Enhancing Art Exhibition Experiences Through Augmented Reality: A Case Study of the Annual Dekalcer Exhibition at UPJ

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Abstract. Art exhibitions offer unique and distinct experiences, from visiting in person to viewing online. Visitors who attend in person gain deeper insights through interactions with the artworks, the artists, or tour guides. The COVID-19 pandemic prompted a shift with the rise of online exhibitions, yet these experiences still cannot fully replicate the physical experience. Post-pandemic physical exhibitions have resumed, presenting new opportunities to leverage Augmented Reality (AR) technology to enhance visitor experiences. This study explores the application of AR technology in art exhibitions, with a case study on the Dekalcer exhibition held annually by the Visual Communication Design (DKV) program at Universitas Pembangunan Jaya (UPJ). AR technology enables visitors to access additional information, enjoy higher interactivity, and create a richer and more immersive exhibition experience. The findings of this study indicate that integrating AR in art exhibitions can enhance visitor satisfaction and engagement, adding value in both educational and artistic appreciation contexts.

Keywords: art exhibition; augmented reality; experience; graphic design

1 Introduction

The COVID-19 pandemic has significantly altered the landscape of art exhibitions, shifting many events to an online format [1]. While online exhibitions offer accessibility and convenience, they lack the immersive and interactive elements of in-person experiences. This disparity has created a gap in how audiences engage with and appreciate art. Additionally, the return of physical exhibitions post-pandemic presents an opportunity to explore new ways to enhance visitor experiences. This study addresses the challenge of bridging the gap between online and physical art exhibitions by integrating Augmented Reality (AR) technology.

Virtual museums significantly benefit documentation, conservation, research, and exhibition. They have the potential to preserve and distribute cultural information effectively and affordably by leveraging innovative technologies. Virtual museums are particularly appealing to diverse visitor groups, providing engaging experiences that can promote physical museums by offering detailed information about exhibitions and enhanced displays of artifacts through cutting-edge technologies. Various users, including tourists, students, and experts, benefit from these digital platforms, catering

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to educational and entertainment needs. Virtual museum visits foster active participation, making the experience both enjoyable and productive while supporting the visibility of real-world museums. [2].

Augmented Reality (AR) is a technology that overlays virtual objects in the real world through smartphones, tablets, and smart glasses. It uses computer vision to project virtual elements, offering interactive and real-time experiences. [3]. AR integrates the real and virtual worlds, creating a mixed-reality environment. AR's history dates to 1957 with Morton Heilig's "Sensorama," evolving through advancements like Ivan Sutherland's "The Sword of Damocles" in 1966, and the term "Augmented Reality" was coined in 1992 at Boeing by Thomas P. Caudell and David W. Mizell. [4]. The first commercial AR application appeared in 2008, with notable examples like the Snapchat Geofilter and the "Pokemon GO" game in 2016.

2 Augmented Reality and Its Role in Education

AR has diverse applications across various fields. In retail, it enhances the shopping experience by providing interactive, immersive experiences, as demonstrated in a study at a sports retail store in London. [5]. AR helps students retain information longer by providing interactive learning experiences. [6]. In medicine, AR is increasingly used in neurosurgery and radiology for training and surgical planning. [7].

AR systems can be developed using software like Unity and Google ARCore. Unity is a versatile game engine popular among developers for creating cross-platform applications. ARCore is a Google-developed SDK that uses motion tracking, environmental understanding, and light estimation to create immersive AR experiences (Google, 2022; Unity, 2023). AR technology uses markers or specific patterns recognized by cameras to display virtual objects. The effectiveness of marker detection can vary based on device specifications, lighting, and marker size. [8].

3 User Interface Design

User interface (UI) design is creating the visual layout of an application or digital product to enhance interaction between users and the system. This includes selecting colors, layouts, graphic elements, and icons to create an intuitive, efficient, and engaging user experience. The primary objective of UI design is to present system interface components in a way that is easy to use, effective, and enjoyable for users. One of the fundamental frameworks in UI design is Ben Shneiderman’s "8 Golden Rules of Interface Design." [9] These are basic design principles suitable for both desktop and mobile interfaces. They include striving for consistency, catering to universal usability, offering informative feedback, designing dialogues to yield closure, preventing errors, permitting easy reversal of actions, supporting internal locus of control, and reducing short-term memory load.

