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Applying the Periodic Review System Method in Progressive Web Apps for E-Commerce Inventory Management

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Abstract

Retail businesses, particularly hardware stores, often encounter challenges in order management such as delayed deliveries, inaccurate stock tracking, and limited information transparency factors that hinder operational efficiency and customer satisfaction. This study proposes a web-based order management system utilizing Progressive Web Apps (PWA) technology, developed with the Next.js framework. The Periodic Review System (PRS) method is implemented to calculate reorder points based on actual demand and safety stock levels. System development follows the Waterfall model, with data collected through observation, semi-structured interviews, and literature review. Testing confirms that the application enhances stock accuracy, minimizes delivery delays, supports offline access, and meets SEO performance standards. The implementation significantly improves operational efficiency and holds promise for boosting customer loyalty. The study concludes that PWA-based digital systems are practical, scalable solutions for the MSME sector, with future potential for integration of AI, CRM, and real-time analytics.

Keywords: Information System, Progressive Web Application, E-Commerce, MSMEs

1. INTRODUCTION

In today's globalized economy, information systems play a pivotal role in streamlining business operations across diverse industries, including the retail segment of building materials [1], [2], [3]. The rapid advancement of information technology (IT) has driven companies to adopt digital innovations that improve operational efficiency, expedite decision-making, and ensure data accuracy [4], [5], [6]. In an increasingly competitive marketplace, leveraging technology is not just a strategic advantage it is a necessity for long-term sustainability and growth [7].

Despite the growing adoption of digital systems in large enterprises, many small-scale building materials retailers continue to rely heavily on manual processes. These businesses often face persistent challenges such as delayed order processing, inaccuracies in inventory records, and ineffective customer communication. Such inefficiencies can compromise service quality, reduce customer satisfaction, and

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erode competitive positioning in a market that increasingly demands speed and transparency. Inventory management, in particular, remains a critical pain point—manual stock tracking makes it difficult to predict restocking needs accurately, leading to frequent instances of stockouts or overstocking. Furthermore, the absence of a centralized system that provides real-time operational data hinders informed decision-making, exposing a clear disconnect between the operational demands of the business and the capabilities of its current tools.

While digital tools like e-commerce platforms and inventory management systems have been widely adopted by large-scale businesses, their penetration among micro, small, and medium enterprises (MSMEs) remains limited. Many MSMEs in the building materials sector have yet to implement integrated systems capable of automating order processing and inventory control efficiently. Moreover, existing technological solutions often prioritize e-commerce functionality without addressing the equally critical need for effective inventory management tailored to smaller-scale operations. This gap highlights the urgent need for simple yet effective systems that can support both customer engagement and backend logistics within MSME environments.

To bridge this gap, this study proposes the development of a Progressive Web App (PWA) a hybrid solution that combines the advantages of web and mobile applications. PWAs offer features like offline functionality, cross-platform responsiveness, and seamless access across various devices [8], [9], [10], making them particularly useful in regions with unreliable internet connectivity [11], [12]. However, front-end improvements alone cannot resolve the fundamental challenges in inventory management.

In response, the study incorporates the Periodic Review System (PRS), a structured inventory control approach that periodically assesses stock levels and determines reorder quantities based on demand and availability [13][14]. Unlike continuous monitoring systems, PRS is more suited to small businesses with limited digital infrastructure, offering a practical pathway to improved inventory control [15], [16], [17]. By aligning reorder schedules with actual stock conditions and consumption trends, PRS reduces the risks of both overstocking and stockouts [18], [19].

The primary aim of this study is to design and implement a PWA-based e-commerce application integrated with the PRS inventory control method. This integrated system is expected to enhance operational efficiency, particularly in managing customer orders and inventory levels. The use of PWA technology ensures accessibility and responsiveness, even in bandwidth-constrained environments. Meanwhile, the PRS component provides a reliable framework for making informed restocking decisions. Beyond addressing a single business case,

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this research aspires to offer a scalable and replicable model for digital transformation among MSMEs in the building materials retail sector. Ultimately, the project contributes to increasing MSME competitiveness through targeted, technology-driven operational improvements.

