

Digital Media Innovation for Sustainable Economic Enhancement: A Case Study of Agricultural Flood-Retention Communities in Phra Nakhon Si Ayutthaya Province

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Abstract

This area-based development research aims to: 1) analyze the economic and marketing potential of community products, and 2) develop 3D Augmented Reality (AR) media to promote sustainable occupations during the flood season for agricultural flood-retention communities in Thap Nam Subdistrict, Bang Pahan District, Phra Nakhon Si Ayutthaya Province. Transitioning from economic volatility (VUCA) to post-pandemic fragility (BANI), the study employed a mixed-methods approach. Using baseline field data collected during 2021 and contextualized through the post-pandemic BANI paradigm, quantitative data were assessed using economic feasibility and sensitivity analyses, while qualitative data were analyzed via the TOWS matrix to formulate strategic implementations. The results revealed that safe vegetable (salad) and lime products are highly economically feasible and resilient, withstanding up to a 15% change in selling prices and input costs. Strategic analysis indicated the necessity of enhancing product visibility; thus, AR media was developed as a corrective strategy for lime and a preventive strategy for salad products. Through community participation, an AR application featuring the “Nong Thap Nam” brand identity was created to bridge the incomprehensibility of digital markets and reduce consumer anxiety. Field trials involving 50 general users and expert assessments by 5 specialists demonstrated that the AR media was highly appropriate in content and usability, effectively increasing product awareness. Ultimately, this study proposes a new conceptual framework utilizing AR innovation as a strategic intervention for community enterprises operating within a BANI environment, serving as a replicable model for building economic resilience in flood-prone agricultural communities.

Keywords: Digital media innovation, Economic enhancement, Flood-retention community, Economic feasibility, Augmented reality

Introduction

In the post-pandemic era, the global economic landscape has fundamentally shifted from traditional volatility (VUCA) to a new paradigm known as BANI (Brittle, Anxious, Non-linear, Incomprehensible). Consequently, grassroots economies, particularly agricultural flood-retention communities, are inevitably confronting unprecedented challenges and structural fragility. Relying solely on traditional agricultural outputs poses a high risk of income disruption due to unpredictable fluctuations in market demands, input costs, and natural disasters. Specifically, recurring seasonal floods in the Phra Nakhon Si Ayutthaya region have consistently resulted in significant economic damages to the local agricultural sector, amounting to approximately 94 million baht in direct agricultural output losses per major flood event. Furthermore, at the micro-economic level, individual farming households in flood-retention areas such as Bang Pahan and Bang Ban are forced to shoulder profound income disruptions and disproportionate adaptation costs. These expenses often exceed 70,000 to 100,000 baht per household for flood mitigation and property elevation, further emphasizing the urgency of the problem. Therefore, strategic adaptation through digital innovation is a crucial mechanism for building economic resilience, aligning with the implementation of sustainable development in an era characterized by extreme brittleness and unpredictability (Bushuyev et al., 2025). Fundamentally, sustainable development must holistically integrate economic feasibility with environmental conservation and social acceptability, while paying close attention to the local culture and way of life to be truly effective (Redclift, 1991; Saengchai, 2002; Sayer & Campbell, 2004).

Establishing economic resilience and sustainable livelihoods requires a strategic shift from conventional farming toward innovative value creation (Thongsrikate et al., 2024). The Creative Economy concept offers a vital pathway for this transition. By integrating intellectual capital, local cultural heritage, and modern digital technology, communities can elevate the value of their agricultural products and foster rural revitalization (Deng et al., 2024). However, in today's highly competitive and digitized marketplace, traditional marketing channels are no longer sufficient to capture consumer attention or build trust. The modern consumer demands transparency, engagement, and seamless Phygital (Physical combined with Digital) experiences before making purchasing decisions, particularly regarding food safety and community-based products (Qi et al., 2023).

To bridge this gap and address the 'incomprehensibility' and 'anxiety' elements of the BANI world, Augmented Reality (AR) technology has emerged as a high-impact strategic tool. Unlike conventional digital marketing, AR merges the real and virtual worlds, allowing consumers to interact with product narratives directly via their smartphones (Arunchoknumlap & Jonpradit, 2023).

From an economic perspective, AR serves as a cost-effective digital marketing instrument that yields a high Return on Investment (ROI). It significantly reduces consumers' perceived risks by providing transparent, engaging storytelling about the product's origin, thereby accelerating the purchasing decision process (Guo & Zhang, 2024). Furthermore, the interactive and immersive experiences provided by AR applications actively enhance consumer trust and satisfaction, which directly translates into higher purchase intentions (Darragi et al., 2024).

Furthermore, utilizing digital media as a mechanism for career development is most effective when integrated into a collaborative community structure, akin to a Social Enterprise (SE) model. This approach aligns with the principles of Community-Driven Development (CDD), where the community actively participates as a development partner alongside government and private sectors. Unlike traditional community-based models that rely solely on independent self-reliance and simple technology (Leach et al., 1997), CDD emphasizes good governance, shared responsibility, and long-term capacity building to maximize positive economic impacts (Mansuri & Rao, 2004). This approach ensures that the technological and economic benefits are equitably distributed among farmers, blending community capital with market logic to foster long-term rural sustainable prosperity (Ricket et al., 2023). Engaging the community through such open social innovations significantly increases the technological acceptance and sustainability of the solutions (Juusola et al., 2024). To translate these conceptual frameworks into practical solutions, this research seeks to empower vulnerable grassroots economies. Specifically, the objectives of this study are twofold: 1) to analyze the production and marketing potential of community products during the flood season in Thap Nam Subdistrict, Bang Pahan District, Phra Nakhon Si Ayutthaya Province; and 2) to develop participatory Augmented Reality (AR) media to promote sustainable occupations, thereby strengthening the economic resilience of the community. Ultimately, this study seeks to synthesize these practical interventions into a new conceptual framework for managing community enterprises amidst the BANI environment, offering a replicable model for other vulnerable agricultural regions. To provide a clear theoretical foundation for this study, the conceptual framework illustrating the relationships between the independent and dependent variables is presented in Figure 1.

