



Streamlining Architectural Design Services with Mobile E-Commerce Development Using Integrated Payment Gateways

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Abstract.

Purpose: This research aims to design a mobile-based e-commerce system integrated with a payment gateway, as well as a centralized data management dashboard for A3+ Architect Design. The main focus of the research is on the efficiency of architectural design service business processes, including data management, information access, ordering mechanisms, payment integration, and real-time order monitoring for customers.

Methods: The research methodology applied a systematic four-stage approach, including needs analysis to identify requirements through interviews with the A3+ studio, system model design, implementation, and testing. The system was built using client-server architecture with Flutter as the mobile application and Laravel as the web service and admin/designer dashboard. Functional validation of the system at the final stage was carried out using the black-box testing method.

Result: Black box testing confirmed that all features are operating optimally and in accordance with the requirements specifications. The system successfully provides a comprehensive transaction workflow and an efficient operational dashboard for administrators and designers to support more organized data management.

Novelty: The uniqueness of this research lies in the integration of a mobile application system with a web dashboard that is specifically tailored to the characteristics of the architectural services industry, which was previously dominated by manual processes. This research contributes to the digitization of customer services and increased transaction transparency, which directly impacts the strengthening of customer trust and the operational efficiency of service providers.

Keywords: Mobile applications, E-commerce, Payment gateway, Architecture design, Efficiency

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INTRODUCTION

Digital transformation has changed and revolutionized the business industry, with digitization now an integral part of every aspect of business. These changes significantly affect business growth and sustainable development. [1]. Technology enables businesses to overcome geographical limitations, expand their market reach through e-commerce, and optimize operations through process automation, data analysis, and other advanced techniques [2]. E-commerce is a type of transactional business involving goods and services conducted by businesses and online customers [3]. E-commerce has become an important part of the business world that can provide many benefits for business actors to continue developing strategies in facing future challenges [4]. Creative service industries such as architectural design services have also felt the impact. Architecture is the art and knowledge of designing a building environment or specific product that encompasses things such as a building blueprint, which is the product of a design [5].

A3+ Architect Design is an architectural studio that provides building and interior design services. A3+ studio uses social media as a promotional medium to offer architectural design services. Transactions for ordering services at A3+ studio still rely on manual processes, where customers contact the contact person listed on social media to make transactions. A3+ Studio also experiences difficulties in managing operational data, transaction data, and secure and well-documented payments. This causes inefficiency in the entire transaction process and data management at A3+ Studio. Therefore, this study aims to design a mobile application-based e-commerce system for ordering architectural design services that facilitates ordering and payment for consumers, as well as designing a website dashboard that can be used as a work tool for A3+ Studio as administrators and designers in handling orders, portfolios, and finances.

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Previous studies [6], [7] designed mobile e-commerce application systems for ordering services. The system designed can help users easily access information about the services offered. Another study [8] designed a service ordering system utilizing payment gateway integration, which can make transactions easier for customers and improve overall operational efficiency. Other studies [9], [10] built an order management system utilizing Laravel technology. The management system designed for administrators can accelerate and simplify order data management, as well as improve the efficiency and effectiveness of order management. Several of these studies have designed systems that could help improve efficiency in service ordering and operational management. In this study, the e-commerce system designed consists of a mobile application for customers and a website dashboard for administrators and designers. This mobile application can handle the entire ordering transaction process, from displaying design portfolios and design service packages offered, to monitoring user order progress and integrating payments through the Midtrans payment gateway, which makes it easier for users to make payments. With this broader range of features, the system can assist operational processes and provide broader business functional benefits compared to previous systems. The website dashboard is designed for centralized business data management, which is also integrated with a MySQL database to facilitate data management and operational efficiency.

The mobile application was developed using the Flutter Dart framework. Flutter implements Dart, a type-safe programming language developed internally by Google. Dart offers a gentle learning curve and has various functional advantages, such as performance optimization, systematic syntax, and comprehensive tool support [11]. The system can process customer order data, display data, and is integrated with the Midtrans payment gateway system. A payment gateway is an online payment service that provides and verifies transaction data in accordance with the rules and guidelines of the service provider [12]. Midtrans is a leading payment gateway provider in Indonesia that offers various payment methods. With these advantages, Midtrans can be easily understood, accepted, and integrated into other third-party business applications [13]. The dashboard page for administrators and designers was developed using the Filament Laravel PHP framework. Laravel technology offers a robust and structured system foundation with excellent security, while Filament provides a faster, safer, and easier solution for data management systems [14], [15]. The database utilizes MySQL to store all data, such as order data, portfolios, payments, and other data. By integrating PHP and MySQL, the system can display data dynamically and responsively, while ensuring an optimal user experience, ease of use, flexibility, and making it easy for administrators to update data as needed while still supporting modern security practices [16][17].

