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Innovative Digital Solutions for Project Auctions to Combat Indonesia's Housing Deficit

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A B S T R A C T

This paper unveils a transformative digital application designed to revolutionize the auction process and tackle Indonesia's pressing housing backlog challenge. Using a structured prototyping approach and innovative tools such as the prototype canvas and validation canvas, the study develops and tests an application to improve the housing procurement process by enhancing user experience and accessibility. Key findings reveal that the app meets critical assumptions and user needs while fostering meaningful communication between project owners and seekers. This research emphasizes the significant impact of usability principles and design thinking in shaping effective digital solutions. Ultimately, this endeavor provides inspiring insights into the potential of digital applications in the housing sector, paving the way for future research and development in this essential field.

1. INTRODUCTION

Indonesia has experienced a gap in the provision of lower-middle class housing which is categorized as a backlog of residential houses, 12.1 million in 2020 (Boediardjo & Suhartoko, 2023), 11.4 million in 2021 (Purnamasari & Krisnadi, 2021), 12.71 million in 2022 (Bank BTN, 2021). Indonesia's housing backlog is a significant problem, with predictions suggesting an increase to 14.9 million homes by 2030 (Boediardjo & Suhartoko, 2023).

Another problem is a gap in the availability of skilled construction workers and the need for skilled construction workers in Indonesia is quite large. According to data from the Ministry of Public Works and Public Housing, in 2020, the need for labor in the construction sector reached 6.38 million people, while only about 3.7 million workers were available (Kaluthantirige et al., 2023). The gap in the availability of construction labor in Indonesia is mainly characterized by a significant proportion of unskilled workers and a lack of certified professionals, which impacts productivity and competitiveness. About 62% of construction workers in Indonesia are untrained, and only 5% have competency certifications, highlighting a critical skills gap in the industry (Adi & Ni'am, 2012; Arthur & Daryati, 2019). This deficit is exacerbated by inadequate training, poor workforce productivity, and insufficient investment in skills development.

The topic of Digital Applications in answering the fulfillment of backlog houses in Indonesia is relatively new, and there has not been much previous research on this issue. However, the World Bank is examining the potential of digital technology to meet the needs of residential homes in Indonesia. (Harrison, 2018; Walley et al., 2023). A project auction digital application can be a viable solution to address the housing backlog in Indonesia by leveraging technology to streamline the process and attract investment. Digital applications can also improve the efficiency of the auction process by providing transparent information, facilitating easier bidding, and streamlining transactions and payments. This can reduce the time it takes to complete tenders and start projects.

Electronic auctions facilitate a transparent bidding process, provide clear information to bidders, and ensure fair market value transactions. This transparency builds trust among participants (Siregar & Siregar, 2022; Yadav, 2024). The online nature of electronic auctions allows participation from any location, removing geographical barriers and making the process more convenient for buyers and sellers (Singh, 2024; Sweetline et al., 2024). Technology in e-auctions simplifies the auction process, making it faster and more reliable. This is especially beneficial for non-technical users who can easily navigate the system (Sweetline et al., 2024).

Despite the advantages, there is still a lack of extensive knowledge and participation in e- auctions in Medan City. This is due to inadequate socialization and outreach efforts by the KPKN; Kantor Pelayanan Kekayaan Negara dan Lelang (Siregar & Siregar, 2022). Challenges such as non-compliance with regulations and incomplete documentation can hinder the auction process, leading to potential errors and inefficiencies (Marpaung et al., 2023).

Digital applications in the construction industry face significant challenges and obstacles, especially for users with low literacy such as construction workers. These challenges are diverse, involving not only reading disabilities but also other sociocultural and cognitive factors. In addition, the integration of digital tools in construction is hampered by a lack of digital literacy and understanding of complex systems such as Building Information Modeling (BIM). The following section explores these challenges in detail.

Users with low literacy often face challenges when navigating traditional text-based user interfaces, which are not designed with their needs in mind. This issue is compounded by cognitive difficulties, cultural differences, and general intimidation of technology, which can hinder effective interaction with digital tools (Medhi et al., 2010). Additionally, language barriers pose further complications, especially for construction workers who are often immigrants with limited English proficiency; as a result, text-heavy training materials become largely ineffective for this demographic (Lin et al., 2018).

The construction industry has been relatively slow to embrace digital transformation when compared to other sectors. One of the main reasons for this is the low qualifications of employees in small companies, which can impede the effective implementation of new IT technologies (Saranchuk & Kochetkov, 2023). Furthermore, Building Information Modeling (BIM) is frequently misinterpreted, with a predominant focus on 3D modeling rather than its broader management capabilities. This misunderstanding restricts the potential advantages of BIM, thereby obstructing its integration into the construction process (Kubecka & Nyvlt, 2023).

To address these challenges, innovations such as non-textual user interfaces and 3D visualization tools have been suggested to enhance interaction and learning for those with low literacy. These tools can help bridge the gap and make digital applications more accessible (Lin et al., 2018; Medhi et al., 2010). Moreover, digital platforms like BIM and Project Management Information Systems (PMIS) can potentially improve communication and coordination within multi-project environments, although their widespread adoption necessitates overcoming significant barriers (Dubinin, 2024).

The study found that digital technology can improve the efficiency of the construction process, reduce costs, and make housing more affordable. The initial step of the research began by describing the persona of digital application users, both Project Owners and construction workers of housing project seekers. Personas can be used to improve digital applications by considering the needs of international users and expanding communication design practices to include users from other cultures (Getto & Amant, 2015). Persona data can be used to maximize UI design quality and minimize costs in small software projects, resulting in fundamentally different UI choices (Datin, 2004). Additionally, personas can help designers better understand and consider a range of digital expertise across populations, highlighting people at risk of being digitally overlooked (Goodman-Deane et al., 2021). By using personas, designers can tailor digital applications to meet the specific needs and capabilities of different user groups, leading to increased usability and user satisfaction.

The next step, mapping the user's problems and goals in the business model canvas offers several benefits. This step identifies gaps and bottlenecks in services (Starks et al., 2022), develops a business strategy (Azmy et al., 2019a), analyzes internal/external strategies (Heni Widyarti et al., 2023), identifies marketing strategies, and improves strategic planning, resource allocation, and value creation for the business (Sukarno & Ahsan, 2021). Application prototyping and mockup validation can be improved by leveraging them during development and involving the end user in a feedback loop. This allows for validation and initial iteration, leading to better quality results and alignment with user needs (D'Souza et al., 2018; Miller et al., 2011; Rivero et al., 2011).

Integrating digital applications in providing lower-middle-class housing holds significant economic value for both Project Owners and Project Seekers, provided that these

applications address key challenges such as understanding user personas, needs, and fears. It is crucial to meet the requirements of digital users, particularly regarding construction costs and workforce availability, while ensuring that application features align with user expectations. There is a pressing need for an efficient communication system among stakeholders in the residential construction process. This paper aims to conduct an empathetic study of housing project owners and construction workers, focusing on defining user personas through interviews, mapping user challenges in a business model to reconcile construction costs, and designing application prototypes to guide the development of a user-centric digital application system architecture.