2. METHODS

2.1. Research Approach and Paradigm

This study adopts a descriptive qualitative research approach underpinned by a constructivist paradigm, which emphasizes understanding and interpreting the social and operational contexts in which individuals interact with systems and technologies [20]. The primary aim is to uncover and analyze the operational challenges faced by a micro-scale building materials store and use these findings to inform the design of a digital solution that is not only technologically feasible but also contextually relevant.

Unlike quantitative approaches that focus on numerical analysis and hypothesis testing, qualitative research allows for an in-depth exploration of user experiences, workflows, pain points, and expectations. The constructivist paradigm positions knowledge as constructed through interaction between researchers and participants, making it especially suitable for participatory system design. This paradigm also accommodates the complex, non-linear nature of small business operations where flexibility, adaptability, and stakeholder feedback are vital.

2.2. Research Setting and Duration

The research was carried out over a four-week period in March 2025, at a small building materials retail store located in Pulau Rakyat Pekan, Asahan Regency, North Sumatra. The store represents a typical micro-enterprise characterized by manual business processes, minimal technological adoption, and resource constraints—conditions common across MSMEs in Indonesia and many developing regions. The store's owner and operator, along with two employees, served as key informants in the research, offering perspectives from both strategic and operational levels.

2.3. Data Collection Techniques

To build a comprehensive understanding of the existing operational system and to inform the technical specifications of the proposed solution, the study employed three primary qualitative data collection techniques: observation, semi-structured interviews, and literature review.

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2.3.1. Observation

The researcher engaged in non-participant observation over three weeks, visiting the store five days per week (Monday to Friday) for 3–4 hours per day. This method enabled the researcher to directly observe the transactional environment, workflow dynamics, and inventory handling practices. Attention was paid to critical processes such as order logging, stock replenishment, and customer service interactions. Observations revealed that all inventory and transaction records were manually maintained in notebooks. This not only introduced frequent inconsistencies and human errors but also created significant operational inefficiencies, particularly in the form of inaccurate stock data and delayed customer service. Customers often needed to confirm product availability by phone before making purchases due to the absence of real-time inventory visibility [20].

2.3.2. Semi-Structured Interviews

Two rounds of semi-structured interviews were conducted with key stakeholders, including the store manager and frontline staff. Each session lasted approximately 45–60 minutes. The semi-structured format allowed for flexibility in questioning, enabling the researcher to probe deeper into specific areas of interest as new insights emerged. The interviews focused on uncovering operational challenges, user experiences with existing systems, and expectations for a digital solution [21]. Findings from the interviews indicated a strong desire for a system that is accessible via mobile devices, operable under low-bandwidth conditions, and capable of automating basic processes such as stock updates and order tracking. Staff expressed difficulty in managing inventory using spreadsheets and requested a system with real-time alerts, usage logs, and intuitive interfaces. These insights directly shaped the requirements for the system's functionality, interface, and usability design.

2.3.3. Literature Review

Complementing empirical data collection, a rigorous literature review was conducted to establish a theoretical and technological foundation for the study. Sources included academic journal articles, industry whitepapers, technology documentation, and prior case studies related to Progressive Web Apps (PWA), inventory control methodologies such as the Periodic Review System (PRS), PostgreSQL database management, and digital transformation strategies for MSMEs. This review affirmed the value of lightweight, scalable, and offline-capable technologies for small businesses and highlighted the critical gap between existing solutions and the specific needs of MSMEs [22].

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The review also informed key architectural and design decisions, including the use of PWA to provide cross-platform accessibility and offline functionality, and PRS as a simplified inventory control strategy suited for enterprises with limited digital infrastructure.

2.4. System Design Methodology

The system design methodology followed a user-centered and iterative approach, aimed at bridging the gap between operational needs and technical implementation. The process was guided by a structured framework consisting of six stages: problem identification, method selection, data collection, system analysis, prototype development, and validation [23-29].

