

Design Of a Website-Based Information System for Optimizing UMKM Product Marketing Using the Waterfall Method

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This study addresses the marketing challenges faced by “Risol Jiya,” a micro, small, and medium enterprise (UMKM) in Langkat Regency, which has not yet optimized a website as its primary marketing channel, resulting in limited market reach and low brand recognition. To address this problem, this study designs a website-based information system for optimizing UMKM product marketing using the Waterfall development method, covering requirements analysis, system design (use case, activity, and sequence diagrams), implementation using PHP and a MySQL database, black-box testing, and system maintenance. Testing success is measured using a validated test-case percentage formula, while marketing effectiveness is evaluated using a before-after growth percentage formula adapted from prior digital marketing studies. The resulting system provides a home page that functions as a digital storefront, a testimonial dashboard, contact and address information, and a product ordering page that operates according to the intended requirements. The findings show that the system successfully supports the marketing process and can help the UMKM increase market reach, product visibility, customer interaction, and its overall competitiveness.

Keywords: Black-Box Testing; Digital Marketing; Information System; UMKM; Waterfall Method;

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1. Introduction

The rapid growth of the global digital era has shifted marketing practices from traditional mechanisms toward online activities, including websites, social media, and e-commerce, as consumers increasingly access information and conduct transactions online. Studies show that optimal website utilization can help UMKM actors improve their business operations and marketing performance [1], while various digital marketing effectiveness studies confirm that the consistent use of digital channels can significantly increase UMKM sales performance and customer loyalty [2], [3]. These findings indicate that digital marketing is not merely a supplementary tool but a foundation for building competitive advantage for UMKM.

Based on field observations, one UMKM partner in Langkat Regency, “Risol Jiya,” which serves as the subject of this study, faces significant challenges in product marketing. Although a number of UMKM have established a digital presence through social media or marketplaces, few have optimally utilized a website as an integrated and controlled primary marketing channel. This has resulted in limited market reach, low brand recognition, and a lack of data for customer behavior analysis, a pattern also reported among other UMKM that have not yet optimized their digital promotion strategy [4], [5].

Furthermore, this UMKM partner often experiences difficulty in selecting an appropriate system to manage its website, ranging from a less responsive interface design to neglected maintenance and content-updating mechanisms, a difficulty also reported in other UMKM website development studies [6], [7]. As a result, the existing website fails to fulfill its function of supporting a measurable marketing strategy, so the potential increase in sales and customer loyalty has not been maximized.

The application of a structured model such as the Waterfall methodology is important to ensure that all stages of analysis, design, implementation, testing, and maintenance are carried out systematically,

an approach that has also proven effective in several previous UMKM information system studies [8], [9], [10]. This model is considered suitable for designing a website-based information system for optimizing UMKM product marketing.

The use of a system development method such as the Waterfall model in designing this website-based information system for optimizing UMKM product marketing is expected to help UMKM optimize their marketing activities. In addition, this study also evaluates the effectiveness of the system in increasing market reach, product visibility, customer interaction, and supporting increased sales and UMKM competitiveness, consistent with prior findings that website-based digital marketing can significantly increase market reach and sales performance for UMKM actors [11], [12].

2. Literature Review and Problem Statement

Information System

An information system is a system within an organization that meets the needs of daily transaction processing, supports operations, is managerial in nature, and supports the strategic activities of an organization, while also providing certain external parties with the reports they require [13].

Web Server

A web server functions to store all website files that will be accessed by clients according to established communication protocols. When a client accesses a website using a browser, the client sends a service request in the form of a file or web page stored on the web server. The server, acting as the service manager, then responds by sending the requested web page, or rejects the request if the intended website page is not available[14].

PHP and MySQL

PHP stands for Personal Home Page Hypertext Preprocessor. PHP is a scripting language that is placed on and processed by the server, after which the result is sent to the client using a browser [15]. PHP is commonly paired with a MySQL database to store and manage system data, an approach that has been widely applied in web-based academic and business information systems [16].

UMKM

UMKM (Micro, Small, and Medium Enterprises) are independent productive economic enterprises carried out by individuals or business entities that are not subsidiaries or branches of companies owned, controlled, or directly or indirectly affiliated with medium or large enterprises that meet the criteria according to their business type (micro, small, or medium enterprise) [17].

