

Long Paper

Hardware Gen: E-Commerce and Inventory Platform with Materials Estimation

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Abstract

Purpose – This study aims to address challenges in traditional hardware store operations by developing an integrated web-based platform called Hardware Gen. The system combines e-commerce, inventory management, and materials estimation features to improve operational efficiency, inventory accuracy, and customer accessibility.

Method – The study used an iterative design approach that integrates agile and user-centered methodologies. Hardware Gen consists of three major components: an e-commerce module, an inventory management system, and a materials estimation tool. The system incorporated a virtual assistant, Chatify, to enhance customer interaction. The



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system was evaluated using the Technology Acceptance Model (TAM) and user testing to assess functionality, usability, and user satisfaction.

Results – Evaluation results from 80 hardware store customers and 16 hardware store owners showed that Hardware Gen effectively improves hardware store operations. The TAM demonstrated high user acceptance, with a grand mean of 4.93 from hardware store owners and 4.89 from customers, indicating highly acceptable to its intended users. The platform successfully addressed issues associated with manual stock recording, limited customer reach, and the lack of tools for accurate materials estimation.

Conclusion – Hardware Gen shows potential as a digital solution for modernizing hardware store operations by integrating e-commerce, inventory management, and materials estimation. The system enhances operational efficiency, improves inventory accuracy, and expands customer accessibility. However, the study was limited to selected hardware stores in Laguna, required stable internet connectivity, and focused primarily on basic residential construction projects. Future improvements may include secure payment integration, delivery tracking, and mobile application development.

Research Implications – This study contributes to research on digital transformation, e-commerce, and inventory management by demonstrating how integrated web-based platforms can support small and medium-sized hardware businesses. The findings suggest that digital solutions can streamline operations, optimize inventory control, and facilitate data-driven decision-making while expanding market opportunities.

Keywords – e-commerce platform, materials estimation, inventory management, customer experience, store management

INTRODUCTION

Online shopping has redefined the trading landscape, extending beyond conventional areas like fashion and electronics to specialized sectors like hardware and construction products. E-commerce websites with digital inventory management systems are now crucial for enhancing the customer service experience, reducing operational inefficiencies, and supporting information-driven decision-making (Madamidola et al., 2024; Schwarz, 2024). They enable real-time inventory tracking, automated replenishment, and demand forecasting, which is becoming necessary to meet the expectations of technology-oriented consumers (Combes, 2021).

Hardware shops in the United States, Germany, and Singapore have implemented other developed tools and e-commerce systems to reduce human error, automate stock tracking, and improve supply chain efficiency (Meyer et al., 2023). Many hardware stores worldwide also implement material estimation programs on their sites, enabling

customers to estimate the amount of building materials they need, reducing waste and improving purchasing accuracy. Nevertheless, even with these developments, most hardware stores worldwide still use outdated or manual inventory systems, resulting in inaccurate stock, slow order fulfillment, excess inventory, and missed sales (Jenkins, 2022).

Poor inventory management continues to undermine customer satisfaction and retail profitability. According to research cited by Jenkins (2020), retailers lose up to 3 percent of sales due to shrinkage from theft, spoilage, and human or supplier errors. These issues are especially acute in the hardware industry, where the range of items to be processed is extremely broad, making miscounts and losses particularly likely. Although digital supply chains are acknowledged as key to post-pandemic retail resiliency (The World Bank, 2022), adoption is uneven, with developing countries hampered by financial and technological constraints (Shahadat et al., 2023).

Most small and medium-sized Philippine hardware stores still use manual record-keeping and basic online catalogs that do not align with physical inventory, resulting in outdated stock information and poor customer experiences (Magnaye, 2023). With the recent surge in e-commerce uptake, which will reach 15.9 million users in 2029 (Statista, 2025), these constraints make it harder for retailers to meet rising demand. Infrastructure projects such as the “Build, Build, Build” program also confirm the need for reliable hardware providers with integrated digital infrastructure (Siman, 2023). Nevertheless, the absence of industry-specific e-commerce and inventory systems has become a significant issue (Brown et al., 2024b).

Despite the availability of e-commerce and inventory management systems, most platforms focus on individual business functions, such as online selling or inventory monitoring, and do not provide a comprehensive solution tailored to hardware retailers. Likewise, materials estimation tools are often offered as standalone applications and are not integrated with inventory management or online purchasing systems. Real-time customer communication is also commonly handled through external messaging applications rather than being incorporated into the platform itself. This fragmented approach requires store owners and customers to use multiple systems, resulting in inefficient workflows, inconsistent inventory information, and reduced customer convenience. Furthermore, few studies have explored developing an integrated digital platform specifically for small and medium-sized hardware stores in the Philippine context.

This study aims to design, develop, and evaluate Hardware Gen. This integrated web-based platform combines e-commerce, inventory management, materials estimation, and live chat support into a single system for hardware retail businesses. Specifically, it seeks to provide a digital solution that streamlines business operations, improves inventory accuracy, enhances customer engagement, and supports informed purchasing decisions. By integrating these essential functions into one platform, the study addresses the

operational needs of small and medium-sized hardware stores in the Philippines. It contributes to digital transformation in the hardware retail sector.

LITERATURE REVIEW

E-Commerce

E-commerce has significantly improved retail by helping hardware stores reach more customers and manage operations efficiently. Studies have shown that digital commerce enhances customer experience through real-time inventory updates, personalized recommendations, and convenient online transactions (Gupta et al., 2023; Peña-García et al., 2024). However, adoption in the Philippines remains slow due to limited digital infrastructure and low technological familiarity among small businesses (Mia et al., 2024). Despite these challenges, neighboring countries such as Thailand and Indonesia show that localized e-commerce platforms can successfully support small hardware retailers by integrating online browsing with in-store transactions (Ohno & Tsunematsu, 2022). Existing platforms focus primarily on online selling but offer limited integration with inventory management, materials estimation, and customer communication. This highlights the need for an integrated platform such as Hardware Gen, which combines these essential business functions into a single system.

Product Posting

Automated product posting allows stores to efficiently upload, update, and organize product details such as names, descriptions, images, and prices across multiple channels. Modern e-commerce platforms utilize content management systems (CMS) and centralized product information management (PIM) to reduce manual work and improve listing consistency (Laudon & Traver, 2021; Chaffey & Ellis-Chadwick, 2019). However, many small hardware stores in the Philippines still face inconsistent product descriptions, limited digital skills, and a lack of real-time inventory synchronization, resulting in inaccurate product listings and stock discrepancies (Telukdarie et al., 2024). Existing studies also emphasize that automated product listing linked with synchronized inventory significantly improves operational efficiency, reduces overselling, and enhances customer satisfaction (Pretorius, 2025; Liu et al., 2022). These findings support integrating automated product posting with inventory management in Hardware Gen.

Generate Reports

Automated report generation improves efficiency by turning user inputs into organized, actionable reports that support business decision-making. Previous studies demonstrate that digital reporting systems improve reporting accuracy, reduce manual errors, and enable real-time monitoring of sales, inventory, and supplier performance (Achachlouei et al., 2021; Macas et al., 2021). Nevertheless, many small hardware stores still rely on manual reporting, resulting in inconsistencies and delayed decision-making

(Macas et al., 2021). Although existing studies emphasize report automation, few integrate reporting directly with inventory and e-commerce transactions. Integrating automated reporting within Hardware Gen enables store owners to monitor business performance and make timely, data-driven decisions.

Product Reservations

Reservation systems allow customers to reserve products online for future pickup, improving inventory control and customer convenience. Studies indicate that reserve-and-collect services reduce double bookings, improve fulfillment efficiency, and increase customer satisfaction (S et al., 2021; Richomme, 2024). However, many small hardware retailers continue to rely on manual reservation processes that lack real-time inventory synchronization, often leading to stock conflicts and inaccurate reservations (Rajendiran, 2024). Previous systems generally treat reservations separately from inventory management. By integrating reservation services with real-time inventory monitoring, as Hardware Gen does, the system improves service reliability while minimizing inventory discrepancies.

Inventory Management

Digital inventory management helps retailers maintain accurate stock levels, minimize shortages and overstocking, and improve operational efficiency through real-time monitoring. Advanced technologies such as ERP systems, cloud-based inventory platforms, barcode scanning, and predictive forecasting significantly improve inventory accuracy and transparency (Kuuse, 2023; Rakshit et al., 2021). Despite these advancements, many Philippine hardware stores continue using manual record-keeping, resulting in stock discrepancies and lost sales opportunities (Magnaye, 2023). Previous studies mainly focus on inventory control and do not integrate customer-facing services such as e-commerce and materials estimation. This highlights the need for an integrated inventory management system that supports both business operations and customer transactions.