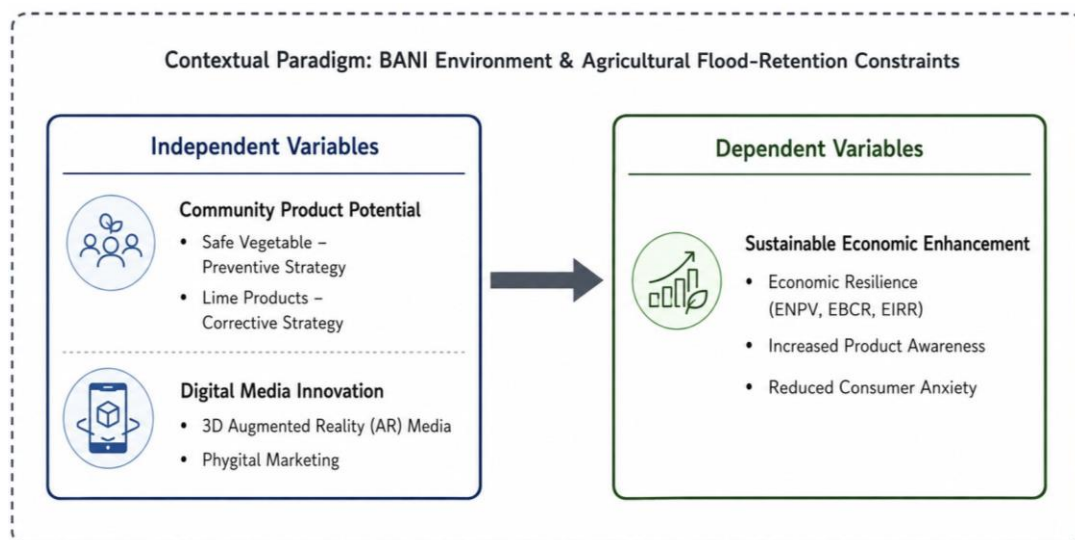


Figure 1 Conceptual framework illustrating the integration of AR innovation and community product potential to achieve sustainable economic enhancement within a BANU environment.

Methodology

This study employed an exploratory sequential mixed-methods design. Qualitative data from FGDs were first used to identify community products and strategic issues. Quantitative feasibility analysis was then conducted to assess economic viability. Finally, the results were integrated into AR media development and user evaluation. The research was conducted in the Ban Ma and Thap Nam communities under the Thap Nam Subdistrict Administrative Organization, Bang Pahan District, Phra Nakhon Si Ayutthaya Province. In strict adherence to human subject protection guidelines, the study protocol, which encompassed all research instruments, questionnaires, and focus group discussion guidelines, was formally reviewed and approved by the Institutional Review Board (IRB) of Rajamangala University of Technology Suvarnabhumi (Approval Number: IRB-RUS2563-010), with informed consent systematically obtained from all participants. The primary field data collection was conducted during March and April 2021, a period reflecting peak economic volatility due to the COVID-19 pandemic. To ensure contemporary relevance and validity, the strategic framework and contextual synthesis were updated and re-evaluated through the BANU paradigm in May 2026. The research was executed in the following two main phases, as illustrated in Figure 2:

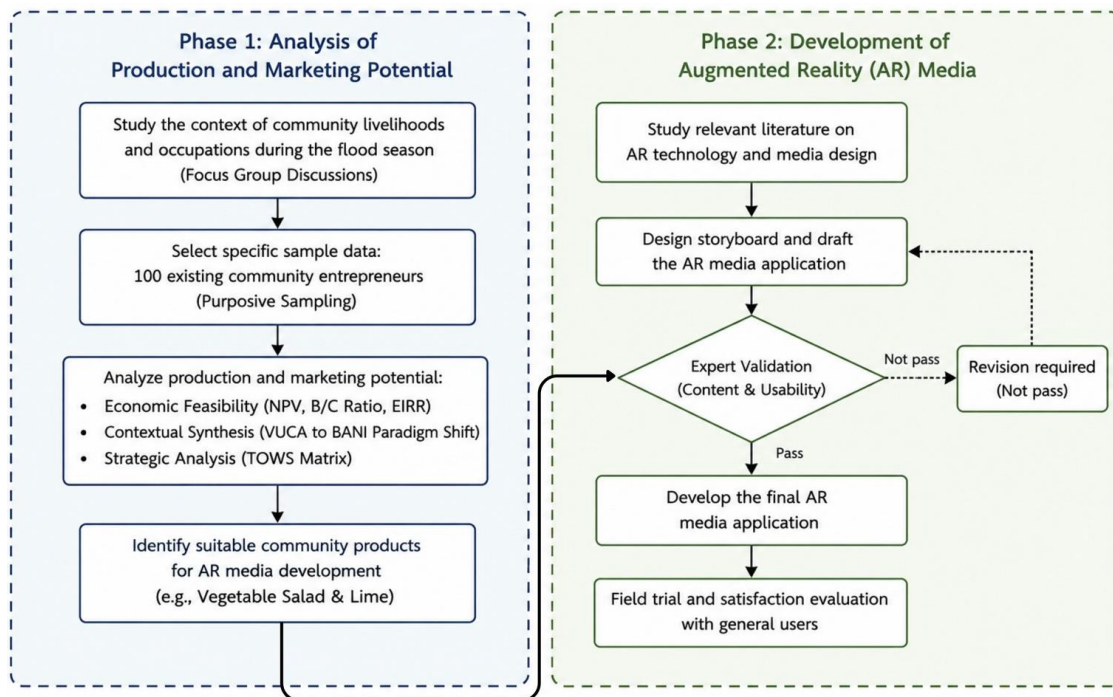


Figure 2 Overall Research Methodology Framework

Phase 1: Analysis of Production and Marketing Potential

1.1 Population and Sample: The study population comprised 1,477 agricultural households within the targeted subdistricts. To analyze the production and marketing potential, a sample of 100 farmers was selected using purposive sampling. This sample was systematically stratified into two equal groups: 50 farmers specializing in lime cultivation and 50 farmers specializing in vegetable salad. The strict inclusion criteria stipulated that participants must be officially registered with the Bang Pahan District Agriculture Office and be actively and continuously engaged in cultivating these specific crops as their primary professional occupation. Additionally, to understand the livelihood context, qualitative data were collected through two focus group discussions (FGDs), each consisting of 6 to 10 farmer leaders recommended by the Bang Pahan District Agriculture Officer. The primary research instruments utilized in this phase included semi-structured interview guides for the qualitative FGDs and structured financial record forms for the collection of quantitative economic data.

1.2 Data Analysis: The economic feasibility of the selected products was evaluated using Net Present Value (NPV), Benefit-Cost Ratio (B/C Ratio), and Economic Internal Rate of Return (EIRR). To address the temporal gap between the primary data collection in 2021 and the current contextual evaluation, it is fundamentally asserted that while nominal prices may shift, the underlying cost structure, agricultural input requirements, and proportional revenue streams for

local safe vegetable and lime production have remained structurally consistent. Furthermore, a rigorous sensitivity analysis was conducted to assess economic resilience against a 15% fluctuation in production costs and revenues. This 15% stress-test threshold was deliberately employed not only to simulate extreme market volatility but also to effectively absorb and account for the cumulative inflationary pressures and price variations occurring over the five-year interval, thereby validating the current applicability of the economic models. Furthermore, qualitative data were analyzed via a TOWS Matrix to formulate strategic marketing actions.

Phase 2: Development of 3D Augmented Reality (AR) Media

2.1 Media Design and Procedure: Based on the TOWS analysis, a participatory approach was utilized to design an AR media application featuring the “Nong Thap Nam” brand identity. Regarding the technical specifications, the 3D AR application was concretely developed utilizing the Unity 3D cross-platform game engine integrated with the Vuforia Augmented Reality Software Development Kit (SDK) to enable robust image-tracking capabilities, while the 2D graphic assets and storyboards were meticulously designed using Adobe Illustrator. The media aimed to act as a corrective strategy for lime and a preventive strategy for salad products.

2.2 Performance and Satisfaction Evaluation: The developed AR media was initially evaluated for content accuracy, economic applicability, and design suitability by 5 experts specializing in digital media, economics, business administration, and community marketing. Following expert validation, a field trial was conducted with a sample of 50 general users, selected via accidental sampling during local field visits.

2.3 Data Analysis: User and expert satisfaction levels regarding system usability, content clarity, and practical applicability were analyzed using descriptive statistics, specifically the mean ($\bar{X}$) and standard deviation (S.D.).

Results

The results of this study are presented in two main sections, corresponding to the research objectives and the methodological framework. The first section details the contextual and economic potential analysis (Phase 1), while the second section presents the outcomes of the Augmented Reality (AR) media development and user satisfaction evaluation (Phase 2).

Phase 1: Analysis of Production and Marketing Potential

1. Context of Livelihood and Occupation in the Flood Season

To systematically understand the livelihood context and occupational dynamics during the flood season, qualitative data were collected through two Focus Group Discussions (FGDs) conducted in the Ban Ma and Thap Nam communities within the Thap Nam Subdistrict Administrative Organization, Bang Pahan District, Phra Nakhon Si Ayutthaya Province (as shown in Figure 4). Content analysis of the discussions revealed crucial insights regarding community capital and occupational adaptability. A comprehensive summary of the livelihood context is presented in Table 1.



Figure 3 Small group meeting to study the context of living and occupation of people in the flood season, Thap Nam community and Ban Ma community.

Table 1 Context of Livelihood and Occupation within the Thap Nam Subdistrict Administrative Organization.

Contextual Dimensions	Ban Ma Community	Thap Nam Community
1) Primary Occupation	The community maintains a simple lifestyle primarily engaged in traditional agriculture, such as cultivating rice, black sesame, and vegetable gardens.	The community maintains a simple lifestyle engaged in traditional agriculture, focusing on cultivating rice, sweet potatoes, and vegetable gardens.
2) Community Capital		
2.1) Soil & Water Resources	Possesses fertile soil suitable for cultivation due to continuous support from the Department of Land Development and District Agriculture. Water for agriculture is sufficiently managed through a piped irrigation system directly to cultivation areas.	Possesses fertile soil suitable for continuous cultivation. Water management utilizes the "Kaem Ling" (Monkey Cheek) retention system, alongside dams to prevent backflow.

