Exported Spreadsheet Data

F. System/Process Comparison

The new material request process, as shown in Fig. 14, indicates that some flows will be handled automatically by the system. Table X can reduce processing time, change the request process via WhatsApp to the new system, and eliminate repetitive processes. Fig.15 also shows similar changes in the material return process, where some flows will be handled automatically by the system. Based on Table XI, this results in a reduced processing time for material requests and eliminates the need to use WhatsApp for requests.

TABLE X
NEW TIME REQUIRED FOR MATERIAL REQUEST

Process	Average Time Required (sec)
Make material requests through the system and wait for approval by the Team Leader	500
Request that the SS Team approve	0
Input Material Request to ERP System	0
Create Transfer Order	0
Transfer Material to SS from RMS	3,650
Deliver Material to the Production Line	525
Total Time	4,675

After the system automated several processes, Table X shows that the time required to make a material request was reduced from 9,122 seconds to 4,675 seconds. Meanwhile, Table XI shows that for material returns, the time was reduced from 8681 seconds to 2189 seconds.

TABLE XI
NEW TIME REQUIRED FOR MATERIAL RETURN

Process	Average Time Required (sec)
Make material return requests via WhatsApp and wait for approval from the Team Leader.	500
Inform the RMS Team of the request that was approved.	0
Approve the return request from WhatsApp	500
Input the return request into the ERP System for traceability	0
Transfer material from the Production Line into the SS	233
Create a Transfer Request to move the material from SS to RMS	0
Transfer Material from SS to RMS	956
Total Time:	2189

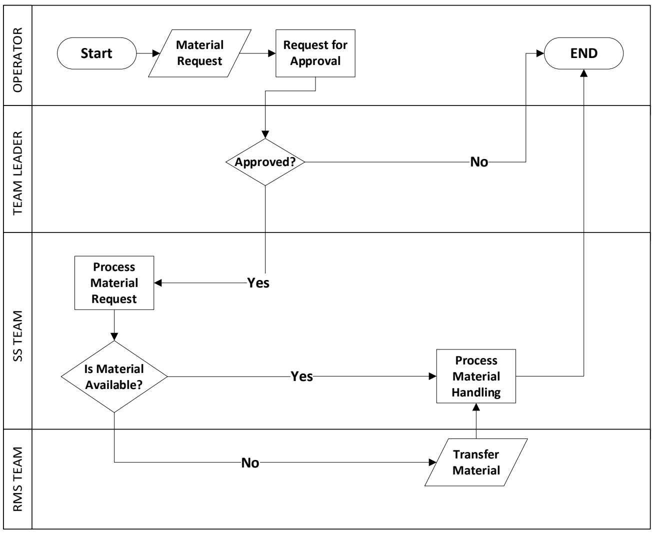


Fig. 14. New Material Request Workflow

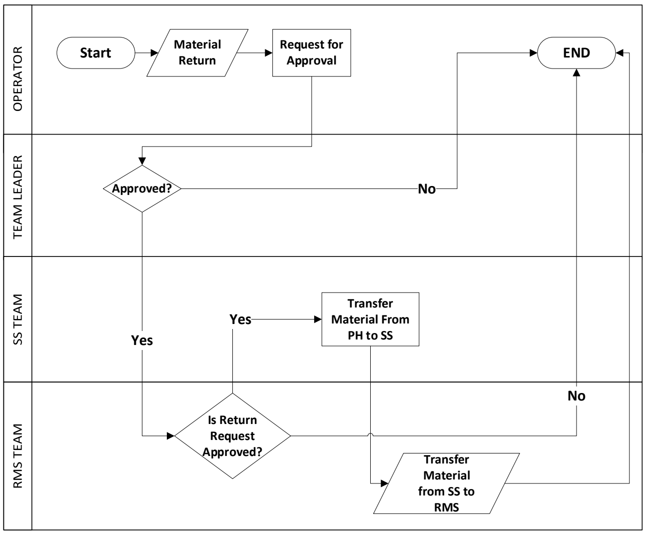


Fig.15. New Material Return Workflow

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G. User Requirement Acceptance

User requirement acceptance, as outlined in Table XII, was conducted to ensure that the system developed meets the specified requirements and is ready for deployment.

TABLE XII
USER REQUIREMENT ACCEPTANCE

Feature	Requirement	Accepted/Rejected
Material Request and Return	The operator can request and return the material from the operation tablet in the production line.	Accepted
Automatic Sync with ERP	The system must automatically sync and return the material request immediately after approval into the ERP system.	Accepted
Quantity Adjustment Based on Transfer Order	The system can adjust the quantity requested and returned based on the transfer order process in the ERP System.	Accepted
Notification to Material Handler	The system can automatically notify the material handler of any material request or return.	Accepted
Notification to Approvers	The system can automatically notify the team leader, RMS Team, and SS Team and comply with the approval layer for every operator request.	Accepted
Historical Data Storage and Log Book	The system can store the log-book for historical data to facilitate future research and provide a preview to monitor the process's performance and condition.	Accepted

Cycle time reduction can be used to measure the effectiveness of the improvement process. To carry out calculations for the time reduction process, it is first necessary to determine and calculate the total time required to complete the previous process, including the duration from start to finish [25]. Equation (1) is used to calculate the Cycle Time for material requests and material returns. The Previous Lead Time refers to the average time, measured in seconds, taken by the previous process. In contrast, the New Lead Time represents the average time, also in seconds, taken by the newly implemented automated system. The resulting comparison is expressed as a percentage, indicating the amount of time saved through the transition from the previous process to the new automated system.

$$CTR = \frac{Previous\ Lead\ Time - New\ Lead\ Time}{Previous\ Lead\ Time}\ x\ 100\% \quad (1)$$

$$= \frac{(9122 - 4675)}{9122}\ x\ 100\% = 49\%$$

The material request was reduced from 9122 seconds to 4675 seconds. System implementation enhanced the efficiency by achieving a 49% reduction in material request processing time.

$$CTR = \frac{(8681 - 2189)}{8681}\ x\ 100\% = 75\%$$

This system implementation enhanced the efficiency by achieving a 75% reduction in material return processing time.

IV. CONCLUSION

Currently, a Consumer Goods Manufacturer located in Cikarang, Indonesia, is using WhatsApp as a tool for material requisition and approval, which causes a lack of real-time visibility, making it difficult to track the location and status of materials, resulting in a time-consuming process. At the same time, the admin must input the requests from WhatsApp one by one, resulting in production delays and downtime.

The problem is solved by developing a centralized system for material requests and returns, integrated with the existing company ERP system, which is tailored to meet user requirements. Now, the process of a requisition in the existing ERP is successfully in the transition stage to go live based on the results of the dry run by the developed application system according to user requirements by integrating the system to synchronize the material request and material return to update the data with the existing ERP company and reduce the manual effort of data entry and delay update the data on ERP system without asking approval by WhatsApp to team leaders continue to team leader request material to SS team and SS team input the material request one by one to ERP system.

Using the developed system, the operator can directly material requisition using the application. The application sends a notification to the team leader for approval, and then processes the material request by the SS team. Significant time reductions were achieved, from 9122 seconds to 4675 seconds, resulting in a 49% reduction in cycle time for material requests, and from 8681 seconds to 2189 seconds, yielding a 75% reduction in cycle time for material returns, which enabled end-to-end visibility of material tracking.

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