ANIDELIVERY: A FARMERS PLATFORM FOR SUSTAINABLE AGRICULTURE THROUGH MACHINE LEARNING-POWERED DIGITAL MARKETPLACE IN PAMPANGA

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ABSTRACT

This research study introduces AniDelivery, a mobile and web-based application designed to connect farmers and consumers in a digital marketplace, promoting sustainable agriculture. The platform enables farmers to showcase their produce, facilitate direct transactions with buyers, and foster efficient supply chain management. This research utilizes a mixed-method sequential explanatory approach that aims to assess the implementation of AniDelivery in the agricultural sector. The researchers employed Agile methodology to develop the research study. There were 350 farmers who willingly participated in answering the survey questionnaire and 25 individuals who participated in an in-depth interview to obtain insights into farmers' challenges, such as over- and undersupply of agricultural products. The researchers used ISO 9126 to evaluate the usefulness and acceptability of the application. The results revealed the strong willingness among farmers to adapt technological solutions like AniDelivery, emphasizing the role of technology in modernizing agriculture. The platform's benefits include reducing reliance on intermediaries, improving communication within the farming community, and connecting farmers directly with consumers. Alpha testers overwhelmingly agreed with all 12 items in ISO 9126. Notably, functionality scored with a mean of 3.77 with a verbal description of "strongly agree," reliability of 3.58 with a verbal description of "strongly agree," usability of 3.5 with a verbal description of "strongly agree," efficiency of 3.5 with a verbal description of "strongly agree," maintainability of 3.60 with a verbal description of "strongly agree," and portability of 3.75 with a verbal description of "strongly agree," all reflecting strong agreement. The overall mean score is 3.62, with a verbal description of "strongly agree indicating respondents' satisfaction with using the application. The study underscores the potential of AniDelivery to contribute to a more just and sustainable e-commerce market. Successful implementation requires collaboration among farmers, government agencies, and technology providers to address the challenges faced by the farming community and promote positive transformations in agricultural practices.

Keywords

AniDelivery, Digital Marketplace, Supply Chain Management, Over Supply, Under Supply, Consumer

1. INTRODUCTION

In the heart of Pampanga's agricultural landscape, where challenges like fluctuating market demands and limited access to broader markets persist, the Department of Trade and Industry (DTI) in the Philippines takes a bold stance, actively supporting the enhancement of Republic Act 8792 also known as the Electronic Commerce Act of 2000.

According to Mr. Jeng Mendoza, a farmer in Sta. Rita, Pampanga, local farmers face an array of difficulties, including climate change impacts and high input costs, compounded by the complexities of middlemen dynamics and the quest for sustainable farming practices.

These struggles in Pampanga's agricultural environment include things like unstable consumer demand, the ensuring risk of an excess or shortage of agricultural products, restricted access to larger markets, and supply chain inefficiencies. Pampanga farmers also face additional difficulties as a result of climate change, pest infestation, and rising input costs. The agricultural industry as a challenging and busy sector, yet new issues persist over existing ones, causing concern for local farmers. Despite constant efforts to address problems, new challenges often surpass existing solutions, causing further difficulties for farmers [1].

The high cost of inputs and the perpetual pursuit of sustainable farming pose significant barriers for farmers striving for food security and sustainability, often due to limited funds and constrained market access. Sustainability in agriculture requires a

comprehensive approach, encompassing customer service, production, and logistics. They advocate for farmers' markets as crucial avenues for selling fresh, local, and eco-friendly produce, supporting local producers, and promoting sustainable living [2].

As the researchers claimed on the intricate dynamics of middlemen affects the sales of the local farmers, traditional Filipino farmers have the challenge of receiving poor prices for their agricultural products at the point of sale. This issue is often worsened by middlemen who provide loans and farming equipment to farmers before the planting season, in return for priority access to their harvest [3].

Middlemen are the intermediaries between farmers' and consumers' transactions. They take a partially large share of the profit, and they may limit farmers' opportunities for progression.

The Department of Agriculture (DA) has launched a marketing strategy called "KADIWA" to empower the agricultural community by establishing a direct food supply chain. The DA and private sector partners have created an online platform, "eKadiwa," which connects farmers with consumers [4]. The mobile and web-based application AniDelivery supports this strategy, enhancing supply chain efficiency and promoting sustainable agriculture.

