E-Farming Implementation Effect On Supply Chain Performance of Sugar Cane Commodities in A Plantation Company

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ABSTRACT: Information technology has been developed by many companies to achieve supply chain performance, E-farming is an application developed to register own sugarcane land/cane people and monitor the progress of plant work based on web and mobile application (android) supported by GIS and satellite technology. The research used is a quantitative method using survey methods through distributing questionnaires to e-farming actors/users at PTPN X. Survey research is research conducted on large and small populations, but the data studied are 352 samples from the population. Analysis using Structural Equation Modeling (SEM) with Smart PLS 3.0 software. The calculation results show that there is a positive and significant effect on the implementation of e-farming on supply chain performance. This means that to improve Supply Chain Performance, it is necessary to increase the role of the application of E-Farming technology, especially application tools can be developed to increase the effectiveness of the company's business processes.

KEYWORDS:*E-Farming Implementation, Supply Chain Performance, SEM*

I. INTRODUCTION

Smart farming 4.0 is an artificial intelligence product that has been used as a mainstay tool for the Ministry of Agriculture in the current digital era. Smart farming 4.0 will encourage farmers' work so that agricultural cultivation becomes efficient, scalable, and integrated. This is beneficial for farmers to carry out cultivation planning properly and appropriately through mechanization so that seasonal dependence can be avoided. The implementation of cultivation from planting to harvest is carried out with precise and accurate planning including labor, cropping patterns, and harvesting. Several smart farming technologies such as blockchain that can facilitate the traceability of the supply chain of agricultural products for modern off-farm agriculture, agri drone sprayer (drones spraying pesticides & liquid fertilizers), drone surveillance (drones for land mapping), soil and weather sensors (soil and weather sensors), smart irrigation (smart irrigation system), Agriculture War Room (AWR), Siscrop (information system) 1.0 have been implemented in several areas (Rachmawati, 2020). [1].

Precision agriculture is a modern approach to agricultural management that exploits cutting-edge technology to monitor and optimize agricultural production processes. The concept of precision agriculture was born in the United States in the early 1990s, where the House of Representatives (1997) defined it as "an integrated production and information-based farming system designed to improve long-term, site-specific, and overall agriculture. production efficiency, productivity and profitability while minimizing unwanted impacts on wildlife and the environment (Trivelli et al., 2019)[2].One of the noble technologies developed for agriculture is E-Farming. An important program is the development of technology and innovation, especially in terms of the creation of local superior varieties (site specific location), weather and climate information systems, the implementation of precision farming, and increasing management effectiveness in order to increase crop productivity and control the cost of production. For technology development and innovation, funding support is needed for technology and innovation development institutions (research & technology institutions and HR development institutions, including P3GI, LPP, & Universities). State-owned sugar companies must be able to transform into superior companies in terms of production, human resources, marketing, IT,

finance and various aspects of the organization. In an effort to carry out this transformation, changes are needed, starting from the perspective of the sugar business going forward, running a business and the competencies that must be built.

Plantation is an agricultural sub-sector that has a contribution to the state. The contribution of the plantation sub-sector in 2019 was 3.27 percent of the total GDP and 27.75 percent of the Agriculture, Forestry and Fisheries sector or was the first in the sector (BPS)[3]. One of the most widely developed and cultivated types of plantation crops by large plantation companies, both private and state-owned, is sugar cane. Large plantations are plantations that are commercially organized or managed by a company that is a legal entity. Large plantations consist of State Large Plantations (PBN) and National/Foreign Large Private Plantations (PBS). The production performance of PTPN Group, the achievement of sugarcane production, has decreased. In the development of the new digital era in the fourth industrial revolution, Information and Communication Technology and cyber-physical System (CPS) based on Internet of Things (IoT) architecture for production logistics and Supply Chain applications have led to the implementation and acceleration of innovations needed for industrial digitization. Mengru Tu, et. all., 2016)[4]. This also has an influence on the direction of national development which was previously based on the agricultural sector to become an industry which then has an impact on the face of the Indonesian agricultural system.

