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Design and Development of a GAS-Based E-Commerce Application with UI/UX Optimization Using a User-Centered Design Approach

Case Study: Cindy Bordir - Pajarakan Probolinggo

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Abstract*—Micro, Small, and Medium Enterprises (MSMEs) offering custom embroidery and tailoring services face significant challenges with digitizing orders. Conventional e-commerce platforms primarily serve ready-made products. They lack flexibility for custom workflow options. For example, customers cannot easily submit their own designs or bring in clothing for embroidery. MSMEs are often burdened by ongoing server maintenance costs. This study seeks to design and implement a web-based e-commerce information system using a User-Centered Design (UCD) approach. The case study is applied to Cindy Bordir in Probolinggo. To address the research gap of high-cost and rigid platforms, the application introduces a zero-cost serverless architecture. This uses Google Apps Script (GAS) and Google Spreadsheet as the database. A "Hybrid Checkout" flow bridges the digital catalog experience with localized negotiation habits via WhatsApp. Results show that applying UCD with a mobile-first interface, chip-style product variations, and micro-interaction feedback supports custom transaction needs. Functional testing confirmed a 100% success rate for all features. Usability evaluations using the System Usability Scale (SUS) achieved an "Excellent" score of 84.5. This indicates high user satisfaction. The serverless architecture and hybrid checkout approach proved to be a cost-effective, secure, and manageable solution for MSMEs. It eliminates traditional hosting fees. At the same time, it maintains operational reliability and data integrity. Despite limitations in sample size and database scalability, future work will focus on UI/UX optimization and migrating to scalable cloud databases.

Keywords*—e-commerce, User-Centered Design, UI/UX, Google Apps Script, MSMEs, Serverless

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I. INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) play a vital role in driving the national economy [1], [2]. In the era of Industry 4.0, the adoption of Information and Communication Technology (ICT) by MSMEs has become a determining factor for business competitiveness and sustainability [3], [4]. One of the sectors that is currently experiencing rapid growth but has high operational complexity is the custom embroidery and garment manufacturing industry [5]. A prime example is Cindy Bordir, an MSME based in Pajarakan, Probolinggo, which frequently struggles with managing complex custom orders manually, leading to operational inefficiencies.

The main obstacle faced by custom embroidery business operators like Cindy Bordir in adopting e-commerce is the mismatch in the order flow [6]. The existing marketplace systems generally do not provide flexibility for customers who require special handling, such as orders for "embroidery services only" where the clothing is sent by the customer, or orders that require the attachment of specific logo designs that need to be negotiated [7]. On the other hand, MSMEs are often hindered by the high costs of server maintenance (hosting) and the complexity of the management dashboard, which is not user-friendly for the general public [8], [9], [10].

In the development of information systems, the success of system adaptation is greatly determined by how well the system can meet the needs and habits of its users. Therefore, the User-Centered Design (UCD) approach is considered highly relevant. UCD focuses on a deep understanding of users, the tasks they perform, and the environment in which the system will be used, ensuring that the resulting application is both intuitive and functional.

While previous studies have extensively explored e-commerce adoption for MSMEs, most proposed solutions rely on conventional Content Management Systems (CMS) or ready-made marketplaces [11]. These platforms present a significant research gap as they typically require ongoing hosting costs and enforce rigid transaction flows that are unsuitable for custom-order businesses [12]. To address this gap, the novelty of this study lies in the implementation of a zero-cost serverless architecture utilizing Google Apps Script (GAS) and Google Spreadsheet, combined with a "Hybrid Checkout" User Experience (UX) design. Unlike traditional e-commerce systems, this hybrid approach provides a modern, mobile-first shopping cart experience that deliberately redirects the final checkout process to WhatsApp. This specific integration seamlessly bridges the gap between digital cataloging and the localized, conversational negotiation habits essential for custom garment MSMEs, while completely eliminating server maintenance barriers [13].

Based on this background, this research aims to design and build an e-commerce application that focuses on the ease of the User Interface (UI) and UX for both customers and administrators. By utilizing a serverless approach, the integration of Google Spreadsheet is expected to provide a transparent, easily understandable order management and cost-effective bookkeeping experience for MSME owners.