Each stage of the process was grounded in real-world observations and validated through stakeholder engagement. The design methodology emphasized continuous feedback loops to refine system components and ensure functional alignment with user needs. Key components of the system design methodology include:

1) Problem Identification: Challenges such as inaccurate stock tracking, inefficient communication, and delayed order fulfilment were documented through observation and interviews.
2) Data Collection: Primary data (field observations and stakeholder interviews) and secondary data (literature review) were synthesized to form a comprehensive understanding of existing workflows and digital needs.
3) Requirement Specification: Based on the identified problems and user expectations, system requirements were documented. These included offline access, mobile compatibility, automated inventory alerts, and simplified reporting tools.
4) Prototype Development: Early mockups and system flows were created and iteratively tested with end-users to ensure usability and effectiveness.
5) System Validation: Through member checking, triangulation, and usability tests, the developed features were refined and confirmed to meet real operational needs.
6) Documentation and Traceability: All design decisions, stakeholder feedback, and implementation changes were meticulously recorded to maintain transparency and allow future replication or extension of the study.

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3. RESULTS AND DISCUSSION

3.1 Implementation of the Periodic Review System Method on Product Stock

The adoption of the Periodic Review System (PRS) at the case study business represents a critical step toward modernizing inventory control within the constraints of a micro-enterprise environment. Historically, the business faced multiple challenges frequent stockouts, delayed order placements, and inconsistencies in inventory data all stemming from a manual stock recording process. PRS was selected as the preferred inventory control method due to its flexibility, operational simplicity, and suitability for small-scale enterprises managing diverse product categories with fluctuating demand. Unlike continuous review systems, which require real-time inventory tracking and often complex IT infrastructure, PRS offers a periodic review model that allows stock levels to be evaluated at fixed intervals. This not only simplifies management but also reduces administrative burdens while maintaining the effectiveness of inventory monitoring.

As a foundational step, the implementation of PRS was informed by a comprehensive review of historical sales data across the product portfolio. Eighteen distinct product types were analyzed to determine their average monthly demand, helping classify them into high-, medium-, and low-demand categories. This stratification ensured that reorder points would reflect real-world consumption trends and operational priorities. The detailed analysis is presented in Table 1, which outlines the average monthly sales volume per product. These figures not only establish a baseline for inventory calculations but also reveal key consumption patterns across different categories.

Table 1. Average Monthly Sales Data

Product Name	Monthly Demand
Ceramic Tiles	1,300 Pieces
Zinc Sheets	800 Sheets
Cement	700 Sacks
Envi Paint	120 Pieces
Yoko Paint	200 Pieces
Halivux Paint	80 Pieces
Grandel	200 Pieces
Hinges	200 Pieces
Door Handles	200 Pieces
Window Curtains	200 Pieces
Door Curtains	200 Pieces
Nails	120 Kg

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Product Name	Monthly Demand
Barbed Wire	30,000 Meters
Water Hose	40 Pieces
Pipes	40 Pieces
Light Bulbs	120 Pieces
Cement Spoons	10 Pieces
Pipe Glue	120 Pieces

From the data in Table 1, it is evident that core construction products—such as Ceramic Tiles, Zinc Sheets, and Cement—are the highest-demand items, representing the backbone of the store's inventory and revenue streams. These products require constant availability due to their integral role in both small and large construction projects. Meanwhile, medium-demand items such as Envi Paint, Door Handles, and Light Bulbs maintain consistent turnover, reflecting their broad utility across residential and commercial applications. Although these items do not dominate sales volume, they are critical to customer satisfaction and project completion, thereby warranting stable inventory levels. Lastly, specialty and low-turnover products—including Barbed Wire, Cement Spoons, and Water Hoses—may not move rapidly but are essential for serving specific customer needs. Neglecting these could lead to lost sales or customer dissatisfaction, underlining the need for balanced stock policies across the product spectrum.

Following the sales analysis, the PRS was operationalized in three main stages: (1) determining the review interval, (2) calculating the safety stock, and (3) establishing the reorder point (ROP). Each stage was data-driven and contextualized to the store's specific operational rhythms, supplier conditions, and financial capacity.

1) Review Interval Determination

The review interval was set at **30 days**, taking into account the average supplier lead time, internal logistics constraints, storage capacity, and cash flow cycles. This monthly schedule provides a consistent opportunity for restocking evaluations, allowing the business to maintain stock visibility without being overwhelmed by excessive reordering tasks.