This paper reviews the barriers to using current digital applications in Indonesia's housing project sector, identifies the key opportunities and challenges to using new features to address the housing backlog, and serves as a reference in determining the type of startup ecosystem.

2. LITERATURE REVIEW

Various authors develop and implement design thinking, Value Proposition Canvas, and Business Model Canvas (BMC) in different contexts. BMC was developed as a tool to help business organizations and entrepreneurs map and analyze their business models (Widyarti, Kusuma, et al., 2023). This is applied in various businesses, such as UD Makmur Mandiri in Semarang and Martabak MM in Bandung (Murtafia & Sari, 2022) (R. Rochani et al., 2023). The Value Proposition Canvas is used to design and evaluate the *value proposition* of a product or service and is implemented in businesses such as Epargne Thrift Shop in Makassar (Triono, 2023). Design thinking, on the other hand, is a problem-solving approach that can be applied in various industries, including the development of a conceptual design business model canvas for Mobile Battery Swap Charging Station (MBSCS) for electric motorcycles in Indonesia (R. Rochani et al., 2023). Overall, these tools and approaches are developed and implemented by different authors and used in various business contexts for strategy formulation, business model evaluation, and product development.

There are few literature studies analyzing the implementation of digital applications using Design Thinking, Value Proposition Canvas, and BMC for housing projects. Design thinking, Value Proposition Canvas, and Business Model Canvas are valuable tools for analyzing and implementing digital applications in residential projects. As shown by Zhang et al. (Zhang et al., 2020a), design thinking is a user-centric approach that can help identify and develop innovative solutions for the construction industry. Value Proposition Canvas, as discussed by Pinem et al. (Pinem et al., 2023), is useful for understanding digital applications' value to customers and stakeholders in residential projects. Lastly, BMC, as explored by Widyarti et al. (Widyarti, Hartono, et al., 2023) and Hermawan et al. (Hermawan et al., 2018), provides a comprehensive framework for mapping and analyzing the business model of a digital marketing service company. By leveraging these tools, residential project stakeholders can gain insights into user needs, value creation, and business feasibility, ultimately leading to the successful implementation of digital applications in the housing industry. The literature review matrix of how design thinking, value proposition, and BMC are used to analyze digital applications in housing projects in **Table 1** is as follows:

Table 1. Literature Review Matrix

References	DT	BMC	Research Object
(Köbler & Eiting, 2018)	📌		Design Thinking as a process model Methods from various disciplines for problem-solving.
(Daniel Marco-Stefan Kleber, 2018)	📌		Design thinking approaches for value proposition enhancement. Improving customer experience in dynamic business environments.
(Baum, 2018)	📌		Design Thinking methodology for digital business value creation. Business model creation in dynamic environments.
(Martins et al., 2020)	📌		Smart home conceptions from a user-centric perspective. Sustainable design in smart home projects.
(Bey & Panchenko, 2024)	📌		Application of design thinking in digital entrepreneurship. Integration of design thinking into business planning processes.
(Radziwill, 2015)		📌	Value proposition dimensions and customer connections. HACCP systems and quality management practices.
(Fuchs & Golenhofen, 2019)	📌		Understanding customers and their true needs. Identifying the right problems and questions to solve.
(English et al., 2010)	📌		Hidden value and commercial opportunities in businesses. Characteristics of high-performance organizations and their impact.
(Bayu Zahran et al., 2024)	📌	📌	Waste management in urban areas. Public awareness about sorting and recycling.
(Dincer et al., 2014)	📌		Customized mass housing design approaches. User- designer interaction in design decision.
(Zhang et al., 2020b)		📌	The process of labor resource management in the construction industry. User-centric digital solution development using Design Thinking.

(Raposo et al., 2023)			Inhabitants' participation in the housing design process. Mass-housing customization through digital means.

From the results of the literature review, the use of design thinking, value proposition, and BMC to analyze the implications of digital applications in the middle and lower housing procurement process involving users who are vulnerable to digital literacy, is suitable for validating the business of both user-centered products and services, both for formulating business strategies, evaluating business models, and developing products and services. The resulting prototype was tested using the Prototype Canvas.

Prototyping Canvas is a valid and effective design tool for planning targeted prototypes in digital applications (Lauff et al., 2019). It helps designers identify critical assumptions and questions to guide development.

The Infinite Canvas is a prototype for displaying news media search results on tablet devices, allowing users to understand the relationships between news articles in a spatial environment (Szigeti et al., 2015). Figma is a prototyping design software that can be used to create user interfaces for mobile applications. It allows developers to design various application components, such as color schemes, fonts, white space, and button placement, intending to provide a good user experience (Hepfer & Christ, 2023).

The self-paced learning and teaching framework was developed as a prototype of a digital application to assist teachers and students in project-based learning, encouraging students' learning skills and autonomy (Jin, 2021). Finite element analysis methods based on computed tomography data are discussed to build numerical models of objects with porous structures, specifically bone organs, in digital prototypes (Gerasimov et al., 2022).

The next stage of prototype testing is the Validation Canvas involving the user. Validation canvases are templates that help develop and map big data applications, strategies, and projects (Willems, 2019). Testing digital application prototypes can be done with a variety of methods, and the use of Prototype Canvas Validation is one approach that has certain characteristics and focus. Here are some of the differences between the canvas validation method and other testing methods:

Table 2. Comparison of Canvas Validation vs other methods

The difference between testing digital application prototypes using the canvas validation method and other methods.	Canvas Validation:	Other Methods:
1. Structured Approach	Use a structured visual format to summarize the key elements of the prototype, such as the problem you want to solve, the proposed solution, and the feedback from the user. This helps the team to be more focused and organized during the testing process.	Some methods may be more ad-hoc or unstructured, such as user interviews or A/B testing, which may not provide an integrated overall picture.
2. Focus on Idea Validation	Emphasis on validating ideas and concepts from the start, ensuring that testing focuses not only on functionality but also on relevance and user needs.	Methods such as usability testing may focus more on the usability aspect of the application without regard to the extent to which the initial idea is valid or not.
3. Team Collaboration	Encourage collaboration between various team members (designers, developers, stakeholders) by providing a clear framework for discussion and feedback	Some methods may be more individual or separate, which can hinder team communication and collaboration.
4. Feedback Integration	Integrate user feedback directly into the canvas, facilitating faster analysis and iteration.	In more traditional testing, feedback may be collected in the form of separate reports or minutes, which can make analysis and follow-up more difficult.
5. Visualization	Use visual elements to facilitate understanding and communication between team members and stakeholders.	Many other testing methods may not provide the same way of visualization, so they may be less effective in presenting information.
6. Continuous Iteration	Drive rapid iteration cycles based on integrated user feedback, so teams can make changes more efficiently.	Other testing methods, such as beta testing, may be slower in implementing the user feedback received.