II. RESEARCH METHOD

This research applies a User-Centered Design (UCD) software development method that prioritizes human-centered solutions. The UCD process in this study involves four iterative stages:

A. Understand Context of Use

Following the understanding of the context of use, this stage identifies user characteristics. Observations indicate that customers predominantly use smartphones for transactions [14]. In contrast, the garment factory admin (manager at Cindy Bordir) prefers working with row and column table formats (like Microsoft Excel/Spreadsheet) rather than complex system dashboards.

B. Specify User Requirements

Building on insights from the previous stage, specific system requirements (User Stories) are gathered. The feature must support custom options in the shopping cart, and the checkout process must forward users to WhatsApp, as garment transactions always involve design negotiations and down payment (DP) confirmation [15].

C. Design Solutions

With user requirements specified, the next phase is the prototype interface design, using the Tailwind CSS framework. The interface is designed using the Mobile-First Design paradigm [16]. User experience is enhanced through product variant designs in a chip-style (rather than traditional dropdown menus) to make information more clearly displayed.

D. Evaluate Against Requirements

After designing possible solutions, the developed prototype is tested for functionality to verify if micro-interactions—such as image animations when adding items to the cart—perform correctly and provide positive psychological feedback to customers during transactions [17].

III. RESULTS AND DISCUSSION

A. User Stories

System requirements are described in the form of user stories which can be seen in TABLE 1, which are brief descriptions of how users interact with the system, using layman's terms to facilitate feature determination [18]. In this context, system users, referred to as 'actors,' are divided into two groups: Customers and Administrators.

TABLE 1. USER STORIES

No	Actor Category	User Story Description
1	Administrator	Be able to log in securely to the control panel system.
2	Administrator	Be able to manage product/catalog data (Add, Edit, Delete).
3	Administrator	Be able to monitor the customer order list in real-time.
4	Administrator	Be able to change the order status and modify order details if there are any changes.
5	Administrator	Be able to record financial bookkeeping (income/expenses).
6	Customer	Be able to see the product catalog with a clean and mobile-friendly interface.
7	Customer	Be able to select size and color variations with easy-to-click visuals.
8	Customer	Be able to check the option 'Bring your own shirt' or 'Have your own design.'
9	Customer	Be able to do a checkout that automatically formats the order into a WhatsApp text for the store.

B. System Design

Functionality modeling uses a use case diagram in Fig. 1, a graphical model in the Unified Modeling Language (UML) that shows how users, called actors, interact with the system's features. Actors are types of users, like customers or admins, who perform actions. In this system, customers can browse the product catalog and manage shopping cart items without creating an account. Admins, after logging in, have full permissions to create, read, update, and delete (CRUD) data in all modules, such as Catalog, Orders, and Booking. CRUD describes the core functions administrators can perform on system data [19].

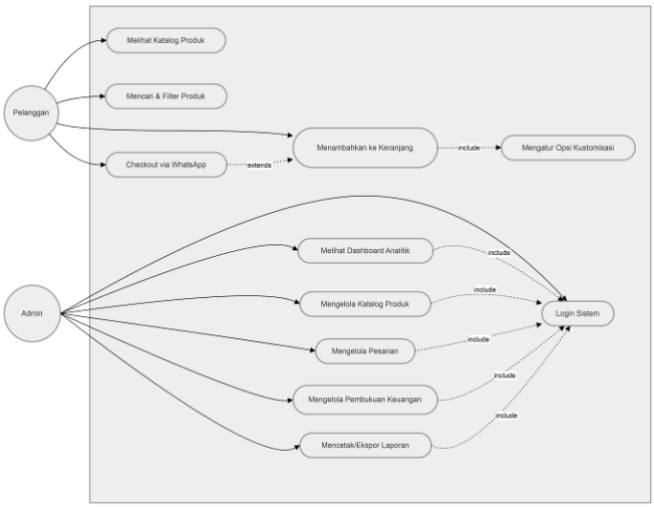

Fig. 1. Use Case Diagram

This application uses a serverless architecture, meaning the code runs on a cloud provider's systems instead of company-owned servers. The database relationship is shown as entities in Google Spreadsheet sheets. The main tables are Settings, Menu/Products, Admin, Orders, Expenses, and Income. All database transactions are protected from race conditions (errors when multiple processes update data at once) by the LockService class. This is a Google Apps Script feature that controls resource access.The database design was developed using class diagram and entity relationship diagram which can be seen in Fig. 2 and Fig. 3.

