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Optimizing Shopping Experience by Integrating Augmented Reality and Payment Gateway in SME Storefronts

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***Abstract*—In the rapidly evolving digital era, utilizing advanced technologies to enhance the online shopping experience is essential, especially for small and medium-sized enterprises (SMEs) aiming to compete in the global market. This research focuses on optimizing the shopping experience by integrating Augmented Reality (AR) and Payment Gateway technologies into a storefront platform specifically designed for women's clothing SMEs. The study begins with a comprehensive analysis of market trends, customer behavior, and the challenges faced by SMEs in adopting these technologies. A detailed literature review provides the foundation for developing a robust conceptual framework. The prototype development phase involves designing 3D models using CLO | 3D Fashion Design Software, converting these models into AR experiences with Meta Spark Studio, and integrating the Midtrans Payment Gateway using Laravel. The AR feature enables users to virtually try on clothes via Instagram, while the Payment Gateway ensures quick and secure transactions. The final phase involves rigorous functional and substantive testing, focusing on user experience, transaction efficiency, and overall system performance. Results demonstrate that the integrated prototype significantly enhances the shopping experience, providing seamless AR interactions and efficient payment processing. Users expressed a high level of satisfaction with the system's ease of use and security features. The study concludes that integrating AR and Payment Gateway technologies into SME storefronts can substantially improve their competitiveness in the digital market, offering practical insights and guidelines for future implementations in the e-commerce sector.**

***Index Terms*—Digital Transformation, E-commerce, SME Competitiveness, User Experience.**

I. INTRODUCTION

In the rapidly evolving digitalization era, the use of technology to enhance online shopping experiences has become increasingly important, especially for small and medium enterprises (SMEs) striving to compete in the global market [1], [2]. One technology that has garnered significant attention is Augmented Reality (AR) [3], along with Payment Gateway systems [4]. AR enables users to interact with products virtually, offering a more engaging and satisfying shopping experience [5]. Meanwhile, Payment Gateway allow SMEs to conduct online payment transactions quickly and securely, broadening their market reach [6]. However, integrating these two technologies on e-commerce platforms or online stores (storefronts) has not yet been fully optimized, causing SMEs to miss opportunities to attract customers and significantly boost their sales. Therefore, this research is essential to optimize the integration of AR and Payment Gateway in the context of SMEs, enabling them to leverage this technology to its fullest potential in an economical manner to enhance their competitiveness and business growth in the digital age.

This research's state-of-the-art encompasses the latest developments in integrating AR technology and Payment Gateway system into e-commerce platforms or online stores (storefronts). Previous studies have explored the potential of AR to enhance online shopping experiences by providing consumers with more realistic product visualizations. Research has been conducted on the application of AR using Facebook [7], [8], [9] and Instagram [10], [11], [12], [13], [14], [15], [16] filters through Meta Spark Studio. Meanwhile, Payment Gateway has become the standard for online transactions to ensure payment security and speed. Several studies have utilized Payment Gateway from Midtrans in mobile-based applications [17], [18], [19], [20], [21], [22] and websites [23], [24], [25], [26], [27] for various purposes.

The novelty of this research lies in its integrated approach to optimizing the online shopping experience by effectively combining AR and Payment Gateway technologies on a storefront platform for women's clothing. This study not only focuses on the development of an application prototype but also provides a comprehensive evaluation of user experience, transaction efficiency, and its impact on sales conversion. By addressing these aspects holistically, this research aims to offer new insights and innovative solutions to enhance the competitiveness of SMEs in the digital era.

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II. METHODS

The research includes Concept Development, Prototype Design, Prototype Development, and Prototype Testing. These stages, as presented in Figure 1, are designed to provide relevant and in-depth information regarding integrating AR and Payment Gateway technologies on the storefront platform for women's clothing.