With the development of a mobile application system, customers can easily access detailed information related to the services offered by A3+ studio, such as design service packages, portfolios, and making orders anytime and anywhere. The use of an e-commerce system can expand the market reach nationally and internationally and increase customer trust through the ease and security of the transaction process [18]. This application can also simplify the previous manual transaction and payment processes, thereby reducing the time needed to complete orders. The operational management of A3+ studio and the delivery of architectural designs from designers to customers can also be facilitated by integrating the A3+ studio dashboard page. The system can improve efficiency, accuracy, and operational structure, significantly reduce manual errors and speed up customer service [19]. The research is expected to help improve overall operational efficiency at A3+ Architect Design.

METHODS

In conducting this study, structured and systematic steps are required to support the development of an e-commerce system at A3+ studio. The use of research methods aims to facilitate analysis, writing, and application design. The research method provides an overview of the stages that must be taken and the requirements needed in the research. The research framework is a guide created with the aim of explaining the research flow by describing the initial conditions of the problem that form the background of the research, the proposed system model, and the final conditions of the proposed system model [20]. The research framework can be seen in Figure 1.

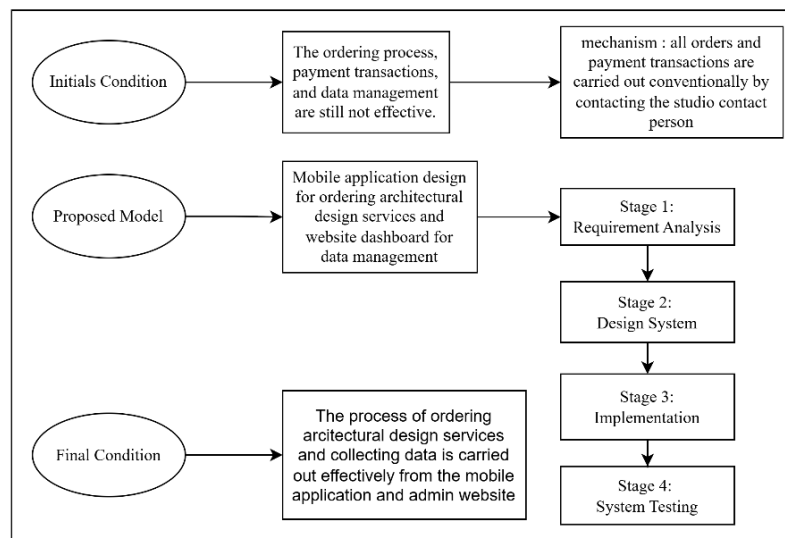


Figure 1. Research framework

Figure 1 shows that there are problems in the operation of the A3+ studio. The problems lie in the inefficiency of the transaction process at the A3+ studio, where orders still must be made by contacting the contact person listed on social media, and the entire transaction process, including payment, still relies on manual bank transfers, which makes the transaction process inefficient. The lack of tools used to manage all data centrally is also an obstacle. To overcome these problems, we propose the design of a mobile application to handle reservations and payments, as well as a dashboard page to manage data centrally. The system design is carried out in four stages, namely requirements analysis, system design, implementation, and system testing. The final condition resulting from the proposed system is that the entire order and payment transaction process is carried out through a mobile application, and data management is carried out centrally through a developed dashboard page.

Requirement Analysis

Requirements analysis is a fundamental phase in the mobile application development cycle, which is critical to the system requirements, system framework, or technology stack being implemented. The purpose of conducting a requirements analysis is to understand the existing problems and translate them into requirements to find the right solution [21]. Data collection was carried out by conducting observations through social media and interviewing A3+ studio designers. The interviews focused on exploring current workflows, order management methods, payments, and problems encountered in running A3+ studio operations. From the results of the interviews and data collection, the requirements for the system to be developed were obtained.

System Design

The system design stage is the stage of designing the system architecture, defining how the system will interact and developing specific technical details of the system [22]. This process consists of stages of creating details for each aspect of the software in accordance with the established requirements and specifications, such as translating the requirements specifications, designing the implementation framework, designing the system architecture, designing business processes, and designing data [23]. System design includes system architecture modeling and Unified Modeling Language (UML), which covers use case diagrams, activity diagrams, and database design.

Implementation

The purpose of implementation is to implement the logic design specifications into the information system being developed, after which the new system is developed using the most appropriate programming language [24]. At this stage, the previously created design is translated into program code using a specific programming language. In this study, programming uses the Flutter framework and the Dart programming language [25]. The proposed system model was developed into a mobile application-based system and

dashboard page. In this study, Flutter technology was used for mobile application development, and Laravel was used for web services and dashboard pages.