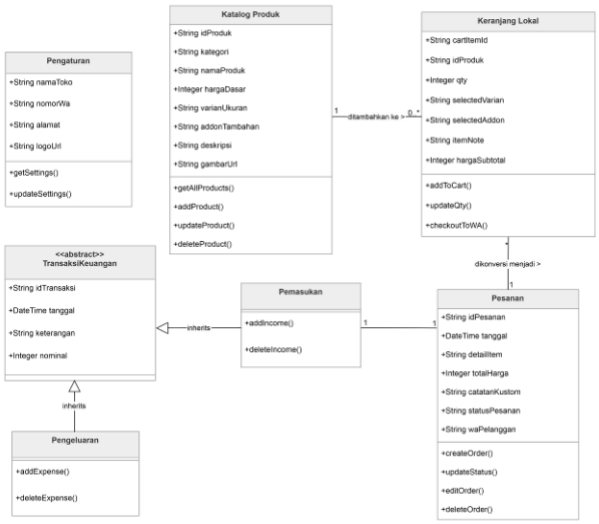

Fig. 2. Class Diagram (Conceptual Data Model)

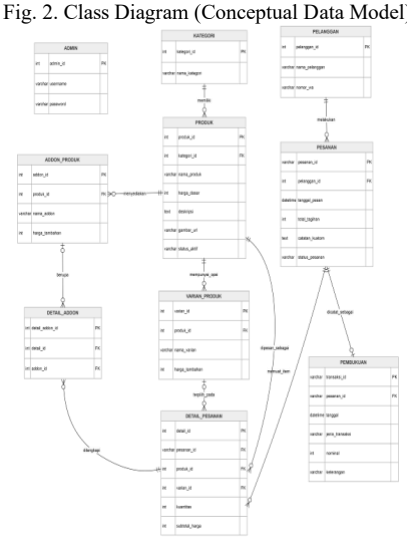

Fig. 3. Entity-Relationship Diagram

C. UI/UX Interface Implementation

Using User-Centered Design has led to several UI/UX improvements [20], such as:

- Chip-Style Variant Selection: Instead of a traditional dropdown menu, users choose size options and add-ons using labeled selectable chips—small, clickable UI elements—arranged in a grid with four columns and styled using Tailwind CSS (a utility-first CSS framework). When a chip is clicked, it highlights visually and shows a checkmark icon to confirm selection.

- Shopping Cart Micro-Interactions: When a buyer clicks the "Add to Cart" button, the system uses JavaScript Document Object Model (DOM) manipulation—programming techniques for updating the website structure—to duplicate the product image and animate it, making it appear to shrink and move toward the shopping cart icon on the screen. This animation provides visual confirmation for the user, replacing disruptive pop-up alerts with a smoother user experience.
- Sticky Navigation: The Header (displaying store information) and Footer (containing main navigation options) are always visible, fixed at the top and bottom edges of the screen, so users do not have to scroll extensively to access main site functions or switch sections.

D. System Testing

TABLE 2 is the system testing scenario to make sure the system works as expected using the compiled user stories [21].

TABLE 2. SYSTEM TESTING SCENARIO

No	Test Scenario	Expected Result	Status
1	Admin performs the Login process.	The system validates and redirects the admin to the Dashboard.	Success
2	Customers press the variant option in the catalog.	The variant changes color and the total price updates in real-time.	Success
3	The customer checks the "Have your own design" option and proceeds to Checkout.	The WA app opens, loading all the order details along with the "Flag" info for the custom option.	Success
4	Admin changes the price on the "Edit Order" form in the panel.	Data is saved, lock service prevents conflicts, price is updated in the Spreadsheet.	Success

Usability Evaluation: To validate the User-Centered Design approach, we conducted a preliminary usability evaluation. We involved representative users from Cindy Bordir, including both customers and administrators. We collected feedback specifically on navigation ease, the chip-style variant selection, and how smoothly WhatsApp checkout worked. Users said the mobile-first interface saved time and reduced confusion compared to traditional manual messaging. Administrators noted that the Spreadsheet-based backend was very familiar and made adapting to this digital system easier.