7. User Engagement	Use a user-based approach to better understand their needs and wants through focused feedback sessions.	Some methods may not engage users directly or only engage them in a certain stage.

Other methods are usability testing, A/B testing, focus groups, interviews, Heuristic evaluation, cognitive walkthrough, card sorting, journey mapping, field studies, and Wizard of Oz testing. Some studies use combined methods to provide comprehensive results. Prototype Canvas Validation provides a structured and collaborative approach to digital application prototype testing, emphasizing idea validation and integration of user feedback. On the other hand, other testing methods may differ in focus, strategy, and how other methods collect and analyze feedback. The selection of the right method depends on the context, objectives, and resources available in the application development project.

2.1. Theoretical Basis

This paper was compiled to create a digital application, especially in realizing housing whose main users are the Project Owner group and the Project Seeker group. Therefore, this paper examines the users' responses to this digital application. In designing digital applications, this paper refers to the rules and principles of the use of digital applications, as well as the user validation process through design thinking and mapping of the BMC business model, as well as referring to the rules and principles in designing digital applications, as well as referring to housing project management theories. Digital application design rules and principles are essential for creating and evaluating user interfaces. Usability conventions and testing help improve the user experience. It is important to focus on consistency, simplicity, and accessibility in design. These elements are essential for creating an effective user interface (Alonso-Virgós et al., 2020). While many principles and guidelines are available to produce usable interfaces, these rules must be simplified and consolidated. Many experts have presented a set of golden or heuristic rules that encapsulate design suggestions and help deliver systems that can be used better. Among these rules, are Shneiderman's eight golden rules (Dix, 2010) and the Heuristic Uses of Nielsen (Preece et al., 2002). Additionally, the Gestalt principle is beneficial for visual perception of interface design (Khamis et al., 2023).

2.2. Digital Applications and Problem Approach Methods

In terms of the use of digital applications by construction workers, 44% of them are poorly educated, so there is a potential gap in Digital Literacy. Therefore, in adopting new technologies, it is necessary to ensure the perceived benefits of technology, the compatibility of technology with existing practices, and the complexity of technology, as described in the Diffusion of Innovation Theory. (Akaiso, 2024). This paper ensures that digital applications answer the needs of their users' communication facilities, ensure the process of edifying and verifying the quality standards of construction workers' skills, organize project contests to obtain reasonable prices for construction services, and provide digital application features that are a priority.

2.3.   Kontesrumah

Kontesrumah is a digital application business idea that aims to solve the problem of meeting the needs of a large number of middle-to-lower housing by bringing together homeowners and construction workers looking for projects (foremen, supervisors, building contractors, surveyors, etc.) in one application to exchange offers. Kontesrumah, as application contests such as Freelancer.com, have several benefits for both Project Owners (homeowners) and Project Seekers. Below are the main benefits of digital applications in housing project contests: Digital platforms act as the central nervous system for construction projects, significantly enhancing coordination and efficiency through the integration of AI and big data (Wang et al., 2024a), while BIM technology optimizes design and construction schemes, reducing periods and costs alongside increasing social and economic benefits (Peng & Peng, 2023). Automating the construction project lifecycle through these platforms not only reduces costs but also strengthens market competitiveness (Prykhodko & Nikolaev, 2022). Although digital tools like the Digital Pen can boost productivity by simplifying defect management, their adoption might encounter resistance from field engineers (Kim et al., 2013). Furthermore, digital applications improve access to critical information necessary for the reconstruction of social housing, allowing for better project planning and execution (Ascione, 2024). Networking with public and private archive sources through these digital platforms enhances the sharing of technical and cultural knowledge, which is essential for sustainable development (Ascione, 2024). As digital technology aligns with the demands for sustainable and personalized living spaces, it addresses inefficiencies present in traditional construction models (Wang et al., 2024b) and introduces innovative methods that contribute to climate change mitigation and adaptation in housing projects (Ascione, 2024).

For Project Owners, Kontesrumah provides access to certified construction workers, price certainty, quality assurance, and time assurance. And for construction workers, they provide access to projects and opportunities to upskill.

3. METHODS

The quantitative and qualitative method approaches allow researchers to harness the strengths of both methodologies and to provide a comprehensive understanding of respondents' needs. Integrating large-scale quantitative data with qualitative insights increases the depth and breadth of research findings. The research plan in this paper is prepared to answer the research objectives. The following are the stages of the research that are schematized in Figure 1.

The process involves using quantitative data to create a persona of project owners and seekers and an empathetic qualitative approach to understand their thoughts and needs. The Design Criteria canvas defines essential app features, while the Value Proposition Canvas describes how the app can meet customer needs. A Business Model is designed using survey data to map user problems and objectives. Prototypes are designed and assessed using the Prototype Canvas, and the Validation Canvas provides a reference for iteration and integration. The steps of the Validation Canvas can be described as follows:

i   **Step #1**, Document the current assumptions that carry the highest level of risk and outline them for testing through experimental methods.

ii **Step #2**, Articulate the Value Proposition by breaking it down into distinct components. First, identify the specific customer segment and the particular needs or challenges they face that require resolution. Next, outline the proposed solutions to effectively address these issues, ensuring that each solution is aligned with the needs identified in the customer segment.

iii **Step #3**, Outline the specific method you plan to evaluate and provide a detailed explanation of the experimental design you will employ. Additionally, establish the criteria that must be met for the experiment to be deemed successful, ensuring these standards are clear and measurable.

iv **Step #4**, Monitor if the experiment aims to validate or invalidate the assumption, and note the findings. Determine if the experiment should be repeated (pivot) or deemed successful. Over time, assess any progress made in the experimental process.
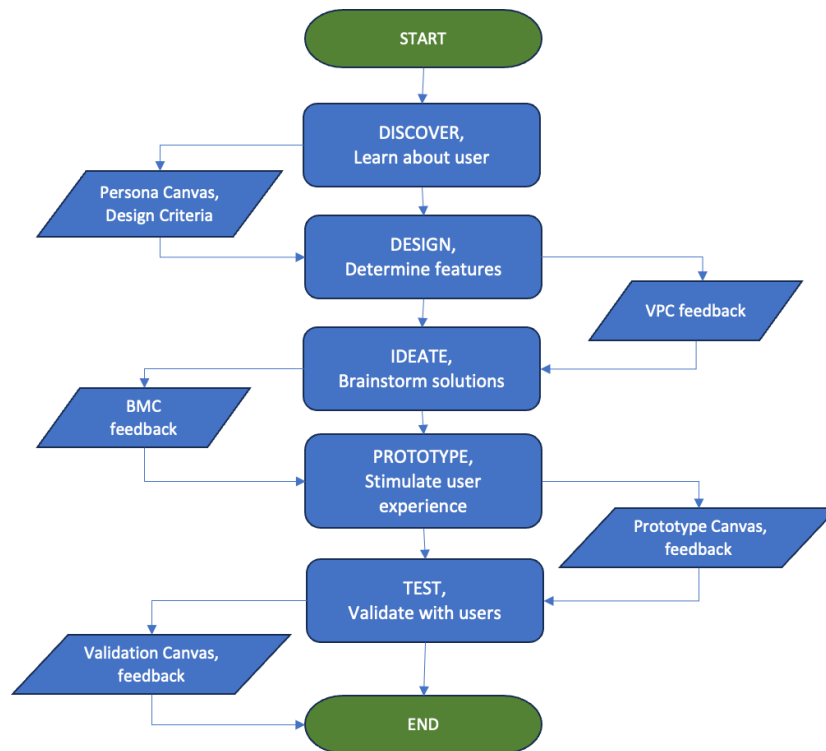