HoldingPerkebunan Nusantara has started implementing E-farming for all PT Perkebunan Nusantara (PTPN) sugar. E-farming provides several benefits, namely ease of land registration in several sugar factories, accuracy of land verification to avoid overlapping areas, ease of monitoring land and ease of communication between farmers and officers from sugar factories. E-farming is an application for land registration and monitoring the progress of plantation work through web and mobile applications (android) supported by GIS and satellite technology. This application has been implemented at PTPN X since 2016 and continues to be developed every year (PTPN). PTPN X has implemented the digitization of land management through E-farming where features continue to be developed to improve supply chain performance from land registration to land management, mainly on their own land. The obstacles faced by the PTPN sugar industry in achieving the feasibility of a sugarcane-based industry, from the on-farm aspect, include: limited land area and dominated by marginal land, climate change and frequent occurrence of extreme weather, limited use of agro inputs, irrigation facilities, labor and technology, and high production costs. The high sugarcane land owned by farmers makes the uncertainty of the fulfillment of raw materials high, so it is necessary to take a precise and measurable inventory of the farmers' sugarcane land. Initially, land records were carried out by each sugar factory, so the potential for overlapping land records between sugar factories was very high because it was not integrated.

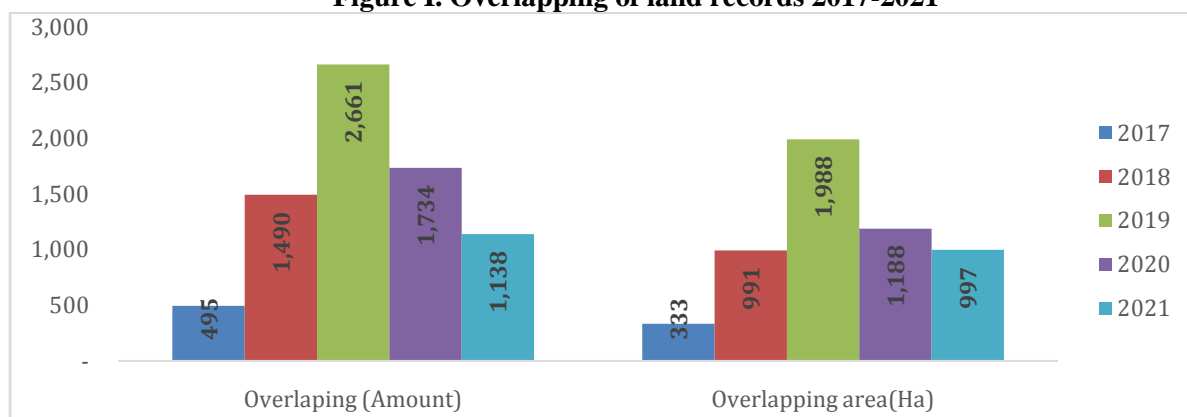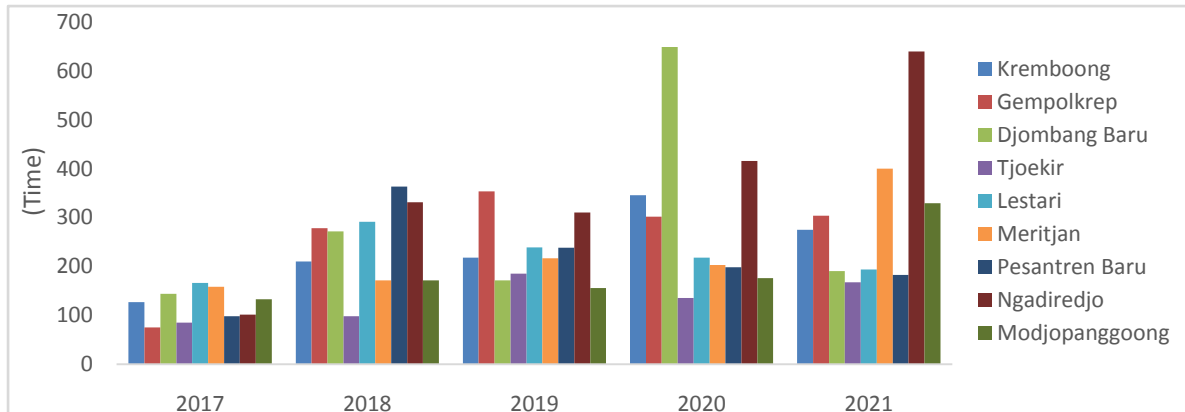**Figure I. Overlapping of land records 2017-2021**