2) Safety Stock Calculation

Safety stock (SS) levels were established to buffer against demand fluctuations, supply chain disruptions, and lead-time variability. Products with higher risk or more volatile consumption patterns such as Halivux Paint and Barbed Wire were assigned higher safety stock levels, ensuring resilience against shortages.

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3) Reorder Point Calculation

Using the standard formula **ROP = D + SS**, where *D* represents average monthly demand and *SS* is the calculated safety stock, specific reorder points were computed for each product. The resulting values are presented in **Table 2**, offering a clear guide for restocking decisions.

Table 2. Reorder Point (ROP) Calculation

Product Name	Demand (D)	Safety Stock (SS)	ROP (D + SS)
Ceramic Tiles	1,300 Pieces	250 Pieces	1,550 Pieces
Zinc Sheets	800 Sheets	150 Sheets	950 Sheets
Cement	700 Sacks	150 Sacks	850 Sacks
Envi Paint	120 Pieces	100 Pieces	220 Pieces
Yoko Paint	200 Pieces	100 Pieces	300 Pieces
Halivux Paint	80 Pieces	100 Pieces	180 Pieces
Grandel	200 Pieces	50 Pieces	250 Pieces
Hinges	200 Pieces	50 Pieces	250 Pieces
Door Handles	200 Pieces	50 Pieces	250 Pieces
Window Curtains	200 Pieces	50 Pieces	250 Pieces
Door Curtains	200 Pieces	50 Pieces	250 Pieces
Nails	120 Kg	30 Kg	150 Kg
Barbed Wire	30,000 Meters	5,000 Meters	35,000 Meters
Water Hose	40 Pieces	15 Pieces	55 Pieces
Pipes	40 Pieces	20 Pieces	60 Pieces
Light Bulbs	120 Pieces	35 Pieces	155 Pieces
Cement Spoons	10 Pieces	5 Pieces	15 Pieces
Pipe Glue	120 Pieces	30 Pieces	150 Pieces

The values shown in Table 2 enable precise, product-level tracking of inventory thresholds. For example, Ceramic Tiles, with a high demand and significant lead time, require restocking when inventory falls to 1,550 units. Meanwhile, low-turnover items such as Cement Spoons have a modest safety stock but are still actively monitored to prevent zero-stock scenarios.

The introduction of PRS has generated substantial improvements across key inventory performance metrics. By transitioning from manual, reactive ordering to proactive, data-informed decision-making, the system has:

1) Enabled consistent, cycle-based reordering that aligns with cash flow and storage capabilities
2) Reduced stockouts and minimized excess inventory, ensuring better service levels and space utilization
3) Improved supplier relationships through more predictable ordering schedules

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4) Enhanced cash flow efficiency, freeing up capital previously tied in overstocked, slow-moving items

This structured, analytics-driven approach marks a pivotal transformation in inventory control practices, providing a replicable model for similar MSMEs seeking digital optimization with minimal technological overhead.

3.2. System Design

The system design process in this study was guided by the objective of developing a user-centric application tailored to the operational dynamics of a retail environment. To visualize the interaction between key actors and ensure proper alignment of system functionalities with user needs, a use case diagram was developed. This diagram, as presented in Figure 5, outlines the roles and responsibilities of the system's two principal actors: the User and the Admin. The User represents either customers or store employees who interact with the system to perform retail transactions. Once authenticated through a secure login mechanism, users are redirected to the User Dashboard, which serves as the central interface for navigating the application. From here, users can explore product categories, view detailed product descriptions, and manage their shopping carts. A critical feature available to users is the stock availability alert, which immediately notifies them when a selected product is out of stock enhancing transparency and improving the overall shopping experience. Additionally, users can access the profile management section to update their personal data and track previous orders. The system also supports customer data entry during the checkout process, which aids in personalized service and record-keeping. The ordering flow is designed to be intuitive and streamlined, progressing from product selection to payment, thereby supporting a seamless e-commerce experience. On the administrative side, the admin actor is responsible for the configuration and maintenance of the system's operational backbone. Upon logging in, the admin accesses an Admin Dashboard, from which various tasks are executed. These include managing product inventories, updating stock data, monitoring transaction history, and managing user accounts. One of the key responsibilities of the admin is to oversee the synchronization of inventory levels with the Reorder Points (ROPs) calculated via the Periodic Review System (PRS), ensuring inventory sufficiency without overstocking.