Figure 1. Stages of Population and Sample Research

3.1. Population and sample

A backlog house is a category of middle-to-lower houses built by individuals, foremen, developers, and contractors. The research sample includes developers, property entrepreneurs, and homeowners. Project Seekers include private goods according to BPS, non-classified contractors, and Foremen. The sample focuses on single-family houses, multi-mass house

building, townhouses, boarding houses and rental house. Construction workers, such as Building Supervisors, Architects, Land Surveyors, Quality Surveyors, and Estimators, are excluded from the project.

According to BPS in its report on the Individual Construction Profile of DKI Jakarta Province, the sample of the 2023 Individual Construction Business Survey is spread across six districts/cities in DKI Jakarta Province, as many as 280 businesses, consisting of 140 building work businesses (50.00 percent), civil works 47 businesses (16.79 percent), and 93 businesses (33.21 percent) doing special work. (BPS, 2023).

The formula, equation 1, for determining the number of samples from Stephen Isaac & William B. Michael (Wilmoth, 1982) is as follows:

$$S = \frac{X2 \, N \, P \, (1 - P)}{d^2 \, (N - 1) + XP \, (1 - P)}$$

With:

S = Number of Samples

N = Total Population

P = Proportion in Population (*P*=0,50)

d = Accuracy/degree of determination (0.05)

X2 = Table chi-square value for a given (X2=3.841 95% significance level) μ

Where is the population known, *N*=280 Thus obtained 3,8 ~ minimum 4 sample.

Meanwhile, the number of samples for Project Owners in DKI Jakarta is calculated as follows:

- The number of contract/rental houses in DKI Jakarta 25.47% in 2023 (BPS-RI, 2023b)
- The number of Households in DKI Jakarta is 2,788,989 families in 2022 (BPS-RI, 2023a). So, the need for residential houses in DKI Jakarta is 710,356 units. The proportion of the people interested in landed houses and flats or apartments in DKI Jakarta is 90% considering the estimated proportion of the population that has certain characteristics that are being studied, (Annur, 2023), which means that 639,320 housing units are needed.

Using the same formula the determination of the number of samples from Stephen Isaac & William B. Michael (Wilmoth, 1982) where the number of Population is known, *N*=710.356. Thus obtained 228 minimum sample.

3.2.   Data Collection Techniques

Project Owners, housing developers, and prospective residents participated in empathy face-to-face interviews throughout the canvas process. Experienced respondents from the housing developer organization and Project Seekers were interviewed to validate initial assumptions.

4. RESULTS AND ANALYSIS
From the results of the Persona Canvas and Canvas Criteria mapping to developers, home-owners, building contractors, and foremen, it is simulated in the following tabulation:

4.1.   Canvas Persona Tabulation

The Persona Canvas Tabulation is crucial in the conclusion, illustrating app user characteristics. It collects data on demographics, preferences, and needs through surveys and interviews. This helps design relevant features, increase app usage, and improve user satisfaction in complex digital applications.

PERSONA CANVAS	NEGATIVES TRENDS	HEADACHES	FEARS	POSITIVE TRENDS	OPPORTUNITY	HOPES
DEVELOPER 1	Gaps in understanding with investors; synchronization of land allocation; Cheap Land;	Gaps in understanding with investors; Land disputes;	Material quality is inconsistent; material is missing; Heirs;	Known as a townhouse developer; customer-accepted designs;	Townhouses in Kemang and Cipete; subsidized modest houses; rental houses;	Non-bank low-cost housing financing scheme; plastic waste block for masonry;
DEVELOPER 2	Material supply chain crisis; regulations and permits; economic uncertainty; new developers are increasing;	Gaps with investors; land disputes; cannot rely on BPN;	Land legality; investor integrity to maintain cash flow; inappropriate design; Foreman availability;	The need for housing is increasing; sales < 1year, digital marketing; efficient construction;	Homes for millennials; government programs; the demand for smart housing features is increasing;	Positive experience buying a house; positive impact on the environment; completed on time;
HOMEOWNER	Late schedule; increase in material prices; scarcity of workers; low quality;	Difficulty managing the budget; communication with contractors; IMB process;	Low quality standards; projects are not on time; the design is not to the liking;	Efficient construction; environmentally friendly materials; demand for homes is increasing; access design trends;	Unique design; smart home; collaboration with architects and contractors;	The house meets the needs of the family; strong construction; safe and comfortable house;
CONTRACTOR	Project opportunities; price transparency;	Plumbing and structural complaints; the housing market is uncertain;	Image changes; increase in material prices;	Jakarta area project is stable; provide benefits;	Always looking for workers; providing jobs;	Zero complaint; employment; provide benefits; Online Material Procurement;
FOREMAN 1	Availability of electricity;	Low teamwork;	Scarcity of construction-	On-time payments; Foreman's	Trusted by superiors;	Attendance application; financial
FOREMAN 2	Late payment; poor communication ; late supply of materials;	Discipline workers are low; handyman loyalty; handling old problems; late material supply;	Availability of HSE; payment; new projects; project validity;	Structural system technology; workers specialty; construction is getting faster;	Craftsman training; working capital; Work Equipment	Report via cellphone; attendance via GPS; better infrastructure; ready land; HSE socialization;
SUMMARY	price certainty; availability of craftsmen; project opportunities ; Material Supply	Gaps in investor understanding; budget management; quality consistency;	Availability of foremen; maintain cashflow; certainty of the working drawing; scarcity of workers; project validity;	The need for housing is increasing; efficient construction; fast construction; specialist workers;	Millennial houses; subsidized simple crumbs; meeting by video call; craftsman training;	Non-bank financing schemes; zero complaint; attendance application; financial applications;

4.2.   Tabulation of Canvas Design Criteria

The Canvas Design Criteria Table outlines design criteria for digital applications, including functionality, ease of use, and system integration. It promotes stakeholder collaboration, ensuring efficient app development and testing, ultimately leading to a product that meets user expectations.