Web-based Live Chat Support

Web-based live chat enables real-time communication between businesses and customers, reducing response time while improving customer satisfaction (Dong et al., 2024). Research indicates that integrated live chat systems enhance customer confidence during purchasing decisions and allow businesses to manage multiple customer inquiries more efficiently (Xu et al., 2022; Sidlauskiene et al., 2023). However, many Philippine MSMEs continue relying on external messaging applications such as Facebook Messenger and Viber, resulting in fragmented communication and delayed customer support (Telukdarie et al., 2024). Existing customer support solutions are often disconnected from inventory and order information. Integrating live chat directly into Hardware Gen enables

store owners to provide immediate assistance while accessing inventory and transaction information simultaneously.

Supplier Notification

Automated supplier notification systems alert suppliers when inventory reaches predefined reorder levels, enabling timely replenishment and minimizing stock shortages. Studies have shown that real-time supplier notifications improve procurement efficiency and strengthen inventory planning (Ugbebor et al., 2024; Mashayekhy et al., 2022). However, many Philippine hardware stores still rely on manual communication methods such as phone calls and messaging applications, leading to delayed replenishment and higher stockout risk. Previous inventory systems rarely integrate supplier communication directly with stock monitoring. Hardware Gen addresses this limitation by incorporating automated supplier notifications into its inventory management module.

Order-Payment Process

Digital payment systems simplify transactions by improving payment accuracy, reducing processing time, and enhancing financial management. Mobile wallets, QR payments, and online payment gateways have become increasingly common among SMEs because of their convenience and efficiency (Brown et al., 2024a; Jacob, 2024). Nevertheless, integrating payment systems with inventory and order management remains challenging because of security concerns, legacy systems, and limited digital infrastructure (Ramayanti et al., 2024; Musyaffi et al., 2022). Existing studies often examine payment technologies independently rather than as part of an integrated retail system. Hardware Gen addresses this limitation by linking payment processing with inventory and order management to support accurate transaction recording and efficient business operations.

Materials Estimation

Materials estimation tools help customers calculate the required quantity of construction materials, reducing waste, unnecessary expenses, and repeated store visits. Studies have shown that digital estimation improves planning accuracy while supporting inventory forecasting and procurement decisions (Yousif et al., 2020; Adelakun, 2023). However, many hardware stores in the Philippines still rely on manual estimation methods that often lead to inaccurate purchasing decisions and material shortages (Bhandari, 2021). Existing estimation tools are commonly developed as standalone applications rather than integrated with e-commerce and inventory systems. Hardware Gen addresses this limitation by combining materials estimation with online purchasing and inventory management to provide more accurate customer recommendations.

Adoption of Hardware Stores E-Commerce

The adoption of e-commerce among Philippine hardware stores remains constrained by technological, organizational, and cultural barriers, including limited digital literacy, inadequate infrastructure, and resistance to organizational change (Cecilio et al., 2022; Omowole et al., 2024). Many retailers still rely on third-party platforms such as Facebook Marketplace and Shopee, which facilitate online selling but offer limited support for inventory management and business operations (Anand, 2020). Previous studies recommend improving digital literacy, strengthening technological infrastructure, and developing user-friendly systems tailored to SMEs (Chen et al., 2021; United Nations, 2023). Collectively, the literature demonstrates that existing solutions improve individual retail functions but remain fragmented. Few studies have developed an integrated platform combining e-commerce, inventory management, materials estimation, live chat support, supplier notification, and payment processing specifically for Philippine hardware retailers. This research gap provides the basis for developing Hardware Gen as a comprehensive digital solution.

METHODOLOGY

Research Design

This study employed descriptive and developmental research designs. The descriptive design gathered data on the current practices, challenges, and needs of hardware store owners, employees, and customers through surveys, interviews, and document reviews, providing the basis for identifying system requirements (Purdy & Popan, 2023). The developmental design guided the design, development, and evaluation of the proposed Hardware Gen system, ensuring that its features addressed the identified user needs and supported practical implementation (Klaassen & Kortland, 2015).

Population of the Study

This study focused on hardware store owners, employees, and customers from the municipalities of Siniloan, Pangil, Pakil, and Paete, Laguna. Store owners and employees provided insights into their sales, inventory management, and operational challenges, while customers shared their experiences with online shopping and materials estimation. A total of 37 registered hardware stores from the selected municipalities served as the basis for identifying potential respondents, ensuring systematic and reliable data collection.

Sampling Design

This study used purposive sampling, selecting respondents based on predefined criteria relevant to the research objectives (Nikolopoulou, 2022). The participants

included hardware store owners, managers, employees, and customers with direct experience in hardware store operations. The study selected four (4) hardware stores and twenty (20) customers from each municipality, resulting in 16 store respondents and 80 customer respondents. This sampling approach ensured the collection of relevant and reliable data from individuals with sufficient knowledge of the study (Etikan et al., 2016; Hair et al., 2021).

Table 1. The Population of Hardware Stores in Siniloan, Pangil, Pakil, and Paete, Laguna

LOCATION OF REGISTERED HARDWARE STORES	NUMBER OF REGISTERED HARDWARE STORES
Siniloan	12
Pangil	6
Pakil	11
Paete	8
TOTAL	37

Data Collection Instrument

The study utilized surveys/questionnaires, interviews, and observation to collect relevant data from hardware store owners, employees, and customers. The survey instrument was based on the Technology Acceptance Model (TAM), which measures users' acceptance and intention to use a system through the constructs of perceived usefulness, perceived ease of use, attitude toward use, and behavioral intention to use (Davis & Granić, 2024). The collected data helped identify user needs, evaluate system acceptance, and support the development of the proposed system.

The Likert scale questions prioritized agreement, satisfaction, or frequency (e.g., Not at all Acceptable through Highly Acceptable), enabling the researchers to measure opinions and identify trends across different roles within the hardware business.

Table 2. Acceptability Likert Numerical Rating

SCALE	RANGE	DESCRIPTIVE RATING
5	4.21-5.00	Highly Acceptable
4	3.41-4.20	Moderately Acceptable
3	2.61-3.40	Somewhat Acceptable
2	1.81-2.60	Slightly Acceptable
1	1.00-1.80	Not at all Acceptable

Survey/Questionnaire Method. The researchers adopted and implemented a systematic survey procedure grounded in the Technology Acceptance Model (TAM) to gain a comprehensive understanding of the current conditions in local hardware stores. (Davis and Granić, 2024) Davis and Granić (2024) define the Technology Acceptance Model (TAM) as a framework that explains how individuals accept and use a specific system.

Interview Method. Semi-structured interviews were conducted with hardware store owners, managers, employees, customers, and a professional engineer to gather insights on purchasing behavior, operational challenges, and user requirements; this focused solely on gathering information needed for the system's functional operation and to align with hardware transactions. The researchers also interviewed an engineer to validate the system's material estimation feature and ensure its accuracy and alignment with construction practices. The findings served as the basis for refining the proposed system.

Observation Method. The researchers conducted direct observations in selected hardware stores to examine actual business operations, including inventory management, customer service, and sales processes. The observations provided practical insights into existing workflows and operational challenges, which served as the basis for refining the proposed system's design and functionality.

Statistical Treatment

The study employed descriptive statistics to analyze and interpret the collected data. The study used weighted mean and ranking to evaluate user responses regarding the acceptability and usability of the proposed system. The results were organized into tables and statistically analyzed to provide clear, objective, and evidence-based interpretations of the findings (Table 3).

Project Design

The Hardware Gen platform can only be built and utilized properly if the project design is done well. Project design defines the architecture, methods, and test cases used throughout the development life cycle, from planning to deployment. The researchers chose the Agile method because it is flexible, allows user feedback, and lets new ideas be introduced in small, incremental steps.

Software Development Model

Agile is the best approach for creating an e-commerce platform that can integrate materials estimation and may use Chatify, since it is flexible and works well with others. The Agile Software Development Model was selected because it allows the researchers

to respond to change quickly and deliver value to users frequently. The approach also supports continuous improvement, enabling the team to find features based on ongoing feedback. Additionally, it promotes collaboration among developers and stakeholders, helping ensure the final system meets expectations.

Table 3. The researchers’ analysis used appropriate statistical methods.

ANALYSIS	STATISTICAL TOOLS
User Acceptability of the Hardware Gen: E-Commerce and Inventory Platform with Materials Estimation. Evaluation in terms of: Evaluation in terms of: • Perceived Ease of Use • Perceived Usefulness • Attitude Toward Use • Behavioral Intention to Use	Weighted Mean, Rank



Figure 1. Agile Methodology

Plan Phase

Researchers began by identifying challenges in traditional hardware stores, such as limited online presence and customer accessibility. The goal was to develop Hardware Gen, an e-commerce platform integrating materials estimation and Chatify for real-time support. We conducted literature reviews, defined project goals and scope, and assigned responsibilities. We created a Gantt chart, database schema, and initial system design to guide development.