Table 1 Context of Livelihood and Occupation within the Thap Nam Subdistrict Administrative Organization. (Continued)

Contextual Dimensions	Ban Ma Community	Thap Nam Community
2.2) Socio-economic Base	The local economy relies heavily on the agricultural sector, including rice, sweet potatoes, black sesame, vegetable gardens, duck eggs, and swine.	The economic foundation is strictly agricultural, predominantly generating income from rice, sweet potatoes, bananas, and vegetable gardens.
2.3) Human Resources	Faces a severe shortage of working-age labor. Currently, the average age of agricultural workers ranges between 60-75 years. Local authorities have initiated a "Return Home" project to attract younger generations back to the agricultural sector.	Faces a similar severe labor shortage with an aging workforce (average age 60-75 years). Relies on retired individuals and those inheriting ancestral agricultural lands.
3) Suitable Careers	Potential products capable of generating year-round income include: 1) Cornmeal, 2) Black sesame, and 3) Vegetable Salad.	Potential products to alleviate flood-season disruptions include: Sweet potatoes, bananas, and Limes.

Note: In the comprehensive analysis, Ban Ma's vegetable salad faces market price limitations despite chemical-free practices, while Thap Nam's lime and sweet potato face production constraints during flooding. These specific community products, shown in Figure 3, were selected for further developmental analysis

As detailed in Table 1, the livelihood context of both the Ban Ma and Thap Nam communities is deeply rooted in traditional agriculture. However, a deeper analysis of their community capital reveals significant structural challenges that necessitate strategic intervention:

Physical and Socio-Economic Capital: While the area possesses fertile soil suitable for diverse cultivation, water management remains a critical operational bottleneck. Situated outside the primary irrigation zone, the communities rely heavily on a "Kaem Ling" (Monkey Cheek) retention system, utilizing dams and active water pumping from Khlong Bang Kung to Khlong Thap Nam. This process is highly resource-intensive; farmers pump approximately 1.4 million cubic meters of water per season. Due to uneven land slopes, water utilization efficiency is merely 50%, sustaining crops for only about two months (half a planting season). Although recent interventions, such as the installation of solar-powered pumps, have partially mitigated fuel costs, the continuous dependency on intensive water management underscores a profound economic vulnerability.

Human Resources: Demographically, the communities are transitioning into an aging agricultural society, facing a severe shortage of active working-age labor. The current agricultural workforce primarily consists of retired individuals managing inherited lands, with the average age ranging strictly between 60 and 75 years. In response, local authorities are actively promoting a “Return Home” initiative, designed to incentivize younger, knowledge-based workers to reintegrate into the local agricultural sector and drive modernization.

Strategic Selection of Suitable Community Products: To establish economic resilience against recurrent seasonal flooding and post-pandemic disruptions, the Focus Group Discussions identified alternative occupational pathways. The Ban Ma community proposed cultivating wax corn, black sesame, and vegetable salads. Notably, their salad production, despite employing chemical-free systems, currently fails to secure premium pricing due to a lack of formal food safety standardization. Conversely, the Thap Nam community prioritized sweet potatoes, cultivated bananas, and limes to mitigate flood-related agricultural losses.



Figure 4 Community products suitable for the local context (Salad from Ban Ma Community and Lime from Thap Nam Community).

2. Economic Feasibility and Business Sensitivity

To evaluate the quantitative potential of the selected community products (Vegetable Salad and Lime), a financial and economic feasibility analysis was conducted based on primary field data. The analytical criteria included Economic Net Present Value (ENPV), Economic Benefit-Cost Ratio (EBCR), and Economic Internal Rate of Return (EIRR). For the financial projection, the initial investment comprehensively accounted for flood-adaptation infrastructures, such as elevated planting racks for vegetable salads (100 sq. wah) and cement pipes with modified irrigation systems for lime cultivation (200 sq. wah). The results indicated that both agricultural product lines yielded highly positive economic returns, making them viable for commercial scaling.

Furthermore, to ensure the robustness of these business models against market volatility, a business sensitivity analysis was performed. The stress test simulated an adverse scenario where production costs increased while simultaneous market returns decreased by 5%, 10%, and 15%. The findings demonstrated that even at a 15% adverse fluctuation, both salad and lime products remained economically viable, maintaining an ENPV greater than zero, an EBCR greater than 1, and an EIRR significantly higher than the standard 7% discount rate. The detailed financial outcomes and sensitivity thresholds are presented in Table 2.

Table 2 The Results of Feasibility and Sensitivity Analysis of Community Products

List	Initial Investment (Baht) PDFAvg. Annual Cash Flow (Baht)	Avg. Annual Cash Flow (Baht)	Increased Costs and Lower Returns: 5%	Increased Costs and Lower Returns: 10%	Increased Costs and Lower Returns: 15%
Salad (Ban Ma Community)					
ENPV (Baht)	15,000.00	12,500.00	27,886.14	18,966.86	7,901.15
EBCR			1.29	1.19	1.08
EIRR			69%	42%	9%
Lime (Thap Nam Community)					
ENPV (Baht)	60,000.00	27,000.00	45,170.15	39,634.86	34,099.57
EBCR			1.75	1.66	1.56
EIRR			32%	29%	26%

Note: (1) The financial calculations are based on an average project lifespan of 5 years (reflecting the depreciation of primary agricultural materials like cement pipes and pots) with a standard discount rate of 7%.

(2) The Initial Investment specifically covers the fixed costs of flood-resilient infrastructures, including pots, elevated racks, cement rings, bases, lime saplings, and localized irrigation systems. Land value is excluded as the operations utilize pre-existing community-owned properties.

(3) The Average Annual Cash Flow represents the net income after deducting yearly operational expenses (OPEX) such as fertilizers, water pumping fuel, and maintenance costs.