Table 4. Design Criteria Canvas Tabulation

DESIGN CRITERIA CANVAS	MUST	SHOULD	COULD	WON'T
DEVELOPER 1	Inventory tracker; House design templates; Contractor list;	Home loan; Budget template;	List of Contractors with a bad reputation;	List of Contractors with a bad reputation;
DEVELOPER 2	Material control; Quality control; Payment control; Foreman list;	Home prototype options; House variants for each prototype; Link BPN >Legal status of land;	Home prototype options; House variants for each prototype; Link BPN* >Legal status of land;	Link project progress for marketing;
HOMEOWNER	Project progress; Joint accounts (escrow);	Access to wholesalers; PBG facilities; Home design job contest;	Online material procurement; MoS status; Prototype of home design;	
CONTRACTOR	List of home projects; Display the prices of competitors and contest winners;	Access to the foreman of the job seeker; Employment contract form; Price escalation options;	Online material procurement; MoS status; Teamwork communication features;	
FOREMAN 1	List of projects; Communication to Contractor;	Logistic features; Payment progress feature; Communication to the Project Owner; payment records; Attendance of workers;	Work progress;	Reputable construction workers;
FOREMAN 2	List of home projects; Account escrow;	Foreman's List; Payment features; Communication to Project Owners; Handyman payment records; Project progress report feature;	Land readiness;	Reputable construction workers;
SUMMARY	List of contractors; list of foremen; project lists; project progress; escrow accounts; design templates; Contest Winners	Home financing; link to BPN* land legal status; PBG** facilities; project progress; payment progress;	PBG process; MoS status; Employment Contract Form;	

*BPN= Badan Pertanahan Nasional, The National Land Agency

**PBG= Perijinan Bangunan Gedung, permitting building owners to build new buildings and change or dismantle buildings.

4.3.   Prototype Testing Results

The results of testing prototypes of applications that have been developed. These tests are conducted to evaluate various key features such as labor search, escrow system, and project monitoring. Researchers collect user feedback to identify technical issues and areas that need improvement. The test results show that the app can meet most user needs, but it also reveals some challenges that must be discussed before the official launch. User feedback is invaluable in this process, as it provides first-hand insights into the user experience and effectiveness of the app.

5. RESULTS AND DISCUSSION

A Value Proposition Canvas (VPC) is a tool used to ensure that the product or service offered can meet the key needs and solve specific customer problems (Pokorná et al., 2015). The study focuses on developing a digital application for Indonesia's middle-to-lower housing procurement process, focusing on user personality and design criteria. The project owner includes small-medium scale developers Persona and Organisata, and the survey identifies the need for escrow accounts to facilitate joint payments between the Project Owner and the Project Seeker. The prototype aims to test key features like manpower search, escrow systems, project monitoring, and online training while evaluating user experience and identifying technical problems. The development process includes analyzing user needs, creating wireframes and mockups, and internal testing before external testing. (Andiman et al., 2023; Carter & Carter, 2020; Ojasalo & Ojasalo, 2018). This application's three main user groups are Developers, Homeowners, and Foremen or Building contractors.
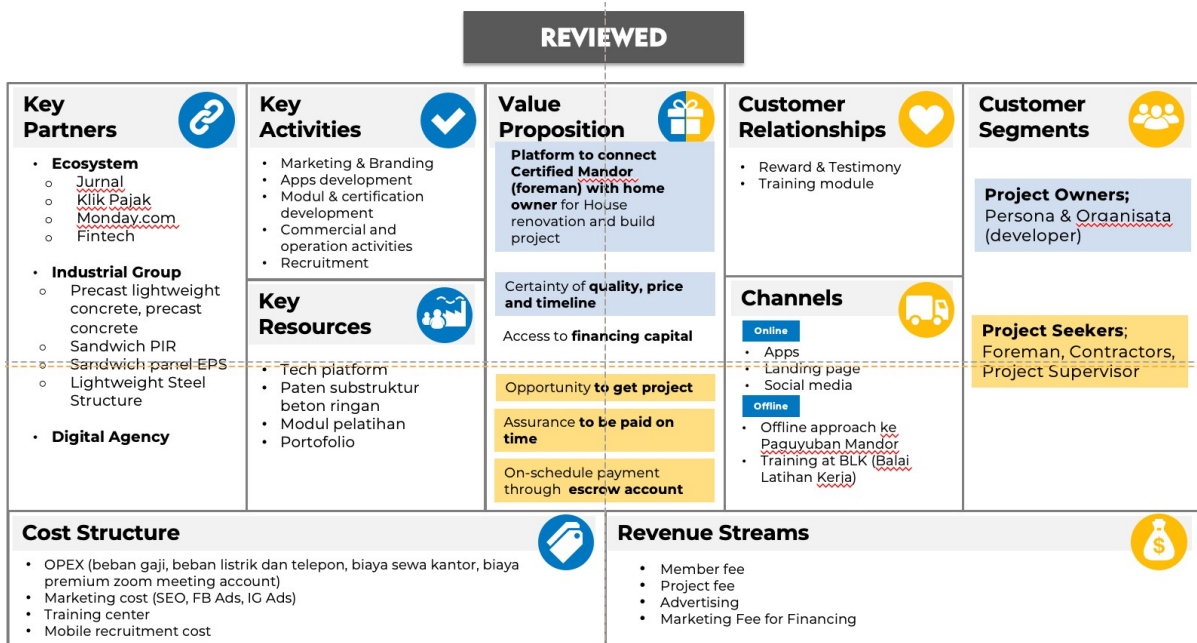

Figure 2. BMC Study Results

The study focuses on developing a digital application for Indonesia's middle-to-lower housing procurement process, focusing on user personality and design criteria. The project owner includes small-medium scale developers Persona and Organisata, and the survey identifies the need for escrow accounts to facilitate joint payments between the Project Owner and the Project Seeker. The prototype aims to test key features like manpower search, escrow systems, project monitoring, and online training while evaluating user experience and identifying technical problems. The development process includes analyzing user needs, creating wireframes and mockups, and internal testing before external testing. The results of the prototype validation provide valuable insights into the app's functionality and areas that need improvement. Figure 3 Prototype Canvas of the Developer Group, Figure 4 Prototype Canvas of the Homeowner Group, Figure 5 Prototype Canvas of the Contractor Group, Figure