Design Phase

The system design emphasized functionality, usability, and operational efficiency to ensure that Hardware Gen would meet the needs of both store owners and customers. Using Canva, the researchers developed detailed mock-ups, wireframes, and flowcharts to map out the platform's navigation, user interactions, and data flow. These visual representations guided the placement of interface elements, menu structure, and task flow across the system. Key features included product browsing for easy item selection, user management to maintain customer and staff accounts, material estimation tools to support inventory planning, and seller dashboards to track sales and stock. By carefully planning these elements, the design phase aimed to create an intuitive, visually appealing platform that provides a seamless user experience while minimizing the learning curve for first-time users.

The Materials Estimation feature follows the Input–Process–Output (IPO) model. Users enter project dimensions and select the required construction materials. The system then calculates the required quantity based on predefined material coverage values and rounds the results up to the nearest whole unit. The output provides an estimated quantity of materials needed, supporting accurate procurement planning and reducing material shortages or excess purchases.

The computation is represented by the following mathematical formula (Equation 1):

$$MQ_i = \frac{PD_i}{C_i} \quad \text{Equation 1}$$

Where:

- MQ_i = Estimated quantity of material i
- PD_i = Project dimension applicable to material
- C_i = Coverage of material i per unit
- $\lceil \]$ = Rounding up to the nearest whole number
- i = Index representing each material type

The system uses the project dimension and each material's predefined coverage value to calculate the required quantity shown in Figure 2. The system then rounds the result up to the nearest whole unit to ensure sufficient materials for construction. This process provides practical and reliable estimates for accurate project planning.

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HOME ABOUT US PRODUCTS HELP MATERIAL ESTIMATION

Estimate Your Materials

Plan your construction needs with our quick estimator.

PROJECT AREA:

PROJECT TYPE:

MATERIAL NEEDED:

PROJECT DIMENSIONS: sqm

SUGGEST MATERIALS

Enter your project type and size, and our estimator will suggest the materials you need. It calculates quantity using the formula: $Quantity = Project\ Dimension \times Coverage$ (round it up). Then it multiplies this by the product price to give you the total cost and adds everything together.

MATERIAL	UNIT PRICE (PHP)	STOCK	RECOMMENDED QTY	TOTAL COST (PHP)	
Bedroom Flooring Remove Section					
Portland Cement (50kg)	200.00	83	4	800	Remove
Gravel (20kg) - Bag	35.00	87	15	1,275	Remove
ABC Concrete Hardener	665.00	40	1	665	Remove
Fine Sand (2.7kg) - Bag	85.00	75	8	510	Remove
ESTIMATED TOTAL COST: ₱10,572					

[SAVE ESTIMATION FOR LATER](#) [ADD TO CART](#) [HISTORY](#) [CLEAR](#)

Figure 2. Illustration of the Materials Estimation Process

Development Phase

During the development phase, the system was built using PHP Laravel for the backend, providing a secure and scalable foundation for processing transactions and managing data. JavaScript enhanced frontend interactivity, ensuring smooth navigation, dynamic content updates, and responsive features. MySQL via XAMPP handled data storage, enabling structured, easily accessible information management. A real-time communication tool, Chatify, was integrated to facilitate direct interaction between store owners and customers. The development process focused on core modules such as product management, which handles inventory updates and item listings; order tracking, which monitors purchase progress from placement to delivery; analytics, which provides insights on sales trends and inventory turnover; and reporting, which generates summaries to assist decision-making. This combination of technologies and modules aimed to deliver a highly interactive and user-friendly system tailored for hardware store operations.

Testing Phase

The platform underwent extensive testing across multiple devices to identify bugs, assess stability, and ensure overall reliability. Real users evaluated its functionality, ease of use, and performance, providing valuable insights into how the system responded under different conditions. This testing helped the development team verify that all features were working as intended and that the platform could meet the practical needs of hardware store operations. The team documented and prioritized any minor issues found during this stage for resolution before full deployment.

Deployment Phase

After successful testing, the team deployed Hardware Gen in selected hardware stores to begin real-world operations. The team distributed surveys and feedback forms to store personnel and customers to assess usability, satisfaction, and areas for improvement. The team conducted training sessions to ensure users understood how to navigate the platform efficiently. Continuous observation during this phase allowed the development team to monitor adoption rates and quickly address user challenges.

Review Phase

Researchers thoroughly inspected all system modules, including connectivity, inventory management, and order processing, to ensure each component functioned correctly. The team documented any issues identified, from minor glitches to workflow inefficiencies, for future enhancements. The review also included cross-checking data accuracy and system responsiveness under different operational scenarios. Insights from this phase informed updates to optimize performance and improve the overall user experience.

Launch Phase

The system launched and was closely monitored under real-world conditions to ensure smooth operations across participating stores. Researchers provided technical support to quickly resolve issues, minimizing disruption to daily business activities. The team tracked performance metrics continuously and collected user feedback to guide future improvements and updates. This phase also evaluated how the system affected store productivity and customer satisfaction, laying the groundwork for long-term enhancements and broader implementation.

RESULTS AND DISCUSSIONS

This study aims to develop a *Hardware Gen: E-commerce and Inventory Platform with Materials Estimation* to support hardware store owners and customers. The platform manages product catalogs and inventory and provides automated material estimates for maintenance and building projects. The research evaluates the system's effectiveness, functionality, and user experience, focusing on how it simplifies product availability and supports decision-making for both customers and store managers.

To Create an e-Commerce Platform for Hardware Stores

Developing a system that helps hardware stores post and sell products, manage reservations, and generate reports. Previously, most transactions occurred in brick-and-mortar stores, which was time-consuming and sometimes made it difficult to track sales

and orders. This further widens the digital divide, and conventional hardware stores are disadvantaged against competitors that are already online (Taylor, 2025).

Posting and selling products

The product posting feature lets store owners add and manage products with details such as name, description, category, price, condition, pre-order availability, reservation fee, image, and supplier information, as shown in Figure 3. A low-stock alert notifies suppliers to prevent stockouts. Save and Publish options let owners draft or display products, while the Product Listing shows active or inactive items, giving real-time inventory control and improving the online shopping experience. Contemporary e-commerce platforms can post product details, including name, description, image, and price, arranged into systematic groups for easy browsing (Laudon & Traver, 2021).

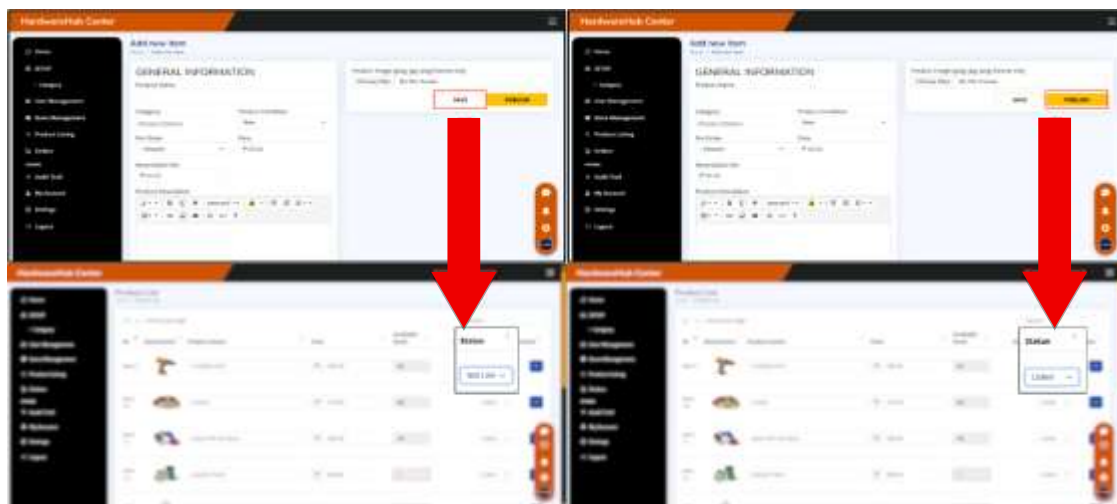


Figure 3. Product Posting Interface

Figure 4 shows the product catalog provided to customers. It demonstrates the grid view, where buyers can view items, sort products by category, and compare prices. Research on e-commerce product search and list sorting shows that optimized search mechanisms significantly improve how efficiently users find desired products (Liu et al., 2022). This feature will help store owners manage their inventory effectively, while giving customers a convenient shopping experience. Furthermore, automation for listing and inventory changes is underused in most small retailers, causing them to upload manually and increasing error rates (Pretorius, 2025).

