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Digitizing Cultural Heritage: Augmented Reality for Education and Visualization of Local Wisdom in Ikat Woven Fashion

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Abstract
The ikat woven fabric of East Nusa Tenggara (NTT) represents one of Indonesia's intangible cultural heritages, rich in philosophical values, symbolism, and local wisdom. Rumah Tenun Ina Ndao in Kupang City plays a significant role in preserving and promoting ikat weaving traditions; however, it continues to face challenges in cultural education and market expansion. Conventional educational methods and suboptimal marketing strategies have made information about the meanings of motifs, philosophies, and production processes of ikat fabrics less accessible to the public.This Community Partnership Program (PKM) offers an innovative solution through the application of Augmented Reality (AR) technology based on QR Codes, utilizing the MyWebAR web platform. The AR technology provides an interactive visual experience through 3D objects, animations, and audio to convey the meanings and philosophies of ikat motifs from various regions of NTT, as well as the traditional weaving processes embedded with cultural values.The implementation methods include socialization, training, technology application, mentoring, and continuous evaluation. Consumers who scan the QR Code on products or promotional media gain an engaging educational experience—allowing them to view the motifs, understand the stories behind them, and virtually witness the weaving process. This enhances both cultural appreciation and consumer interest.The expected outcomes of this program include increasing public knowledge of local cultural heritage, strengthening the marketing of ikat woven products in local and global markets, and preserving NTT's cultural legacy. The program outputs consist of scientific publications, mass media publications, and documentary videos to support the promotion and cultural education of NTT ikat weaving in a broader and more sustainable manner.

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1. INTRODUCTION

Indonesia has a diverse cultural wealth, one of which is woven fabrics that have been passed down from generation to generation. Ikat woven fabric has been recognized as one of 33 traditional fabrics designated as intangible cultural heritage by the Ministry of Education and Culture. In addition to storing rich cultural values, woven fabrics are also rich in local wisdom, philosophy and have become part of people's lives with a strong cultural identity. Woven fabrics can also be interpreted as the result of the process of weaving life. This is because woven fabrics are often used in various cycles of human life, both at birth, marriage, death, and during traditional ceremonies. The determination of woven fabrics as cultural heritage can increase people's enthusiasm for wearing woven fabrics as everyday clothing, which can also encourage craftsmen and the younger generation to see woven fabrics as a promising profession in the future [1][2].

NTT is one of several weaving-producing regions in Indonesia. This ikat-woven cloth is the pride of the people of NTT province, because according to tradition and culture, it has many functions, for example, as clothing worn at parties, dances, traditional ceremonies, appreciation for visiting guests, as a dowry, as a gift at a funeral, and as a form of appreciation, and many more. In fact, according to experts, NTT is one of several weaving-producing regions in the archipelago recorded as the earliest in developing decorative woven patterns [3].

Types of NTT ikat weaving come from areas in the province of NTT, including: Sumba ikat weaving with the characteristic of decorative motifs of land animals, water and reptile animals, poultry, and human decorative motifs with characteristic dark colors such as dark blue, brown, reddish brown. Sabu ikat weaving with the characteristic of decorative motifs of plants with small and large lotus flower motifs, characteristic of dark blue and bright red base colors. Alor ikat weaving with decorative shapes of plants, such as canaries and decorative motifs of animals such as fish, turtles, dragons, and elephants, with characteristic black, green, and yellow colors. Then Rote ikat weaving with the characteristic of decorative motifs of plants arranged in symmetrical lines with basic colors of black and white. Flores ikat weaving with the characteristic of motifs in the center of the cloth, the motifs are repeated and only stop at the border lines, using dark colors such as dark blue and brown. Timor ikat weaving with the characteristic of animal motifs flanked by small lines with geometric decorative motifs with characteristic bright colors, [4].

Ina Ndao Weaving House is one of the weaving centers that is the center of production and preservation of ikat-woven fabrics in East Nusa Tenggara (NTT). Ina Ndao Weaving House has an important role in preserving local cultural heritage. This weaving house not only functions as a production site, but also as an education center for the local community and tourists who want to understand more about the process of making ikat weaving. Ina Ndao Weaving House, which initially only produced ikat weaving from the Rote region, also collaborates with ikat weaving suppliers from other regions in NTT, including Timor, Sabu, Sumba, and Flores, while maintaining the quality and authenticity of the weaving from each region [4].

Despite its significant potential, Rumah Tenun Ina Ndao faces several challenges that hinder the optimization of its ikat woven products, particularly in education and marketing. The educational methods used are still conventional, such as live demonstrations by artisans and information dissemination through print media. This has limited the dissemination of knowledge about the philosophy of woven motifs, production techniques, and the uniqueness of woven fabrics to the wider community, particularly the younger generation, who are more familiar with digital technology.