The use case diagram utilizes <<include>> and <<extend>> relationships to define core and optional processes. For instance, login is a necessary prerequisite (<<include>>) for accessing both the user and admin dashboards, while actions like viewing transaction status or modifying product data are conditionally triggered (<<extend>>), depending on user intent and permissions. Overall, the design encapsulated in Figure 5 reflects a balanced and modular architecture, where

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every use case directly corresponds to a functional requirement. This approach not only supports usability and efficiency but also ensures that the system remains scalable and adaptable to future enhancements.

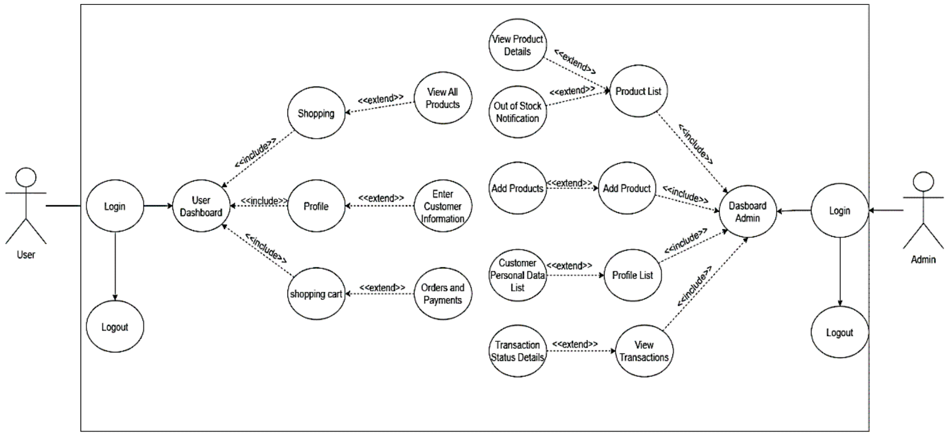

Figure 5. Use Case Diagram User and Admin

3.3. Implementation of Progressive Web Application

To modernize and optimize inventory and order management operations, a Progressive Web Application (PWA) was developed utilizing contemporary web technologies. The primary architecture integrates Next.js as the React-based frontend framework, chosen for its support for server-side rendering and high-performance delivery. For backend database management, Neon PostgreSQL was employed to ensure data consistency, concurrent access, and real-time inventory monitoring. This combination delivers a robust infrastructure, effectively bridging user interface functionalities with critical backend data handling, thereby enabling a seamless digital workflow suitable for small to medium enterprise environments. To validate the system's usability and stability, black-box testing was conducted across multiple devices, ensuring platform independence and consistent user experience. As displayed in Table 3, the system was tested using a Redmi 11 Pro and an HP Laptop 14S, both running Chrome browsers on Android 11 and Windows 11 respectively. The application passed all tests, confirming its responsiveness, data accuracy, and successful interaction with the database across both mobile and desktop environments.

Table 3. Testing Device Details

Name	OS	Browser	Results
Redmi 11 Pro	Android 11	Chrome	Succeed
HP Laptop 14S	Windows 11	Chrome	Succeed

Furthermore, the PWA was validated for its ability to function offline and support installation on devices as native-like applications. The testing focused on verifying critical PWA characteristics such as responsiveness, offline access, and installation capabilities. Figure 7 and Figure 8 showcase successful trials of the PWA interface on both desktop and mobile devices, affirming its adaptability and practical utility in real-world use cases.

