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Utilizing the Technology Acceptance Model (TAM) to Drive E-Warehouse Adoption in Brebes' Shallot Sector

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Abstract

This study explores the factors influencing the adoption of SiJuna, a cold storage-based e-warehouse platform, among shallot farmers in Brebes Regency. Price volatility significantly impacts farmers, leading to economic losses, particularly when prices drop below production costs. SiJuna aims to help farmers by offering cold storage to preserve their harvests during price declines and sell when prices stabilize. Using the Technology Acceptance Model (TAM), data was collected from 90 farmers and analyzed through Structural Equation Modeling (SEM). The results reveal that perceived ease of use and perceived usefulness positively influence farmers' behavioral intention to adopt SiJuna, which in turn significantly affects the actual use of the system. The findings underscore the importance of usability and perceived value in technology adoption, suggesting that a user-friendly design and clear benefits can enhance the adoption of agricultural technologies, ultimately improving post-harvest management and farmers' profitability.

Keywords: *Technology Acceptance Model; e-warehouse platform; shallot*

Abstrak

Studi ini mengkaji faktor yang mempengaruhi adopsi SiJuna, platform penyimpanan dingin e-warehouse, oleh petani bawang merah di Brebes. Fluktuasi harga menyebabkan kerugian, terutama saat harga turun di bawah biaya produksi. SiJuna membantu petani menyimpan hasil panen saat harga rendah dan menjualnya saat harga stabil. Menggunakan Model Penerimaan Teknologi (TAM) dan data dari 90 petani yang dianalisis dengan Structural Equation Modeling (SEM), hasil penelitian menunjukkan bahwa kemudahan penggunaan dan manfaat SiJuna memengaruhi keputusan petani untuk mengadopsi platform ini. Desain yang mudah digunakan dan bermanfaat sangat penting untuk meningkatkan pengelolaan pascapanen dan pendapatan petani.

Kata-kata kunci: *Technology Acceptance Model; platform e-warehouse; bawang merah.*

1. Introduction

In the realm of post-harvest management for shallots, farmers in Brebes Regency encounter substantial challenges, particularly in relation to price volatility that frequently results in economic losses. Brebes is recognized as one of Indonesia's leading producers of shallots, with an annual output reaching 384,448 tons **[1].** Nonetheless, despite this significant production potential, many farmers— especially those operating on small and medium scales— struggle to effectively manage their harvests. During peak harvest periods, the surge in supply often outstrips demand, compelling farmers to sell their shallots at prices that fall below production costs. The fluctuation of shallot prices in Central Java Province in 2023 can be seen in **Figure 1.**

Figure 1. Shallot Prices in Central Java Province in 2023

The quality of shallots markedly declines during storage, particularly when maintained at room temperature. Research conducted by Nugraha et al. (2020) indicates that after eight weeks of storage at temperatures between 25 and 30°C, approximately 19.81% of the shallots experience damage, accompanied by a weight loss of 25%. This deterioration is characterized by various quality changes, including discoloration, shriveling, and decay. To address these challenges, effective post-harvest management practices are essential, with cold storage identified as a highly efficacious solution **[2].** By regulating temperature and humidity, cold storage can effectively retard the ripening process, minimize weight loss, inhibit microbial proliferation, and preserve moisture content. This controlled storage environment ultimately extends the shelf life of shallots, thereby maintaining their quality and enhancing their market viability **[2].**

To mitigate this issue, the establishment of a cold storage-based e-warehouse platform has emerged as a viable solution. This platform not only facilitates optimal storage conditions **[3]** but also affords farmers the flexibility to sell their products when market prices stabilize **[4].**

However, the implementation of this technology is fraught with challenges, as many farmers exhibit hesitance in adopting new methodologies. Factors contributing to this reluctance include a lack of awareness regarding the technology's benefits, uncertainty about initial investment costs, and an inherent resistance to deviating from established traditional practices.