Figure 5 Data collection activities and verification of cost-effectiveness and economic feasibility results.

3. Contextual Synthesis: The Transition from VUCA to BANI

Although the financial feasibility analysis (Table 2) confirmed the projects' economic viability, understanding the macro-environmental forces is crucial for sustainable development. The primary data collection coincided with the peak of the COVID-19 pandemic, a period characterized by a VUCA environment (Volatility, Uncertainty, Complexity, Ambiguity). During this phase, the community faced severe logistical volatility and unpredictable market pricing. The ability of the business models to withstand a 15% financial shock during this VUCA period proved their baseline resilience.

However, in the post-pandemic era, the economic landscape has fundamentally shifted into the BANI paradigm, dictating new structural challenges that require digital strategic adaptation:

3.1 Brittle: The grassroots economic structure is highly fragile due to geographic flood constraints and an aging workforce (average age 60-75 years), highlighting the urgent need for shock-resistant alternative occupations.

3.2 Anxious: Farmers worry about income instability and rising fuel costs for water pumping, while post-pandemic consumers exhibit heightened anxiety regarding food safety. Producing chemical-free vegetables serves as a critical strategy to reduce consumers' perceived risks.

3.3 Non-linear: Economic impacts can no longer be predicted linearly. A minor fluctuation in input costs can severely disrupt net profits. Consequently, Augmented Reality (AR) media emerges as a vital tool to generate exponential brand awareness and establish a direct-to-consumer channel.

3.4 Incomprehensible: Modern digital market mechanisms have become overly complex for traditional farmers. Integrating smartphone-based AR technology effectively decodes this complexity, transforming it into accessible technology that elevates the community's competitive advantage.

4. Strategic Analysis (SWOT and TOWS Matrix)

Building upon the economic feasibility baseline and the structural challenges identified in the BANI synthesis, a comprehensive strategic formulation was conducted. A SWOT analysis was performed to evaluate internal community capital against external market dynamics (data collection activities shown in Figure 6). Subsequently, these factors were cross-analyzed using the TOWS Matrix to develop actionable Proactive (SO), Corrective (WO), Passive (ST), and Preventive (WT) strategies.



Figure 6 Participatory data collection activities for analyzing Strengths, Weaknesses, Opportunities, and Threats.

4.1 TOWS Analysis for Salad Products. For the Ban Ma community's salad products, the analysis revealed that while the community produces safe vegetables, they struggle with low production volume and limited marketing channels. Therefore, leveraging government support policies through a Preventive Strategy (WT) involves continuous production coupled with modern digital marketing.

Table 3 Results of TOWS Analysis for Salad Products (Ban Ma Community)

TOWS Matrix	Strengths (S)	Weaknesses (W)
	• Safe from toxins (chemical-free). • Existing enterprise group to drive activities.	• Lack of production continuity to meet market demand. • Low productivity volume. • Constraints of organic plant characteristics.
Opportunities (O)	SO (Proactive Strategy)	WO (Corrective Strategy)
• Local administrative vision to promote production and marketing. • Consistent with government policies promoting safe crops.	Encourage villagers in nearby neighborhoods to grow organic vegetables to generate supplementary income and increase overall productivity.	Apply disease and insect control using Neem (Azadirachtin) and utilize dome cultivation to align with government safe-crop policies.
Threats (T)	ST (Passive Strategy)	WT (Preventive Strategy)
• Extremely limited marketing channels presented to consumers.	Build a robust network of enterprise groups that can be strengthened and extended to drive new marketing channels.	Ensure continuous production and aggressively promote products by developing 3D (AR) media and video clips to increase awareness and add product value.

4.2 TOWS Analysis for Lime Products. For the Thap Nam community's lime products, the analysis indicated strong product longevity and safety, but highlighted weaknesses regarding the intense care required and market price fluctuations. The Corrective Strategy (WO) focuses on breaking through traditional market barriers.

Table 4 Results of TOWS Analysis for Lime Products (Thap Nam Community)

TOWS Matrix	Strengths (S)	Weaknesses (W)
	• Safe planting methods. • Long shelf life and preservability.	• Requires continuous and intensive care from farmers. • Fixed growing and harvesting periods.
Opportunities (O)	SO (Proactive Strategy)	WO (Corrective Strategy)
• Availability of various product distribution channels. • Potential to expand planting areas during high-demand trends.	Expand the cultivation area for safe, chemical-free limes to produce high-quality products that meet consumer safety demands.	Utilize 3D (AR) media to increase advertising channels and promote lime awareness among new customer segments, overcoming the fixed harvesting periods and intense care requirements by adding digital value.
Threats (T)	ST (Passive Strategy)	WT (Preventive Strategy)
• Presence of substitute products. • Inability of farmers to dictate selling prices.	Preserve unsold limes by paper-wrapping and refrigerating them during the dry season to maintain flavor and sell across different seasons without extra care costs.	Hire local unemployed experts for lime care and implement pest control by spraying wood vinegar daily to prevent insect infestations.

Strategic Transition to Phase 2: The Imperative for AR Media

Synthesizing the quantitative financial viability and the qualitative TOWS strategic analysis within the BANI framework yields a definitive conclusion. While both “Vegetable Salad” and “Lime” products are economically feasible for commercial investment, their fundamental vulnerability lies in marketing communication and consumer trust. Through participatory FGDs with farmers and local authorities, it was strategically resolved that developing Augmented Reality (AR) Media is the most critical intervention. Functioning as a Preventive strategy for salads and a Corrective strategy for limes, this digital innovation will increase distribution channels, decode market complexities, and substantially elevate product value, leading to the initiation of Phase 2 of this research.