Digital Marketing for UMKM

Digital marketing refers to the use of online channels, such as websites, social media, and e-commerce platforms, to promote products and reach a wider customer base. Several studies confirm that a consistent digital marketing strategy can significantly increase UMKM sales volume, customer reach, and brand awareness [2], [3], [4], [5], [11], [12].

Unified Modeling Language (UML)

UML is a standard modeling language used in software system development to visualize, specify, and document the artifacts of a system. Use case modeling is one of the most important parts of UML, as it textually and visually describes the interaction between actors and the system [18], while class and other structural diagrams are commonly used to complement use case, activity, and sequence diagrams in describing a complete system design[19].

Black-Box Testing

Black-box testing is a software testing technique that focuses on the functionality of a system without examining its internal program structure, and is commonly used to validate input handling, business processes, and interface behavior against user requirements[20], [21]. The results of black-box

testing are typically expressed as a success percentage to describe the overall reliability of the tested system [22], [23].

3. Method

This study uses the SDLC (Software Development Life Cycle) approach with the Waterfall development method, aiming to produce a website-based information system that can improve the effectiveness of UMKM product marketing. The research approach is shown in the following figure.



Figure 1. Research Methodology Block Diagram

Based on the figure above, the following is an explanation of the research methodology block diagram:

1. Problem Identification
Determining the UMKM's problems related to digital marketing and optimization needs, including an analysis of the UMKM's marketing situation and a study of user requirements.
2. Data Collection
To support the requirements analysis and evaluation process, data collection techniques including observation, interviews, documentation, and literature review are carried out.
3. System Requirements Analysis
Producing system requirement specifications as the basis for the design process, covering both functional and non-functional requirements.
4. Application of the Waterfall Method
Applying the Waterfall method in designing the website-based information system for optimizing UMKM product marketing, with stages including analysis, system design, implementation, testing, deployment, and maintenance, following a sequence that has been successfully applied in similar UMKM and web-based information system studies [24], [25], [26].
5. System Design
This stage covers the design of the system interface, database design, and UML (Unified Modeling Language) design.
6. System Implementation
This stage presents the results of the system design using web programming languages (HTML, CSS, JavaScript, PHP/Framework) and a MySQL database, producing a UMKM product marketing website application as the output.
7. System Testing
Testing is carried out using the black-box testing technique to examine whether the system functions run according to requirements. The testing performed includes validation of product input, the ordering process, the product catalog, and interface responses. The success rate of each test scenario is calculated using the following percentage formula, which is commonly used in black-box testing

studies.

$$P = (\Sigma \text{ValidTestCases} / \Sigma \text{TotalTestCases}) \times 100\% \quad (1)$$

where P is the test success percentage, Σ Valid Test Cases is the number of black-box test scenarios that produce output matching the expected result, and Σ Total Test Cases is the overall number of test scenarios designed for the system. This formula follows the black-box testing approach used in prior information system studies [20], [21], [22], [23].

A. System Design

1. Use Case Diagram

A use case diagram is a graphical representation of the relationship between actors (users) and the system, used to describe the scope of the system, who interacts with the system, and what actions can be performed[18]. The following is the use case diagram for the design of the marketing product optimization information system.

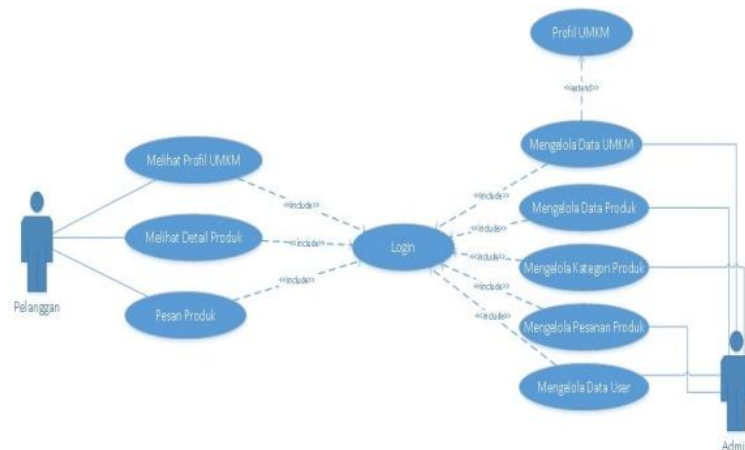


Figure 2. Use Case Diagram

2. Activity Diagram

An activity diagram describes the workflow or sequence of activities in a business process and system. This diagram emphasizes logical flow, decision branching, and parallel activities, which are important in explaining the ordering, login, form validation, and transaction processes within the information system. The following is the activity diagram for the product ordering process.