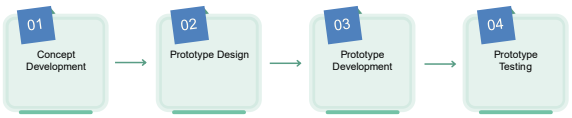

Fig. 1. The stages of the research

Concept Development is the initial stage that underpins the understanding of the research context. It involves market analysis, customer behavior analysis, and the challenges faced by SMEs in adopting AR and Payment Gateway technologies. Subsequently, an in-depth literature review is conducted to understand the implementation of these technologies in the context of online shopping and to identify potential benefits for SMEs. These steps help formulate a solid research concept, providing a strong foundation for the next stages. The literature review also provides the necessary insights to steer the research in a productive direction.

The Prototype Design includes 3D Modeling AR design using CLO | 3D Fashion Design Software [28], converting the 3D model to AR using Meta Spark Studio [29], [30] for uploading to Instagram, creating a Midtrans [31] account for Payment Gateway, integrating Midtrans Payment Gateway with Laravel [32], and the AR and Payment Gateway mechanism.

The Prototype Development stage involves programming using PHP [33] to implement the previously designed prototype. This includes integrating the storefront with Midtrans using the Laravel framework.

In the final stage, Prototype Testing, both functional and substantive tests are conducted with a focus on user experience. The developed prototype is ensured to not only meet the needs and expectations of the SME actors but also adhere to desired quality and performance standards. Data on their preferences, perceptions, and interactions will be gathered through interviews and observations.

III. RESULT AND DISCUSSION

The concept development results are shown in Figure 2, which illustrates the interaction patterns of the main components of the application prototype, and Figure 3, which presents a broad process flow diagram.

The interaction patterns between customers, storefronts, computers, smartphones, AR, payment gateways, and Instagram create an interconnected ecosystem for an integrated and interactive shopping experience. Customers access the storefront platform via computer or smartphone to browse and purchase products. They also use smartphones to access Instagram, where they find advertised products and interact with content. AR technology on smartphones lets customers virtually try products, enhancing their shopping experience. After selecting products, customers complete transactions through a payment gateway, ensuring quick and secure payments. Smartphones play a crucial role in activating AR and connecting customers with Instagram and the storefront, while computers provide an alternative means to access the storefront.

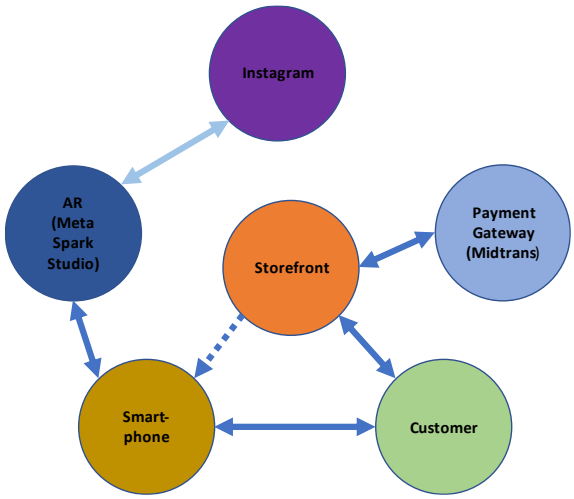

Fig. 2. Interaction patterns of the main components aplication

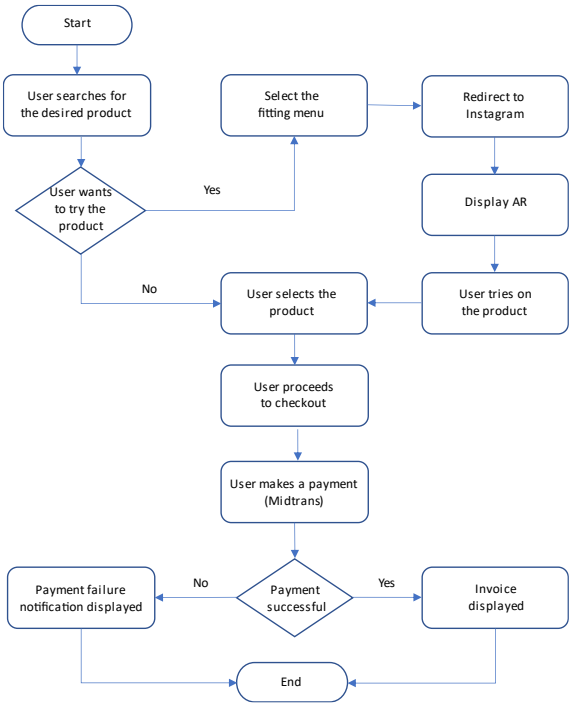

Fig. 3. Broad process flow diagram

The design mechanisms for using AR and the Payment Gateway are illustrated in Figures 4 and 5. These figures provide a detailed visual representation of how the AR technology and Payment Gateway are integrated into the storefront platform, showcasing the step-by-step interaction process from a user's perspective.