Phase 2: Development of 3D Augmented Reality (AR) Media

5. Performance and Satisfaction Evaluation of AR Media

5.1 Participatory Design and Development Process. Following the TOWS strategic formulation, the development of the 3D Augmented Reality (AR) media was initiated with absolute community participation at every stage. The AR application was strategically designed to serve as a corrective mechanism for lime products and a preventive mechanism for vegetable salads. The participatory development process consisted of four sequential steps, ranging from needs exploration to practical community utilization, as illustrated in Figure 7.



Figure 7 The participatory four-step process for creating engaging 3D (AR) media.

5.2 AR Media Outputs and Integration. The execution of the development process successfully yielded a comprehensive digital marketing ecosystem integrated with smartphone AR technology. The primary outputs designed to elevate community product awareness include:

1) Product Slogan: To establish consumer trust, the core promotional message was defined as: *“Safe Vegetables, Grown with Heart, Toxin-Free.”*

2) Brand Identity and Mascot: A spatial participatory logo featuring the mascot “Nong Thap Nam” (an elephant representing local agricultural abundance) was developed in collaboration with the educational institution to build brand recognition (Figure 8).



Figure 8 The “Nong Thap Nam” product logo representing safe community vegetables.

3) Digital Storyboarding and Video Integration: Engaging video clips were produced according to the storyboard, highlighting the chemical-free cultivation process. These videos are embedded within the AR experience (Figure 9).

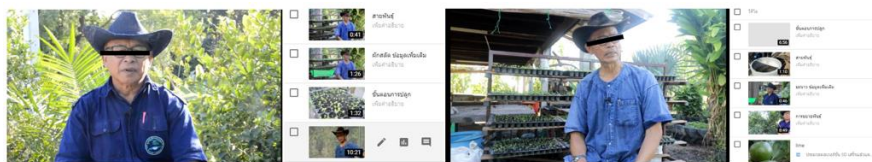


Figure 9 Storyboard content and promotional video integration for the 3D media.

4) AR Application Interface: A user-friendly 3D AR application was developed for smartphones, providing an interactive home screen where consumers can navigate product information seamlessly (Figure 10).

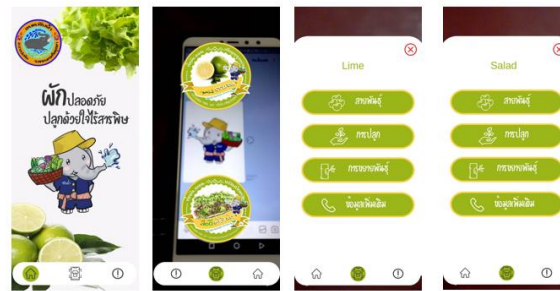


Figure 10 The smartphone AR application's user interface and home screen.

5) Physical-Digital Marketing Integration (Phygital): To maximize outreach, physical advertising media (posters) and central brand labels equipped with AR triggers and QR codes were distributed to community stores. This allows consumers to scan the physical product and instantly access the 3D digital content (Figures 11 and 12).



Figure 11 Advertising media promoting safe vegetable products in local community stores.



Figure 12 Product brand labels equipped with AR triggers for interactive consumer engagement

5.3 Performance and Satisfaction Evaluation. To ensure the efficacy of the developed AR media in promoting career building during the flood season, a comprehensive satisfaction assessment was conducted among two distinct groups: domain experts and general users.

1) Expert Evaluation: An assessment by a panel of 5 experts revealed that the AR media is highly suitable for practical application. The media's content accuracy received a Very Good rating ($\bar{x} = 4.65$, $SD = 0.48$), and the overall system design was equally rated at a Very Good level ($\bar{x} = 4.67$, $SD = 0.48$). These results confirm the media's professional standard and readiness for community utilization.

2) User Satisfaction: A field trial involving 50 general users demonstrated positive reception across all metrics. In terms of System Usability, the overall satisfaction was rated as Good ($\bar{x} = 4.13$, $S.D. = 0.60$). Specifically, the appropriateness of illustrations for the screen interface achieved a Very Good score ($\bar{x} = 4.23$, $S.D. = 0.62$), and the ease of use was rated Good ($\bar{x} = 4.17$, $S.D. = 0.65$). Regarding Content and Clarity, the overall narrative was rated Good ($\bar{x} = 4.18$, $S.D. = 0.55$). Users found the content highly useful ($\bar{x} = 4.27$, $S.D. = 0.58$), with descriptions being clear and easy to understand ($\bar{x} = 4.20$, $S.D. = 0.55$). Crucially, the media's capability to actively promote local occupations was rated Very Good ($\bar{x} = 4.27$, $S.D. = 0.45$). Overall, general user satisfaction stood at a Good level ($\bar{x} = 4.17$, $S.D. = 0.55$), conclusively indicating that the 3D AR media is a highly effective strategic tool for elevating community products.

Discussion

The development of 3D Augmented Reality (AR) media to promote career sustainability during the flood season in the Ban Ma and Thap Nam communities offers critical insights into modern community-based business management. While traditional sustainable development paradigms heavily emphasized physical resource allocation, the findings of this study suggest that in the contemporary, highly volatile post-pandemic landscape, maintaining physical capital is insufficient. Community enterprises must pivot towards strategic Agricultural Economic Resilience (Wang et al., 2025).