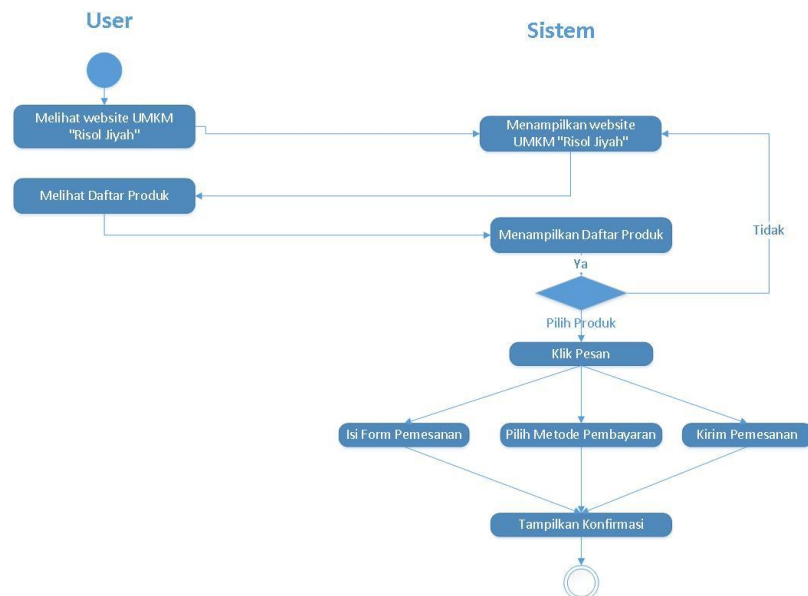


Figure 3. Activity Diagram

3. Sequence Diagram

A sequence diagram describes the interaction between objects in the system based on time sequence, including the exchange of messages that occur between actors and the system during the product ordering process. The following is the sequence diagram for the product ordering process.

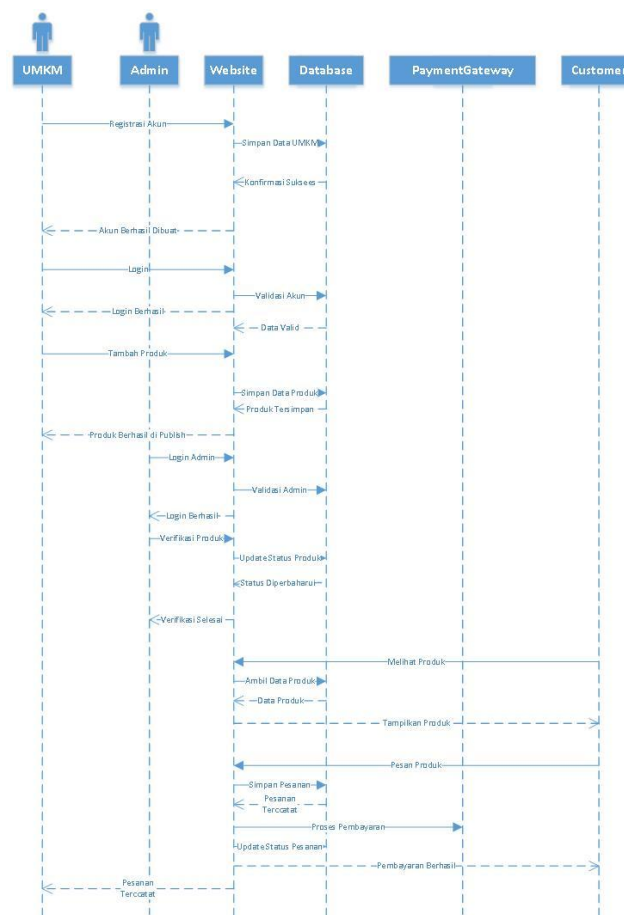


Figure 4. Sequence Diagram

4. Results And Discussion

Home Page

The home page is the initial view seen by users when accessing the system. This page is designed to serve as a digital storefront for UMKM products, displayed in card form containing visual elements and important information, such as a product catalog in a grid layout. On this page, visitors can view product images, names, prices, and an order button. The home page is shown in the following figure.