Figure II. Overlapping of land records 2017-2021

According to the President Director of PTPN X (2019), Dwi Satriyo Annurogo, said that entering the industrial era 4.0 one of the main principles is the connection to technology and e-farming is the starting point for plantations to become more advanced (PTPN). With the existence of e-farming, it will certainly affect the management system or agricultural management, meaning that e-farming will affect supply chain performance. The low productivity of sugarcane is allegedly due to the cultivation process that is not up to standard, especially in terms of timeliness of work execution. The existing work progress reporting system cannot accurately monitor the timeliness of plantation work implementation. Holding Perkebunan Nusantara has assigned PTPN X to develop e-farming including additional work progress features and preparation for cutting sugar cane. Management can monitor the realization of work progress more accurately. With the implementation of work according to standards and at the right time, it is expected to significantly increase the productivity of sugarcane plants (Magfiroh & Wibowo, 2019)[5].

In today's business developments, orders are getting tighter not only from competitors but also from between supply chains within the company. This requires a supply chain that has good performance to survive in changing dynamics in the industry. Performance that refers to the product Supply chain performance measurement is one of the information needed by management with information about whether it is improving or decreasing. Among the supply chain performance measurement models are related to supply chain activities in the company, including procurement activities, production planning, customer order fulfillment, and product returns. This measurement activity can provide improvements in determining the current operating system policy. Several factors that affect supply chain performance are operating conditions or environmental factors and supply chain decision parameters or internal factors. Satria Utama Analysis (2019) Information technology has an important role in the development of agro-industry which helps in managing the supply of agricultural products. E-farming, which was compiled as a service system in an effort to develop the Android-based agricultural sector, offers several services in the form of counseling, consulting, and marketing related to agriculture. The E-Farming application here helps farmers get more profits if they are sold on the application. Farmers get information on harvest trends and selling prices so that they can determine the calculation of selling prices.

Table 1
Research Gap
E-farming Implementation on Supply Chain Performance

No	Authors	Result	Description
1.	Rum et al., (2019)	There is a significant relationship between supply chain management practices and farm performance	Significance (+)
2.	Suharto & Devie, (2016)	There is a significant and positive influence between Supply Chain Management on competitive advantage	Significance (+)
3.	Putri et al., (2019)	There is a positive influence on supply chain practices on competitive advantage and supply chain performance	Significance (+)

Based on the phenomena that have been described above and empirical studies of previous studies that are relevant to the phenomena found, Based on the background of the problems above, there are problems related to this research. The

obstacles faced by the PTPN sugar industry in achieving the feasibility of a sugarcane-based industry from the on-farm aspect include: limited land area and dominated by marginal land, climate change and frequent occurrence of extreme weather, limited use of agro inputs, irrigation facilities, labor and technology, and high production costs. The high sugarcane land owned by farmers makes the uncertainty of the fulfillment of raw materials high, so it is necessary to take a precise and measurable inventory of the farmers' sugarcane land. Initially, land records were carried out by each sugar factory, so the potential for overlapping land records between sugar factories was very high because it was not integrated.