Human-centered design (HCD) is a problem-solving approach that prioritizes the user throughout the development process, ensuring that products and services meet user needs (Landry, 2020). As the Interaction Design Foundation states, HCD concentrates on addressing user challenges and understanding systems. Don Norman, recognized as the father of UX, highlights four

fundamental principles of HCD: being people-centered, identifying the right problem to solve, viewing everything as a system, and designing simple interventions.

Design Thinking builds on the principles of HCD, employing a human-centered approach to tackle design problems effectively. Tim Brown explains that Design Thinking integrates design sensitivity, strategic thinking, and methodology to fulfill end-user needs while considering business feasibility, ultimately creating customer value and market opportunities. The Design Thinking process consists of several key steps: empathy (understanding and relating to user issues), defining (analyzing observations to identify core problems), ideating (generating a diverse array of potential solutions), prototyping (developing simple models for testing), and testing (gathering user feedback to validate solutions).

Within the Design Thinking framework, user personas are essential for creating effective UI designs. User personas are detailed representations of ideal or target users, encompassing demographics, backgrounds, behaviors, needs, and motivations. These profiles aid design teams in comprehending who their users are and what they require, maintaining a user-centered focus in the design process. By integrating user personas, designers can better ensure that their products align with the expectations and requirements of their target audience.

4 Essential Graphic Elements for Effective UI Design

Typography is crucial in UI design, comprising 70% of the content. Effective typography considers font choice, size, and consistency to ensure readability and convey the brand message. Serif fonts, often used for their readability in print, and sans-serif fonts, favored for their clean and modern appearance, are commonly used. In designing UI for websites, it's essential to consider font size variations for effective communication. For instance, a body text size of 11px ensures readability, while a 24px font for the homepage header captures attention immediately. An 18px size is suitable for page titles, helping to distinguish them from other content, and a 16px size for navigation buttons and tertiary headers provides a cohesive visual hierarchy. The careful selection of these sizes is crucial, as typography significantly influences user experience. Therefore, meticulous planning and consideration are necessary to achieve a harmonious design that resonates with users [10].

Color is an essential element in UI design, significantly influencing user emotions, establishing the overall mood, and directing focus within a layout. Designers commonly rely on standard color palettes, which include primary colors (red, blue, yellow), secondary colors (green, orange, purple), and tertiary colors. To create harmonious color schemes, tools like Adobe Color and Figma Color Wheel are invaluable, providing generators for various schemes, including complementary, split-complementary, triadic, monochromatic, and analogous. For those without a design background, choosing the right colors can be overwhelming. The 60–30–10 rule simplifies this process, suggesting that a balanced color palette should consist of three colors in specific proportions: 60% dominant color as the primary visual element, 30% secondary color to complement the dominant hue, and 10% accent color to introduce contrast and excitement. This approach, widely used across design disciplines such as interior and graphic design, enables designers to create visually appealing and effective user interfaces that resonate with users [11].