The significance of the Technology Acceptance Model (TAM) becomes particularly salient in this context. TAM serves as a framework for identifying and understanding the determinants influencing technology acceptance among users **[5].** Two critical components of TAM are "perceived usefulness," which gauges farmers' beliefs regarding the extent to which the e-warehouse platform can enhance their harvest outcomes and profitability, and "perceived ease of use," which evaluates the perceived simplicity of utilizing the platform without necessitating extensive training. By conducting a comprehensive analysis of these components, developers can formulate targeted training interventions and communication strategies that elucidate the advantages and user-friendliness of this technology. Employing a TAM-based approach is anticipated to foster the adoption of improved technology, thereby enabling shallot farmers in Brebes to enhance their harvest management practices and stabilize their income in a fluctuating market environment **[6].** Consequently, the e-warehouse platform is positioned not merely as a technical solution **[7]** but also as a pivotal tool for empowering farmers to adeptly navigate the intricate challenges of the agricultural market **[8].**

2. Method

A. Research Framework

This study employs a mixed-methods approach, combining quantitative and qualitative research methods to comprehensively assess the challenges faced by shallot farmers in Brebes Regency and the potential of a cold storage-based e-warehouse platform. The research will focus on identifying factors influencing the adoption of this technology, guided by the Technology Acceptance Model (TAM). TAM is a theoretical framework predicated on the belief that prospective users will adopt specific technologies contingent upon their perceived usefulness and ease of use. TAM consists of several key variables that subsequently act as drivers of users' willingness (motivation) to adopt a technology. This user motivation can be interpreted as whether users accept or reject the technology. The desire to adopt or not is referred to as Actual

using the system (ATU) which is mediated by Behavioral Intention (BI) and influenced by Perceived Ease of Use (PEU) and Perceived Usefulness (POU) **[5].** The conceptual framework of this study is illustrated in **Figure 2.**

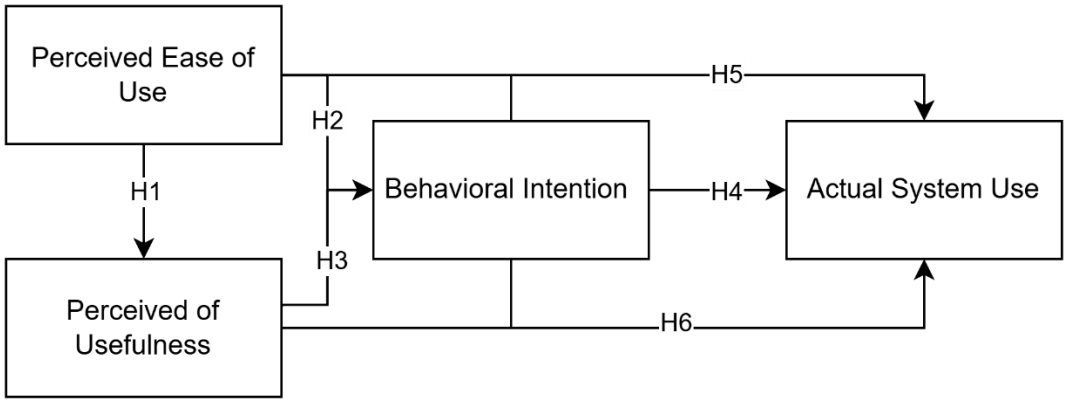

Figure 2. Research Framework

H1: Perceived Ease of Use influences the perceived usefulness among shallot farmers in Brebes as prospective users of SiJuna.

H2: Perceived Ease of Use influences the behavioral intention among shallot farmers in Brebes as prospective users of SiJuna

H3: Perceived usefulness influences the behavioral intention among shallot farmers in Brebes as prospective users of SiJuna

H4: Behavioral intention influences the actual system use among shallot farmers in Brebes as prospective users of SiJuna

H5: Perceived Ease of Use influences Behavioral Intention, which in turn affects Actual Technology Use among farmers as prospective users of SiJuna

H6: Perceived Usefulness influences Behavioral Intention, which in turn affects Actual Technology Use among farmers as prospective users of SiJuna.

B. Instruments

A structured questionnaire will be developed based on the components of TAM such as perceived usefulness and perceived ease of use. Questions will be designed using a Likert scale to measure farmers' attitudes toward the e-warehouse platform. Below are the instruments used in this study.

