Journal of Informatics, Computer Science, Data Science And Arificial Intelligence
Volume 3 No. 2 December 2025, ISSN : 3031-9145

AUGMENTED REALITY TECHNOLOGY IMPLEMENTATION FOR JEPARA CARVING PRODUCTS AS A PROMOTIONAL MEDIUM AT SAMUDRA PUTRA FURNITURE STORE

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ARTICLE INFO

ARTICLE HISTORY:
Received : 10 November 2025
Revised : 15 November 2025
Accepted : 19 November 2025

Keywords: *Augmented Reality (AR), Media Promosi Interaktif, Visualisasi 3D, Black Box Testing, UMKM, Furnitur, Toko Samudra Putra.*

ABSTRACT

The furniture business competition in the digital era faces challenges in promotion, namely the inability of 2D media to present product scale and proportion visualization accurately. This limitation creates visual uncertainty (customer hesitation) that hinders purchasing decisions. This research aims to design and develop an Augmented Reality (AR)-based interactive promotional medium to provide a virtual try-before-you-buy experience. The development methodology employs the Multimedia Development Life Cycle (MDLC) with a backend interface for product management (CRUD) and a frontend for product catalog and AR visualization. The implemented technologies include AR as the core of 3D visualization, Quick Response Code (QR Code) as an access trigger, and WebAR as a browser-based platform. System testing utilizes Black Box Testing methods covering functional testing, AR quality, and User Acceptance Testing (UAT). The research results demonstrate that the system was successfully built with 100% functionality operating according to specifications. AR functionality proved capable of projecting 3D models stably and interactively in the user's environment. UAT results show that the system is well-accepted by the store for managing products and by prospective customers for assisting the visualization process. The novelty of this research lies in the implementation of markerless WebAR with plane detection that enables direct access through browsers without application installation, as well as a focus on digitizing Jepara carving products with high visual complexity. This research concludes that AR implementation is a functional and valid solution to overcome 2D media visualization problems and has the potential to increase customer confidence in making online furniture purchasing decisions.

INTRODUCTION

The rapid development of information and communication technology has driven significant changes across various industrial sectors, including the furniture trade sector (Cahyaningsih, 2020). In the intense competition of the digital marketplace, business success no longer depends solely on product quality, but also on the ability to create interactive and personalized experiences for customers. Conventional promotional methods, such as printed catalogs or physical store displays, present tangible barriers, particularly in industries that prioritize product visualization such as furniture, where consumers struggle to envision how a product will appear in their space (Wibowo, Sanjaya, & Handani, 2020).

As a response to this challenge, Augmented Reality (AR) technology has emerged as a transformative solution in the marketing landscape. AR is a technology that integrates virtual elements into the real environment in real-time (Cahyaningsih, 2020). The use of AR in marketing strategies not only enhances visual appeal but also builds deeper interactions between brands and consumers (Laiya, Katili, & Kadim, 2023). Various studies demonstrate that AR implementation can significantly increase user engagement.

The application of AR in the furniture industry offers innovative approaches to address problems inherent in traditional promotion. Through AR features, prospective buyers can project 3D visuals of furniture into their rooms using smartphone or tablet cameras (Arthana, 2021); (Saputra & Budiyanto, 2020). This capability enables them to ensure whether the design, size, and color of the furniture harmonize with their existing interior, thereby minimizing the possibility of unsuitable product purchases (Ozturkcan, 2021).

Samudra Putra Furniture Store, as a local furniture business specializing in Jepara carved products, still relies on conventional promotional methods such as physical catalogs and non-interactive social media. This condition makes the store struggle to compete with technologically advanced competitors. The limitations of 2D media (photographs) make it difficult for consumers to obtain a comprehensive understanding of products, particularly the intricate carving details, which can hinder their purchasing decisions.

This research identifies an urgent need for more interactive promotional media at Samudra Putra Furniture Store. Therefore, the development and implementation of AR technology is proposed as a solution. By integrating 3D models of carved furniture into consumers' real environments, this technology is expected to create superior shopping experiences, accelerate decision-making, and ultimately contribute to enhancing the store's competitiveness and sales in the digital era.