6 Prototype Canvas of the Foreman Group. The developers feel that the labor search feature helps them in finding workers with relevant skills. They find this feature very useful in speeding up the recruitment process.
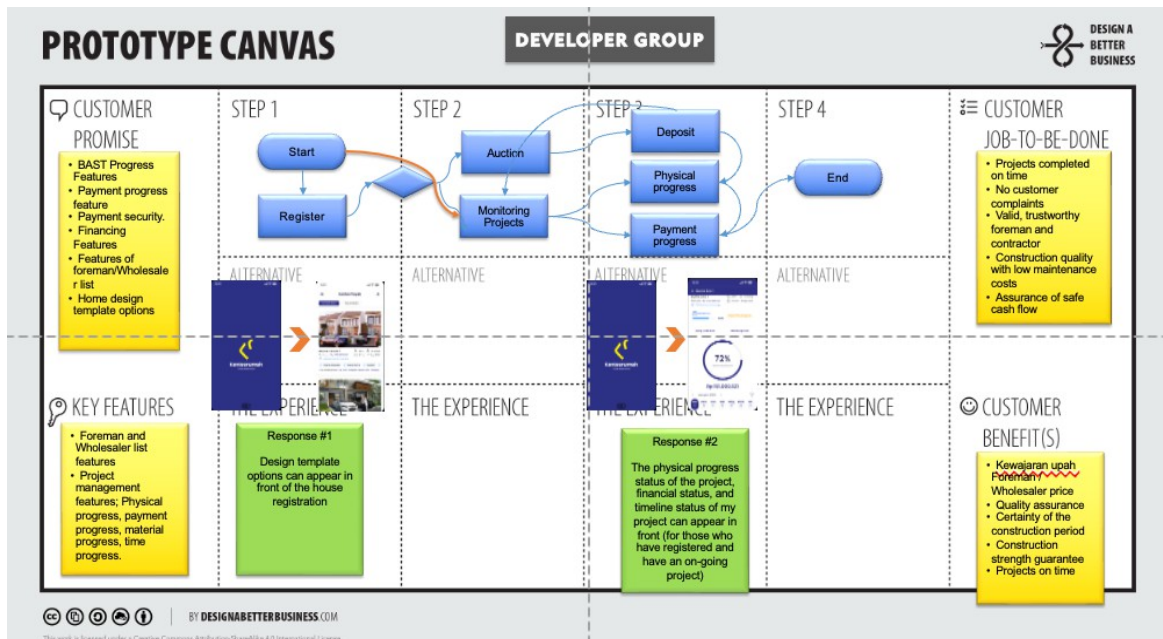

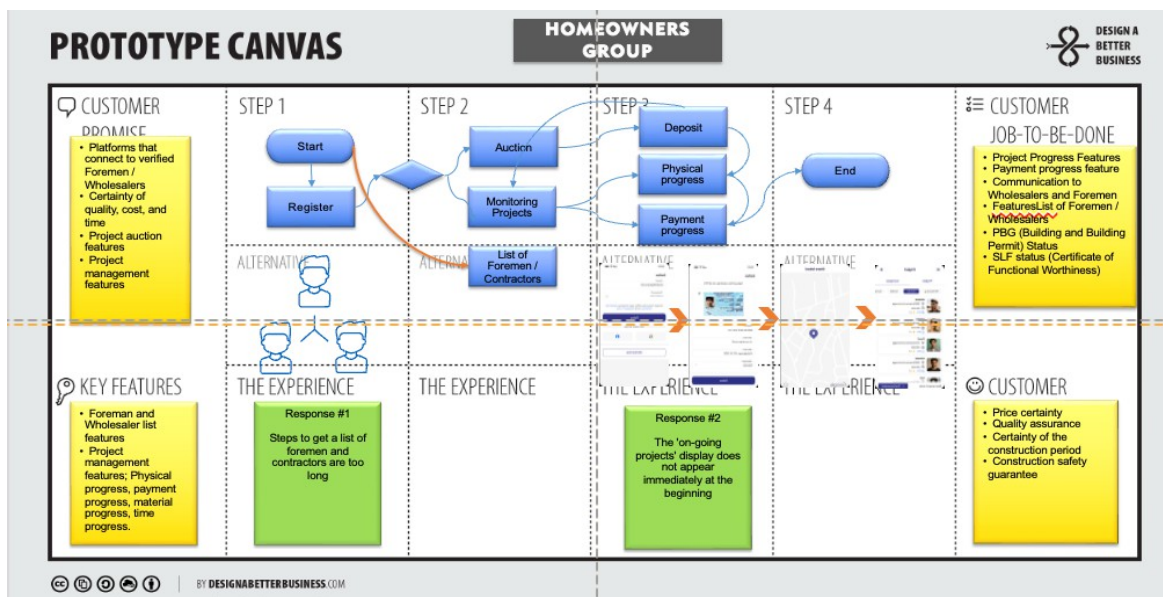**Figure 3.** Prototype Canvas - Developer Group
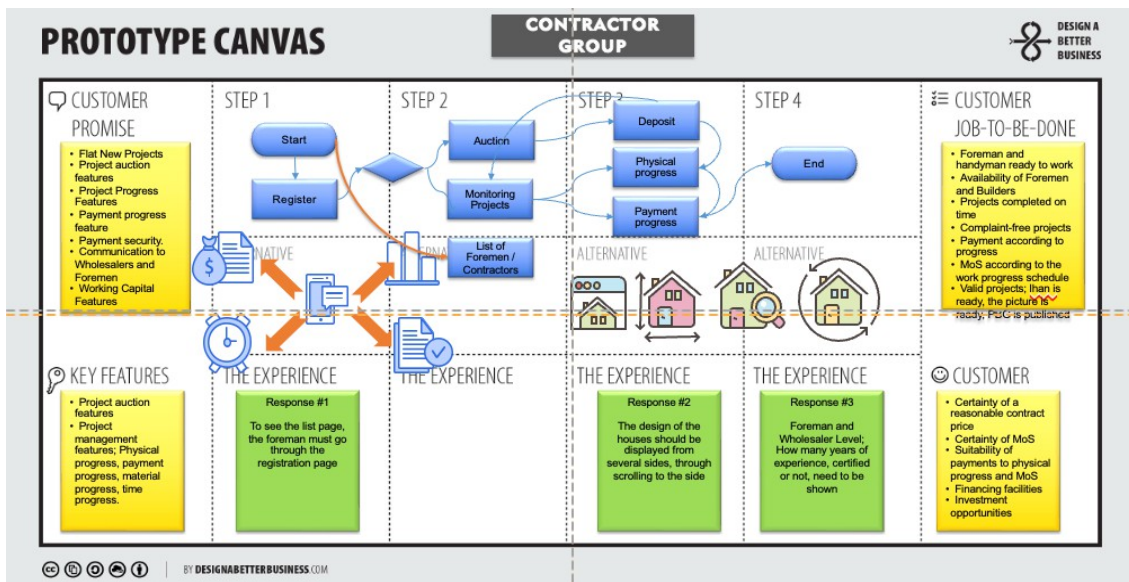