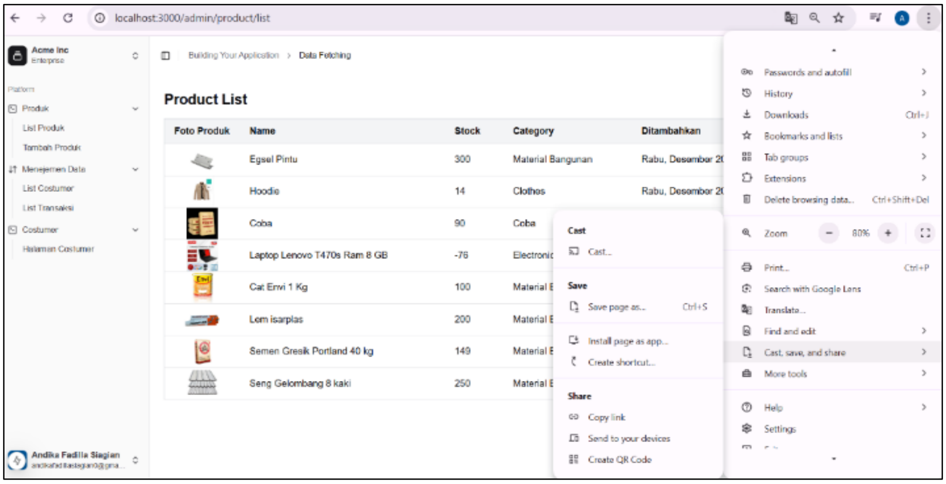

Figure 7. Desktop PWA Feature Trial

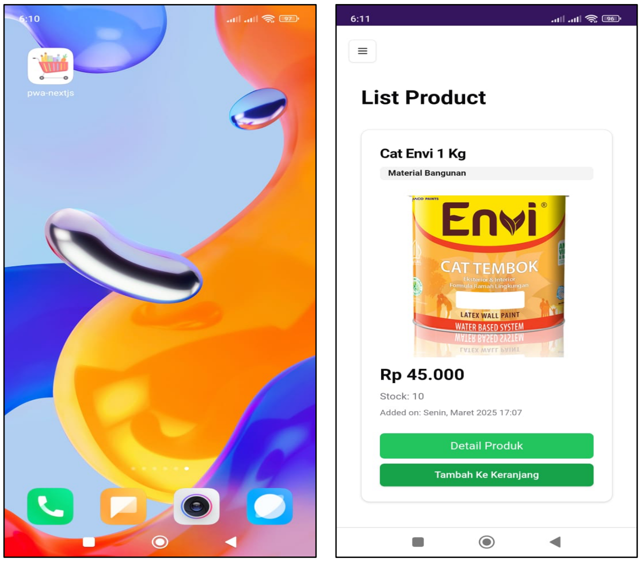

Figure 8. Mobile PWA Feature Trial

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A major advantage of this PWA lies in its advanced caching system. Utilizing service workers, the application stores vital resources including HTML, CSS, JavaScript, and images locally after the initial download. This file caching mechanism significantly reduces dependency on network connectivity by allowing users to access previously loaded content during offline periods. It also accelerates page load times for returning users, thereby enhancing usability and reducing server load. As illustrated in Figure 9, the caching trial demonstrated improved performance and stability across multiple access points, even in bandwidth-constrained scenarios.