Furthermore, marketing challenges for ikat woven products also continue to hinder their ability to reach a wider market. This stems from an increasingly competitive market and rapid changes in consumer lifestyles, necessitating more effective and efficient marketing approaches. Furthermore, distance and time constraints are significant factors limiting global market reach and product recognition within the local fashion industry. Therefore, innovative efforts are needed to optimize the marketing of local fashion products through the use of digital technology, which can expand global reach. Currently, the marketing of woven fabrics produced as fashion products at Rumah Tenun Ina Ndao is conducted online, but still faces limitations in presenting attractive and informative product visualizations.

Several studies have shown that the implementation of Augmented Reality (AR) technology in promoting local wisdom can increase interaction and appreciation of traditional culture. AR technology allows users to see and interact with three-dimensional (3D) virtual objects projected into the real world through devices such as smartphones or tablets. The use of Augmented Reality (AR) technology with QR Codes through the MywebAR web application presents 3D objects and their animations into the real world, equipped with visual elements such as images, animations, and audio for marketing purposes. In a broad scope, AR allows users to explore products in detail before purchasing and adjust features according to their preferences directly. This technology not only increases purchasing interest but also functions as a communication medium that offers

solutions according to customer needs, can be accessed from anywhere, and provides a competitive advantage, [5][6].

In the context of ikat woven fashion, AR can provide various benefits, including: Interactive Visualization – AR allows users to view ikat woven designs in 3D digital form, including color variations, motifs, and how they are used in modern fashion. According to research conducted by Kurniazaman and Saludin, a Web-based application device that runs on the Android operating system, which has the main feature of being able to introduce fashion to potential customers with AR technology that displays fashion products in the form of 3D objects to potential customers so they can see the front and back of the clothes, [7].

AR technology can also be useful in providing more engaging education. With AR, information about the philosophy and meaning of ikat weaving motifs can be displayed more interactively through animation, informative text, or narrative audio. According to Kusuma et al., an Augmented Reality application for information on Balinese Endek Cloth patterns can support the preservation and maintain the existence of information on Balinese Endek Cloth patterns. The Augmented Reality application for Information on Balinese Endek Cloth Patterns that applies Augmented Reality technology can present information in a more varied and engaging way [8].

Supporting the creative industry and marketing, AR technology can be used in marketing ikat woven products, such as the virtual try-on feature that allows customers to virtually try on woven designs before purchasing. The application of AR to fashion products can also increase customer loyalty, as providing added value, such as interactive features or product personalization, can create a stronger emotional connection with customers [9].

Implementing AR in ikat woven products can be one way to preserve cultural heritage so that it remains known to future generations. AR can increase appreciation for local wisdom by acting as a bridge between traditional culture and modern technology, helping the younger generation understand the cultural values inherent in ikat weaving in a more relevant way.

This community service program seeks to provide practical digital applications by providing soft skills training to several communities within the weaving group supported by Rumah Tenun Ina Ndao, enabling them to utilize AR in education and the visualization of ikat woven fabrics. Partners, meanwhile, provide a variety of woven fabrics (shawls, blankets, and sarongs) as well as fashion products, ensuring the benefits of this community service program are realized and contribute to increasing cultural awareness and appreciation of Indonesia's textile heritage.

1.1 Partner Issues

Based on the situation analysis, this Community Partnership Service (PKM) program will focus on two main issues that are priorities in the development of the Ina Ndao Weaving House, namely

A. Problems with educational methods and the visualization of woven fabrics and fashion products. One of the main problems faced by Rumah Tenun Ina Ndao is the lack of engaging and interactive educational methods to introduce the motifs, philosophy, and process of making ikat woven fabrics. By utilizing Augmented Reality (AR) technology, information about woven motifs can be visualized in a more engaging and easily understood digital form. AR can be used to:
   1) Displaying the history and philosophy of woven cloth motifs interactively.
   2) Providing a visual experience of how the process of making woven cloth from start to finish is carried out.
   3) Educating the public, tourists, and the younger generation in a more modern and interesting way.

B. Product marketing issues. There is a need to improve marketing strategies for ikat-woven products as part of the fashion industry. One of the main obstacles in marketing is the limited ability to present products attractively, particularly in showcasing design variations, color combinations, and product compatibility with users. By utilizing AR in marketing ikat woven fashion products, several benefits can be gained, including:

1) Virtual Fitting: Consumers can try on various woven clothing styles digitally before purchasing, enhancing the interactive shopping experience.
2) Visualization of motifs and color combinations: Users can see how woven motifs will look in various fashion designs, both directly through the AR application and on digital marketing platforms.
3) Increasing product appeal: AR technology can be used to provide interactive information about the uniqueness of the product, the materials used, and the cultural values contained in each woven fabric.