Background of the Study

Farmers in Pampanga deal with issues including unstable prices and market access, this may result in decreased earnings and financial instability. The Department of Agriculture's initiative known as "Kadiwa ni Ani at Kita." The program's objective is to establish a direct connection between farmers and customers, bypassing middlemen and guaranteeing equitable compensation for farmers' agricultural products.

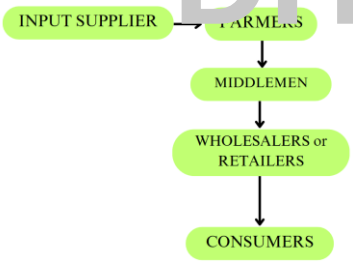

Figure 1. *Current Market Chain*

As shown in Figure 1 above, the current market chain provides a view of how the farmers get to sell their produce and how the middlemen have control over who sells the produce to the retailers who sell it to the consumers. This shows that the middlemen have more control over the business side of the market than the farmers [5].

2. RELATED LITERATURE

The significant growth of the digital marketplace, which includes e-commerce platforms, online transactions, marketing, customer interaction, and the use of digital technologies for business objectives [6].

The rise of mobile technology and smartphone adoption has significantly impacted the internet market, allowing consumers to make purchases at their convenience. Companies have shifted their focus to online marketplaces, with over 50% of global e-commerce transactions in 2019 being conducted on mobile devices. The internet market has revolutionized agricultural product buying and selling, allowing farmers to directly engage with consumers and reduce dependence on traditional distribution methods [7].

Machine learning is mostly employed in AniDelivery for the purpose of sales forecasting. Machine learning can provide valuable insights into client behavior and patterns [8]. Machine learning can aid sales professionals in identifying prospective consumers, creating targeted marketing campaigns, and predicting the products or services that clients are most inclined to purchase through the analysis of customer data. Sales forecasting is a crucial element of machine learning for digital markets. Machine learning algorithms can be employed by businesses to predict future sales by studying past sales data and making informed choices regarding inventory management, resource distribution, and overall sales strategy [9].

3. METHODS

The researchers used a mixed-method sequential explanatory research design, involving quantitative data collection through surveys and qualitative data assessment through interviews. Close-ended questions were used to extract precise responses, allowing for a methodical and organized analysis of the research topic. The researchers used a Likert scale or similar rating system to convert subjective opinions into measurable data, enabling statistical analysis. Surveys were also used to understand user perspectives and address study needs, consisting of a pre-survey and a post-survey phase.

Given the absence of an existing online marketplace system in the study's locale, the researchers conducted a pre-survey to gather data on what the locale requires and gain valuable insights into making the project user-friendly and functional before its implementation. This step aimed to align the project with the specific needs and preferences of the local community.

The researchers conducted a post-survey user acceptance testing process using ISO 9126 framework to evaluate the software's performance and effectiveness. This process ensured the software meets user expectations and requirements, enhancing its reliability, user-friendliness, efficiency, and adaptability to various platforms. The researchers aimed to gather insights and address local requirements.

To determine the sample size of the survey, the researchers used Raosoft.com, an online sample size calculator, as a medium for calculation. With the population size N = 14, 337 (farmers) taken from the Department of Agriculture (DA) records, the sample size was then calculated using the sample size formula below. Raosoft.com yielded a total of 375 farmers as the number of respondents.

Table 1. *Likert Scale*

LIKERT SCALE	
4	*Strongly Agree*
3	*Agree*
2	*Disagree*
1	*Strongly Disagree*

Researchers used a 4-point Likert scale to gather partial data, excluding neutral options to encourage decisive opinions and collect clear, clear-cut perspectives in research projects.