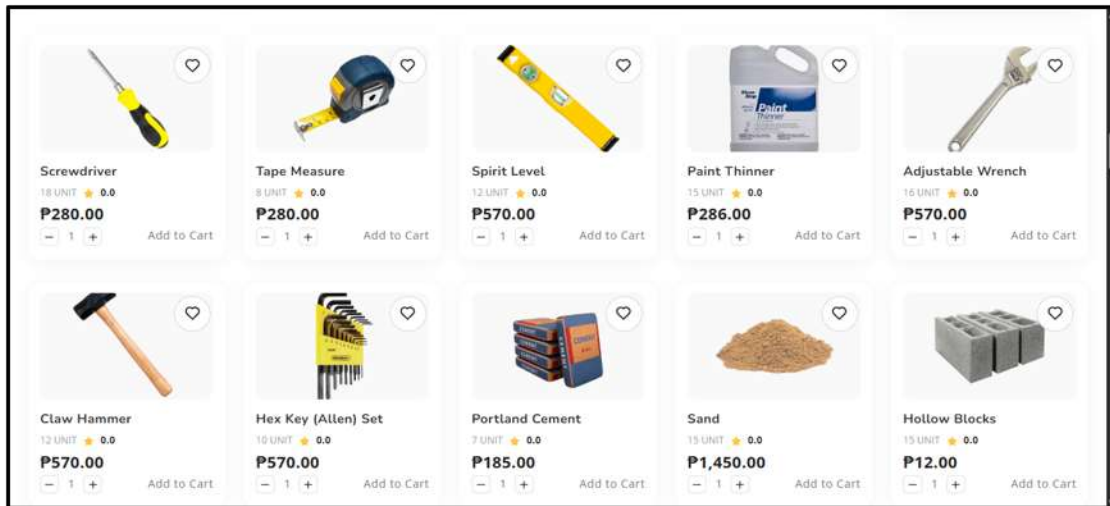


Figure 4. Product Catalog

Generates reports and sales

The report module allows store owners to automatically generate sales, transaction, and product performance reports, reducing manual work and errors, as shown in Figure 5. It enables monitoring of high- and low-selling products, supports informed inventory and sales decisions, and offers customization by month, category, or product data. Real-time data ensures reports are up to date, helping owners respond quickly to sales trends and improve overall business management. Moreover, real-time data can be used to create current reports and respond early to changing information demands in organizations (Achachlouei et al., 2021).

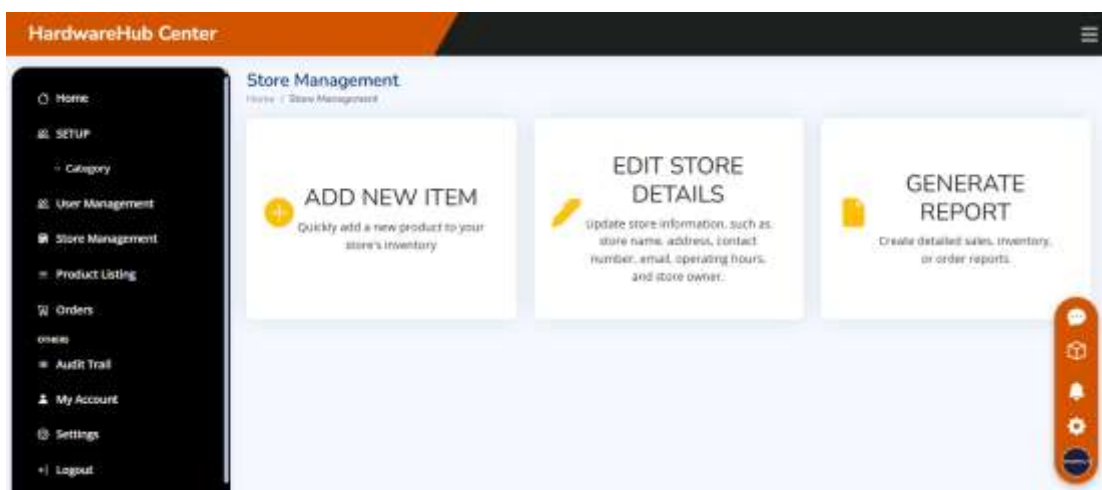


Figure 5. Generate Report Interface

Figure 6 shows two sales report methods: tabular and graphical. The tabular report lists details such as order ID, delivery address, quantity, price, status, feedback, and product date, making it suitable for documentation. The graphical report displays item- or category-wise sales, highlighting fast- and slow-moving products with bar charts. These

automated reports help store owners track performance, identify popular products, and make data-driven inventory and sales decisions (Macas et al., 2021).

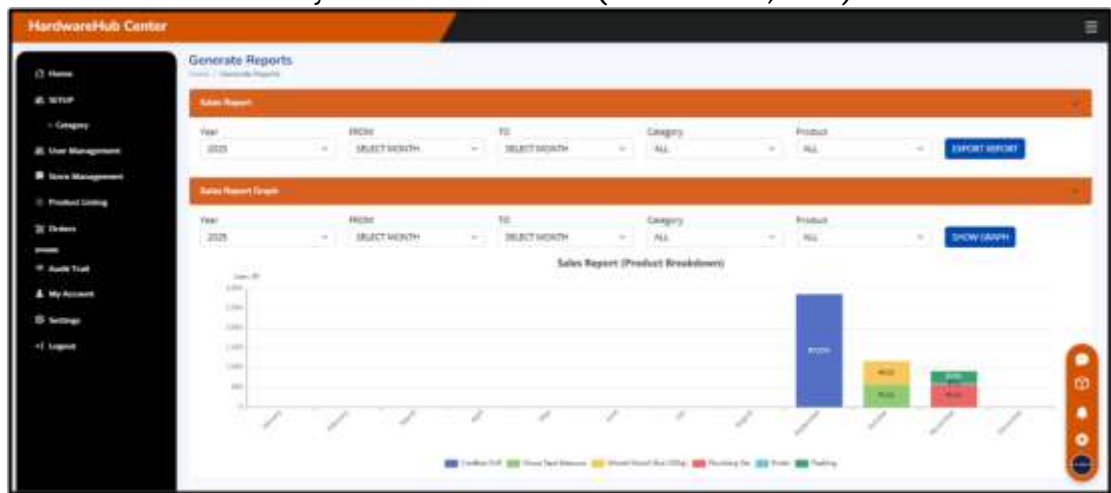


Figure 6. Sales Reports

Reservation of products

The reservation feature allows customers to secure products online before purchase, reducing the risk of unavailability shown in Figure 7. Customers make a minimum 5% down payment via the store's GCash QR code, with payment receipt upload and reservation date selection ensuring proper validation. Reservations are time-limited; unclaimed items are returned to inventory, promoting timely pickup and fair access. This system enhances customer convenience, prevents double-selling, and helps store owners maintain accurate inventory records (Zieleń, 2020).

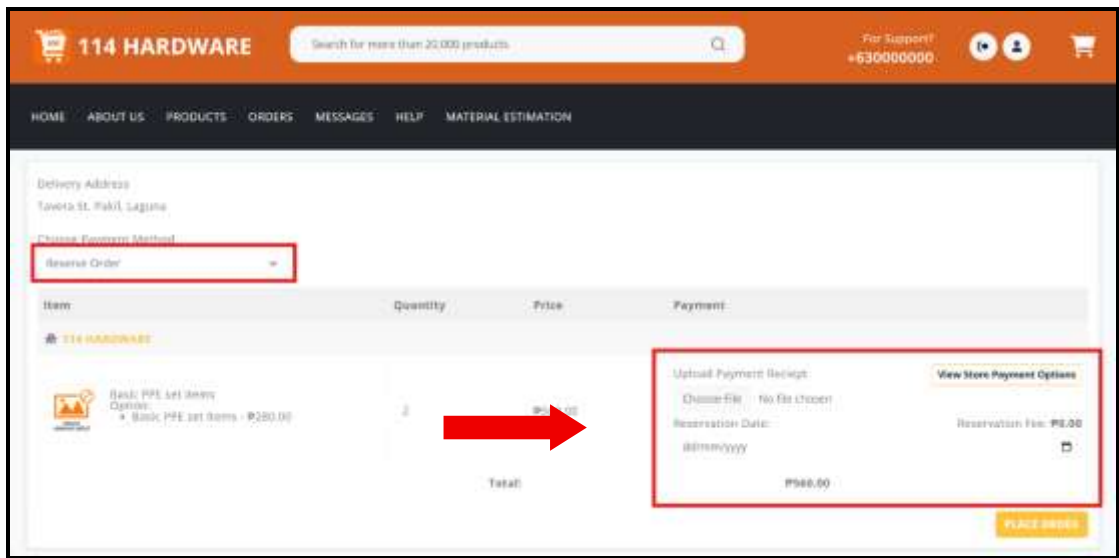


Figure 7. Reserve Order (Payment Method)

Live chat for direct communication with customers

The built-in Chatify messaging tool enables real-time communication between customers and store owners, allowing queries about product availability, pricing, and order status to be addressed directly within the platform shown in Figure 8. The live chat supports back-and-forth messaging similar to face-to-face interaction, ensuring no concerns are left unattended. By centralizing communication, it reduces reliance on external applications, minimizes miscommunication, and enhances service responsiveness. Research shows that live chat shortens waiting times and improves accessibility by providing real-time, web-based support (Dong et al., 2024).