1. The e-warehouse platform (SiJuna)

SiJuna is an integrated digital information and recording system within a cold storage-based e-warehouse platform, designed to facilitate the monitoring, bookkeeping, and labeling of agricultural products, particularly shallots. SiJuna is accessible to farmers, whether small-scale or medium scale. With the presence of this cold storage-based e-warehouse platform, it is expected to stabilize the national shallot supply and reduce the risk for farmers who are often forced to sell their harvest at a loss when commodity prices plummet, even below their production costs. Another issue is that most small and medium-sized farmers typically do not have access to cold storage facilities due to the high cost of establishing such an infrastructure. Therefore, with this cold storage-based e-warehouse platform, it is hoped that small and medium-scale farmers can access cold storage to store their harvests during price declines and sell them when prices stabilize, ultimately increasing farmers' profitability. The platform interface of SiJuna can be seen in **Figure 3.**

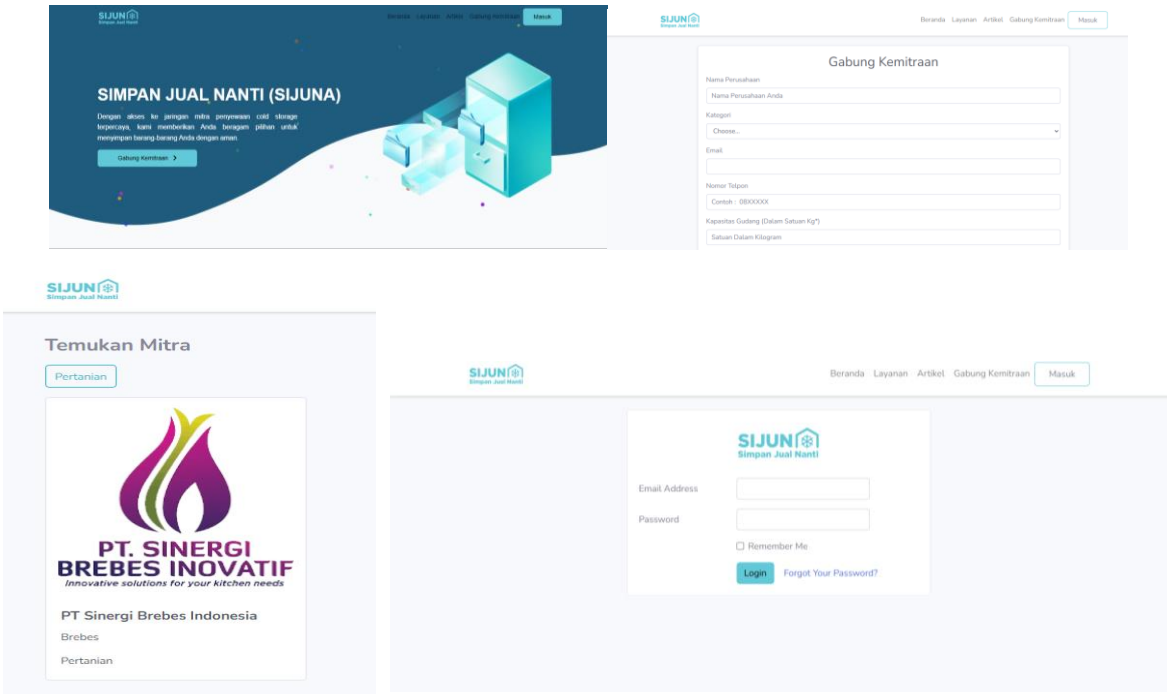

Figure 3. The platform interface of SiJuna

2. Technology Acceptance Model questionnaire

The questionnaire used in this study is structured into two sections: the respondent's profile and questions directly related to the research objectives. It consists of 21 closed-

ended items, each addressing the variables specified in the research framework based on the Technology Acceptance Model (TAM), as illustrated in Figure 1. Respondents' answers to all items are recorded on a 5-point Likert scale, ranging from Strongly Disagree (1) to Strongly Agree (5). The details of the questionnaire items employed in this study are presented in Table 1.

Table 1. Technology Acceptance Model questionnaire

Kode	Variable	Attributes
PEU1	Perceived Ease of Use	I find it easy to learn how to use the Sijuna Application
PEU2		I am skilled at using the Sijuna Application easily
PEU3		I can use the Sijuna Application to make my work easier
PEU4		I can interact with the Sijuna Application clearly
PEU5		I can understand how to interact with the Sijuna Application well
PEU6		I believe that the Sijuna Application is a flexible program
POU1	Perceived Usefulness	I can complete tasks more quickly with the Sijuna Application.
POU2		I believe that my work becomes easier with the Sijuna Application.
POU3		I can increase my work productivity with the Sijuna Application.
POU4		I can improve work effectiveness with the Sijuna Application.
POU5		I believe that the Sijuna Application is useful for me.
POU6		I believe that the Sijuna Application can simplify the work process
BI1	Behavioral Intention	I am comfortable using the Sijuna Application.
BI2		I enjoy using the Sijuna Application.
BI3		I believe that the Sijuna Application is not boring.
BI4		The Sijuna Application provides the information I need.
BI5		I work based on the information provided by the Sijuna Application.
BI6		The Sijuna Application provides accurate information.
BI7		I will continue using the SiJuna application
ATU1	Actual Technology use	I use the Sijuna Application for long durations of time.
ATU2		I am satisfied using the SiJuna application.