RESEARCH METHODS

System Development Method

This research employs the Multimedia Development Life Cycle (MDLC) method, which was selected because this framework is specifically designed to ensure the quality of visual content and interaction in a multimedia project. MDLC provides a systematic and sequential workflow through six stages: Concept, Design, Material Collecting, Assembly, Testing, and Distribution.

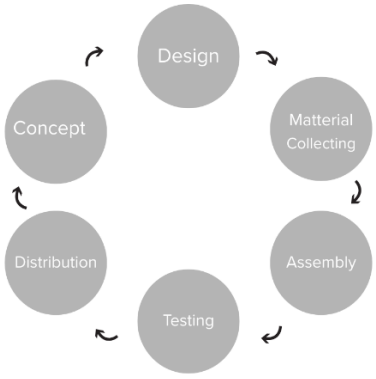

Figure 1. Multimedia Development Life Cycle (MDLC) Stages

Data Collection

Data collection was conducted through three methods:

1. Literature Study: Reviewing textbooks, technical documentation, scientific articles, and relevant publications about AR, WebAR, 3D visualization algorithms, and web development frameworks.
2. Observation: Direct observation of the manual promotion process at Samudra Putra Furniture Store to identify weaknesses in conventional media and system requirements.
3. Interviews: Semi-structured interviews with the store owner and potential customers to understand system needs and challenges faced.

System Requirements Analysis

System requirements are classified into two categories:

A. Functional Requirements

For Admin:

- Authentication and master data management (products, prices, descriptions)
- Upload 3D models (.glb format) and product images
- Generate QR Codes for each product
- Product monitoring and reporting

For User (Customer):

- Access to digital product catalog
- View product details (name, price, description, images)
- Scan QR Code to trigger AR
- Visualize 3D product models in real environment

B. Non-Functional Requirements

- Performance: 3D model loading time < 10 seconds
- Security: Secure authentication and role-based access control
- Usability: Intuitive and user-friendly interface
- Compatibility: Runs on modern browsers (Chrome, Safari, Firefox)

System Design

System Architecture

The system is designed using a layered architecture involving:

- Admin and User Frontend (HTML, CSS, JavaScript)
- Backend API (PHP with Laravel framework)
- Database (MySQL for persistent data)
- AR Library (Model Viewer for WebAR)
- QR Code Generator (PHP library)

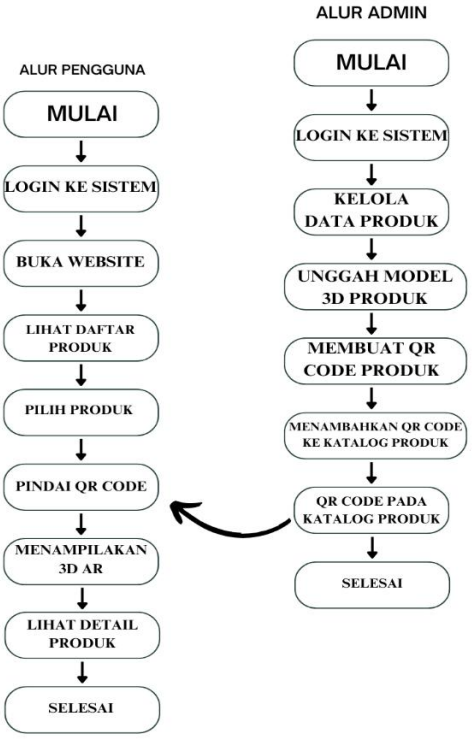

Figure 2. AR-Based Promotion System Architecture

Database Design

The relational database (MySQL) is designed with main entities: users (admin), products, and settings. The product table stores product information including the path to 3D model files (.glb) and QR Codes.