1.2 Solutions Offered

The approach used to solve partner problems and achieve the main targets and general targets is by applying Augmented Reality (AR) technology to ikat woven products, with QR Codes through the MywebAR web application that presents 3D objects and their animations into the real world, equipped with information in the form of visual elements such as images, animations, and audio to improve product education and marketing, to expand market reach, increase competitiveness, and strengthen appreciation for woven fabrics as part of local cultural identity. Implementation stages:

1) Socialization and training of Augmented Reality (AR) technology on ikat woven products, with QR Code via the MywebAR web application, which will be implemented.
2) Collection of woven fabrics from various regions provided by partners,
3) High-quality image capture for each weave with different motifs, as an image of the ikat weaving product or 3D model
4) Collection of supporting information in the form of descriptions of types of motifs, symbolic meanings, and philosophies of weaving, and stages of making ikat weaving
5) Creation of the official Ina Ndao website
6) Uploading various woven fabrics from several regions in NTT, along with their derivative products in the form of clothing and fashion accessories, to the product menu on the website.
7) Provides detailed information for all types of woven fabrics in the form of fabric/product name, product type, area of origin, size/dimensions, price, and explanation of the philosophical motifs in each weave.
8) Account registration on the MywebAR website
9) Creation/design of 3D models and application of Augmented Reality (AR) technology to ikat woven products.
10) Monitoring and evaluation of the implementation of Augmented Reality (AR) technology is carried out between the implementation team and partners to resolve partner problems.

2. IMPLEMENTATION METHOD

The activity method is designed systematically and participatory to actively involve partners from problem identification to solution implementation. The activity procedure includes problem analysis, solution design, technology implementation, mentoring, and sustainability evaluation. The steps are briefly yet in detail described below:

1. Problem Analysis and Identification
   The initial stage begins with observation and discussion with partners to identify the main problems faced, namely:
   - Limited educational media about the philosophy and motifs of woven fabrics.
   - Marketing of ikat woven products was not visually appealing and had not yet reached a wide digital market. The community service team then analyzed partner needs and determined the focus of the solution: the creation of an official website for Rumah Tenun Ina Ndao, which would be integrated with Augmented Reality (AR) technology using the MyWebAR platform.
2. Planning

Based on the analysis, the official Ina Ndao website was designed, integrated with an augmented reality (AR) system to display interactive information about motifs, philosophical meanings, and the stages of the woven fabric-making process. This design phase includes:

- Digital content planning (images, videos, 3D models, and audio narration).
- Storyboarding and design of AR web-based user interface.
- Preparation of tools and materials such as a digital camera, laptop, internet network, and Blender and MyWebAR software.

3. Socialization Stage
   The team conducted outreach to partner groups to introduce the activity's objectives, the website's benefits, the use of AR technology, and its implementation stages. The activities took the form of group meetings and open discussions to align perceptions and gauge participants' initial understanding.
4. Training Stage
   The training was held in two meetings: Training I: Exploration of ikat woven fabrics from various regions in NTT, introduction to philosophy and motifs, taking product photos, and creating a website.
   Training II: Introduction to the concept of Augmented Reality (AR), how to create digital content, manage a MyWebAR account, and demonstrate the application of AR to woven products. The training involves hands-on practice to help participants understand the technology's functions and benefits.
5. Implementation of Technology in the Field
   The implementation stages are carried out collaboratively between the implementation team, students, and partners, including:
   - Collection of visual and narrative data: taking high-quality photographs of the weaving and collecting descriptions of the motif philosophy.
   - Creation of the official Ina Ndao website
   - Creation of 3D models and educational videos using software.
   - AR project development in MyWebAR with an image tracking feature that displays interactive content.
   - Test the AR system on various devices to ensure compatibility.
   - Launch and integration of QR Code on woven products and promotional media.
6. Mentoring and Evaluation Stage
   - Ongoing mentoring is provided to help partners operate and develop AR content. Evaluation is conducted through:
   - Feedback from users and partners regarding the ease and benefits of the technology.
   - Analysis of increasing product marketing appeal and reach.
   - Assessment of the effectiveness of the AR method as a medium for weaving culture education.
   - Evaluation data is used as a basis for preparing reports and program sustainability plans.
7. Program Sustainability Stage
   After the activity is completed, the community service team and partners will develop a sustainability strategy, including:
   - Website maintenance by updating the woven collection and its derivative products, then including the philosophy and story of each motif.
   - AR content maintenance.
   - Advanced training for the younger generation of weavers.
   - Development of the Ina Ndao Weaving House website integrated with an AR system as a sustainable digital promotional media.