System Testing

System testing was conducted using Black-box Testing, a method strategically chosen to prioritize functional verification of the service flow architecture within the developed architectural framework. By focusing on input-output validation, this test provides a user perspective in assessing the extent to which the system meets system requirements, testing various inputs and conditions, and focusing on outputs. Input accuracy, boundary conditions, error handling, usability, performance, and security are some of the aspects that can be verified through Black Box testing [26]. Testing requires a deep understanding of the workflow and system operations, as well as explaining how to evaluate every aspect that works in the system to ensure that the system functions as planned [27].

RESULTS AND DISCUSSIONS

Requirement Analysis

Based on the requirements analysis conducted on the workflow in A3+ Architect Design, several functional requirements were identified to address operational inefficiencies, as presented in Table 1.

Table 1. Functional requirements	
End User	Functional Requirements
Admin	1. Manage order data 2. Manage service package data 3. Manage portfolio data 4. Manage payments
Designer	1. Add portfolio designs 2. Add order designs
Customer	1. View service packages 2. View portfolio 3. Create orders 4. Make payments 5. View order progress

Table 1 shows the functional requirements generated from the requirements analysis process that has been carried out. The admin of A3+ studio needs to manage all data, such as order data, service packages, portfolios, and payments. Designers need to add designs to orders and portfolios. Customer functional requirements include access to service package information, portfolios, order creation, payment transactions, and real-time order progress monitoring. These functional requirements serve as a guide for system design so that the system can meet the necessary requirements.

System Design

System Architecture is the overall structure of the system, which includes the components, the relationships between components, and the basic guidelines underlying the design of the system. This ensures that the system can meet business and technical requirements [28]. The results of the System Architecture design can be seen in Figure 2.

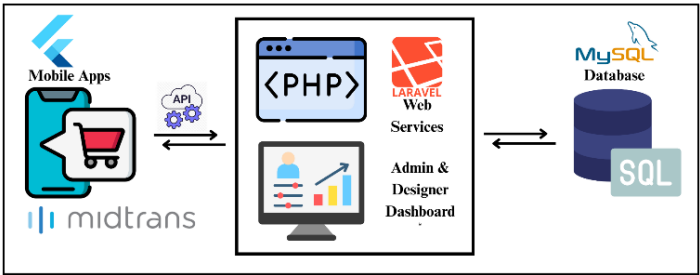


Figure 2. System architecture

Figure 2 shows the system architecture design that was created to meet the functional needs of the system. This system architecture design uses the Client-Server pattern, which is reliable because the client and server sides can be separated, meaning that if one component fails, the other components can keep working. The client-server model can be made secure by using encryption and authentication techniques[29]. The mobile application was built using the Flutter framework from Dart. Flutter was chosen because it offers high performance thanks to its rendering engine, which is responsible for visual elements (such as buttons, images, text, etc.) on the display when the Flutter application is running, providing a smooth user experience[30], Their ability to simplify the development process, reduce costs, and improve performance makes them the right choice for businesses and developers [31]. The integration of Midtrans as a payment gateway provides convenience and security in the payment process. The server part, which functions as the main brain of the system, was built using the Laravel PHP framework. PHP is among the most stable programming languages and has a well-established framework that suits architectural needs. The Laravel framework from PHP was chosen for this project due to the maturity of its code base[32]. The Laravel web service is useful as a backend API that will be used to communicate with mobile applications in managing and displaying data, while the dashboard interface uses Filament, which is also from Laravel PHP. The Filament dashboard will be the center of business operations management. The dashboard allows administrators to manage order data, design packages, portfolios, and finances, while designers can manage project designs from user orders and portfolios. The database used for data storage is built using MySQL, MySQL can be optimized to handle large volumes of data and traffic while ensuring that applications remain fast, reliable, and secure by implementing best practices in programming [33]. Overall, the designed system architecture demonstrates a modern, structured, and easy-to-manage e-commerce management system that maintains data security with a clear separation between the user interface and the business management interface.

Unified Modeling Language (UML) is a visual modelling technique that can assist in the system design process, thereby reducing the risk of failure in application programs [34]. UML serves as a tool for system analysis and development so that each process can be clearly illustrated in various diagrams. Developers can understand system requirements, process flows, and relationships between components before implementation so that the design results are more structured and efficient [35]. The first UML diagram designed was the use case diagram. Use case diagram is a model of the expected functionality of a system that presents an interaction between an actor and the system. In a use case, there is an actor who is a representation of an end user entity performing work within the system [36]. Use cases describe the interactions between one or more actors and the designed system. This can be used to determine what functions are available in a system and who is authorized to use those functions [37]. The use case diagram of the system can be seen in Figure 3.