Notifications to suppliers for stock updates

An automated Low Stock Alert facilitates the restocking process by notifying store owners when inventory reaches critical levels and providing supplier contact details directly within the system shown in Figure 9. This enables quick coordination and replenishment requests without relying on external communication, reducing delays and preventing stock shortages. The low-stock modal allows real-time review of inventory, supplier contacts, and replenishment actions, ensuring sufficient stock to meet customer demand. Research shows that such automated systems improve supply chain efficiency by triggering timely notifications. Digital supply chain studies emphasize that automated replenishment processes eliminate the human element by activating notifications when inventory changes occur in real time (Ugbebor et al., 2024).

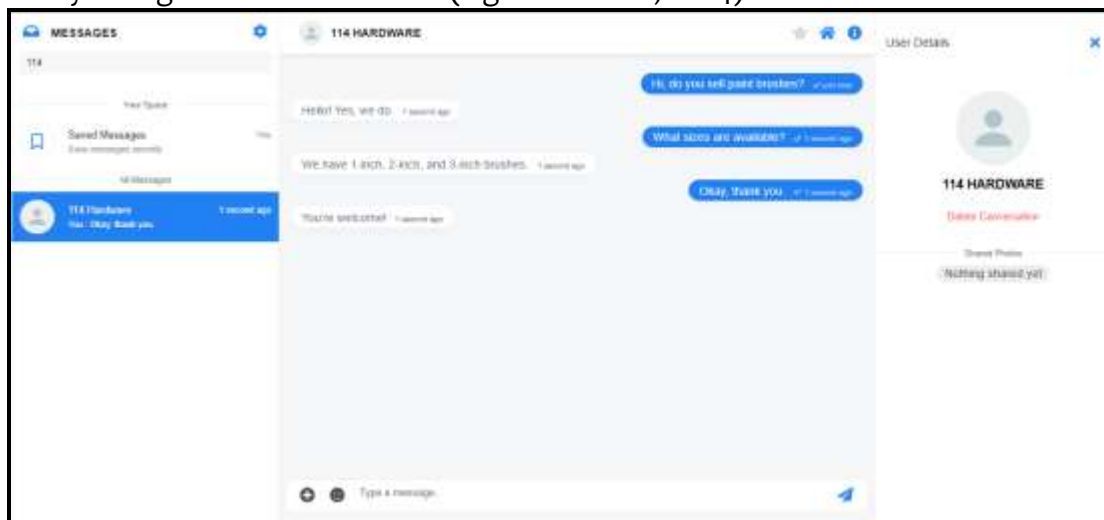


Figure 8. Live Chat Messages

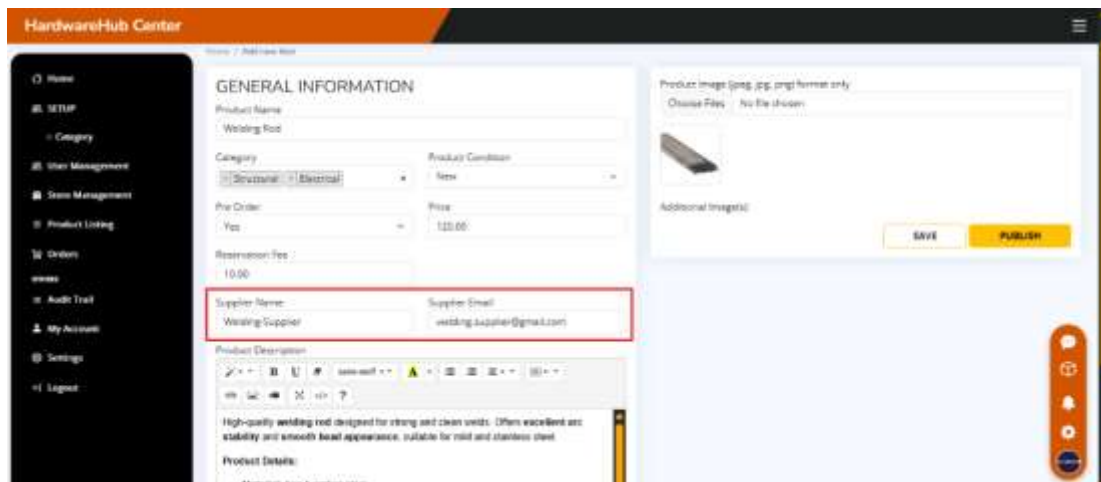


Figure 9. Low Stock Alert

Order processing and initial payment handling

The order processing and payment feature lets store owners manage transactions through the Orders module, which displays all order details and status, as shown in Figure 10. Customers can pay via QR Code (with proof upload), Reserve Order (partial payment), or Cash on Delivery. The system records the payment, updates order status, and clears items, streamlining processing, reducing errors, and improving cash flow management while providing financial insights. To support this point, Brown et al. (2024a) state that seamless integration of e-payment into SME back-end systems is not only convenient but also critical for data insights that help business owners better manage cash flows.

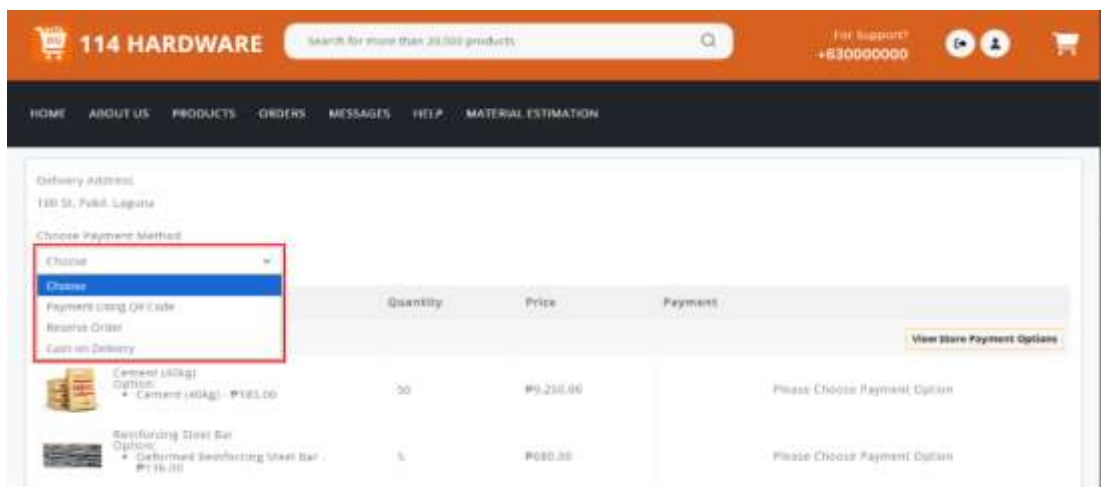


Figure 10. Order Processing and Initial Payment Methods

To Develop a System that has a Real-time Tracking Feature for Inventory and Stocks

The system was developed to enable hardware store owners to monitor inventory and stock levels in real time, addressing the inaccuracies, delays, and inefficiencies associated with manual inventory management. By automatically updating stock records whenever items are added, sold, or replenished, the system improves inventory accuracy and operational efficiency (AZTech Training & Consultancy, 2025). Figure 11 presents the real-time product list interface, which displays essential inventory information such as item ID, product name, price, stock quantity, sold quantity, and status. Accurate, real-time inventory information also builds customer trust by ensuring product availability and supporting timely order fulfillment (Schwarz, 2024).

Figure 12 shows a modal window that appears when a user clicks the three-dot button on a selected product. This window displays detailed product information, including name, description, category, condition, preorder availability, price, remaining stock, publication status, and product image. It also includes action buttons such as Update Product Info, Stock Logs, and Add Options, allowing users to edit product details, review stock history, and manage product variations like pricing and stock levels. The feature improves workflow to ensure accurate updates to product records. Making these technologies accessible and convenient on localized digital platforms will enable small hardware retailers in the Philippines to operate effectively without spending excessive money (Brown et al., 2024b).