3. RESULTS AND DISCUSSION

The implementation of the Community Partnership Program at the Ina Ndao Weaving House has yielded several scientific findings relevant to strengthening cultural education and developing

digital marketing based on Augmented Reality (AR) technology. These findings were obtained through website implementation, AR training, and digital content management assistance. The following discussion is based on scientific analysis, not simply a description of the activity results, and is compared with previous research findings.

3.1 Research result

1. **Increasing the Absorption of Cultural Information through Digital Visualization.**
   The first scientific finding shows that presenting cultural information in digital visuals and AR enhances users' understanding of ikat weaving motifs and philosophy. Scientifically, this phenomenon aligns with Dual Coding Theory, which states that information conveyed verbally and visually is easier to process and remember. Users responded positively to AR content because they were able to "see" the details of the motifs, patterns, and stages of weaving more concretely than verbal explanations or static images.
   This trend emerged because interactive media facilitates learning by seeing and learning by exploring. This is reinforced by the findings of Kusuma et al. [8], who found that AR can improve user retention of understanding of Balinese Endek cloth motif content. Thus, the digitalization of ikat woven motifs not only functions as an information medium but also as an educational tool that strengthens the community's cultural literacy.
2. **Increasing Consumer Interest and Purchase Interest through AR**
   The following findings show that AR integration into ikat woven products increases purchase intention. This occurs because AR provides a more realistic and detailed product visualization effect, thereby increasing user perceived value. Theoretically, this phenomenon aligns with the concept of Social *Presence dan Virtual Experience*, where the experience of viewing a 3D object resembles direct interaction with the product.
   The emerging trend is that the higher the visual quality and interactivity of AR, the greater the consumer's trust and interest in the product. This result is consistent with research by Kurniazaman and Muis [7], who found that AR applications on fashion products increase purchase intention because they provide a more informative preview experience.
   Overall, AR has proven to be not only a promotional medium but also a supporting instrument for purchasing decision-making.
3. **Multi-Content Websites Expand the Reach of Information and Promotion**
   The program also found that websites featuring product catalogs, photo galleries, and cultural narratives can broaden the reach of information and reach a wider user segment. Scientifically, this phenomenon is influenced by search engine visibility and information accessibility. When cultural information is published through digital platforms, the chances of that content being discovered increase, particularly through keyword-based searches.
   This finding is relevant to the research results of Nadek and Lutfiati [4], which showed that consumers were more interested in purchasing NTT woven fabrics if complete descriptions and cultural narratives were available. This strengthens the evidence that websites are a strategic medium for disseminating cultural information and marketing products.
   The trend that is emerging is that the richer the website content, the greater the interaction and visits it receives.
4. **Increasing Partner Digital Literacy as an Impact of Technology Adoption**
   Partners demonstrated improved digital literacy after participating in training on website creation, content management, and MyWebAR platform operation. Partners embraced the

technology because they saw immediate benefits for marketing and education, and because the MyWebAR platform was relatively easy to learn.

This phenomenon of increased literacy is also supported by a practice-based training approach that allows participants to operate the system directly. This is in line with Cahyaningsih's findings [5], that hands-on training has a higher success rate of technology adoption in MSMEs.

These findings indicate that technological interventions not only produce digital products but also increase the human resource capacity of partners.

5. **AR as a Technology-Based Cultural Preservation Media**

Another important scientific finding is the effectiveness of AR as a medium for cultural preservation. AR can transform static cultural content into interactive experiences, facilitating the transmission of cultural values to younger generations. Scientifically, AR functions as an immersive cultural tool that combines documentation, education, and cultural interpretation in a single platform.

This is in line with research by Kusuma et al. [8], which proves that AR can maintain the existence of traditional fabric patterns due to its immersive and easily accessible nature. The visible trend is that interactive media is more popular with the younger generation because it provides a learning experience that is more relevant to their digital habits.

Thus, AR has the potential to become a new method for technology-based cultural preservation.