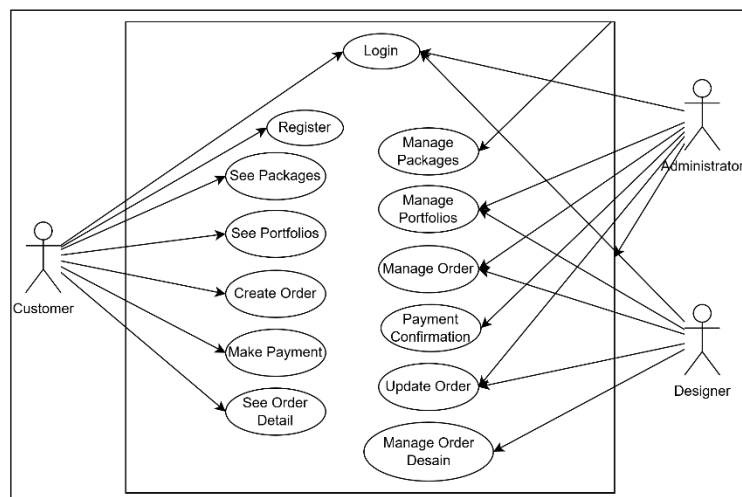


Figure 3. Use case diagram

Figure 3 illustrates a Use Case diagram that maps the interactions between three main actors: customers, administrators, and designers. Customers interact through a mobile application for the service ordering transaction process, while administrators and designers use their respective administrative dashboards for

centralized data management and design management, while the designer is a designer who uses the dashboard page to add design images to orders or portfolios. The design of this use case diagram is important to ensure the scope of the system's functionality, which ensures that all system requirements for customers, administrators, and designers have been identified before the implementation process is carried out.

Based on the interactions of actors that have been mapped in the use case diagram, the process continues with the design of an activity diagram to systematically represent the operational logic and control flow of the system. Activity diagram is a model of the process or flow of system operations to be built, starting from input to output, which takes the form of a complete flow of functionality where the workflow begins and where the system ends [38]. Activity diagrams can be used to describe the system process flow in detail and visualize the steps taken by users or the system in performing a system activity [39]. The activity diagram can be seen in Figure 4.

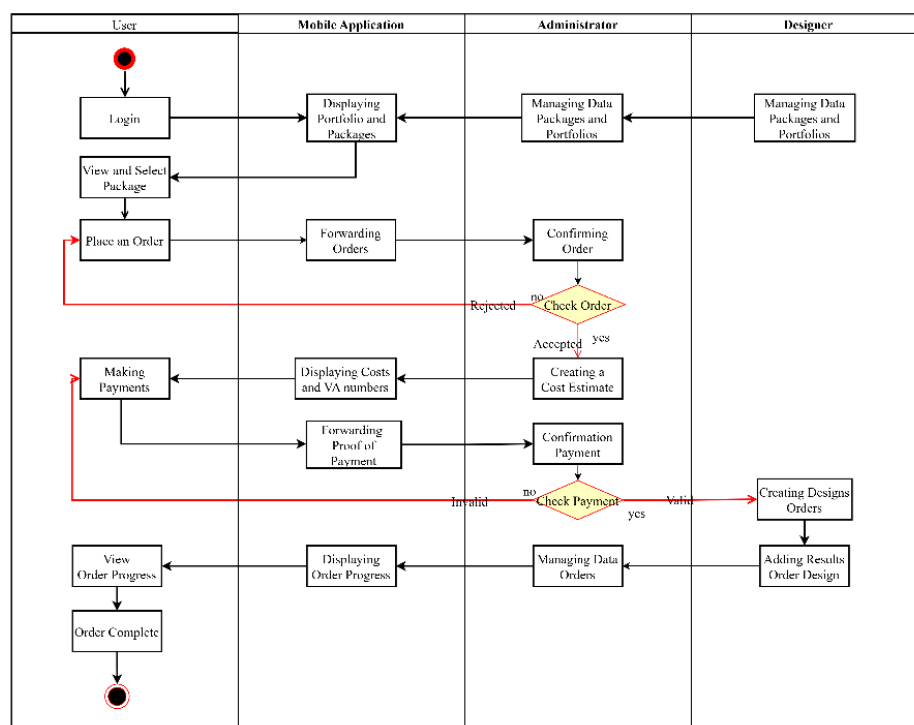


Figure 4. Activity diagram

Figure 4 shows an activity diagram that illustrates the ordering transaction process from start to finish. The transaction begins when the user views the service packages displayed by the mobile application, creates an order, which is then confirmed by the admin, and proceeds to make a payment through the payment gateway in the mobile application. After the payment is made and confirmed, the designer will process the user's order, which will then be displayed in the mobile application when the design is complete. The workflow for this ordering transaction is designed to ensure a structured and simple user experience, so that the transaction process can be carried out easily and efficiently.