Table 2. *Equivalent Descriptive Rating for the 4-Point Likert Scale*

Weights	Descriptive Rating
4	Strongly Agree
3	Agree
2	Disagree
1	Strongly Disagree

Table 3. *Descriptive Rating for the Preliminary Results*

Weighted Mean	Descriptive Ratings
3.26 – 4.00	Strongly Agree
2.51 – 3.25	Agree
1.76 – 2.50	Disagree
1.00 – 1.75	Strongly Disagree

Table 4. *Descriptive Rating for the Alpha & Beta Evaluation Results*

Weighted Mean	Descriptive Ratings
3.26 – 4.00	Strongly Agree
2.51 – 3.25	Agree
1.76 – 2.50	Disagree
1.00 – 1.75	Strongly Disagree

A weighted mean assigns a weight to each data point, multiplied by its corresponding weight, and adds to find the total. Higher weighted data points contribute more to the final mean.

Figure 4. *Agile Method*

AniDelivery, a mobile app, was developed using the agile methodology, a dynamic and iterative process that emphasizes cooperation, adaptation, and continuous improvement. The design phase involved creating a user-centric experience, with feedback loops and regular design reviews. Agile development involved short sprints, with frequent releases and stakeholder feedback. Testing was integrated throughout the process, with automated scripts and user acceptance testing. AniDelivery deployed increments of the application after each sprint, using continuous integration and pipelines. Regular reviews at the end of each sprint allowed for evaluation, feedback, and adjustments to the project's direction. The launch was a conclusion of continuous delivery cycles, ensuring the product met evolving needs of farmers and consumers.

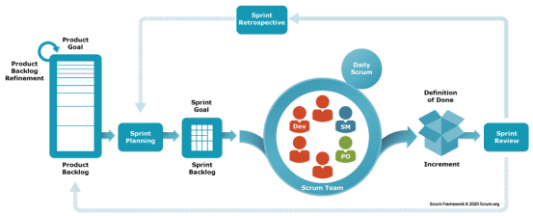

Figure 5. *Scrum Framework*

Researchers used Scrum methodology for collaboration, transparency, and iterative development. The framework consists of sprints lasting two to four weeks, with the goal of increasing product. Daily scrum meetings facilitate communication and coordination. The iterative structure allows for early problem detection and requirement modifications. The Scrum framework adapts to changing requirements and market situations.

Respondents of the Study

The researchers obtained preliminary survey information from the 350 farmers-respondents of the study and another 25 farmers who participated in the interview part. These farmers are the primary users of the platform, utilizing its capabilities to list their produce, search for products, and make purchases. The researchers used simple random sampling technique to select samples randomly from the population list. Additionally, judgmental/purposive sampling technique was used where researchers exercise their own judgment when selecting individuals from the population to participate in their surveys.

Simple Random Sampling Technique for Survey

The researchers used this technique because it offers an equal probability for every person in the population to be selected as a subject for their quantitative data. Each subject is chosen independently of the other population members in a single phase throughout the sampling process.

Purposive Sampling Technique for the Farmers

The researchers used the purposive sampling technique because this method relies on the researchers' judgment in selecting the study participants for their qualitative data. The researchers selected the most suitable willing respondents using this sampling strategy who met their predetermined criteria.

4. RESULT AND DISCUSSION

In this section, the outcomes and insights derived from a analysis of interviews, both pre- and post-surveys, as well as alpha and beta testing of AniDelivery are thoroughly presented. The interviews provided valuable qualitative data, while the survey offered quantitative perspectives, and the alpha and beta testing phases allowed for real-world evaluation of the AniDelivery system.

To develop a user-friendly mobile and web-based platform facilitating direct interactions between farmers and consumers, enabling seamless product showcasing and informed purchases.

Figure 6. *Developed Mobile and Web-based Application*

Pre-Survey Results

The pre-survey questionnaire was administered to 350 farmers, providing insights into the demographic profile of AniDelivery, a digital agricultural marketplace. The survey revealed a balanced representation of gender, land ownership, and technology adoption. 336 farmers own smartphones, highlighting the platform's accessibility. 314 farmers have internet connections, and financial transactions are facilitated through e-wallets. Educational backgrounds varied, indicating AniDelivery's broad reach and user-friendly design. The survey questions highlight the platform's efficiency and accessibility.