1) Financial Viability as a Baseline for Resilience. The quantitative analysis demonstrated that the cultivation of vegetable salads and limes is highly economically feasible, capable of withstanding a 15% fluctuation in production costs and market prices. This aligns with recent studies on agricultural resilience, which argue that baseline profitability is crucial for surviving supply chain disruptions and macro-environmental shocks (Wang et al.,

2025). However, this study expands on that premise by revealing that financial viability alone cannot protect traditional agriculture from the structural vulnerabilities of the BANI paradigm (Brittle, Anxious, Non-linear, Incomprehensible). Although the communities possess excellent water management infrastructure (Kaem Ling systems), their heavy reliance on an aging workforce and fluctuating pumping costs leaves their economic ecosystem inherently brittle.

2) Strategic Adaptation via TOWS Matrix. The TOWS strategic analysis highlighted a significant paradigm shift required for these communities. Previously, traditional community enterprise management focused primarily on production-side solutions. In contrast, the corrective (WO) and preventive (WT) strategies formulated in this study underline that the modern bottleneck is market perception and distribution channels. For Ban Ma's salad products, despite utilizing chemical-free, safe planting methods, the lack of formalized mass-market channels limits profitability. Similarly, Thap Nam's lime products face price-setting limitations. Consequently, the strategic imperative shifted from merely "producing more" to "communicating value effectively," leading directly to the adoption of AR technology.

3) The Role of AR Media in Decoding Market Complexity. The most pivotal discussion point is the implementation of 3D AR media as a strategic intervention. While previous community marketing efforts relied heavily on standard social media platforms, these conventional channels often fail to establish deep consumer trust regarding "Food Safety." The introduction of the "Nong Thap Nam" AR application acts as a Phygital (Physical + Digital) bridge. By allowing consumers to scan physical product labels to experience immersive 3D digital content detailing the chemical-free cultivation process, the AR media directly addresses the 'Anxious' and 'Incomprehensible' components of the BANI environment. Psychologically, consumer anxiety regarding food safety is deeply rooted in the "fear of the unknown" and the inability to visually verify agricultural inputs, which significantly elevates their perceived risk. AR technology serves as a critical psychological intervention by transforming intangible safety claims into tangible, visual evidence. This immersive visualization grants consumers a higher cognitive sense of control and transparency, directly mitigating their anxiety and fostering profound trust. This approach to reducing perceived risks through visual verification aligns with critical trends in modern agri-food applications (Xie et al., 2022). This psychological mechanism is strongly supported by recent empirical research within the Thai context.

Furthermore, this psychological mechanism is strongly supported by recent empirical research within the Thai context. Wongchaichinsri and Phonsakulwanich (2025) demonstrated that the adoption of Augmented Reality technology significantly reduces consumers'

perceived risks while concurrently increasing their confidence and satisfaction through virtual experiences. Although their study focused on consumer products, the underlying psychological implication is universally applicable: AR decodes complex product information into an easily digestible visual format, thereby overcoming consumer hesitation. These findings also resonate with recent domestic research exploring the integration of AR within the Thai agricultural sector. Specifically, Srimultri and Chutjaraskul (2024) found in their study on the development of AR media for organic farming that immersive and interactive AR experiences significantly enhance learning and comprehension regarding chemical-free agricultural processes. However, while their study primarily emphasizes AR as an educational and promotional tool for organic agriculture, this current research extends its practical application by positioning AR as a strategic mechanism to directly decode market complexities and build economic resilience in vulnerable, flood-prone communities.

4) Technology Acceptance in Aging Agricultural Communities. Finally, the satisfaction assessment results from both domain experts ($\bar{x}$ = 4.67) and general users ($\bar{x}$ = 4.17) confirm the practical applicability of the developed media. A critical takeaway is that digital transformation in grassroots economies does not require farmers to become tech experts. As noted in recent technology adoption literature for low-to-middle-income agricultural settings, integrated and accessible strategies are essential for sustained digital uptake (Manzoor et al., 2025). By centralizing the AR development through participatory design and deploying it via simple smartphone interfaces, the technology becomes accessible even within an aging demographic (average age 60-75 years). This structural integration provides a replicable model for other flood-prone agricultural communities seeking to elevate their community-based products through digital innovation.

5) A New Conceptual Framework for BANI Resilience. Beyond immediate area-based problem solving, the integration of economic feasibility, TOWS strategic formulation, and AR media development culminates in a novel conceptual framework. By positioning AR technology not merely as a marketing gimmick, but as a dual-action strategic intervention, this framework provides a strategic blueprint for grassroots economies operating in a BANI environment. Specifically, this intervention acts as a preventive measure for sustaining market presence (e.g., salad products) and a corrective measure for breaking market barriers (e.g., lime products). It empirically proves that digital integration, when driven by community participation and grounded in solid economic baselines, can effectively transform structural fragility into economic resilience. Consequently, this framework serves as a highly replicable model for other geographically constrained or flood-prone agricultural communities seeking sustainable rural development.

Conclusion

This research analyzed the production and marketing potential of community products to develop 3D Augmented Reality (AR) media for career sustainability in the Ban Ma and Thap Nam communities. Quantitative findings confirmed that “Vegetable Salad” and “Lime” businesses are highly viable, yielding an Economic Net Present Value (ENPV) > 0 , Benefit-Cost Ratio (EBCR) > 1 , and Internal Rate of Return (EIRR) $> 7\%$, as well as being economically resilient against a 15% market fluctuation. However, TOWS analysis revealed vulnerabilities stemming from traditional storefront dependencies. To address this within the BANI paradigm, the study established a unified brand identity featuring the “Nong Thap Nam” mascot and the slogan “Safe Vegetables, Grown with Heart, Toxin-Free.” By integrating the agricultural expertise of local “village sages” into interactive 3D AR media, the communities successfully bypassed physical distribution barriers, decoded digital market complexities, and effectively addressed the ‘Anxious’ aspect of the BANI environment. Psychologically, this AR intervention provided consumers with transparent, visual verification of the chemical-free cultivation process, thereby significantly reducing their anxiety regarding food safety and significantly elevated consumer satisfaction. Consequently, this research successfully establishes a new conceptual framework that positions participatory AR innovation as a core mechanism for building economic resilience in the BANI era, providing a robust and replicable model for sustainable rural development.