C. Data Analysis

The data analysis was conducted using a statistical approach, employing the SmartPLS application for structural equation modeling (SEM). The data collected were initially processed

and SPSS version 22 for preliminary analysis. Following this, advanced data processing and analysis were carried out using the SmartPLS application to model and evaluate the relationships between the variables.

3. Results and Discussion

3.1 Results

3.1.1 Participant's Demography

The participants in this study were shallot farmers from Brebes Regency, with a total sample size of 90 respondents. The demographic analysis of the respondents revealed that a significant majority, 86%, were male, indicating that shallot farming in this region is predominantly a male-dominated occupation. This finding is consistent with traditional agricultural practices, where farming roles are often divided along gender lines.

In terms of age, the average age of the shallot farmers was approximately 32 years, suggesting a relatively young farming population. This could indicate that younger generations are taking an active interest in agriculture, possibly driven by advancements in farming technology, access to education, and governmental support for the agricultural sector.

Moreover, the age distribution showed a mix of both younger and older farmers, with some nearing retirement age, which might present challenges in the long-term sustainability of the farming workforce. The respondents' years of experience in shallot farming varied, with many farmers having more than 5 years of experience, indicating a certain level of expertise and knowledge in shallot cultivation.

The demographic profile of the respondents provides a comprehensive view of the socio-economic landscape of shallot farming in Brebes Regency, highlighting key factors that influence the farming community's characteristics, behavior, and potential needs for intervention in agricultural development programs.

3.1.2 Structural Model Testing

The following is the structural model path developed in this study that can be seen in **Figure 4.**