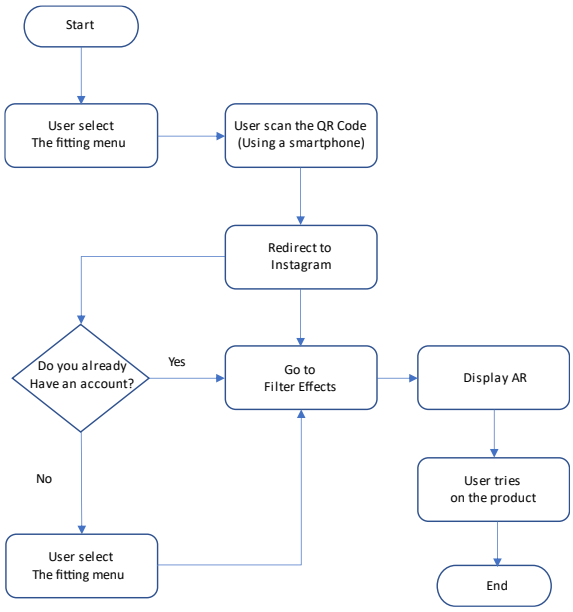

Fig. 4. Augmented Reality process

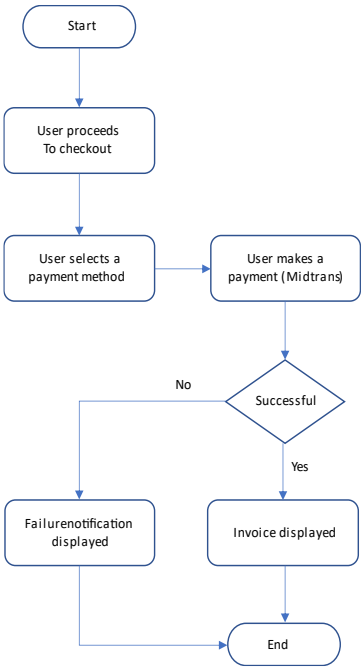

Fig. 5. Payment Gateway process

3D modeling for AR clothing fitting involves creating three-dimensional models, as shown in Figure 6. These models are converted into AR using Meta Spark Studio, as depicted in Figure 7. The result is a realistic simulation of how the clothing will look and fit on the user's body when tried on through Instagram.

An account is created on the Midtrans registration website [34] to use Midtrans as a payment gateway. Once the account is active, log in to the Midtrans dashboard [35] to set payment preferences, access the Application Programming Interface (API), and manage business transactions, as shown in Figure 8.