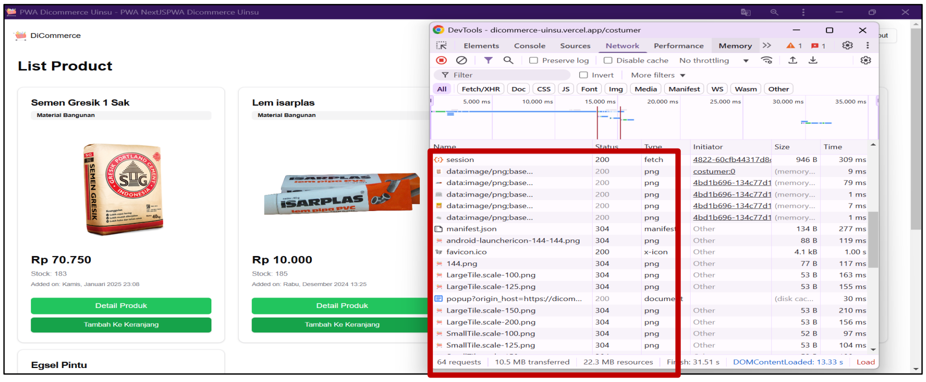

Figure 9. PWA File Caching Trial

From an SEO perspective, the application was designed with modern best practices in mind. Using Lighthouse, a performance and SEO audit tool, the system achieved a score of 100% in SEO, 96% in accessibility, and 74% in best practices, as shown in Figure 10. These metrics affirm that the system is optimized not only for performance but also for discoverability in search engines, which is crucial for MSMEs aiming to expand their digital footprint.

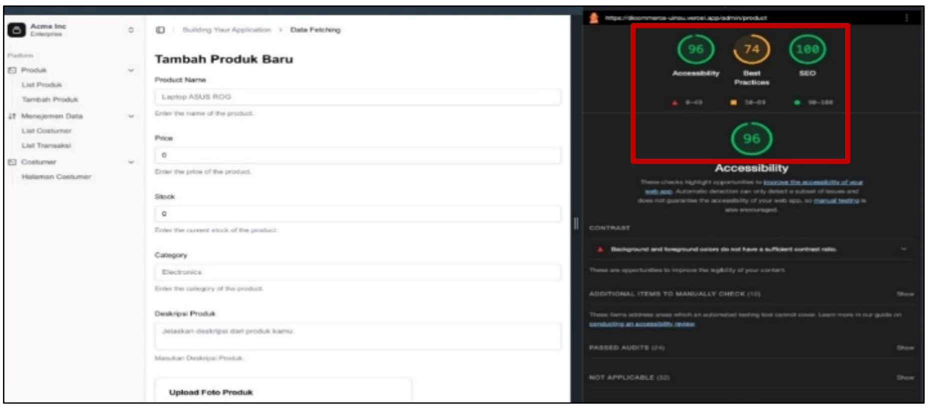

Figure 10. SEO-Friendly Testing

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Beyond performance and accessibility, one of the most impactful innovations in this system is its integration with the Periodic Review System (PRS). The application includes a built-in feature that continuously monitors stock levels in real time. When the inventory of any product approaches or falls below its Reorder Point (ROP)—calculated based on monthly demand and safety stock parameters—the system triggers an alert visible on the admin dashboard immediately after login. This real-time notification system, as shown in Figure 11, ensures timely and accurate procurement decisions, minimizing the risk of stockouts and improving service quality.

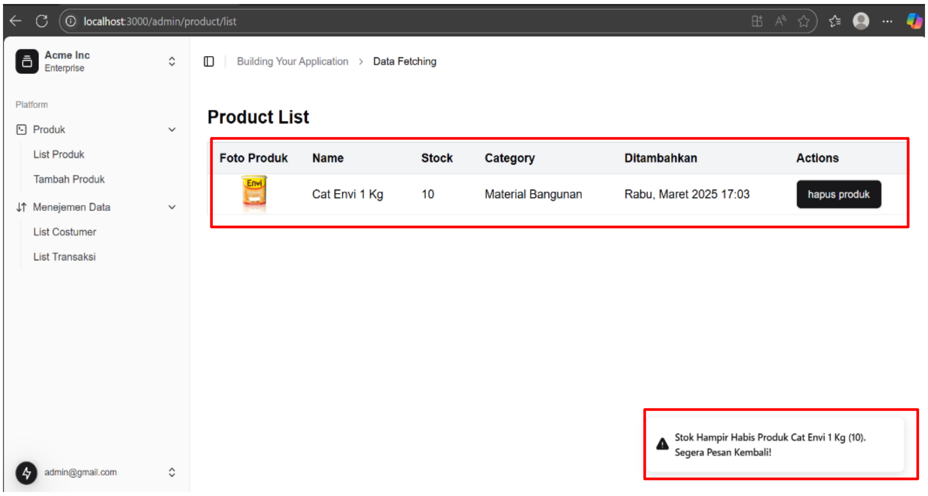

Figure 11. PRS Method Implementation Notification Feature

Overall, the implementation of this Progressive Web Application not only addresses the operational challenges previously identified—such as manual errors, delayed responses, and lack of inventory visibility but also positions the business for scalable digital transformation. The system's ability to run across platforms, operate under low-connectivity conditions, and provide instant stock alerts makes it a highly suitable solution for businesses operating in environments where technological infrastructure may be limited yet mission-critical. This PWA model offers a strong blueprint for MSMEs seeking a balance between digital sophistication and operational simplicity.