Table 5. Pre-Survey Results

Questions	M	DR
1. There is an imbalance between the production of agricultural goods and the demand.	3.52	Strongly Agree
2. The oversupply of agricultural products is a significant issue in Pampanga.	3.46	Strongly Agree
3. As a farmer, oversupply and undersupply of agricultural products affect my income.	3.56	Strongly Agree
4. The oversupply and undersupply of agricultural products leads to dynamic market prices.	3.60	Strongly Agree
5. Direct farmer-to-consumer sales could reduce the use of intermediaries.	3.50	Strongly Agree
6. I am open to implementing technology to improve the profitability of agricultural products.	3.66	Strongly Agree
7. Technology adoption by farmers can lead to better market insights and reduced reliance on middlemen.	3.70	Strongly Agree
8. It is easier to communicate with fellow farmers using technology.	3.66	Strongly Agree
9. Improved communication channels and could help farmers make more informed planting decisions.	3.67	Strongly Agree
10. As a farmer I experience the oversupply and undersupply phenomenon.	3.65	Strongly Agree
Overall rating and description	**3.60**	**Strongly Agree**

The study found that most farmers agree on ten items related to agricultural products. They strongly agree on the imbalance between supply and demand, the impact on their income, the impact of unstable market pricing, and the potential benefits of direct sales from farmers to consumers. They are open to implementing technology to improve profitability and gain better market insights. They also agree that technology simplifies interactions with other farmers and aids in making informed planting decisions. The study also found that most farmers experience over- and undersupply phenomena, with a strong rating of 3.65.

Alpha Testing Results

The researchers administered the following alpha testing questionnaire for their quantitative part to the 19 municipalities and 3 cities in Pampanga specifically for the Department of Agriculture IT experts of the municipalities and cities. The results are as follows:

Table 6. Alpha Testing Average Mean and Overall Description

ISO 9126 Phase		
Functionality	3.77	Strongly Agree
Reliability	3.58	Strongly Agree
Usability	3.5	Strongly Agree
Efficiency	3.5	Strongly Agree
Maintainability	3.60	Strongly Agree
Portability	3.75	Strongly Agree
Average mean and overall description	***3.62***	***Strongly Agree***

Table 6 illustrates that most alpha testers express strong agreement across all 12 items outlined in ISO 9126. The combined scores of all phases, the researchers gathered an average mean score of 3.62 with overall description of strongly agree.

Beta Testing Results

The researchers administered the following beta testing for their quantitative part to 375 farmers in Pampanga. The questions are as follows:

Table 7. Beta Testing Results

Questions	M	DR
Functionality		
1. The essential features, such as product listings, search, and transactions are available and working properly.	3.49	Strongly Agree
Reliability		
2. The platform maintains data accuracy and consistency in transactions and interactions it also always generates reports.	3.48	Strongly Agree
Usability		
3. The graphical user interface (GUI) and overall user experience of the platform are user-friendly.	3.45	Strongly Agree
Efficiency		
4. The platform adeptly utilizes system resources, ensuring smooth user experience	3.36	Strongly Agree
Maintainability		
5. The platform has the ability to preserve its performance and it is also easy to customize products any time.	3.49	Strongly Agree
Portability		
6. The platform's user interface adapts well to different screen	3.50	Strongly Agree

sizes and resolutions		
Average mean and overall description	3.46	Strongly Agree

The study showed that end users strongly agree on all six items of ISO 9126. The researchers scored 3.49 in the functionality phase, 3.48 in the reliability phase, 3.45 in the usability phase, 3.36 in the efficiency phase, 3.50 in the maintainability phase, and 3.50 in the portability phase. The researchers also scored 3.46 in the post-survey.

The following are the screenshots of the system on how the objectives are achieved.

To enable farmers to establish fair pricing for their produce based on Department of Agriculture's recommended retail prices, eliminating intermediary price disparities.

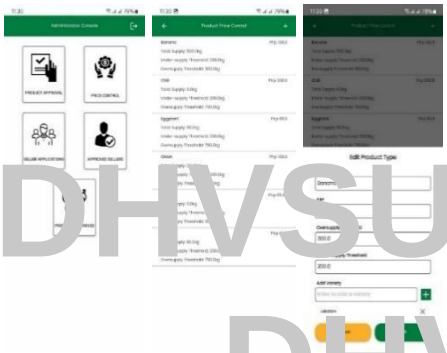

Figure 7. Price Control Monitoring

To incorporate machine learning algorithms to predict and manage over- and undersupply situations, empowering farmers with insights for optimal product listings, and supply chain management.