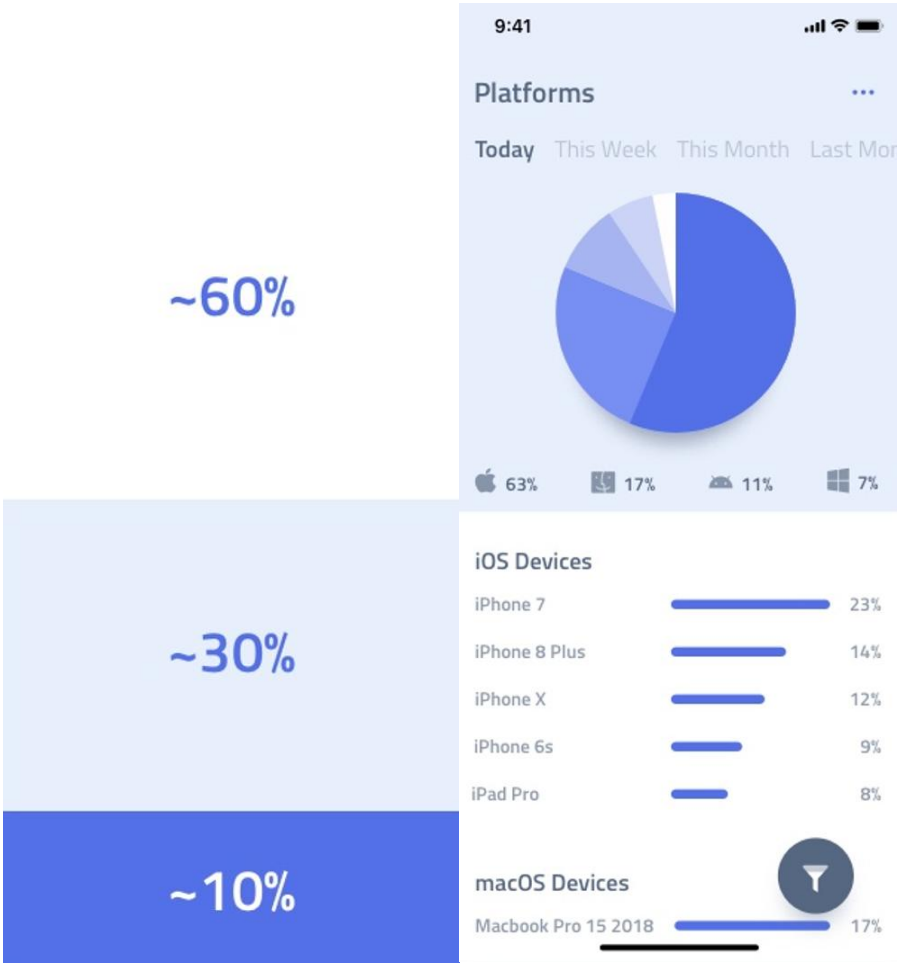


Fig. 1. 60-30-10 Rule in Color Combination for UI Design (https://uxmisfit.com/2019/05/21/ui-design-in-practice-colors/**)**

Visual balance in design can be symmetric or asymmetric, influencing the formal or modern feel of the composition. Different layout types, such as linear, relative, constraint, table, and frame layouts, are used in mobile UI design to create engaging and practical user experiences. Effective navigation in UI design helps users quickly and intuitively explore an application or website. Common navigation types include tab menus, bottom navigation, top navigation (app bars), hamburger menus (side drawers), navigation rails, floating action buttons (FABs), and bottom sheets.

Icons serve as communicative symbols in UI design, aiding in system interaction. Common icon types include system, application, and navigation icons. Buttons, such as call-to-action (CTA),

ghost, text, and floating action buttons, are critical UI components facilitating user interactions like form submissions or accessing different pages.

UI/UX designers use various tools to create application designs, such as Sketch, Adobe XD, Whimsical, Miro, and Figma. Figma is particularly popular for real-time collaboration, allowing designers and stakeholders to work together directly. Its features, like auto layout and prototyping, streamline the design and testing process. [12].

The primary objective of this study is to investigate the potential of Augmented Reality (AR) to enhance visitor experiences in art exhibitions. By examining the case of the annual Dekalcer exhibition at Universitas Pembangunan Jaya (UPJ), the study seeks to explore how AR can provide additional layers of information, interactivity, and engagement. This research aims to determine whether AR can effectively augment the physical exhibition experience, making it more immersive and educational for visitors.

5 Methodology

This study utilizes a mixed-method approach to evaluate the design and effectiveness of an AR-enhanced application for the Annual Dekalcer Exhibition at UPJ. The methodology begins with an on-site analysis of the original Dekalcer Exhibition to understand its physical layout, the presentation of artworks, and the overall visitor experience. This initial step establishes a baseline for how the exhibition was designed and how visitors interacted with it in a traditional setting.

Following this, a comparative study was conducted at the ART.JAKARTA exhibition to observe and analyze its setup, artwork presentation, and visitor engagement. This visit provided valuable insights into contemporary trends and best practices in art exhibitions, especially those incorporating digital and interactive technologies. The findings from ART.JAKARTA informed us of the development and evaluation of AR applications.