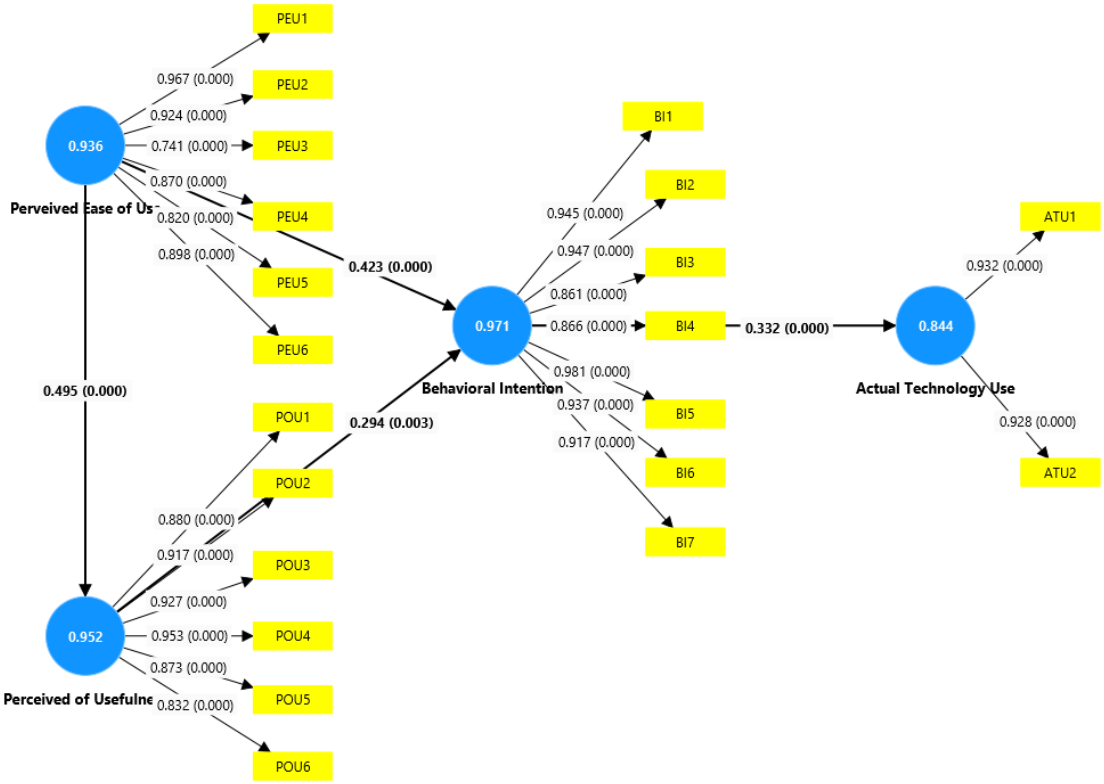

Figure 4. The structural model path

The outer loading factor represents the degree of association between the indicators and the constructions being evaluated. It quantifies the extent to which each indicator contributes to the underlying latent constructs and is pivotal for assessing the validity of the measurement model (outer model). As presented in Table 3, the loading factors corresponding to each construct surpass the critical threshold of 0.7, thereby fulfilling the established criteria for convergent validity. The highest outer loading values for each variable are POU4 (0.957) for perceived usefulness, PEU1 (0.967) for perceived ease of use, ATU1 (0.932) for actual usage, and BI5 (0.981) for intention to use. The results from Table 2 show that all indicators have an outer loading factor value greater than 0.5. This means that the indicators are suitable for referencing the variables, as they have met the convergent validity. Based on the Average Variances Extracted (AVE) table, the AVE value for each variable in the construct is greater than 0.5, indicating that each variable in the study meets discriminant validity. Looking at the composite reliability coefficient values, it shows that each variable—PEU (0.950), POU (0.952), BI (0.971), and ITU (0.844)—meets the rule of thumb.

Table 2. Outer Loading Factor

Kode	Outer Loading	AVE	Reliability
PEU1	0.967	0.762	0.950
PEU2	0.924		
PEU3	0.741		
PEU4	0.870		
PEU5	0.820		
PEU6	0.898		
POU1	0.880	0.806	0.952
POU2	0.917		
POU3	0.927		
POU4	0.953		
POU5	0.873		
POU6	0.832		
BI1	0.945	0.852	0.971
BI2	0.947		
BI3	0.861		
BI4	0.866		
BI5	0.981		
BI6	0.937		
BI7	0.917		
ATU1	0.932	0.865	0.844
ATU2	0.928		

3.1.3 The hypothesis testing results

The output results from the mediation test can be seen in Table 3.

Table 3. Hypotheses testing

Hypothesis	Effect	Path Coefficient	p-value
H1	PEU → POU	0.495	0.000
H2	PEU → BI	0.423	0.000
H3	POU → BI	0.294	0.003
H4	BI → ATU	0.332	0.000

The hypothesis testing results presented in Table 3 show significant direct effects between the various variables tested. The path coefficients for all hypotheses are positive, indicating that each variable has a positive influence on the others. Additionally, the p-values, which are all less than 0.05, suggest that the relationships tested are statistically significant. First, perceived ease of use positively affects perceived usefulness, with a path coefficient of 0.495 and a p-value of 0.000, meaning that the easier a system is to use, the higher users' perception of its usefulness. Second, perceived ease of use also positively influences behavioral intention, with a path coefficient of 0.423 and a p-value of 0.000, indicating that the easier a system is to use, the greater the intention to use it. Third, perceived usefulness positively impacts behavioral intention, with a path coefficient of 0.294 and a p-value of 0.003, suggesting that the higher the perception of a system's usefulness, the stronger the intention to use it. Finally, behavioral intention has a positive effect on actual system use, with a path coefficient of 0.32 and a p-value of 0.000, implying that the greater the intention to use a system, the more likely it is that the system will actually be used.

Overall, these results demonstrate that factors such as ease of use, perceived usefulness, and behavioral intention play crucial roles in influencing actual system use.

The results from the hypothesis testing provide strong support for the relationships outlined in the hypotheses (H1, H2, H3, H4) regarding the use of the SiJuna system among shallot farmers in Brebes. Here's how the results of the path coefficients and p-values align with each hypothesis.

H1: Perceived Ease of Use influences the perceived usefulness among shallot farmers in Brebes as prospective users of SiJuna.