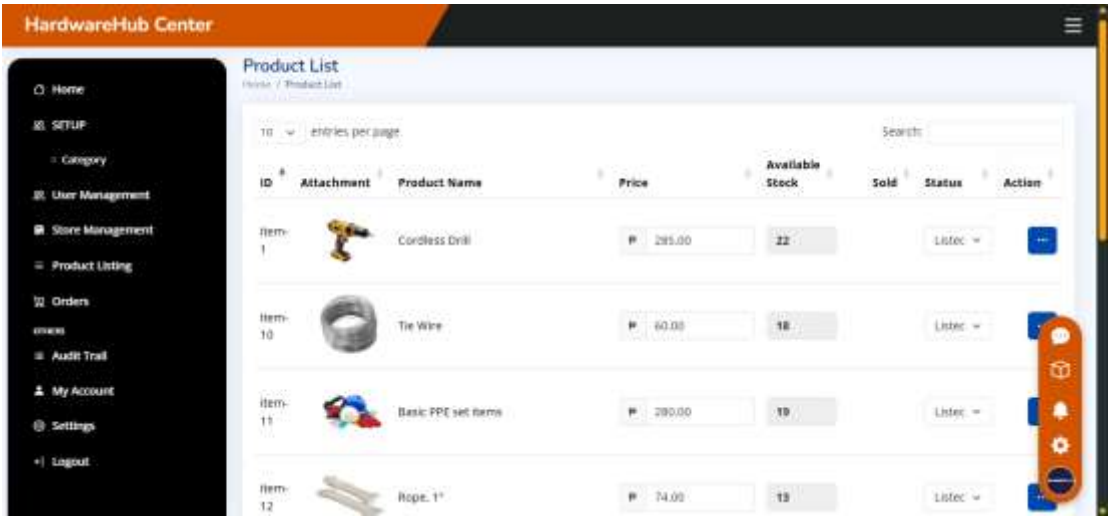


Figure 11. Product List

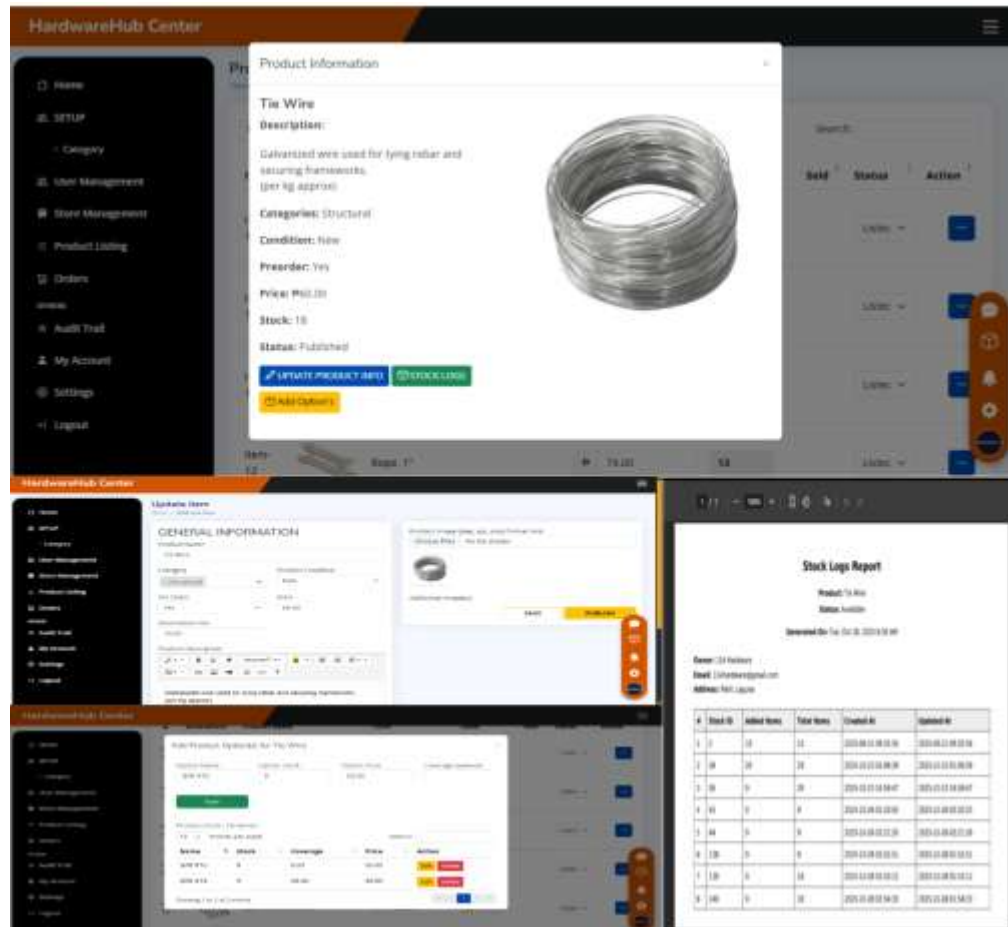


Figure 12. Product List

Overall, the real-time tracking feature effectively improved inventory accuracy, automated stock updates, reduced manual errors, and provided reliable, up-to-date inventory information through an organized product management interface. These findings support Fred and Rajab (2024), who emphasized that real-time inventory systems enhance operational accuracy, responsiveness, and business competitiveness.

To Create a System that can Provide Materials Estimation Features for Residential House Construction

The system was developed to help users accurately estimate construction materials for different project types, addressing the errors, inconsistencies, and delays associated with manual estimation methods (Rehiara et al., 2025). Figure 13 presents the materials estimation interface, where users can select the project category, project type, required materials, and project size through dynamic dropdown menus. The available options automatically adjust based on the selected project, ensuring that only relevant parameters are used for the calculation. To ensure accurate estimates, a licensed civil engineer validated and tested all formulas, materials, and measurement processes. This

digital estimation tool simplifies project planning, budgeting, and resource management while reducing human error and improving estimation reliability (Yousif et al., 2020).

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HOME ABOUT US PRODUCTS ORDERS MESSAGES HELP MATERIAL ESTIMATION

Estimate Your Materials

Plan your construction needs with our quick estimator.

PROJECT AREA:

PROJECT DIMENSIONS:

SUGGEST MATERIALS

Enter your project type and size, and our estimator will suggest the materials you need. It calculates quantity using the formula: $\text{Quantity} = \frac{\text{Project Dimension} \times \text{Coverage}}{\text{Coverage}}$ (rounded up). Then it multiplies this by the product price to give you the total cost and adds everything together for your project's estimated budget.

MATERIAL	UNIT PRICE (PHP)	STOCK	RECOMMENDED QTY	TOTAL COST (PHP)
ESTIMATED TOTAL COST:				

Figure 13. Materials Estimation

Figure 14 illustrates the materials estimation result generated after users input the required project measurements into the system. It displays a detailed table of the recommended materials, required quantities, and estimated total cost. The calculations use the formula $\text{Quantity} = \frac{\text{Project Dimension}}{\text{Coverage}}$, ensuring the estimated material quantities match the project size. Designed for small residential construction projects, the feature allows users to customize estimates based on their selected project type, specifications, and measurements. By presenting organized, easy-to-understand results, the system supports informed purchasing decisions, minimizes estimation errors, and improves project planning and resource management, ultimately increasing buyer confidence and construction efficiency (Adelakun, 2023).

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HOME ABOUT US PRODUCTS HELP MATERIAL ESTIMATION

Estimate Your Materials

Plan your construction needs with our quick estimator.

PROJECT AREA:

PROJECT TYPE:

MATERIAL NEEDED:

PROJECT DIMENSIONS:

SUGGEST MATERIALS

Enter your project type and size, and our estimator will suggest the materials you need. It calculates quantity using the formula: $\text{Quantity} = \frac{\text{Project Dimension}}{\text{Coverage}}$ (rounded up). Then it multiplies this by the product price to give you the total cost and adds everything together

MATERIAL	UNIT PRICE (PHP)	STOCK	RECOMMENDED QTY	TOTAL COST (PHP)
Bedroom Flooring Remove Section				
Portland Cement (40kg)	200.00	93	4	800
Gravel (20kg) - Bag	85.00	87	15	1,275
ABC Concrete Hardens	883.00	40	1	883
Fine Sand (22 Tg) - Bx	85.00	75	6	510
ESTIMATED TOTAL COST: ₱16,373				

Figure 14. Recommended Materials Estimation Results

The Hardware Gen estimation system reduces reliance on manual estimates, which are usually slow and inaccurate. It proved useful for accurately estimating the materials needed for simple residential construction projects. The system also automated manual calculations, thereby saving time. A licensed engineer confirmed that the results were close to professional estimates. This makes it reliable for customers and store employees to plan and budget materials. Automated material estimation tools are used worldwide and enable builders and customers to save on unnecessary expenses and prevent construction project delays (Schwarz, 2024).

To Test the Functionality of the System using Test Cases

The functionality test evaluates whether each system module performs according to its intended functions and identifies any issues that require correction. This testing assessed the system's overall functionality and operational performance. The results summarize the functionality assessment and show that all major system components performed successfully. The Hardware Hub system consists of four (4) major modules: the Materials Estimation Module, Inventory Management Module, Order Processing Module, and User Management Module.