To support the previously mapped functionality, database design was carried out systematically to determine the table structure, data types, and relations between entities required in the system implementation process. Database design is very useful for a system. Databases play a very important role in managing information components, systems, and information management infrastructure [40]. Database design uses MySQL with tools from PhpMyAdmin. The database table description can be seen in Figure 5.

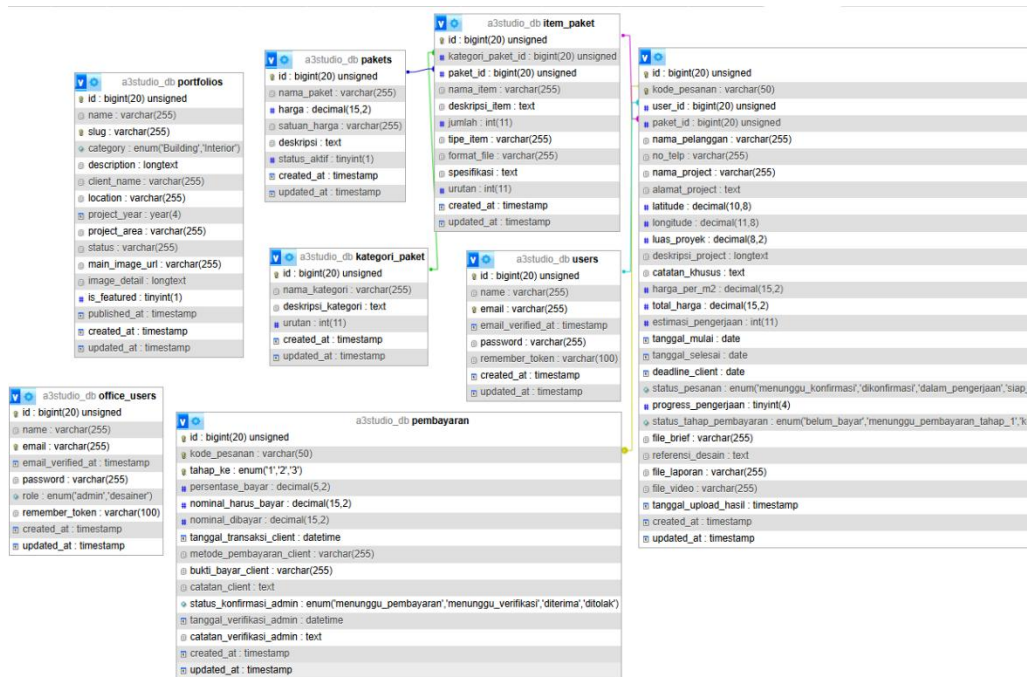


Figure 5. Database design

Figure 5 shows the database table display in accordance with system requirements. This design is based on database normalisation principles to ensure data integrity and avoid redundancy. The tables consist of a users table to store mobile application user data. Portfolios table containing design portfolio data, this data is separate from transaction data, allowing administrators to freely manage 'marketing' content (portfolio) to attract new clients without interfering with operational order and payment data. The pakets table, kategori_paket table, and item_paket table contain data about the design service packages offered, this structure is highly flexible, the administrator can easily add, modify, or delete packages and categories without altering the data structure. The Pembayaran table contains detailed payment data for an order, separating payments from orders and adding a stage to column in this system can handle the business logic of instalment payments (e.g. down payment, instalment 1, final payment), which is very common for large-value design service projects. The office_users table contains admin and designer data for logging into the web dashboard. The separation between users (customers) and office_users (internal) is a fundamental design decision for security. This ensures that customer login data and admin/designer operational data are isolated, thereby reducing security risks and simplifying access rights management.