Two AR-based applications, "We & The World" and "ART.AUGMENTED," were then analyzed to compare their usability and visual design. The analysis focused on user interface (UI) design, examining how each application’s layout and aesthetic choices impacted user interaction and experience. This involved assessing the interface's ease of navigation, visual appeal, and overall intuitiveness.

Additionally, the number of artworks displayed in each application and the quality of information provided about these artworks were compared. The study evaluated how effectively each application presented and contextualized the art, enhancing user understanding and engagement. Resolution quality was another crucial factor, focusing on the clarity and detail of digital representations of the artworks.

Application performance was also assessed, including responsiveness, stability, and the seamless integration of AR features. This evaluation ensured that the applications provided a smooth and efficient user experience. The ease of use of AR functionalities was examined to determine how intuitively users could interact with the AR elements, which is essential for a positive user experience.

Finally, the color palette used in each application was analyzed to assess its impact on readability, aesthetic cohesion, and alignment with the exhibition’s theme. This comprehensive evaluation, supported by literature on AR applications in art contexts, guided the development of

the Dekalcer app, ensuring it effectively enhances the art exhibition experience through well-informed design and functionality.

6 Result and Discussion

6.1 Field Study: Insights from Art Exhibition Observations

Interviews were conducted with attendees of the "Dekalcer Exhibition 2023," a cultural art showcase focusing on Indonesian art and heritage richness. The Universitas Pembangunan Jaya students from the Department of Visual Communication Design organized the exhibition from September 14 to 17, 2023, featuring unique student artworks exploring Balinese culture. Strict exhibition protocols, such as prohibiting interaction with the displayed works, were enforced to preserve the pieces' integrity.

Fig. 2. Dekalcer 2023 Art Exhibition

Further interviews were conducted with visitors to the “dd. weekend market” on October 7, 2023. This event was organized by PT. Dedato Indonesia combined an art exhibition with a local artisan market, fostering a creative exchange between artists and the community.

Fig. 3. Documentation of Art & Craft Exhibition "dd. weekend market"

Feedback from the "Dekalcer" exhibition revealed certain dissatisfaction among visitors, particularly concerning the lack of detailed explanations regarding the techniques used in creating the artworks and the inspiration behind them. This absence of context detracted from the overall experience of the exhibition. Despite these shortcomings, "Dekalcer" provided a platform for DKV students to present culturally immersive and innovative artworks while focusing on safeguarding the integrity of the pieces displayed.

Unlike the "Dekalcer" exhibition, which solely focused on showcasing art, the "dd. weekend market" combined an art exhibition with a market where local Indonesian artists and artisans could sell their work. During this event, interviews were conducted with six visitors and one vendor. The interviews revealed that five of the six visitors had made purchases, with the main reason for attending being to acquire items such as paintings, carpets, and handmade crafts.

The unique, handcrafted nature of the exhibited items made them particularly appealing, as these products, created by local artists and artisans, were considered rare and exclusive to the Indonesian market. However, the outdoor setup and the hot weather posed a slight inconvenience for some attendees. Despite these conditions, visitors remained enthusiastic and enjoyed the event, drawn by the charm of the one-of-a-kind, locally made items on display.

We also conducted direct observations by visiting the "ART JAKARTA" art exhibition on November 19, 2023. This international exhibition featured collaborations with numerous artists, both local and global. Upon entering the venue, visitors were provided with brochures containing a layout of the event and a list of participating art galleries and collaborators. The rectangular design of the exhibition facilitated easy navigation, allowing visitors to tour all the galleries from the entrance to the exit. The brochure also provided a comprehensive list of participating galleries.

(a) (b)

Fig. 4. (a) Vice Versa Gallery at ART.JAKARTA Exhibition and (b) Usage of QR Code that Explains the Artworks

Each gallery was given its own space to display its collection of artworks, and some even provided e-catalogs accessible via QR codes displayed beside the artworks. Most galleries offered detailed information about the pieces, including the artist's name, the work title, the medium used, and the canvas size. Visitors accompanied by a tour guide could gain deeper insights into the philosophy and story behind the artworks, often explained by the artists themselves.