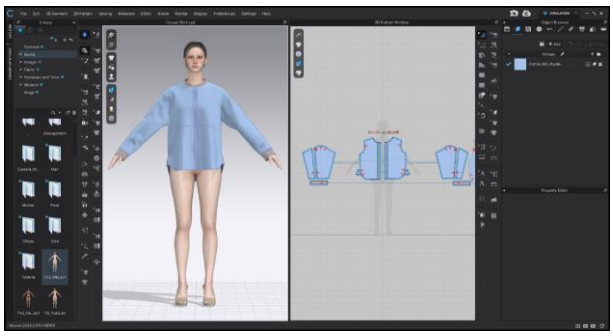

Fig. 6. 3D *Modeling Augmented Reality* CLO | 3D

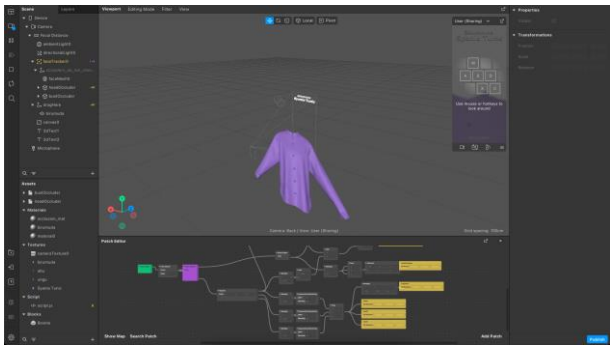

Fig. 7. Converting 3D models into AR using Meta Spark Studio

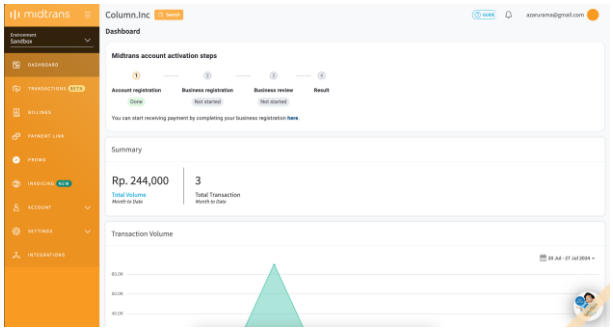

Fig. 8. Midtrans Dashboard for Payment Gateway configuration

Figure 9 is the pseudocode for integrating with the Midtrans API. First, set the `$serverKey` variable with the server key from your Midtrans account. Then, configure the settings by setting `setIsProduction` to `false` for a development environment, `setIsSanitized` to `true` to clean the data from special characters, and `setIs3ds` to `true` for additional credit card security. Prepare the necessary transaction parameters such as `transaction_details`, `item_details`, and `customer_details` with the actual transaction values. After that, use `params` to obtain a transaction token with `MidtransSnap.getSnapToken(params)`, and then send the `snapToken` to the view to implement the payment gateway in the storefront.

Next is the Prototype Development phase, which includes the implementation of AR and the Midtrans Payment Gateway. As shown in Figure 10, the application users must scan the provided QR code with their smartphones to use AR for fitting purposes. Upon scanning, they will be navigated to Instagram where the AR system will display the fitting, as illustrated in Figure 11.

```
// Step 1: Set Up Payment Gateway Configuration
PaymentGatewayConfig.setServerKey('SB-Mid-server-
xxxxxxxxxxxxx')
PaymentGatewayConfig.setIsProduction(false)
PaymentGatewayConfig.setIsSanitized(true)
PaymentGatewayConfig.setIs3ds(true)

// Step 2: Prepare Transaction Parameters
params = {
  'transaction_details': {'order_id':
generateRandomNumber(), 'gross_amount': 'Total Price},
  'item_details': [
    {'id': 'item1', 'price': 'Price A', 'quantity':
'Quantity A', 'name': 'Product A'},
    {'id': 'item2', 'price': 'Price B', 'quantity':
'Quantity B', 'name': 'Product B'}
  ],
  'customer_details': {'first_name': 'john', 'last_name':
'doe', 'email': 'john.doe@example.com', 'phone':
'08000000000'}
}

// Step 3: Generate Payment Token
paymentToken = PaymentGateway.getPaymentToken(params)

// Step 4: Return Payment Token to View
return view('payment', {'payment_token': paymentToken})
```

Fig. 9. Pseudocode for integrating with the Midtrans API

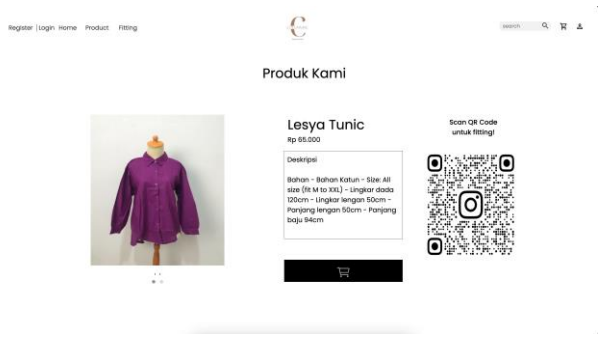

Fig. 10. QR Code scanning for AR fitting

Fig. 11. AR fitting displayed on Instagram

In Figure 12, the interface for payment using a GoPay [36] QR Code is shown. The process involves simply scanning the QR Code with the GoPay app. Transaction details such as the merchant's name and the payment amount will then be displayed in the GoPay app. If all the information is correct, the user presses the "Pay" button to complete the transaction. When the payment is successful, a "Payment Successful" notification will appear, as shown in Figure 13.