3.4. Discussion

The implementation of the Periodic Review System (PRS) within a Progressive Web Application (PWA) framework represents not just a technical upgrade but a shift in operational philosophy for small and medium-sized enterprises. Rather than merely automating existing workflows, this integration encourages a

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rethinking of how inventory decisions are made moving from intuition-based, manual management to structured, data-informed practices. This transformation is particularly relevant for MSMEs, which often face the dual challenges of limited technological infrastructure and highly variable demand.

From a systems perspective, the use of PRS in this context illustrates how classic inventory control models can be adapted to suit digital-first environments. The primary value of PRS lies not in its novelty but in its accessibility and relevance for businesses without sophisticated ERP systems. Its periodic structure reduces the cognitive and administrative load on small business owners while still providing control over fluctuating inventory levels. By integrating this with PWA capabilities, the system bridges the gap between theory and practice PRS provides the logic, while the application ensures execution.

Moreover, the real strength of the solution lies in its context sensitivity. Rather than applying a one-size-fits-all inventory model, the system was tailored to the enterprise's actual sales data, risk factors, and supplier behaviors. This nuanced application of the PRS model suggests that its success hinges more on how well it is contextualized than on the formula itself. For instance, the variation in safety stock allocations—calculated not uniformly but according to product risk and volatility demonstrates strategic inventory thinking adapted to specific business constraints.

Another critical implication of the study is the importance of technological alignment. The use of Next.js and PostgreSQL wasn't just a matter of choosing modern tools it reflected a deliberate attempt to ensure that performance, scalability, and user experience were all optimized without introducing unnecessary complexity. This decision underscores a broader lesson for digital transformation in MSMEs: technology adoption must match the enterprise's capacity to implement, manage, and sustain new systems.

Furthermore, the implementation of features such as real-time stock alerts, offline accessibility, and platform independence reveals an understanding of user behavior and business needs beyond basic functionality. These aren't merely technical features they are enablers of business resilience, especially in environments where connectivity or staffing might be inconsistent. In doing so, the system demonstrates that meaningful digital transformation in MSMEs is not about technological sophistication alone but about designing systems that reflect operational realities.

In sum, this discussion reaffirms that the value of integrating PRS into a PWA lies not in automating what was done before, but in enabling what was previously impossible for resource-constrained businesses: reliable forecasting, responsive

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inventory control, and a consistent user experience across devices. For MSMEs, the implications are profound. With the right framework, even simple models like PRS can be leveraged to create complex efficiencies, provided that they are integrated thoughtfully into systems designed for usability, adaptability, and growth.

4. CONCLUSION

This study successfully developed a web-based order management application using Progressive Web Apps (PWA) and the Next.js framework, tailored to the operational needs of CV Karya Baru. By applying the Periodic Review System (PRS) method, the system accurately calculated reorder points (ROP) based on real-time demand and safety stock, significantly enhancing stock accuracy and reducing delays in product delivery. Compared to the store's previous manual processes, the application offers greater transparency, streamlined transaction tracking, and improved customer service. The solution's lightweight architecture and low development cost make it highly applicable for adoption by other micro, small, and medium-sized enterprises (MSMEs). However, the study's limitations include its short testing period and narrow scope limited to a single store location. The system also lacks advanced functionalities such as AI-based forecasting, payment gateway integration, and resilience testing under unstable network conditions. Future research should explore wider implementation across multiple business contexts, while enhancing the system with additional features such as customer relationship management (CRM), predictive analytics, and loyalty program modules. Despite implementation challenges like training and digital adoption, the results underscore the value of PWA-based solutions in strengthening operational efficiency and competitiveness within the MSME sector.

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