For practical implementation, local administrative bodies, specifically the Thap Nam Subdistrict Administrative Organization (SAO), should officially integrate these phygital assets into their web platforms and local tourism campaigns (e.g., OTOP Nawatwithi) to maximize visibility. Simultaneously, local enterprises must systematically adopt this centralized brand to increase market bargaining power. Future research should prioritize integrating the AR application with real-time e-commerce and digital payment gateways (FinTech) to create a seamless purchasing experience. Additionally, conducting a longitudinal study to track actual income growth over a three-to-five-year period and scaling this participatory digital adaptation model to other high-potential regional products are highly recommended.

Research Limitations and Future Directions

A notable limitation of this study is the temporal gap between the primary data collection (early 2021, during the peak of the COVID-19 pandemic) and the conceptual synthesis using the BANl framework (2026). While the 2021 data provided an optimal “stress test” environment for evaluating extreme market volatility, applying it to a 2026 context introduces a longitudinal variable. Nevertheless, the sensitivity analysis, which proved the products' resilience against a 15% economic fluctuation, confirms the enduring robustness and long-term viability of these agricultural business models across shifting economic paradigms.

Implications

The findings of this study offer multifaceted implications that significantly contribute to both academic knowledge and community-based business management. Theoretically, this research establishes a novel conceptual framework for agricultural economic resilience tailored to navigate the complexities of a BANl environment. It underscores that baseline financial viability alone is insufficient; it must be coupled with strategic digital interventions, such as Augmented Reality (AR), to effectively communicate product value and mitigate consumer anxiety. On a practical and managerial level, the study advocates for local administrative bodies to integrate these Phygital (Physical combined with Digital) assets into municipal platforms and local tourism campaigns to maximize product visibility. Furthermore, the success of the participatory design approach empirically proves that aging agricultural demographics can effectively adopt smartphone-based digital marketing without requiring advanced technical expertise. For future directions, initiatives should prioritize integrating the AR application with real-time e-commerce platforms and digital payment gateways (FinTech) to create a seamless purchasing experience. Additionally, longitudinal studies spanning three to five years are highly recommended to track tangible income growth and to scale this replicable digital adaptation model to other high-potential community products. The comprehensive synthesis of these theoretical, practical, and future implications has been crystallized into a specific Knowledge Model, as illustrated in Figure 13.

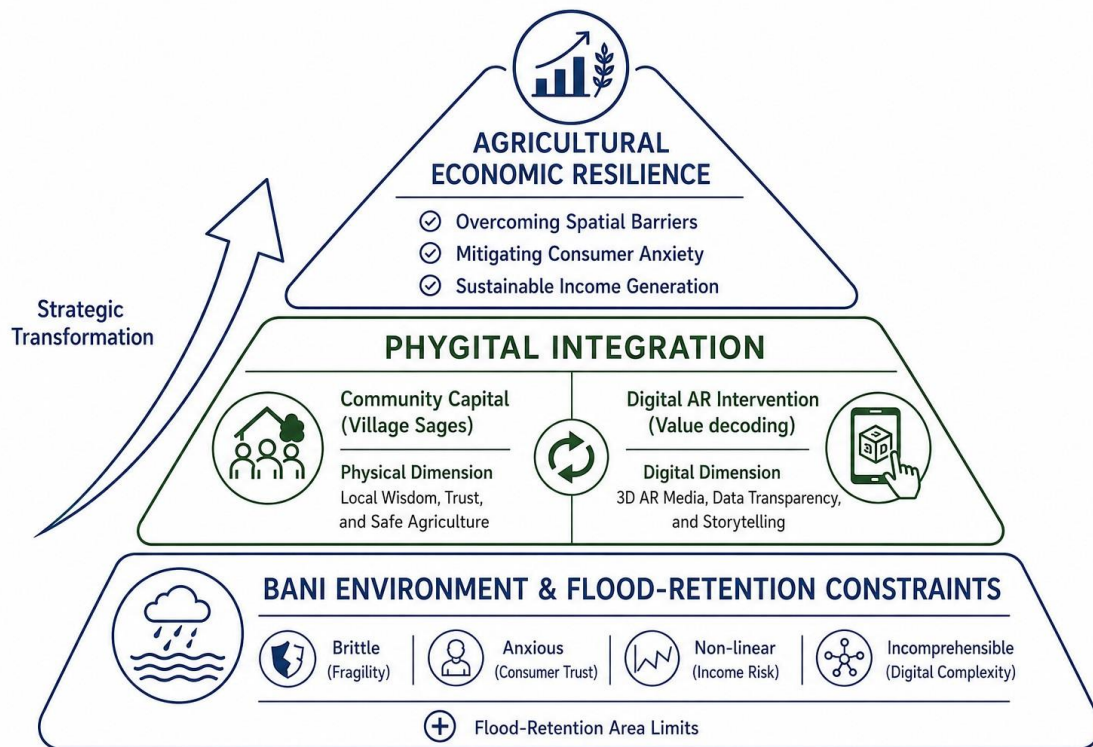


Figure 13 A crystallized Knowledge Model summarizing research implications and contributions to BANI resilience.

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