As shown in Table 4, functionality testing of the Materials Estimation Module evaluated the module's ability to accurately generate construction material estimates and validate user inputs against the specified functional requirements. We performed six test scenarios, including four valid estimation cases for Bedroom, Bathroom, Kitchen, and Roofing projects, as well as two input validation cases involving a missing project type and an invalid floor area value. For each test case, the expected results were compared with the actual system output to determine whether the module functioned correctly. The system successfully generated the required material estimates within 1.06 to 1.43 seconds, while the Kitchen estimation produced a one-block difference in CHB due to the system's automatic rounding mechanism, which remained within acceptable limits. The module also correctly displayed validation messages and prevented estimation when invalid or incomplete inputs were provided. All six test cases passed, demonstrating that the Materials Estimation Module performs its intended functions, efficiently processes user inputs, enforces input validation rules, and meets all specified functional requirements.

Table 5 shows that functionality testing of the Inventory Management Module evaluated the module's ability to manage inventory records, monitor stock levels accurately, and process inventory-related transactions according to the system's functional requirements. Seven test scenarios were performed, including adding a new inventory item, updating stock after a sale, triggering a low-stock notification, preventing overselling, deleting a discontinued product, searching for an existing product, and editing a product's price. For each test case, the expected results were compared with the actual system output to verify the module's functionality.

Table 4. Materials Estimation Module

NO.	TEST SCENARIO	INPUT DATA	EXPECTED RESULT	ACTUAL RESULT	PASS/FAIL
1	Generate material estimate for a Bedroom	Project Type: Bedroom; Floor Area: 25 m ²	System generates the required materials and estimates 7 bags of cement, 115 CHB, and 3 gallons of paint.	System generated 7 bags of cement, 115 CHB, and 3 gallons of paint in 1.18 seconds.	Pass
2	Generate material estimate for a Bathroom	Project Type: Bathroom; Floor Area: 12 m ²	System generates 3 bags of cement, 60 CHB, and 2 gallons of waterproof paint.	System generated 3 bags of cement, 60 CHB, and 2 gallons of waterproof paint in 1.06 seconds.	Pass
3	Generate material estimate for a Kitchen	Project Type: Kitchen; Floor Area: 20 m ²	System generates 5 bags of cement, 100 CHB, and 3 gallons of paint.	Generated 5 bags of cement, 99 CHB, and 3 gallons of paint in 1.24 seconds; 1-block difference due to rounding.	Pass
4	Generate material estimate for a Roofing project	Project Type: Roofing; Roof Area: 80 m ²	The system estimates 28 roofing sheets, 6 ridge rolls, and 12 kg of roofing screws.	The system generated 28 roofing sheets, 6 ridge rolls, and 12 kg of roofing screws in 1.43 seconds.	Pass
5	Validate missing project type	Project Type: Not Selected; Floor Area: 30 m ²	System displays "Please select a project type." and prevents estimation.	The system displayed the validation message in 0.37 seconds; no estimate was generated.	Pass
6	Validate invalid floor area	Project Type: Kitchen; Floor Area: -20 m ²	System rejects the invalid input and displays an error message.	Displayed "Floor area must be greater than zero." in 0.34 seconds; estimation prevented.	Pass

The system completed all inventory operations in 0.41 to 0.71 seconds, accurately updating stock quantities, displaying product information, generating low-stock alerts when inventory reached the predefined threshold, preventing transactions that exceeded available stock, and successfully modifying or removing product records. All test cases passed, demonstrating that the Inventory Management Module maintains inventory accuracy, supports efficient stock monitoring, enforces inventory controls, and meets all specified functional requirements.

Table 5. Inventory Management Module

NO.	TEST SCENARIO	INPUT DATA	EXPECTED RESULT	ACTUAL RESULT	PASS/FAIL
1	Add a new inventory item	Cement = 500 bags	Inventory updates to 500 bags.	Inventory successfully updated to 500 bags in 0.71 seconds.	Pass
2	Update inventory after a sale	Initial Stock = 500 bags; Sold = 35 bags	Remaining stock becomes 465 bags.	Stock updated to 465 bags in 0.63 seconds.	Pass
3	Trigger low stock notification	Current Stock = 8 bags; Threshold = 10 bags	System displays a low-stock notification.	The low-stock alert triggered immediately at 8 bags.	Pass
4	Prevent overselling	Available = 12 bags; Requested = 20 bags	Transaction is rejected.	Order was rejected with an "Insufficient Stock" message in 0.46 seconds.	Pass
5	Delete a discontinued product	Product ID = P-1025	Product is removed from inventory.	Product record was deleted successfully in 0.58 seconds.	Pass
6	Search for an existing product	Keyword = "Cement"	Product details are displayed.	Product information was displayed in 0.41 seconds.	
7	Edit product price	Cement Price: ₱285 → ₱295	Product price is updated successfully.	Product price changed to ₱295 in 0.56 seconds.	Pass

Table 6 summarizes the functionality testing conducted for the Order Processing Module to evaluate its ability to accurately process customer orders, calculate transaction totals, manage order statuses, and enforce order validation based on the system's functional requirements. Eight test scenarios were performed, including placing single-item and multiple-item orders, canceling a pending order, preventing checkout when the requested quantity exceeded the available stock, completing an online payment, applying a discount coupon, generating an order receipt, and updating an order status to Shipped. For each test case, the expected results were compared with the actual system output to verify the module's operations. The system successfully processed all order transactions within 0.45 to 2.15 seconds, accurately calculated order totals, applied discounts, verified payments, restored inventory after order cancellation, generated downloadable receipts, updated order statuses accordingly, and prevented transactions involving insufficient stock. All test cases passed, demonstrating that the Order Processing Module effectively manages the complete order lifecycle, maintains transaction accuracy, enforces business rules, and meets all specified functional requirements.

Table 7 presents the functionality testing conducted for the User Management Module to evaluate its ability to manage user accounts securely and efficiently in accordance with the system's functional requirements. Seven test scenarios were performed, including user account registration, login using valid credentials, login with an incorrect password, registration using an existing email address, password reset, user profile update, and system logout. For each test case, the expected results were compared with the actual system output to verify that the module performed its intended functions correctly. The system completed all user management operations within 0.29 to 1.48 seconds, accurately creating new accounts, authenticating valid users, preventing unauthorized access and duplicate registrations, sending password reset emails, updating user profile information, and securely terminating user sessions upon logout. All test cases passed, demonstrating that the User Management Module effectively supports secure user authentication, account management, data validation, and session control while meeting all specified functional requirements.

As presented in Table 8, the Hardware Hub system successfully passed all functionality test cases across its four major modules. The number of functional requirements represents the key system functionalities, including the operational buttons, input fields, navigation controls, validation features, and system processes implemented within each module. Meanwhile, the test cases refer to the specific testing procedures conducted to verify whether these functionalities perform as intended. The Materials Estimation Module, evaluated through 12 functional requirements and 6 test cases, verified the accuracy of material calculations, project type selection, estimate generation, and input validation for different construction areas.

Table 6. Order Processing Module

NO.	TEST SCENARIO	INPUT DATA	EXPECTED RESULT	ACTUAL RESULT	PASS/FAIL
1	Place a single-item order	20 bags of Cement × ₱285	Total amount is ₱5,700.	The system calculated the total as ₱5,700 in 1.10 seconds.	Pass
2	Place a multiple-item order	Cement (10 × ₱285), Paint (3 × ₱950), Nails (5 × ₱120)	The total amount is ₱6,300.	The system calculated the total as ₱6,300 in 1.29 seconds.	Pass
3	Cancel a pending order	Order No. ORD-10025	Order status changes to Canceled and inventory is restored.	The order status changed to Canceled, and 20 items were returned to inventory in 0.84 seconds.	Pass
4	Order quantity exceeds available stock	Requested = 150 CHB; Available = 100 CHB	Checkout is blocked.	Checkout was prevented, and an "Insufficient Stock" message appeared in 0.45 seconds.	Pass
5	Complete online payment	Total Amount = ₱12,450	Order status changes to Paid.	The payment was verified, and the order status changed to Paid in 2.15 seconds.	Pass
6	Apply a discount coupon	Coupon = 10% OFF; Order Total = ₱5,700	Total amount becomes ₱5,130.	Discount applied successfully; total became ₱5,130 in 1.07 seconds.	Pass
7	Generate order receipt	Paid Order No. ORD-10025	Receipt is generated successfully.	Receipt was generated and downloaded in 0.89 seconds.	Pass
8	Update order status to "Shipped"	Order No. ORD-10026	Order status changes from Processing to Shipped.	Order status updated to Shipped in 0.61 seconds.	Pass

Table 7. User Management Module

NO.	TEST SCENARIO	INPUT DATA	EXPECTED RESULT	ACTUAL RESULT	PASS/FAIL
1	Register a new account	Name, Email, Password	The account is created successfully within 2 seconds.	Account was created successfully in 1.02 seconds.	Pass
2	Login using valid credentials	Registered Email and Password	User is redirected to the dashboard.	The user logged in successfully and reached the dashboard in 0.87 seconds.	Pass
3	Login using an incorrect password	Registered Email; Incorrect Password	System denies access and displays an error message.	The system denied the login attempt and displayed an error message in 0.31 seconds.	Pass
4	Register using an existing email	Existing Email Address	System prevents duplicate account creation.	The system detected a duplicate email and blocked registration in 0.43 seconds.	Pass
5	Reset password	Registered Email Address	Password reset link is sent successfully.	Password reset email was sent in 1.48 seconds.	Pass
6	Update user profile	Change Contact Number to 09171234567	User profile is updated successfully.	Profile information was updated in 0.66 seconds.	Pass
7	Log out from the system	Click the Logout button	User session ends and returns to the login page.	User was logged out successfully in 0.29 seconds.	Pass

The Inventory Management Module, consisting of 10 functional requirements and 7 test cases, validated product management, stock updates, inventory deduction, low-stock notifications, product search, and product deletion, ensuring accurate inventory records and preventing overselling. The Order Processing Module, tested through 14 functional requirements and 8 test cases, confirmed the proper functionality of cart management, order computation, payment processing, receipt generation, order cancellation, order status updates, and inventory synchronization.