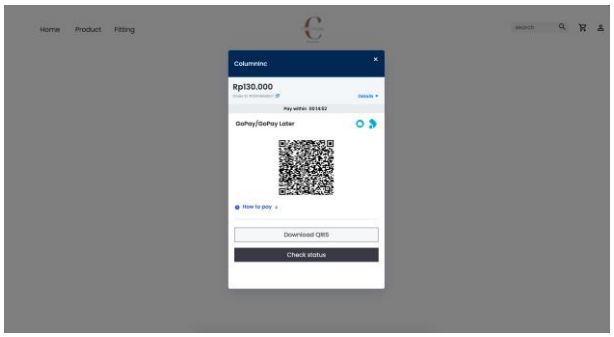

Fig. 12. QR Code payment interface

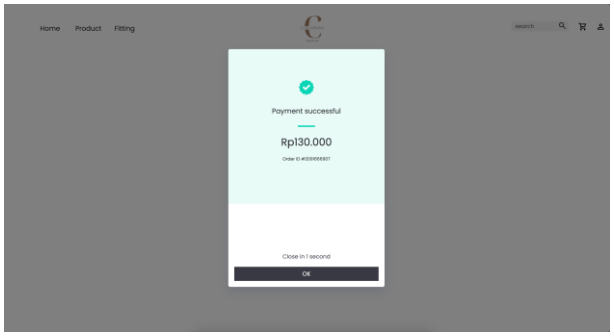

Fig. 13. Payment successful notification

After the payment is completed, the SME actors can view the transaction report on the Midtrans web page, as shown in Figure 14.

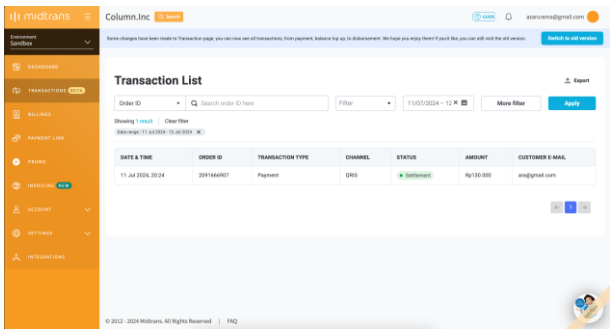

Fig. 14. Transaction report on Midtrans web page

The challenges encountered and the solutions applied during the implementation of AR technology are summarized in Table 1.

The final stage of this research is Prototype Testing, involving comprehensive functional and substantive testing as presented in Table 2.

Table 1. Challenges and solutions in implementing AR technology

Challenge	Solution
3D models for AR must have sufficient detail for a realistic appearance but not too complex, making it difficult for developers to create 3D models for AR.	Attention to detail is required when creating 3D models for AR to ensure the results meet expectations.
Using high-resolution materials and textures can slow down device performance, while low-resolution ones can reduce visual quality.	Adjust the resolution of textures and materials to match the weakest device intended to be supported for optimal performance.
The scale and size of the model must be adjusted to look proportional in the real environment.	Use relative sizing to real-world objects (users) for better adjustment.
Accurate visual positioning in the real environment is necessary to ensure seamless and successful integration.	Conduct trials with SME operators to gather feedback, then improve based on the feedback to enhance user experience.

Table 2. Comprehensive prototype testing

Category	Question	Success Criteria	Result
Functional Testing	Can the AR feature be accessed through the storefront (QR Code) to Instagram from a smartphone?	AR feature is accessible without errors	Success
Functional Testing	Does the payment transaction process run quickly and securely?	Transaction completes in less than 10 seconds	Success
Functional Testing	Is the user interface (UI) navigation on the storefront easy to use?	SME operators find the navigation easy	Success
Usability Testing	What is the user experience in using this application?	SME operators are satisfied with the user experience	Success
Security Testing	Is the payment transaction data adequately encrypted?	Data is encrypted	Success
Compatibility Testing	Does the application work well on devices (smartphones and computers)?	Application functions on all major devices	Success
Integration Testing	Does the integration between the storefront, AR, and Payment Gateway run smoothly?	All integrations work without issues	Success