- The result shows that perceived ease of use positively influences perceived usefulness with a path coefficient of 0.495 and a p-value of 0.000. This finding confirms H1, indicating that the easier the SiJuna system is to use, the more useful it is perceived to be by the shallot farmers. This aligns with the idea that ease of use can enhance the perception of the system's utility, which is critical for encouraging adoption.

H2: Perceived Ease of Use influences the behavioral intention among shallot farmers in Brebes as prospective users of SiJuna.

- The results also show a positive relationship between perceived ease of use and behavioral intention, with a path coefficient of 0.423 and a p-value of 0.000. This supports H2, suggesting that when farmers perceive the SiJuna system as easy to use, they are more likely to intend to use it in the future. This is consistent with the idea that user-friendly technology increases the likelihood of users planning to engage with the system.

H3: Perceived usefulness influences the behavioral intention among shallot farmers in Brebes as prospective users of SiJuna.

- The path coefficient for perceived usefulness influencing behavioral intention is 0.294 with a p-value of 0.003. This result supports H3, showing that farmers who perceive the SiJuna system as useful are more likely to have a strong intention to use it. This demonstrates that perceived usefulness plays a critical role in shaping the willingness of prospective users to adopt the system.

H4: Behavioral intention influences the actual system use among shallot farmers in Brebes as prospective users of SiJuna.

- The relationship between behavioral intention and actual system use is confirmed with a path coefficient of 0.32 and a p-value of 0.000. This finding supports H4, indicating that the stronger the intention of the shallot farmers to use SiJuna, the more likely they are to actually use the system. This underlines the importance of behavioral intention as a key predictor of actual system use.

3.1.4 Indirect Effect Hypothesis Test

Here are the results of the Indirect Effect Hypothesis Test, as shown in **Table 4.**

Table 4. Indirect Effect Hypothesis Test

Hypothesis	Effect	Indirect effect	Total effect
H5	PEU → BI → ATU	0.140	0.188
H6	POU → BI → ATU	0.097	0.294

In order to test the mediation, the SEM-PLS method was used with the Variance Accounted For (VAF) approach. VAF is a measure used in Structural Equation Modeling (SEM) to determine the extent to which a particular variable accounts for the variance of an endogenous variable in a model. It's especially useful when testing mediation or indirect effects in a model. Below is the model and formula of Variance Accounted For.

$$VAF = \frac{\text{Indirect effects}}{\text{Total effects}}$$

Using the formula above, the VAF for H5 is found to be 74%, and the VAF for H6 is 32%. According to the VAF interpretation, if VAF ≥ 80%, it indicates a strong mediation effect. If the VAF is between 20% and 80%, it suggests partial mediation. If VAF < 20%, it implies a weak or insignificant mediation effect. Therefore, both H5 and H6 are classified as partial mediation. This indicates that while the mediator, Behavioral Intention, accounts for a significant portion of the relationship between independent and dependent variables, it is not the exclusive factor driving the effect. In the case of both H5 and H6, the mediation is partial, meaning that Behavioral Intention plays an important role in linking Perceived Ease of Use and Actual Technology Use (H5), as well as Perceived Usefulness and Actual Technology Use (H6). However, other direct effects and factors may also influence the outcomes, suggesting that the relationship is not entirely mediated by Behavioral Intention alone.

For instance, there could be other external or internal variables, such as external motivations **[9]**, environmental factors , or even individual characteristics, that directly impact Actual Technology Use, beyond the influence of Behavioral Intention **[10].** This highlights that while Behavioral Intention is a crucial factor in explaining technology adoption and usage **[10],** it is only one part of a larger, more complex mechanism. Thus, while the mediation effect is statistically significant, it is not the dominant force in determining the final outcomes, and the full explanation of Actual Technology Use requires considering these other potential influences alongside the mediation effect **[11].**

3.2 Discussion

The study's findings provide a thorough understanding of the factors influencing the adoption of SiJuna among shallot farmers in Brebes, revealing key insights into the interrelationships between perceived ease of use, perceived usefulness, behavioral intention, and actual system use. The positive and significant path coefficients observed across all hypotheses suggest a well-connected framework where each factor influences the others in a meaningful way. Specifically, the result that perceived ease of use (PEU) positively influences perceived usefulness (POU) highlights the foundational role of usability in technology adoption. When farmers find the SiJuna system easy to use, they are more likely to believe that it will be helpful in improving their farming practices **[12],** which aligns with established technology adoption theories, such as the Technology Acceptance Model (TAM). This underscores the importance of designing systems that are intuitive and user-friendly, as ease of use directly affects users' perceptions of the system's utility **[13], [14].**