Implementation

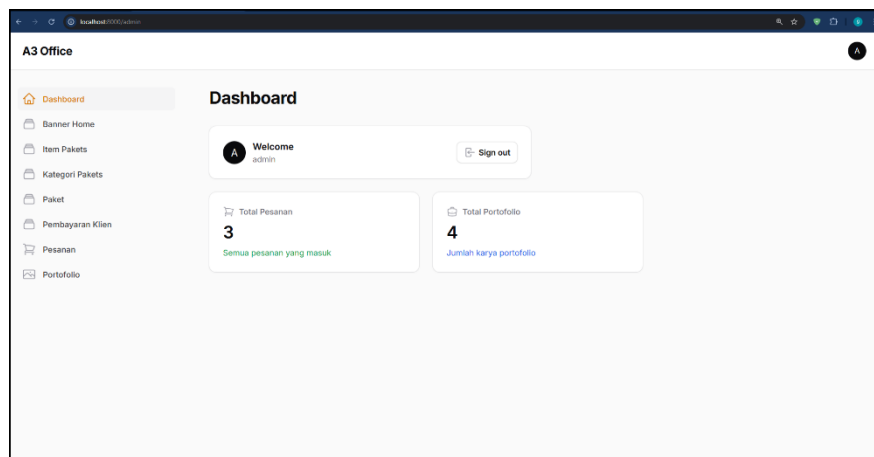


Figure 6. Admin page

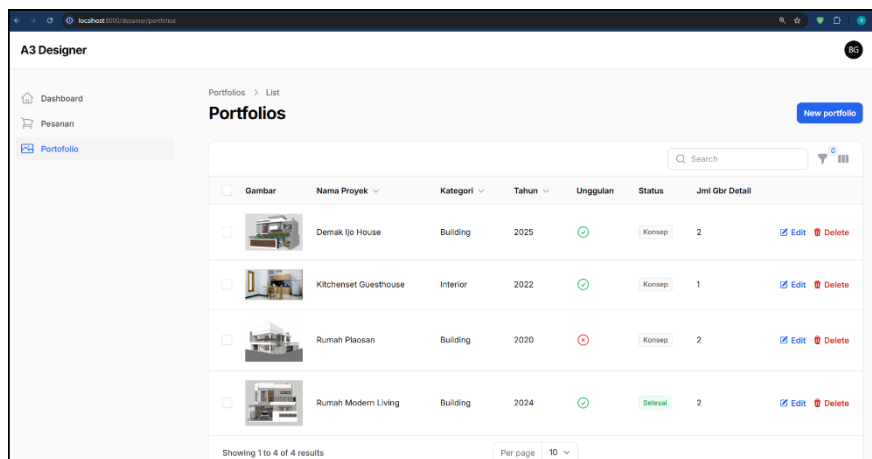


Figure 7. Designer page

Figure 6 shows the dashboard page designed for administrators to manage all data. There are several menus that can be used by administrators to manage data, such as the banner menu to set banner images on the mobile application display, the package menu, package categories, package items, and portfolio can be used to manage design service packages, the benefits of each service package, and portfolio data that will be displayed on the mobile application. Customer transactions and payments can also be managed by administrators through the available menu. Figure 7 shows the page for designers, which has two menus: orders and portfolio. Designers can directly add designs that have been created according to customer orders or designs they want to display in their portfolio on the mobile application. This simpler interface helps designers focus on their main tasks, such as working on orders and uploading portfolios. Designers are not distracted by administrative menus that are irrelevant to their work.

These two images together prove that the backend system that has been built has successfully implemented different access rights for the Administrator and Designer roles. This is in line with research [41] which states that separating user access rights according to role can maintain system security and ensure that each user role can only access features according to their assigned role.

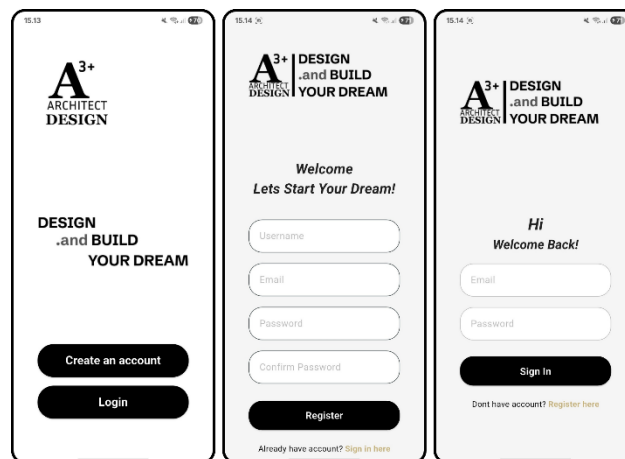


Figure 8. Landing page, register page, and login page

Figure 8 shows the mobile application display on the landing page, which is the initial page when the application is opened, the registration page for users to register an account, and the login page to enter the application after registering an account. These three screens together form a complete and logical authentication process. The clean and minimalist interface design aims to make it easy for new users to register and existing users to access their accounts. This process is a very important initial security measure, ensuring that only users who have registered an account can place orders.