Figure 5. Home Page

Testimonial Dashboard Page

The testimonial dashboard page serves as a place where reviews or feedback from customers who have made a purchase are displayed publicly. The purpose of this page is to build trust among potential buyers and create two-way interaction between the business owner and its customers. The testimonial dashboard page is shown in the following figure.



Figure 6. Testimonial Dashboard Page

Contact and Address Page

This page provides complete information about the business owner, sales location, and how to contact them directly. The contact and address page is shown in the following figure.



Figure 7. Contact and Address Page

Product Page

The product page is the part of the system that allows users to place orders for available products. On this page, the main focus is an ordering form that is easy to fill in and does not confuse users, especially non-technical users. The system was tested locally and then uploaded to a free hosting service for trial use by selected UMKM actors. The product page is shown in the following figure.



Figure 8. Product Page

Black-Box Testing Results

Black-box testing was carried out on the system's main functions, namely product input, the ordering process, the product catalog, and interface responses, by comparing the actual results with the expected results for each test scenario, following formula[1]. The success percentage obtained determines whether each function has met the intended requirements.

Marketing Effectiveness Discussion

Beyond functional testing, the marketing effectiveness of the website can also be evaluated quantitatively by comparing a marketing indicator, such as the number of visitors, product views, or orders, before and after the website is implemented. This effectiveness is commonly measured using a growth percentage formula, as follows.

$$G = \left(\frac{X_{\text{after}} - X_{\text{before}}}{X_{\text{before}}} \right) \times 100\% \quad (2)$$

where G is the marketing growth percentage, X_{after} is the value of the marketing indicator after the website is implemented, and X_{before} is the value of the same indicator before implementation. This before-after comparison approach follows the evaluation method used in prior UMKM digital marketing

effectiveness studies [2], [3], [4], [5], [11], [12]. Applying this formula to the actual visitor, engagement, or sales data collected before and after the system is deployed will allow the UMKM to quantify the real marketing impact of the website. Furthermore, the effectiveness of the website can also be evaluated using the Conversion Rate (CR), which measures the percentage of website visitors who successfully complete a purchase transaction. A higher conversion rate indicates that the website is more effective in converting visitors into customers. The formula is as follows.

$$CR = \left(\frac{\text{Total orders}}{\text{Total isitors}} \right) \times 100\% \quad (3)$$

where CR is the conversion rate, Total Orders is the number of successful customer orders, and Total Visitors is the total number of website visitors.

In addition, user interaction with the website can be evaluated using the Engagement Rate (ER), which measures the percentage of visitors who interact with website features such as viewing products, submitting testimonials, or contacting the business owner. The formula is as follows.

$$ER = \left(\frac{\text{Total nteractions}}{\text{Total isitors}} \right) \times 100\% \quad (4)$$

where ER is the engagement rate, Total Interactions is the number of user interactions with the website, and Total Visitors is the total number of website visitors.

5. Conclusion

This study successfully designed a website-based information system for optimizing UMKM product marketing by applying the Waterfall method, which can increase market reach, product visibility, and customer interaction, as well as improve sales and UMKM competitiveness. The system was developed using the PHP programming language and a MySQL database, and its functional reliability was validated using the black-box testing success-percentage formula, while its marketing impact can be quantified using the before-after growth percentage formula. Based on the implementation results, the designed system can be considered appropriate, with key features such as the home page, testimonial dashboard page, contact and address page, and product page that are able to address the problems formulated, particularly regarding UMKM product marketing in Langkat Regency[27].

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Design Of a Website-Based Information System for Optimizing UMKM Product Marketing Using the Waterfall Method, Wulandari et.al

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