Figure 4. Prototype Canvas - Homeowners Group

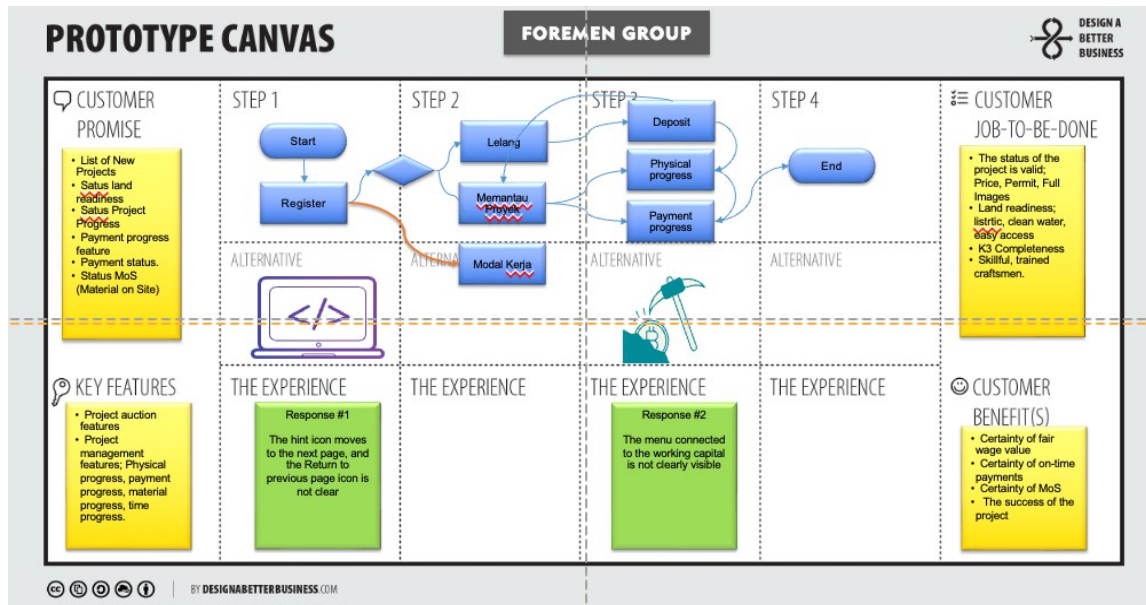**Figure 5.** Prototype Canvas – Building Contractors Group

Figure 6. Prototype Canvas - Foreman Group

Figure 7. Validation Canvas Kontesrumah

The app (see Figure 8, Figure 9) has met most user needs, but there are challenges to consider in future development. It needs interactive tutorials or visual guides for low digital literacy users. Collaboration with professional certification bodies can increase skill verification credibility. Real-time notifications for project management can reduce delays. The app's success in the lower-middle housing sector opens opportunities for expansion to other construction segments, such as commercial housing or infrastructure projects, to have a greater impact on the Indonesian construction industry.
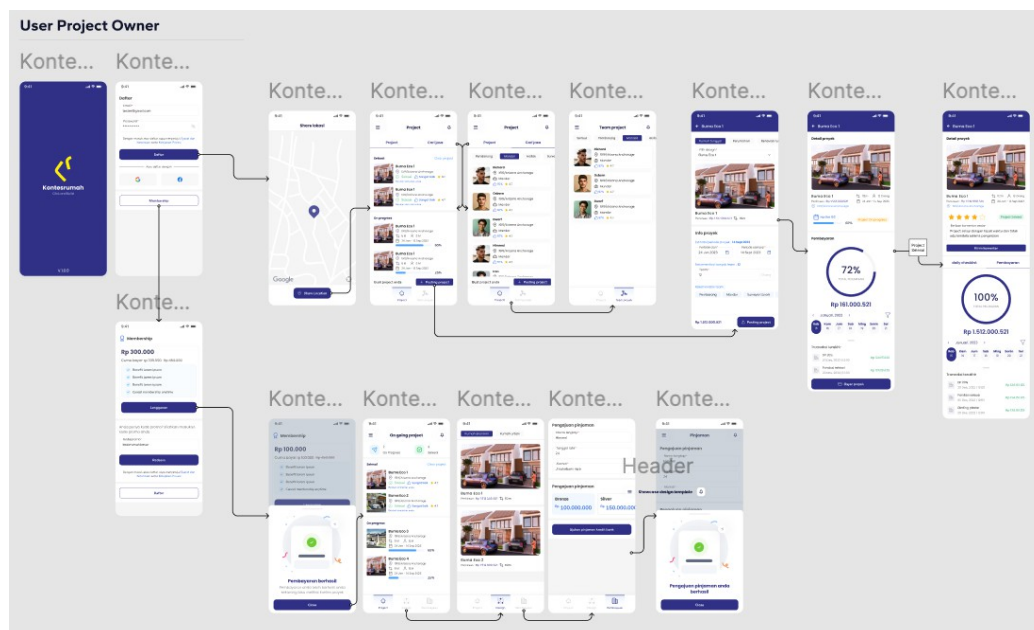

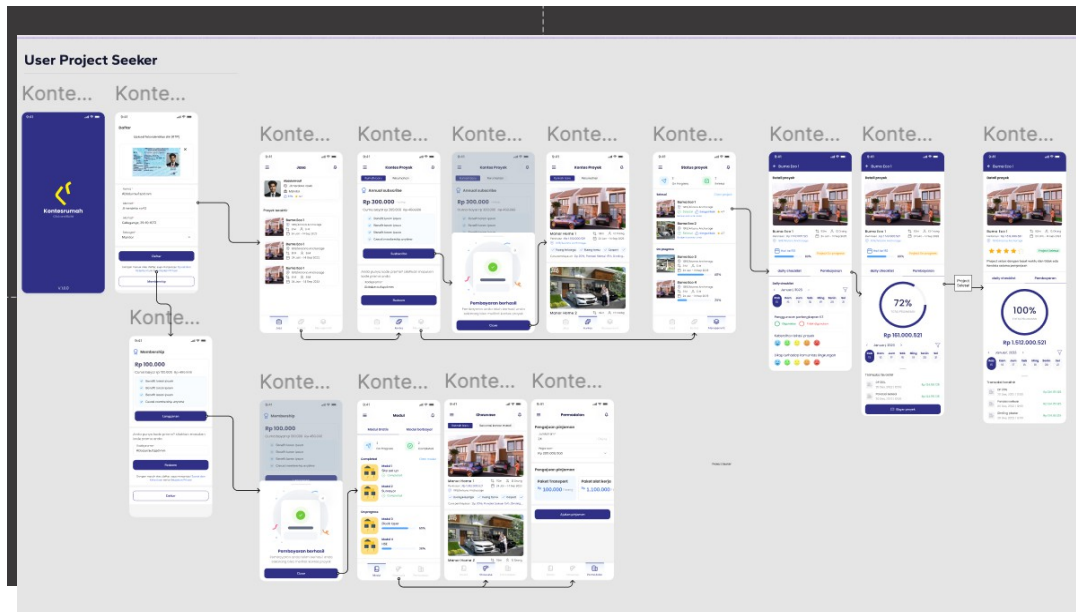**Figure 8**. App Prototype Project Owners

Figure 9. App Prototype Project Seekers

The development of digital applications for construction labor procurement in the lower-middle housing sector in Indonesia aims to create efficient, transparent, and easy-to-use solutions. Based on the results of prototype validation and feedback from key users—developers, *foremen*, and homeowners—it can be concluded that this application provides significant benefits in overcoming various obstacles faced in the labor procurement process and construction project management.