E. Serverless Backend Integration

Using Google Apps Script removes financial barriers and server tasks for SMEs. There is no need to make a separate API service. The backend code is in a .gs function. The HtmlService.createTemplateFromFile() method renders the user interface (HTML/CSS), while Google.script.Run enables database calls. This setup is lightweight, reliable, and very responsive [22].

F. Deployment

The final stage of this development process is deployment (system implementation), during which the system is made publicly accessible for commercial use. Because the infrastructure relies on Google Apps Script (GAS), deployment is accomplished using Google's built-in Web App publishing feature. This feature automatically generates a unique public website address (URL) that connects directly to the Google Spreadsheet database system in real time. This process eliminates the need to manually configure Domain Name System (DNS) settings or separate web hosting, thus simplifying setup [23]. System implementation demonstrates that the functionality and user interface design fully match the prototype which can be seen in Fig. 4, Fig. 5, Fig. 6, Fig. 7, and Fig. 8 .

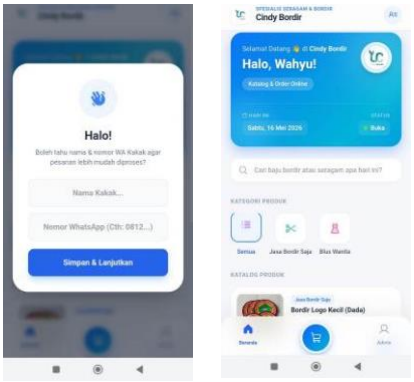

Fig. 4. Homepage Display (Mobile-First) and Product Catalog

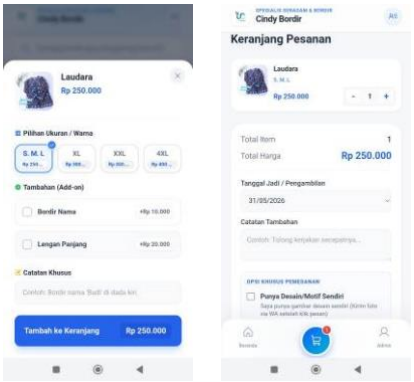

Fig. 5. Display of the Item Selection Page and Order Cart

G. Usability Evaluation

To quantitatively measure the effectiveness of the user interface and user experience (UI/UX) optimization applied through the User-Centered Design (UCD) approach—which prioritizes designing products based on users' needs—a usability evaluation was conducted using the System Usability Scale (SUS) [24]. a standardized questionnaire that rates the usability of a system. The evaluation involved a total of 30 participants, consisting of 27 prospective customers and 3 store administrators.

Participants were given specific scenarios to complete using the prototype, such as browsing the catalog, selecting product variants using the new chip-style interface (an interface that uses clickable chips, similar to labels or tags, for selecting options), and completing the checkout process via WhatsApp. The average SUS score was 84.5, as shown in Fig. 9. The industry average System Usability Scale (SUS) score is 68. A score of 84.5 is well above the 80.3 threshold and is rated "Excellent" (Grade A). This shows high usability and strong user acceptance.