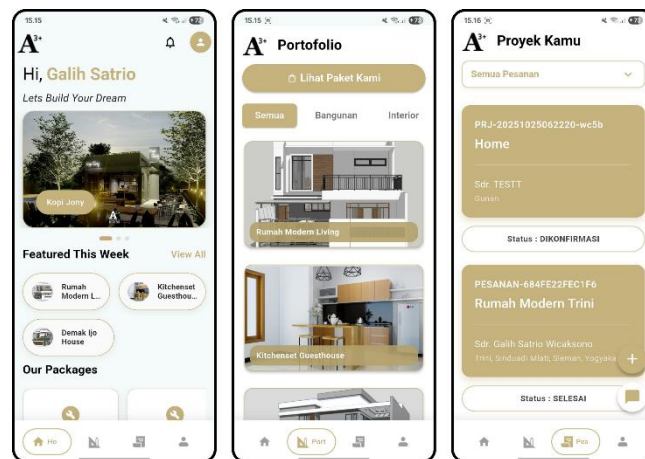


Figure 9. Home page, portfolios page, and my orders page

Figure 9 shows the home page as the main page displayed by the application after the user logs in. Then there is a portfolio page that displays designs created by A3+ studio, this page is equipped with a portfolio filter that makes it easy for users to choose to view building or interior designs. Next, the order page displays the order history created by the user, this feature makes it easy for users to view orders that have been made and monitor orders that are currently in progress.

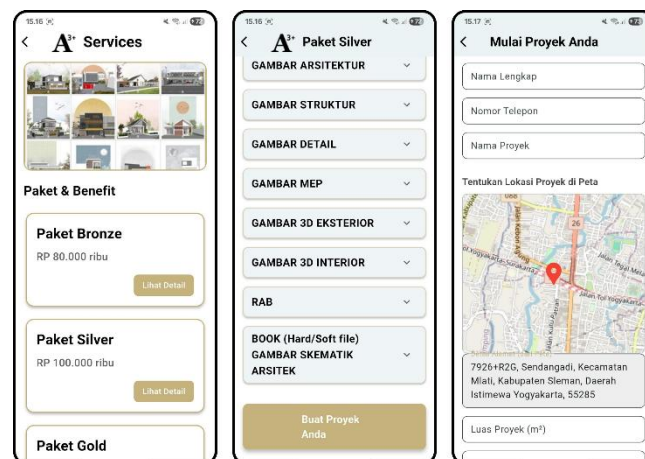


Figure 10. Service packages page, package detail page, and checkout page

Figure 10 shows the transaction flow page, starting with the package page that displays the packages and prices of design services offered by A3+ studio, this helps guide users in selecting a package by allowing them to compare the available packages, the “Lihat Detail” button allows users to view the full benefits of each package and directs interested users to the next step in the transaction. The package details page displays details of what will be obtained from each design service package, including the output that will be received, this can reduce potential conflicts in the future regarding the design output obtained, because clients know exactly what they are buying. The last page is the checkout page, which is the order page where users must fill in some order details for the selected package. On this page, users must fill in their personal details, specify the location on the provided map, and enter the project area, as the cost depends on the size of the project to be carried out. The geolocator feature which can display a map, is also utilized in processing order location data, making it easier for customers to determine an accurate location point and for A3+ studio to conduct a suitable site survey.

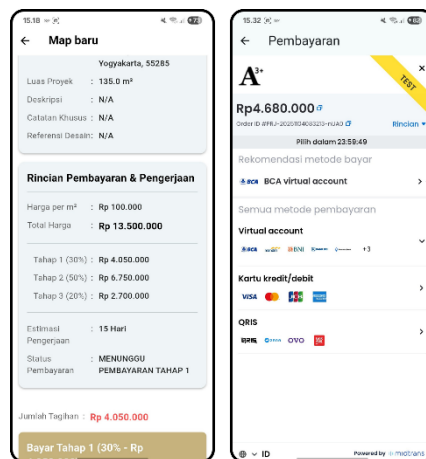


Figure 111. Order detail page and payment page

Figure 11 shows the post-order page, which first displays the order details page containing details created by the user. These details include complete information about the order, such as user identity, project data, cost data, work estimates, and other data. On this page, users can make payments according to the amount and payment stages displayed. The payment page uses the payment gateway service from Midtrans, which provides various payment methods, allowing users to choose the payment method that suits them.

This system successfully meets the need for automation and efficiency. The system eliminates manual administrative work in data management, and payment gateway integration can automatically confirm payments, allowing the design team to start designing faster. Compared to previous research [42], which also designed an e-commerce application to handle order transactions, the system developed in this study provides more advanced innovations in the customer payment handling system. This system successfully integrates payment gateway services as a key feature in helping to improve transaction process efficiency, which can make it easier for customers to make payment transactions. This approach is in line with the argument [43], which states that the application of payment gateway integration in the transaction process can enable transactions to be carried out quickly, safely, and flexibly, as well as providing convenience in data management, transaction monitoring, and financial reporting.