Lastly, the User Management Module, evaluated through 9 functional requirements and 7 test cases, verified user registration, login, password recovery, profile updating, duplicate account validation, and logout, ensuring secure account management and reliable system access. Furthermore, the successful functionality testing demonstrates the system's ability to reliably integrate e-commerce, inventory management, and materials estimation features within a single platform, distinguishing it from existing hardware management systems that typically provide only standalone functionalities.

Table 8. Summary of the Functionality Test

MODULES	NO. OF FUNCTIONAL REQUIREMENTS	TEST CASES	REMARKS
Materials Estimation Module	12	6	Passed
Inventory Management Module	10	7	Passed
Order Processing Module	14	8	Passed
User Management Module	9	7	Passed
Total	45	28	Passed

To Evaluate the Website using the Technology Acceptance Model (TAM)

To ensure successful adoption and long-term use of the Hardware Gen e-commerce and inventory platform, the study examined user perception and acceptance using the Technology Acceptance Model (TAM). TAM focuses on perceived ease of use and perceived usefulness, which influence users' attitudes and intention to use the system. The study evaluated hardware store owners, staff, and customers based on the platform's efficiency, functionality, user-friendliness, and contribution to business operations.

Table 9 presents the evaluation of the Hardware Gen Platform using the Technology Acceptance Model (TAM) based on responses from hardware store owners and staff. The system was assessed using four criteria: Perceived Ease of Use, Perceived Usefulness, Attitude Toward Use, and Behavioral Intention to Use, all of which received Highly Acceptable ratings. Attitude Toward Use received the highest score (4.96), indicating a very positive perception of the platform, followed by Perceived Usefulness and Behavioral Intention to Use (4.94), suggesting that users find the system valuable and are

willing to continue using it. Meanwhile, Perceived Ease of Use (4.86) also received a Highly Acceptable rating, showing that the platform is easy to operate. The overall mean confirms that the Hardware Gen Platform is highly acceptable among users, suggesting strong potential for adoption and long-term use in hardware retail businesses.

Table 9. Results of TAM (Hardware Stores)

CRITERIA	MEAN	INTERPRETATION	RANK
Perceived Ease of Use	4.86	Highly Acceptable	4
Perceived Usefulness	4.94	Highly Acceptable	2
Attitude Toward Use	4.96	Highly Acceptable	1
Behavioral Intention to Use	4.94	Highly Acceptable	3
Grand Mean	4.93	HIGHLY ACCEPTABLE	

Table 10 presents the evaluation of the Hardware Gen Platform using the Technology Acceptance Model (TAM) based on responses from hardware customers. The platform was assessed using four variables: Perceived Ease of Use, Perceived Usefulness, Attitude Toward Use, and Behavioral Intention to Use, all of which received Highly Acceptable ratings. Perceived Ease of Use obtained the highest mean score of 4.94, indicating that customers find the platform convenient and easy to use. This was followed by Attitude Toward Use (4.88) and Behavioral Intention to Use (4.86), showing that customers view the system positively and are willing to continue using it. Perceived Usefulness (4.77) also received a Highly Acceptable rating, indicating overall customer satisfaction with the platform and suggesting strong adoption potential in the hardware retail sector.

Table 10. Results of TAM (Hardware Customers)

CRITERIA	MEAN	INTERPRETATION	RANK
Perceived Ease of Use	4.94	Highly Acceptable	1
Perceived Usefulness	4.77	Highly Acceptable	4
Attitude Toward Use	4.87	Highly Acceptable	2
Behavioral Intention to Use	4.86	Highly Acceptable	3
Grand Mean	4.89	HIGHLY ACCEPTABLE	

Table 11 compares the Technology Acceptance Model (TAM) results between hardware store employees and customers in evaluating the Hardware Gen Platform. Both groups rated all four criteria, Perceived Ease of Use, Perceived Usefulness, Attitude Toward Use, and Behavioral Intention to Use as Highly Acceptable, with overall means of 4.93 for store users and 4.89 for customers. Store owners and employees gave the highest ratings to Perceived Usefulness and Behavioral Intention to Use (4.94), showing that they value the platform's support for business operations. In contrast, customers rated Perceived Ease of Use the highest (4.94), indicating that the platform is convenient and easy to navigate. This was followed by Attitude Toward Use (4.87) and Behavioral Intention to Use (4.86), while Perceived Usefulness (4.77) ranked fourth. Overall, the results show that both groups have a positive attitude toward the platform, with store users focusing on functionality and customers valuing convenience and accessibility.

Table 11. Comparison of Results between Hardware Stores and Hardware Customers

CRITERIA	STORES' MEAN	RANK	CUSTOMERS' MEAN	RANK
Perceived Ease of Use	4.86	4	4.94	1
Perceived Usefulness	4.94	2	4.77	4
Attitude Toward Use	4.96	1	4.87	2
Behavioral Intention to Use	4.94	3	4.86	3
Grand Mean	4.93		4.89	

Overall, the Hardware Gen Platform was rated highly acceptable by both hardware store owners/staff (Grand Mean = 4.93) and customers (Grand Mean = 4.89) across all Technology Acceptance Model (TAM) constructs. The results indicate that the system is easy to use, useful, and supports users' intention to adopt the platform for hardware store operations, demonstrating its potential for long-term implementation (Rosda et al., 2023; Sawa et al., 2024).

CONCLUSION AND RECOMMENDATIONS

The developed Hardware Gen system provides an integrated web-based solution that supports the digital transformation of small and medium-sized hardware businesses by combining e-commerce, real-time inventory management, construction materials estimation, and customer support into a single platform. Its integrated approach streamlines operations, improves inventory control, enhances customer convenience, and supports more efficient decision-making, making it a practical solution for modern hardware retail.

Future studies may evaluate Hardware Gen across more hardware stores and geographic locations to assess its scalability and long-term applicability. Researchers are also encouraged to conduct security, performance, and real-world deployment evaluations, and to explore additional features such as predictive analytics, demand forecasting, secure payment integration, and expanded materials estimation for larger construction projects.

IMPLICATIONS

This study contributes to e-commerce, inventory management, and information systems research by demonstrating how integrating multiple business functions into a single web-based platform can improve the digital transformation of small and medium-sized hardware stores. The findings support the Technology Acceptance Model (TAM) by showing that perceived usefulness and perceived ease of use positively influence users' acceptance of integrated retail technologies. The study also extends existing literature by presenting a localized e-commerce solution that combines online selling, inventory management, materials estimation, supplier notification, and customer communication within one platform, addressing gaps in current hardware retail systems.

From a practical perspective, the findings suggest that integrated digital platforms such as Hardware Gen can improve operational efficiency, inventory accuracy, and customer service while reducing manual processes and decision-making errors. For SMEs, particularly local hardware stores, the system can increase competitiveness, expand market reach, and support sustainable digital adoption. Economically, improved inventory control and streamlined operations can reduce operating costs and increase sales opportunities. Socially, the platform promotes greater accessibility, supports digital inclusion among small businesses, and encourages the adoption of modern technologies within the Philippine hardware retail sector.

DECLARATIONS

Conflict of Interest

The authors declare no conflict of interest.

Informed Consent

All participants were informed about the study's purpose and the data to be collected before completing the evaluation form. Participation was voluntary, and no personal information was collected. All responses were kept confidential and used only for research purposes.

Ethics Approval

The study was conducted ethically, ensuring the safety, privacy, and rights of hardware store owners/staff and customers. Participants remained anonymous, and the study maintained data confidentiality throughout. The researchers obtained authorization from the appropriate authorities and secured informed consent. The team followed safety protocols when handling all hardware components. We conducted a plagiarism check, and we properly cited all sources.

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