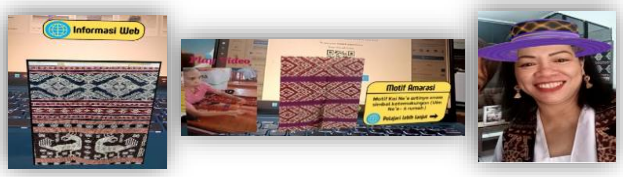
Synthesis of Scientific Findings

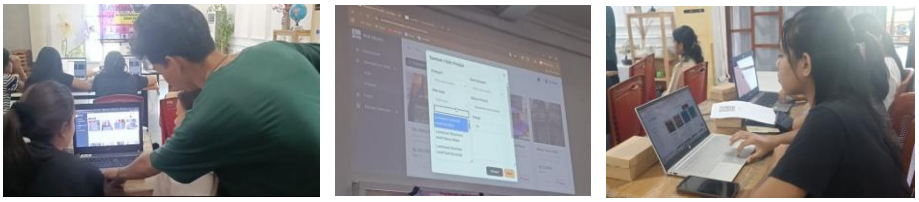
Based on the overall findings, it can be concluded that:

1. Digital visualization and AR enhance cultural understanding because they activate multimodal cognitive pathways.
2. AR increases purchasing interest because it strengthens perceived value and provides a more realistic visual experience.
3. The website acts as a cultural information center and a marketing tool that expands market reach.
4. Partners' digital literacy increases through a practice-based technology adoption process.
5. AR functions as an effective and relevant cultural preservation medium for the needs of the digital generation.

These findings strengthen the evidence that digitalization of culture through AR and websites not only increases marketing capacity but also strengthens mechanisms for sustainable cultural preservation.





4.1 Discussion

The analysis was carried out critically to understand the patterns, relationships, and differences that emerged from the implementation of website technology and Augmented Reality (AR) at the Ina Ndao Weaving House.

The application of AR and digital platforms has been shown to enhance user understanding of the motifs, philosophy, and process of ikat weaving. Pattern analysis shows that the more interactivity of the digital content (high-quality photos, 3D models, AR QR codes), the greater the user engagement and understanding. However, there were differences in user adaptation rates based on age group. Younger participants with higher digital literacy mastered AR and the website more quickly, while older participants required more intensive guidance.

Cultural narrative content, such as philosophical motifs and historical stories, engages users more than purely product content. This broadens the understanding that culture-based digital promotion requires a more narrative approach, not just a visual one. In a cultural context, AR acceptance is also strongly influenced by the user's emotional relevance and cultural identity to the displayed content. Therefore, *cultural value salience emerged* as an important variable in technology adoption in cultural communities, and this has not been widely discussed in previous AR literature.

4. CONCLUSION

The Community Partnership Program (PKM) implemented at the Ina Ndao Weaving House successfully demonstrated that integrating digital technology, particularly a website integrated with Augmented Reality (AR), can be an effective strategy for strengthening cultural education, improving digital literacy, and supporting the marketing of ikat woven products. Through interactive visual presentations in the form of 3D models and web-based QR scanning, users gain a more meaningful and in-depth learning experience regarding the motifs, philosophy, and process of ikat weaving.

The results of the activity demonstrated that AR serves not only as an educational medium but also as a promotional tool, increasing consumer purchasing interest through more detailed and realistic product visualizations. Furthermore, the developed website serves as a cultural information center and a more modern, effective, and accessible marketing tool. The training provided has also been shown to improve partners' skills and independence in managing digital content and leveraging technology for business sustainability.

Overall, this PKM emphasizes that culture-based digitalization is a relevant approach to addressing the challenges of cultural preservation in the modern era, while simultaneously opening up new economic opportunities for traditional weaving MSMEs. Appropriate technology integration can bridge the gap between traditional culture and the needs of today's digital society.

5. SUGGESTION

As a follow-up to the results that have been achieved, several things can be used as input for improving the implementation of subsequent PKM activities, including:

1. There is a need to improve the optimization of digital content, especially in the development of 3D models and the improvement of AR systems, so that they can be used interactively by consumers and tourists.
2. Further training for staff and craftspeople needs to be planned periodically so that partners are able to manage the website and update content independently, thus ensuring the sustainability of the program.
3. It is recommended that there be broader collaboration with government agencies, tourism institutions, academics, and creative economy actors to strengthen the promotional network and expand the market share of NTT ikat woven products.
4. Evaluation and maintenance of digital systems (websites and AR) must be carried out periodically to ensure functionality and data security and to adapt to the latest technological developments.
5. A similar program can be developed as a pilot model for digitalizing culture-based weaving centers that can be replicated in other weaving groups in the NTT region, so that the program's impact can be widespread and sustainable.

6. ACKNOWLEDGEMENT

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We hope that the collaboration and synergy established in this activity can continue to support efforts to preserve ikat weaving culture and develop digital innovations based on local wisdom in East Nusa Tenggara.

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