Although the current system implementation is effective in streamlining architectural service orders, this application is essentially optimized for specific data structures in the A3+ Architect Design case study, requiring reconfiguration if applied to broader uses. Furthermore, although payment gateway integration has ensured secure transactions, the current system is limited to certain service providers, which can be developed with broader API integration in the future. The client-server system architecture provides a solid foundation for development, ensuring that the frontend and backend can be scaled independently. If user demand increases simultaneously, the server side can be scaled horizontally without affecting the performance of the mobile application. Additionally, moving complex business logic such as data processing architecture to the server side ensures that the client side remains lightweight and responsive, even as the database and functional complexity of the system increase in the future. Future development can focus on features that are more realistic for the market, such as a direct consultation module within the application (real-time chat) to facilitate communication between clients and architects. Additionally, the integration of automatic cost estimation tools (RAB/Bill of Quantities) and project progress tracking features with result visualization will provide greater transparency for users regarding their budgets and the physical progress of their construction projects, which will significantly enhance the user experience in the architectural services market.

System Testing

To ensure the functionality of the application, Black Box testing is implemented as a verification tool to ensure that each feature produces outputs that meet system requirements. This testing is used to analyze system behaviors based on inputs and outputs to be adjusted to specified user requirements [44]. The test results on the system can be seen in Table 2 and Table 3.

Table 2. Dashboard page testing

No	Menu/Features	Input / Test Case	Expected results	Result
1	Login	Email and Password	The system can perform login operations according to role (admin/designer)	<i>Valid</i>
2	View menu	Select one of the menus on the sidebar.	The system can open one of the selected menus	<i>Valid</i>
3	Add data	Select the Add menu on one of the menus.	The system can add data	<i>Valid</i>
4	Delete data	Select the Delete button on one of the menus.	The system can delete data	<i>Valid</i>
5	Edit data	Select the Edit button on one of the data items.	The system can change data	<i>Valid</i>

Table 3. Mobile application testing

No	Menu/Features	Input / Test Case	Expected results	Result
1	Register	Username, Email, and Password	The system can perform registration operations for users.	<i>Valid</i>
2	Login	Email and Password	The system can perform login operations for users.	<i>Valid</i>
3	View portfolio	Select the portfolio menu on the navigation bar	The system can display portfolio pages.	<i>Valid</i>
4	View service packages	Select the view package button on the portfolio page	The system can display design package pages.	<i>Valid</i>
5	Place an order	Select the start project button and input project details	The system can create user orders.	<i>Valid</i>
6	View order	Select the orders menu on the navigation bar	The system can display orders created by users.	<i>Valid</i>
7	Make a payment	Select the payment button on the order details page	The system can display payment gateway pages.	<i>Valid</i>
8	monitoring order progress	select orders that have been created and displayed on the order page	The system can display real-time updates on order progress.	<i>Valid</i>
9	Logout	Select the logout button	The system can perform logout operations.	<i>Valid</i>

The functional testing results presented in Table 2 and Table 3 show that the system is effectively capable of handling core functionality on web and mobile platforms, while also validating cross-platform synchronization and the performance of the API connecting the Laravel backend with the frontend. The selection of Black-box Testing as the primary evaluation method is a strategic decision tailored to the current research phase, where the system is still running in a local development environment through an IDE. The main priority is focused on ensuring the functional integrity and stability of the developed system architecture to guarantee that the Logic Layer has processed data with precision before the system is implemented in the actual production environment. This functional verification is a crucial foundation for ensuring the reliability of the system structure before moving on to a more extensive testing phase.

Furthermore, a comparative analysis shows that this study offers a broader approach than study [45] through the expansion of functional coverage in post-transaction processes, payment gateway integration, and real-time transaction monitoring. This advantage proves the system's reliability in maintaining data consistency between client payment status and the architect's administrative dashboard transparently, providing a more robust solution for the professional architecture services market. Although current testing is still limited to functionality due to local hosting constraints, this stage is a crucial prerequisite for the future transition to cloud-based servers. In the next development phase, further evaluations such as the System Usability Scale (SUS) and security load testing will be conducted to validate performance and user experience under real-world traffic conditions.

CONCLUSION

This research successfully implemented an e-commerce system for architectural design services at A3+ Architect Design by integrating the Flutter framework, Laravel, and the Midtrans payment gateway. By adopting an API-based client-server architecture, this system was validated through black-box testing to prove the stability of functional integrity in managing transaction cycles automatically and in real-time. This research offers advantages in terms of post-transaction management and consistent cross-platform data monitoring, which can significantly improve the studio's operational efficiency and strengthen customer trust through system transparency. Although testing is currently limited to the local development environment, the technical foundation that has been built ensures the system's readiness for future transition to a cloud server, which will be followed by further evaluation using the System Usability Scale (SUS) and a comprehensive security audit to ensure optimal performance in the production environment.

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