Moreover, the relationship between perceived ease of use and behavioral intention (BI) reveals that when the system is easy to use **[15],** farmers are more inclined to intend to use it in the future. This finding emphasizes the psychological aspect of technology adoption, where a positive user experience reduces resistance to new technology, thereby fostering a willingness to adopt it. The significant path coefficient of 0.423 further demonstrates that perceived ease of use not only enhances the perception of the system's usefulness but also directly influences the intention to engage with it, which is a critical step before actual usage **[16].**

Equally important is the impact of perceived usefulness on behavioral intention (0.294). Farmers who view SiJuna as useful are more likely to form a strong intention to use the system. This reinforces the idea that, beyond ease of use, the actual value that the system brings to the farmers' daily operations **[17]**—such as improving crop management, offering relevant market data, or increasing productivity—drives their motivation to adopt it **[17]**. This relationship is crucial because it suggests that marketing and user education efforts should focus not only on making SiJuna easy to use but also on clearly demonstrating how it benefits the farmers' needs and goals **[16].**

Finally, the direct influence of behavioral intention on actual system use (0.332) confirms that farmers' intention to use SiJuna is a reliable predictor of whether they will actually adopt the system in practice. This finding underscores the importance of nurturing a positive attitude towards the system, as intention is a precursor to action. If farmers intend to use SiJuna, they are much more likely to integrate it into their daily routines [18] [19]. This makes behavioral intention a critical focus area for interventions aimed at encouraging adoption [20]. Moreover, the fact that all hypotheses were supported with path coefficients greater than 0 and p-values below 0.05 adds significant statistical strength to these relationships, further validating the model's explanatory power **[20].**

In terms of the measurement model, the results indicate excellent reliability and validity. The high outer loadings for the indicators (such as POU4 at 0.957 for perceived usefulness, PEU1 at 0.967 for perceived ease of use, and BI5 at 0.981 for behavioral intention) confirm the strength and precision of the constructs used in the study. Additionally, the Average Variance Extracted (AVE) values greater than 0.5 for each construct suggest that the indicators are effectively capturing the underlying dimensions of the constructs, fulfilling the criteria for both convergent and discriminant validity. Furthermore, the composite reliability coefficients for each construct (PEU at 0.950, POU at 0.952, BI at 0.971, and ITU at 0.844) further establish the internal consistency of the model, ensuring that the measurements are dependable and reflect the true constructs they intend to measure.

Overall, the findings from this study provide a comprehensive picture of the key drivers of SiJuna's adoption among shallot farmers in Brebes. The significant relationships between perceived ease of use, perceived usefulness, behavioral intention, and actual system use highlight the interconnectedness of these factors and offer practical insights for system designers and implementers. To maximize adoption, it is essential to ensure that SiJuna is user-friendly, clearly demonstrates its usefulness, and fosters positive behavioral intentions **[21].** Targeted strategies that focus on improving ease of use, showcasing tangible benefits, and supporting farmers' behavioral intentions can play a pivotal role in enhancing both the adoption rate and sustained use of the SiJuna system. These results provide a robust foundation for further research and practice in the context of agricultural technology adoption and its potential to improve farming outcomes

4. Conclusion

In conclusion, this study underscores the critical role of perceived ease of use, perceived usefulness, and behavioral intention in the adoption of the SiJuna e-warehouse platform by shallot farmers in Brebes. The findings suggest that a user-friendly platform that is perceived as useful will likely encourage farmers to adopt the technology, which can lead to improved post-harvest management and reduced economic risks due to price volatility. The positive relationships found between the factors—ease of use, usefulness, intention, and actual usage—align with the Technology Acceptance Model (TAM) and emphasize the importance of designing intuitive, practical systems. The strong support for the hypotheses indicates that the ease of use of SiJuna directly enhances farmers' perceptions of its usefulness and their intention to use it. Furthermore, behavioral intention serves as a strong predictor of actual system usage, confirming that fostering positive attitudes and intentions is key to achieving widespread adoption. These insights provide a solid foundation for further development and implementation strategies that can enhance the adoption of SiJuna and similar agricultural technologies, ultimately benefiting farmers in the region.

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