5.1. Evaluate the effectiveness of the app's key features

The validation results show that most of the features developed in the app have effectively met users' needs and addressed the main problems they face. Key features evaluated include a workforce search system, escrow payments, skills verification, and online training modules. The labor search and filter feature is highly appreciated for helping developers search for labor based on specific skills, reducing recruitment time and costs, and speeding up selection without a time-consuming manual process. The escrow system has proven effective in ensuring the security of transactions between developers and the workforce, overcoming payment uncertainty that was previously often an obstacle, and increasing the sense of security for foremen and developers. Skills verification plays an important role in ensuring the quality of work, increasing developer trust, and helping the workforce build a reputation on the platform, which increases their chances of landing new projects. The online training feature has been positively welcomed by foremen and developers, allowing the workforce to improve their skills without leaving the job. It is seen as a plus by developers looking for a workforce with ever-evolving competencies.

5.2. Analysis of Application Contributions in Overcoming Key Problems

The app is designed to address key challenges in construction worker procurement. Based on the results of interviews and trials, this application has successfully solved most of the problems users face, especially in four main aspects. First, improving the procurement and

recruitment process efficiency is carried out by providing access to a directory of skilled workers through a search and filter system, thereby speeding up recruitment and reducing operational costs previously incurred for manual selection. Second, risk reduction in payment transactions is achieved through the escrow system, which provides a sense of security for developers and the workforce by ensuring timely payments and reducing concerns related to the quality of work. Third, the skills verification feature and review system increase transparency and trust, allowing developers to assess workforce skills and previous project reviews, thereby reducing uncertainty in hiring. Lastly, the app provides online training modules that support the development of workforce skills, raising the quality standards of construction projects, especially in the lower-middle housing sector, thereby contributing to the development of a more qualified workforce in the construction industry.

5.3. Implications of Research Results on the Construction Industry in Indonesia.

The results of this study show that digital applications for construction labor procurement have great potential to encourage the development of the lower-middle housing sector in Indonesia. Some of the important implications of the results of this study are as follows:

- This application accelerates the adoption of digital technology in the construction sector, which previously relied on conventional methods. This digital transformation supports greater efficiency and transparency in the construction industry, which has traditionally been known as a labor-intensive and inefficient industry.
- Skills verification and online training provide added value for construction workers with limited access to formal training. The app allows the workforce to improve their skills independently, potentially improving the quality of work in the lower-middle housing sector.
- By optimizing the labor procurement process, this application supports faster and more efficient housing development, which ultimately helps provide more affordable housing for the lower middle class. This is in line with the government's development goals of providing decent and affordable housing for all levels of society.
- The app is designed to accommodate users with varying digital literacy backgrounds, especially among the informal construction workforce. By introducing technology that is easily accessible and understandable, these applications can reduce the tech skills gap in the informal sector.

5.4. Future Application Development Challenges and Opportunities

The app has met most user needs, but there are challenges to consider in future development. It needs interactive tutorials or visual guides for low digital literacy users. Collaboration with professional certification bodies can increase skill verification credibility. Real-time notifications for project management can reduce delays. The app's success in the lower-middle housing sector opens opportunities for expansion to other construction segments, such as commercial housing or infrastructure projects, to have a greater impact on the Indonesian construction industry.

5.5. Practical Implications

The development of this application has several practical implications for the construction industry in Indonesia, particularly in enhancing the procurement of middle-to-lower housing to be more efficient, transparent, and safe. By reducing the time and cost of the labor recruitment process, the application helps developers achieve higher efficiency, enabling projects to run more smoothly and on schedule. Additionally, online skills verification and training provide the workforce with opportunities to develop skills aligned with project needs, thereby improving overall construction quality. Moreover, the app plays a significant role in the digital transformation of the construction sector, offering innovative technology solutions for the workforce, developers, and homeowners, which has the potential to foster a more modern and integrated construction ecosystem.

6. CONCLUSIONS

The study identifies significant gaps in the availability of skilled construction workers and access to various house-design templates for low-rise buildings. It underscores the potential of digital applications to enhance the efficiency of the housing procurement process. Key features of the developed app include a user-centric design based on developer and homeowner needs, a skills verification feature to ensure project management by competent workers, and cost estimation tools for budget management.

However, the study has limitations, such as a small sample size that may affect the generalizability of the findings, technology barriers related to digital literacy, and a short evaluation period that might not capture long-term user experiences. Broader user testing with diverse participants and longitudinal studies are recommended to improve future research. Homeowners and developers are encouraged to explore digital tools for smoother construction processes. At the same time, industry stakeholders should engage in training programs to enhance their digital skills, ensuring effective use of the app. In researching the application of digital applications in the procurement process of affordable housing in Indonesia, it is important to recognize and overcome limitations that can affect the findings and conclusions drawn from this study. Acknowledging these limitations shows transparency and provides a clearer understanding of the research context. Below are the key limitations identified in this study, along with their implications for the study's findings:

- **Limited Stakeholder Representation**

The study mainly focuses on two groups: project owners and project seekers. This narrow scope may overlook the perspectives of other important stakeholders, such as contractors and financial institutions. As a result, the findings may not fully capture the complexity of the housing procurement process, potentially leading to incomplete conclusions about the effectiveness of digital applications in meeting the needs of all users.

- **Digital Literacy Variability**

The success of the proposed digital application depends on the digital literacy of the user. In areas with varying levels of technology and skill access, apps may not be used effectively. These limitations can alter outcomes, as users with limited digital skills may struggle to engage with the app, impacting their overall experience and satisfaction.

- **Short-Term Evaluation Period**

The evaluation of the application is carried out over a limited period, which may not adequately reflect its long-term usability and effectiveness. The user experience can evolve, and short-term judgments may miss important insights into how the app is performing over time. These limitations can lead to an over-assessment of the app's benefits and a lack of appreciation for potential long-term challenges.

- **Focus on Special Features**

While the research identifies the key features of the app, it may not explore all possible functions that can improve the user experience. The limited scope of features considered may limit understanding of how well an app meets the diverse needs of its users, potentially leading to an incomplete evaluation of its overall effectiveness.

- **External Influences**

Research may not adequately consider external factors such as economic conditions, regulatory changes, and market dynamics that can impact the housing sector. These external influences can significantly affect the feasibility and success of implementing digital solutions, and their failure can limit the applicability of findings to real-world scenarios.

In conclusion, while this study provides valuable insights into the potential of digital applications in improving the housing procurement process, it is crucial to acknowledge these limitations. Thus, the study enhances its credibility and sets the stage for future research that can address these shortcomings and provide a more comprehensive understanding of the topic.

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