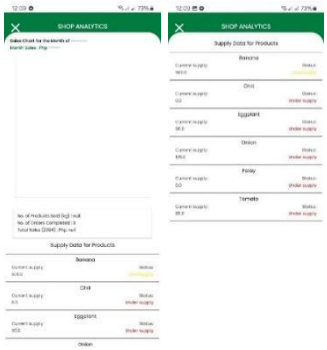

Figure 8. Over- and Undersupply Monitoring

To implement comprehensive features including traceability, product cataloging, chat systems, varied payment gateways, shipment options, sales analytics, feedback mechanisms, user forums, and advanced inventory management.

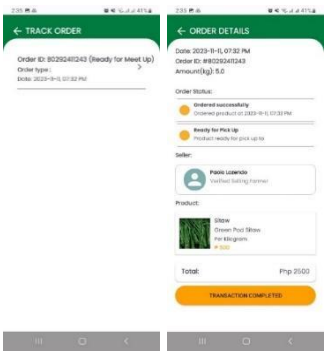

Figure 9. Traceability

Figure 10. Product Catalog

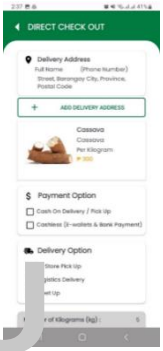

Figure 11. Payment and Shipment Option

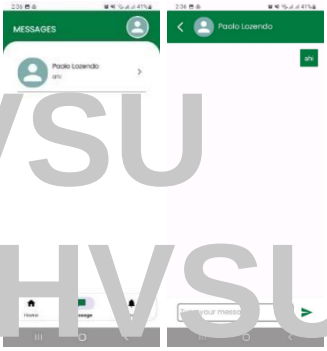

Figure 12. Chat System

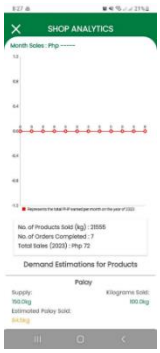

Figure 13. Sales Analytics

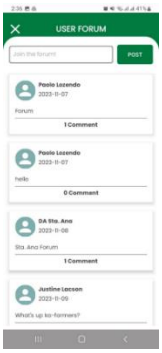

Figure 14. User Forum

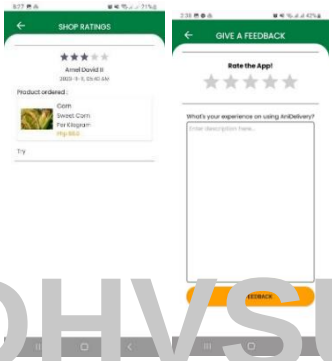

Figure 15. Feedback Mechanism

4.1 Conclusions

The study highlights the challenges faced by farmers in Pampanga, particularly oversupply and undersupply of agricultural products. It shows a strong willingness among farmers to adopt technological solutions like AniDelivery to address these issues. The benefits of technology adaptation include reducing reliance on intermediaries and improving communication within the farming community. The study emphasizes the importance of technology in modernizing the agricultural sector and connecting farmers directly with consumers. Successful implementation requires collaboration among stakeholders, including farmers, government agencies, and technology providers.

4.2 Recommendations

The study suggests promoting technology adaptation in Pampanga to address oversupply and undersupply issues, focusing on direct farmer-to-consumer sales and improved communication channels. It also recommends providing market education and government support to encourage farmers to adopt digital marketplaces and improve internet access. A continuous monitoring system is suggested to help farmers make informed decisions and manage the supply chain effectively. A feedback mechanism within AniDelivery can help refine the platform and address specific needs.

The study suggests expanding AniDelivery's service area beyond fruits and vegetables to increase sales potential and reach a broader customer base. Expanding the platform's geographic reach to other regions in the Philippines or beyond can further reduce oversupply issues. Collaborating with local authorities and regulatory bodies is also suggested to ensure compliance with e-commerce and agricultural market regulations.

Future researchers have the opportunity to enhance control panels, particularly those related to controlling product pricing. These control panels can be improved by creating more advanced features, increasing customization options, ensuring data security, or enhancing scalability. This could lead to innovation and contribute to the field of pricing management by improving the technology and tools available to businesses.

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