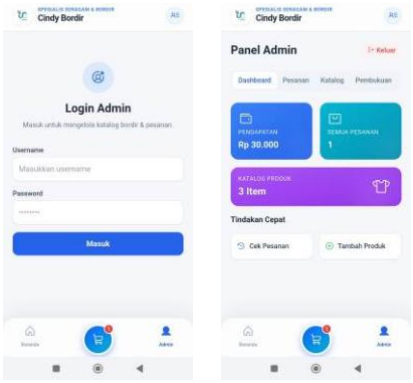

Fig. 6. Login Page and Admin Dashboard Display

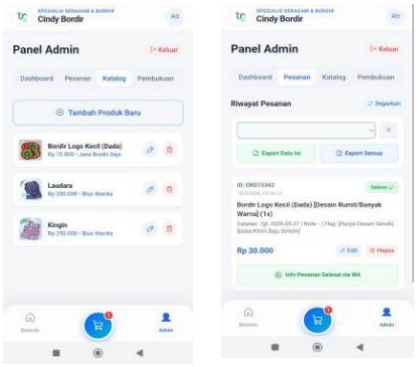

Fig. 7. Order and Catalog Page Display

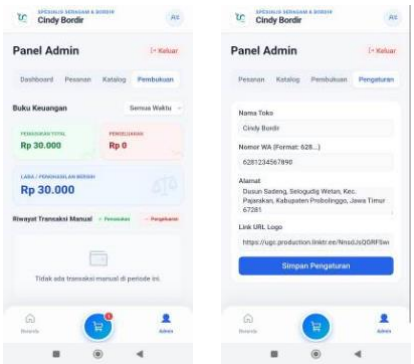

Fig. 8. Display of the Booking and Settings Page

Qualitative feedback from the evaluation showed that the mobile-first design, chip-style variants (user interface elements that look like chips or tags), and WhatsApp integration made tasks easier and workflows smoother for both customers and administrators. These results show that the user-centered design (UCD) approach helped overcome past transaction barriers in the micro, small, and medium enterprise (MSME) context.

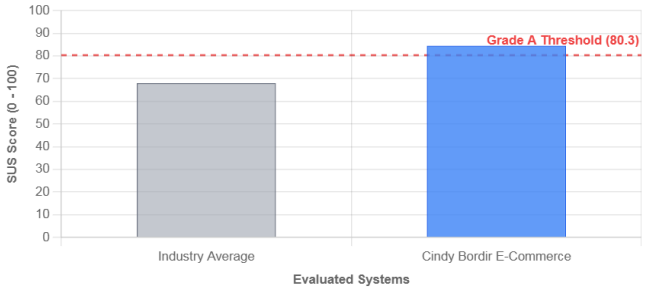

Fig. 9. System Usability Scale (SUS) Score Result

H. Data Security Analysis

Data security is a critical component of the developed serverless e-commerce architecture. The application leverages Google's cloud infrastructure through Google Apps Script (GAS) [25]. This inherently applies industry-standard security protocols, such as data encryption in transit via HTTPS. For backend data integrity, the system uses the LockService class to strictly manage resource concurrency. This mechanism successfully prevents race conditions and data conflicts. It does so when multiple users or processes attempt to update the Google Spreadsheet database at once. Access control is enforced through a secure control panel login. This restricts Create, Read, Update, and Delete (CRUD) administrative operations strictly to authenticated users. Consumer data privacy is also considered. The hybrid checkout model significantly mitigates data exposure risks. Bespoke order specifications and communication are routed directly to WhatsApp, which uses end-to-end encryption. This avoids permanent storage or vulnerability on public web servers [26].

While this study demonstrates a successful implementation of the system, certain limitations should be noted. First, the preliminary usability evaluation was conducted with a relatively small sample of 30 participants. These included prospective customers and store administrators. Second, the total reliance on Google Spreadsheet as the primary database introduces architectural boundaries. These boundaries include maximum cell constraints and execution performance limits. They may affect the system during high-volume transaction spikes in the future. Finally, the transaction workflow remains hybrid. It depends on an external communication platform (WhatsApp) for final negotiations and down payment verifications. This limits fully automated real-time payment reconciliation within the app itself.

IV. CONCLUSION

Based on the design and testing results, it can be concluded that the developed e-commerce application successfully helped solve operational and ordering problems at Cindy Bordir. The User-Centered Design (UCD) approach focuses on meeting the needs and preferences of end users. This

has proven to enhance user comfort for the user interface and user experience (UI/UX), achieving a 100% functional success rate during testing. The application's user-friendly interface is adapted for mobile screens with a Mobile-First approach, meaning it was designed primarily for smartphones. Features include a chip-style product selection that is easy to click and a simple checkout process directly connected to the WhatsApp application. Using Google Apps Script (a platform for automating tasks in Google products) and Google Spreadsheets as a database has also been very effective, efficient, and secure. This system frees business owners from server maintenance costs while making it easier to manage orders and financial bookkeeping through a familiar table format.

For further development, this application can be connected to an automatic payment system (Payment Gateway, a service that processes online payments), such as digital wallets. It can also be developed into a Progressive Web App (PWA), which is a web application that can be installed and used like a native mobile app. This will allow customers to download and install the application on their smartphones like a regular app. For future UI/UX enhancements, subsequent research should consider longitudinal A/B testing on shopping cart micro-interactions to further optimize checkout conversion rates. Improving interface accessibility is also important to ensure inclusivity for a broader demographic of MSME customers. Future work should explore database migration to scalable cloud services to overcome the architectural boundaries of spreadsheets as data volumes grow.

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