Table 1. Product Table Structure

No	Field	Data Type	Description
1	id	INT	Primary key, auto increment
2	nama	VARCHAR(255)	Furniture product name
3	harga	DECIMAL(10,2)	Product price in Rupiah
4	deskripsi	TEXT	Detailed product description
5	gambar_url	VARCHAR(255)	2D product image file path
6	model_url	VARCHAR(255)	3D model file path (.glb)
7	url_qr_code	VARCHAR(255)	QR Code file path
8	dibuat_pada	TIMESTAMP	Data creation time

UML Modeling

The system is modeled using Use Case Diagrams, Sequence Diagrams, Class Diagrams, and Activity Diagrams to illustrate user interactions, process flows, and data structure.

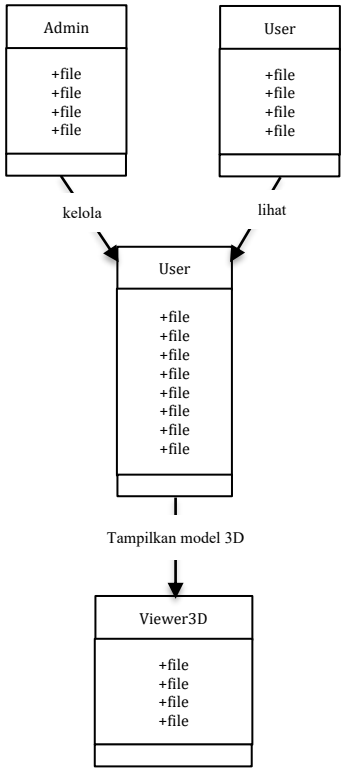

Figure 3. System Use Case Diagram

The diagram shows two main actors (Admin and User) along with their respective use cases.

AR Technology Implementation

AR technology is implemented using the Model Viewer library that supports WebAR. Model Viewer is a web component that enables interactive rendering of 3D models (.glb format) in browsers with AR mode support. The AR visualization process begins when users scan a QR Code that directs them to a special page containing the Model Viewer component configured with the related product's 3D model.

AR Process Pseudocode:

```
FUNCTION displayARModel(productId):
   // Retrieve product data from database
   product = getProductById(productId)

   // Load AR viewer page
   renderPage("ar_viewer.html")

   // Initialize Model Viewer
   modelViewer = initModelViewer({
      src: product.model_url,
      ar: true,
      camera-controls: true,
      auto-rotate: true
   })

   // Display AR button
   displayARButton()

   // AR button event handler
   ON_CLICK arButton:
      activateARMode()
      projectModelToRealWorld()
   END
END FUNCTION
```

System Testing

Testing was conducted through three methods:

1. Functional Testing (Black Box): Verifying all system features according to specifications for both user roles (Admin and User).

2. AR Quality Testing: Validating the stability of 3D model rendering, interaction responsiveness (rotation, zoom), and loading performance under various network conditions.
3. User Acceptance Testing (UAT): Acceptance testing by the store and potential customers to evaluate ease of use and system benefits.

RESULTS AND DISCUSSION

System Implementation

The system was successfully implemented with the following components:

Backend (PHP Laravel)

- MVC structure with Eloquent ORM
- RESTful API endpoints with authentication middleware
- Implementation of CRUD functions for product management
- Integration of QR Code generator library

Admin Frontend

- Dashboard for product monitoring
- Product data input form with validation
- Upload handler for images and 3D models
- Automatic QR Code generation interface

User Frontend

- Product catalog with card-based grid layout
- Product detail modal with complete information
- QR Code modal for AR access
- AR viewer page with Model Viewer component

AR Visualization and 3D Interaction

The user interface provides an interactive AR experience using the Model Viewer library. Users can access the AR feature through QR Codes that load a dedicated page containing the product's 3D model.

Figure 4. AR Visualization Interface with 3D Model

3D Model Rotation Testing

To validate the visualization quality, 3D model rotation testing was conducted from various viewing angles:

- 0° (Front View): Validation of backrest carving details and frontal structure
- 90° (Right Side View): Verification of depth proportions and component thickness
- 180° (Back View): Confirmation of complete geometry of support structure
- 270° (Left Side View): Validation of design symmetry
- 360° (Return to Front): Demonstration of full rotation continuity

Testing results showed that the 3D model could be rotated smoothly without visual distortion, with carving details preserved from all viewing angles.