The development and integration of AR and Payment Gateway technologies presented several technical challenges that required careful solutions to ensure a seamless user experience. One major challenge was creating 3D models for AR that were detailed enough to provide a realistic appearance without being overly complex, which could hinder performance. To address this, developers optimized 3D models by simplifying geometry and using texture maps effectively, balancing visual quality and system efficiency. Additionally, the use of high-resolution materials and textures posed a risk to device performance, especially on lower-end devices, while low-resolution textures could compromise visual quality. Developers adjusted texture resolutions to match the capabilities of the least powerful devices, ensuring an optimal balance between performance and visual appeal. Another significant challenge was ensuring that the scale and size of 3D models appeared accurate and proportional in real-world environments. By using relative sizing techniques based on real-world objects, developers ensured that virtual objects were appropriately scaled and positioned. Accurate visual positioning within the user's environment was also essential for creating a seamless AR experience. Extensive trials were conducted with SME operators to gather feedback on the AR features, leading to iterative improvements in the algorithms for tracking and positioning virtual objects. This included optimizing plane detection, surface recognition, and anchor point algorithms to enhance the precision of object placement, ultimately improving the overall realism and user experience. These targeted solutions enabled the development of a robust AR system that provided a high-quality experience while maintaining optimal performance across different devices.

The results from the prototype testing show strong performance across all assessed categories, highlighting the effectiveness of integrating AR and Payment Gateway technologies within the storefront platform. The AR feature was easily accessible via smartphones through Instagram, enhancing user engagement and providing a more interactive shopping experience. Payment transactions were processed swiftly and securely, reflecting the reliability and efficiency of the Payment Gateway integration. Users reported high satisfaction with the application's ease of navigation, indicating a user-friendly design. Security protocols were robust, with adequate data encryption safeguarding transaction information. The application was compatible with various devices, including smartphones and computers, ensuring widespread accessibility. Moreover, the seamless integration of the storefront, AR, and Payment Gateway components demonstrated the system's overall efficiency and coherence. These positive outcomes suggest that the prototype successfully meets the criteria for functionality, usability, security, compatibility, and integration, making it a promising tool for enhancing the online shopping experience for SMEs. However, future research should investigate potential limitations, such as scalability issues or the need for further customization to cater to different product types and user demographics.

The study showcases how integrating AR and Payment Gateway technologies can enhance the online shopping experience for SMEs by improving user engagement and streamlining transactions. However, exploring alternatives like Virtual Reality (VR), which offers a more immersive shopping experience but requires more advanced hardware, or Artificial Intelligence (AI) for personalized product recommendations, could provide additional insights. Blockchain technology could also enhance transaction security and transparency but involves complex

implementation. While AR and Payment Gateways are accessible and practical for SMEs, considering these alternatives could offer a more comprehensive view of available options for optimizing digital storefronts.

IV. CONCLUSION

This study successfully developed and tested a prototype that integrates AR and Payment Gateway technologies into a storefront platform designed for SMEs. The integration of AR provided users with an immersive and interactive shopping experience, allowing them to virtually try on products via Instagram. The Payment Gateway integration facilitated quick and secure transactions, enhancing the overall efficiency and security of the purchasing process.

This study provides valuable insights and practical guidelines for future implementations of similar technologies in the e-commerce sector. However, further research is necessary to explore several areas for potential enhancement. Future studies could examine the effectiveness of this prototype in other market segments, such as luxury goods or consumer electronics, to determine if the benefits of AR and Payment Gateway integration are consistent across different product categories. Testing the prototype with a broader range of products could also help identify any limitations or areas for improvement in the AR functionality or payment process. Researchers could also consider integrating additional features, such as personalized recommendations, advanced filtering options, or augmented reality tutorials, to further enhance the user experience. Exploring the long-term impact of these technologies on user behavior, customer retention, and business performance could provide a deeper understanding of their value to SMEs. By addressing these aspects, future research could contribute to developing even more robust and versatile e-commerce solutions.

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