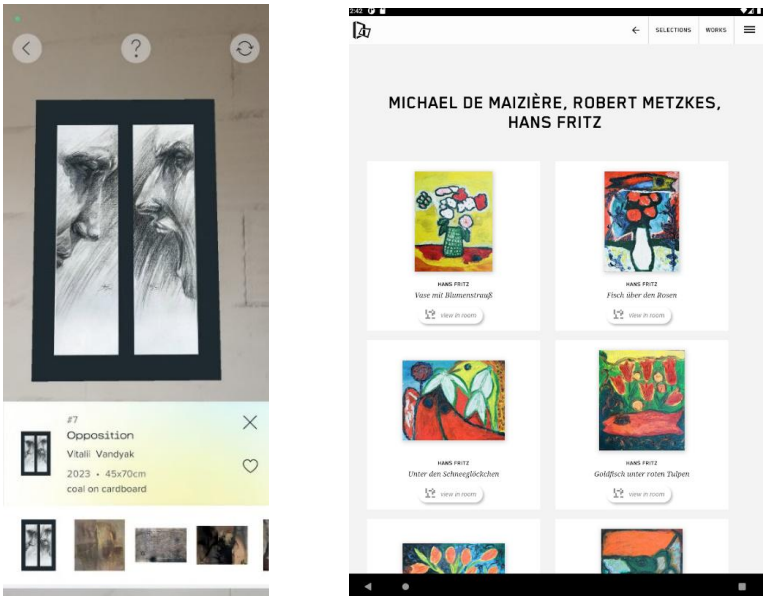
Although visitors were limited in observing the artworks without any physical interaction, they reported satisfaction in being able to view the pieces closely. The bright lighting in the exhibition halls enhanced the visibility and clarity of the artworks. The venue also accommodated visitors with special needs, providing ample space and good lighting. However, areas like the cafeteria were less accessible to wheelchair users due to narrow spaces and obstructive stairs.

Additionally, the exhibition featured a children's painting area, where young visitors were given paper and various painting tools to express their creativity and imagination. The event received positive feedback from many visitors, who appreciated the opportunity to view the art and interact with the artists present. Art collectors could participate in auctions hosted by several galleries, making the exhibition beneficial for art lovers and creators.

6.2 Study of "We & The World" and "ART.AUGMENTED" Apps

When comparing digital art applications, it is essential to consider multiple aspects such as content, functionality, visual design, and user experience—applications like **We & the World** and **ART.AUGMENTED** offers unique approaches to interacting with art, utilizing augmented reality (AR) to enhance user engagement with various artworks. While both apps are rooted in art exploration, their differences in user interface design, visual presentation, and overall accessibility significantly impact the user’s interaction and experience. These factors are crucial in determining how effectively each app delivers its content to the user, whether it’s through showcasing specific exhibitions or providing access to a wide array of artworks. The following comparison highlights key distinctions in design and functionality between these two platforms.

"We & The World" is a mobile application focused on environmental sustainability and art. Its content is centered around a specific art exhibition featuring a curated collection of works that explore themes related to the environment. The app provides detailed information on each artwork, including the title, artist, medium, and year of creation. However, the number of works available is limited to more than a few dozen pieces due to its singular exhibition focus. Additionally, the app requires users to interact with augmented reality (AR) to enhance the viewing experience, mainly using specific textured surfaces to anchor the AR display. This can create some challenges when attempting to engage with the content in specific environments fully. In terms of performance, the AR functionality may also lag depending on the device's specifications, often taking up to a minute to load AR objects.



(a) (b)

Fig. 5. Screenshot of (a) "We & The World" and (b) "ART.AUGMENTED" Apps

"ART.AUGMENTED," in contrast, offers a more extensive collection of art. The app features hundreds of works from various exhibitions, providing users with an expansive AR gallery experience. While the app offers less detailed information on each piece (only including the title, artist, and year), its vast collection makes up for it. Users can interact with the art using AR, but unlike "We & The World," "ART.AUGMENTED" allows more flexibility in displaying AR, using textured surfaces or printed QR codes to trigger the AR experience. This versatility and a more responsive AR feature make for a smoother experience overall.