Testing Results

A. Functional Testing (Black Box)

Testing was conducted on 20 scenarios covering features for Admin (10 scenarios) and User (10 scenarios).

Table 2. Summary of Functional Testing Results

Role	Total Scenarios	Successful	Percentage
Admin	10	10	100%
User	10	10	100%
Total	20	20	100%

The results indicated that all main system features operated according to specifications, including:

- Authentication for both roles
- Product data management (CRUD)
- Image and 3D model upload
- Automatic QR Code generation
- Product catalog display
- Product detail visualization
- AR access through QR Code
- Interactive 3D model rendering

B. AR Quality Testing

Testing was conducted across 5 aspects to validate AR performance:

Table 3. AR Quality Testing Results

No	Testing Aspect	Expected Result	Actual Result	Status
1	3D Model Loading	Loading time < 10 seconds	Average 7.2 seconds	Compliant
2	Rendering Stability	Model displays stably without glitches	Stable model, no distortion	Compliant
3	Rotation Responsiveness	Smooth rotation with touch gesture	Responsive rotation, minimal delay	Compliant
4	Zoom Function	Zoom in/out with pinch gesture	Zoom functions normally	Compliant
5	AR Mode	Model projected in real environment	Successful projection with stable tracking	Compliant

The results demonstrated that AR implementation using Model Viewer was capable of delivering stable, interactive 3D visualization suitable for furniture product promotion needs.

C. User Acceptance Testing (UAT)

Acceptance testing was conducted involving the store (1 admin) and potential customers (5 respondents).

Table 4. Summary of UAT Results

Category	Number of Respondents	Assessment Results	Satisfaction Percentage
Admin (Store)	1	Easy product management, efficient QR generation	100%
User (Customer)	5	AR aids visualization, carving details clearly visible	100%

UAT results indicated that the system was well-received by both parties. The admin assessed that the system facilitated product management and QR Code automation, while users evaluated that the AR feature was highly beneficial in visualizing products before making purchase decisions.

Discussion

System Advantages

1. Comprehensive 3D Visualization: Model Viewer implementation enables users to view carving details from various angles, overcoming the limitations of 2D media that only presents a single perspective.
2. Easy Access via WebAR: The WebAR approach allows direct access through browsers without application installation, reducing technology adoption barriers for users.
3. QR Code Automation: The system automatically generates unique QR Codes for each product, simplifying admin tasks and accelerating the publication process.
4. Structured Architecture: The use of Laravel framework (MVC) and frontend-backend separation provides a foundation that is easy to maintain and has good scalability potential.

Comparison with Previous Research

Compared to research by Laiya et al. (2023) which used native Android applications

with marker-based AR, this system is more flexible due to its web-based nature and markerless approach. Research by Sutedi et al. (2022) and Nasoba et al. (2021) was also limited to native applications requiring installation.

The novelty of this research lies in:

1. Implementation of markerless WebAR enabling direct browser access
2. Focus on Jepara carved products with high visual complexity
3. Integration of QR Code as an easy-to-use trigger for offline-to-online promotion

CONCLUSION

This study successfully developed an interactive promotional media system based on Augmented Reality for Jepara carving products at Samudra Putra Furniture. The testing results showed a 100% success rate in both functional testing and AR quality assessment, along with full acceptance in the User Acceptance Testing. The novelty of this research lies in the implementation of markerless WebAR, which enables high-detail 3D visualization of carving products without requiring any application installation.

The system has proven to improve the efficiency of promotional processes, enhance product visualization accuracy, and provide a try-before-you-buy experience that cannot be offered by conventional 2D media. The integration of QR Codes facilitates easy access, while the structured admin interface simplifies content management. This research makes an important contribution to the development of digital promotional systems for MSMEs in the furniture sector through an innovative AR-based approach.

Recommendations for Future Research:

1. Develop analytics features to track user interactions with AR models
2. Implement Progressive Web App (PWA) support for offline functionality
3. Optimize 3D model compression algorithms to accelerate loading times
4. Integrate with e-commerce platforms to complete the sales cycle

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