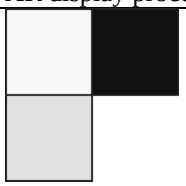
Regarding visual design, both apps take different approaches to creating an engaging user experience, reflecting their respective themes and functionalities. "We & The World" adopts a modern, minimalist aesthetic that ties into its environmental focus. The app uses a muted color palette comprising earth tones like greens and browns to evoke a natural atmosphere. The layout is relatively simple, but the homepage mimics a desktop website, making navigation tricky for some

users. The font size is generally large and readable, emphasizing clarity and ease of understanding. The app's workflow is straightforward but requires patience, particularly when interacting with the AR components, which rely on textured surfaces to function correctly. This requirement can interrupt the smoothness of the experience, making it somewhat cumbersome in less ideal environments.

"ART.AUGMENTED," on the other hand, uses a more polished, clean aesthetic that aligns with its high-end gallery experience. The visual design employs neutral colors like whites, greys, and blacks, creating a refined and elegant interface. The font style is minimalist yet sophisticated, giving the app a sleek appearance emphasizing the artwork rather than the interface itself. The layout is intuitive, allowing users to browse through hundreds of pieces effortlessly without feeling overwhelmed by the extensive content volume. Despite the significant number of works, the clean interface ensures that users can focus on the art with minimal distractions. The workflow is streamlined, guiding users smoothly from the homepage to the artwork selection and the AR display. Additionally, using QR codes for AR triggering adds an extra layer of convenience, ensuring users can engage with the AR in various environments without needing specific textured surfaces.

Table 1. Comparison of "We & The World" and "ART.AUGMENTED"

	We & The World	ART.AUGMENTED
UI displays	The design appears simple and modern, but the homepage could be easier to navigate due to its desktop website-like layout.	It appears neat and modern, with easy navigation from the homepage to the artwork selection.
Number of artworks displayed	The number of artworks is limited to only a few dozen, restricted to a single art exhibition.	There are hundreds of artworks from various art exhibitions within a single application.
Artworks' information	Displays the artwork's title, the medium used, the artist's name, and the year of creation.	Displays the title of the artwork, the artist's name, and the year of creation.
The display quality of the artwork	Limited by a single exhibition, all artwork is displayed in clear, high-definition quality.	Due to the inclusion of multiple exhibitions, the artwork quality tends to be less precise and appears blurry.
Apps performance	The time required for the app to display AR can take over a minute, depending on the user's smartphone specifications.	The time required for the application to display AR can exceed one minute, depending on the specifications of the user's smartphone.

Ease of use of the AR	The application requires a textured wall surface, making finding suitable surfaces to display AR features somewhat challenging.	In addition to using wall surfaces, this application also offers a QR function that can be printed to expedite the AR display process.
Color Palette		

In summary, "We & The World" excels in offering a unique, environmentally focused experience with a visually cohesive design, although it faces challenges in navigation and AR functionality. "ART.AUGMENTED," with its broader art selection and more flexible AR features, delivers a superior user experience through its polished, gallery-like aesthetic and user-friendly interface. Each app has strengths and weaknesses, but "ART.AUGMENTED" provides a more consistent and versatile AR experience, making it a better choice for users seeking seamless interaction with digital art.

6.3 Enhancing Art Exhibition Engagement through Mobile Applications

Based on data gathered from the “Dekalcer Art Exhibition” and “dd.weekend market”, we developed an application called “Dekalcer Mobile” to evaluate the visitor experience in viewing art exhibitions. For the design aspect, we used analysis from apps like “We & the World” and “ART.AUGMENTED” as our reference points. This AR-based app enhances the visitor's experience by allowing them to access additional information about the artwork using AR display technology on their smartphones. This eliminates the need for a tour guide and offers a more immersive, self-guided tour. The app also assists artists in promoting their social media and personal websites. Moreover, the AR application extends beyond the physical exhibition, enabling users to view past exhibitions from any location.

The design employs natural and warm colors such as white, red, and yellow, which evoke cultural richness and traditional elements, a hallmark of Indonesian identity. Red and white, being the national colors of Indonesia, are prominently used, with neutral shades like black providing contrast. The use of color contrast in user interface design is crucial for enhancing readability, accessibility, and user engagement. High contrast ensures that text and elements are easily distinguishable, especially for users with visual impairments. Nilsson [13] and Kristanto et. al [14] emphasized this in print media, Kristanto [15] demonstrated that the same principle applies effectively in digital contexts as well. The right balance of contrast improves visual hierarchy, drawing attention to key content, and making interactions more intuitive across different platforms.

Fig. 6. Color Palette for UI Design of The Dekalcer Mobile Apps

Regarding typography, we opted for industry-standard sans-serif fonts commonly used in UI/UX design: Montserrat for titles and subtitles and Roboto for body text. Boulton [10] suggests a body text font size of 11px for UI; however, testing with 17 participants from various backgrounds found that a body text size of 32px was more comfortable for smartphone use. Consequently, the final design adopts 32px for body text, 72px for headers, and 48px for sub-headers.

The application employs a "Column Grid" system consisting of five columns separated by 25px gutters. The author chose this grid system due to its common use and flexibility, making it a practical choice for ensuring that content is well-organized, responsive, and aesthetically pleasing across different device types.

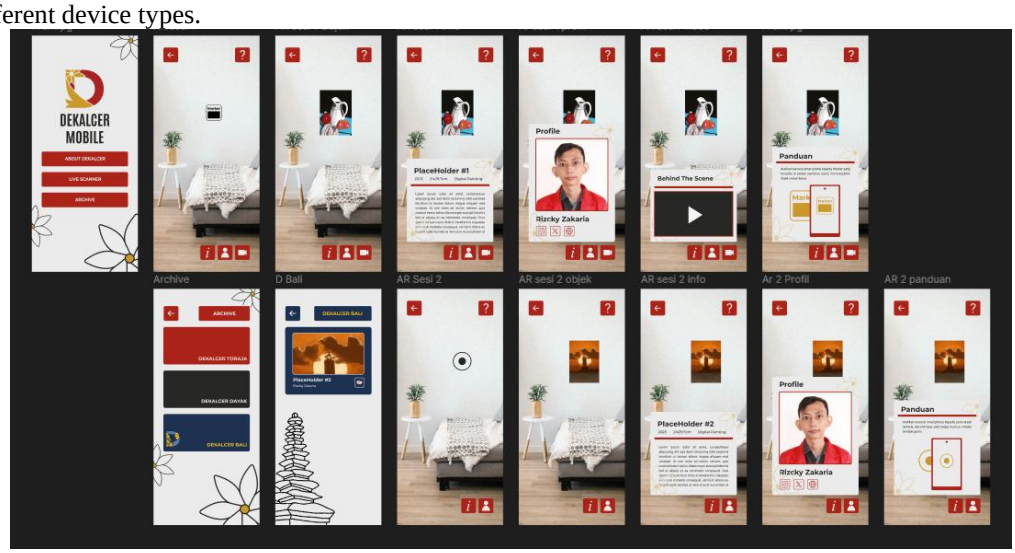


Fig. 7. UI Design of The Apps

The main page of the application, known as the live scanner page, serves as the central feature where the AR functionality is utilized. When accessed, the smartphone camera activates, allowing users to scan markers, which then triggers the appearance of AR objects. The page also includes a guide function that directs users to scan the markers properly to ensure the AR content is displayed.

Additional features include an information button that details the artwork, such as the title, canvas size, medium, and the artwork's meaning and philosophy. A profile button gives access to the artist's biography and includes hyperlinks to their social media, allowing users to connect directly with the artist online. Lastly, there is a video button, which showcases behind-the-scenes footage of the creation process.

Another app feature is the live scanner, which utilizes AR with markers. In contrast, the archive scanner page employs marker less AR, allowing users to view AR objects without the need to download or print a marker. This marker less technology enhances user accessibility and convenience. The archive scanner page also includes a guide, information, and profile buttons, like those on the live scanner page, providing consistent functionality for accessing artwork details and artist information.

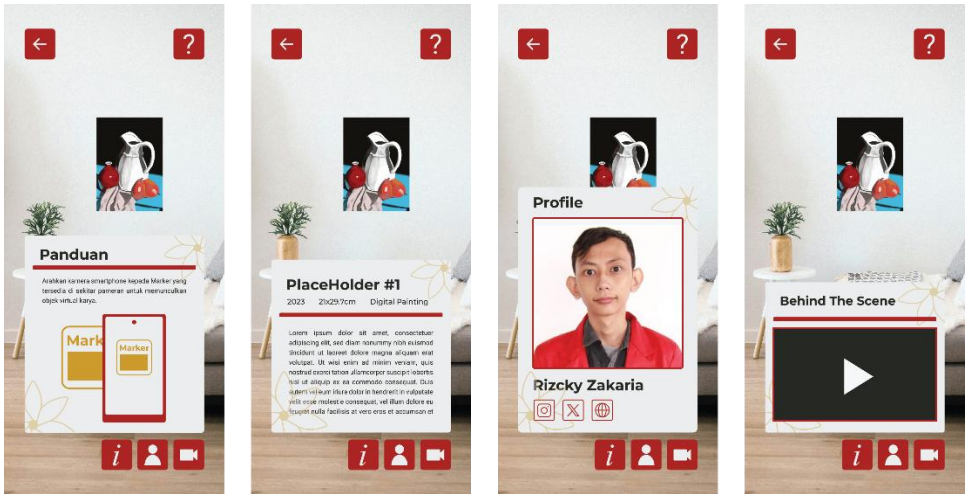


Fig. 8. The Archive Scanner Feature

In testing the application, we engaged 30 participants, all of whom were students who had previously attended the Dekalcer Art Exhibition. The results showed that the app added value by offering deeper insights into the displayed artworks. The users were categorized into two types: (a) active visitors who enjoyed engaging with others and (b) passive visitors who preferred less direct interaction. Active visitors generally favored direct exchanges with the artists or exhibition staff, finding it disappointing when there was no one available to answer their questions about the artwork. Their experience was hindered by the lack of interaction when such people were absent.

On the other hand, passive visitors were less concerned with the presence of the artists or staff. If no one was available to provide additional information, these visitors were more likely to move on without it affecting their experience significantly. However, both visitor types shared a common challenge: when no one was available to explain the artworks, their understanding remained surface-level. This lack of engagement ultimately reduced the potential for a deeper connection between the visitor and the artwork.

Fig. 9. Apps Testing

The introduction of the mobile app helped mitigate this issue. Whether the artist or exhibition staff were present or not became less of a concern since the app supplied the necessary information. The app's features bridged the gap, allowing visitors to explore and understand the works in more depth on their own, thus enriching their overall experience. By providing detailed information through the app's various features, the mobile platform enhanced the visitor's ability to engage with the artworks autonomously, fostering a more meaningful and informed interaction regardless of the type of visitor.

7 Conclusion

In conclusion, the development of the Dekalcer AR app demonstrates the potential of augmented reality to significantly enhance the experience of art exhibition visitors. By providing visitors with supplementary information about the artworks on display, the app fills the gaps in understanding that often arise when there is no direct interaction with the artists or gallery attendants. This is particularly important for different types of visitors, whether they are more socially active or prefer a solitary viewing experience. The app's AR features allow users to engage with the artwork more deeply, regardless of whether the artist is present to explain the work.

The design choices, such as the use of natural, warm colors and industry-standard sans serif fonts like Montserrat and Roboto, support a modern and minimalist aesthetic while honoring the cultural essence of Indonesia. The integration of features such as live AR scanning, additional artwork information, artist profiles, and behind-the-scenes videos contributes to a more comprehensive visitor experience. Moreover, the app's flexibility, with options like marker-based and marker less AR, ensures that users can interact with the exhibition content easily, both on-site and remotely.

Ultimately, the Dekalcer AR app bridges the gap between traditional art exhibition experiences and modern digital interaction. By leveraging technology to offer detailed insights into each piece of art, the app not only enriches the exhibition experience but also helps artists promote their work through social media and online platforms. This innovation showcases the importance of digital

tools in expanding the reach and impact of art exhibitions, making them more accessible and engaging for a diverse audience.

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