The low productivity of sugarcane is allegedly due to the cultivation process that is not up to standard, especially in terms of timeliness of work execution. The existing work progress reporting system cannot accurately monitor the timeliness of plantation work implementation. Holding Perkebunan Nusantara has assigned PTPN X to develop E-Farming including additional work progress features and preparation for cutting sugar cane. Based on the description of the background above and the phenomenon, the authors determine the formulation of the problem in this study is how the influence of E-Farming Implementation on the Supply Chain Performance of Sugarcane Commodities at PT. Perkebunan Nusantara X?. The purpose of this study was to determine the effect of
E-Farming Implementation of Sugar Cane Commodity Supply Chain Performance at PT. Perkebunan Nusantara X.

II. LITERATUREREVIEW

E-Farming at PTPN X is an application resulting from the development of internal business processes in PTPN. The process that has been done manually and there is no integration between lines or between sugar factories is now integrated through the application. In 2020 the E-Farming program has been able to carry out land registration and monitoring the progress of garden work through the web and mobile application (android) supported by GIS and satellite technology. According to Satria Utama (2019)[6], E-Farming is a service system in an effort to develop an Android-based agricultural sector that offers several services. Information technology has an important role in the development of agro-industry in realizing sustainable modern agriculture in a timely manner. Utilization of technology in agriculture can be realized by using E-Farming.

The implementation of this E-Farming application provides information services about agricultural activities from the production process to the marketing of products. Application.E-Farming helps farmers get more profit by getting information and being able to develop strategies in selling products.

Despite being a relatively well-known concept, precision agriculture still has low adoption rates as reported by academic surveys and professional reports (Mentzer et al, 2001)[7]. The government has announced the national priority of "making Indonesia 4.0" which is the gateway to the openness of the technological era so that Indonesia is able to increase competitiveness as well as a place to prepare Indonesia to enter the 4th industrial revolution, but until now its implementation is still far from satisfactory. Currently, there are still farmers who are new to the introduction stage or even those who are not familiar with the digitalization of agricultural technology. When compared to China and Thailand, Indonesia is still far behind. The rapid population, the difficulty of regeneration at the farmer level, and limited land make it seems that it is no longer possible for farmers to use conventional methods (Rachmawati, 2021)[8].

E-Farming is an application for land registration and monitoring the progress of garden work through web and mobile applications (android) supported by GIS and satellite technology. the implementation of E-Farming at PTPN X also supports productivity improvements on the on farm side. In addition, there will be certainty of the area of sugarcane plantations and the amount of Sugar Cane Raw Materials, both TS and TR. (PTPN10, 2018). The dimensions of E-Farming are taken from research conducted by (Trivelli et al., 2019) [9], as follows:

1. Monitoring
This cluster represents one of the most important aspects in precision agriculture as it is the basis for implementing advanced agricultural systems. It directly interacts with most other clusters and represents the counterpart of the IoT.

2. IoT (Internet of Things)
These clusters complement monitoring as sensors play a central role in IoT. This cluster describes a new technology that enables data communication between machines. IoT and monitoring are at the base for data extraction and analysis enabling system automation.

3. Automation
Data coming from sensors makes it possible to automate processes that previously required human

intervention.

4. Decision

This cluster is closely related to the automation one. Decision systems (especially AI and data analytics) are the bridge between machines and humans.

　　　Supply Chain Performance has been defined as a systematic process for measuring the effectiveness and efficiency of supply chain operations (Anand, and Grover, 2015)[10]. Effective supply chain performance can reduce costs, waiting times, delivery delays, and improve product quality, while company performance reflects how the company performs to achieve the goals, missions and values that have been set according to mutual agreement (Gandhi et al., 2015)[11]. In identifying supply chains in applications that have been created, it is necessary to observe and evaluate supply chain performance assessments. According to Rizkya et al (2019)[12], Performance of activity (POA) is a performance measurement model for each activity. The modified POA dimensions in previous research are as follows:

1. Time (waktu)
2. Capacity (Kapasitas)
3. Productivity (Produktivitas)
4. Benefits (Manfaat)

Sugarcane plant with the Latin name Saccharum officinarum is one of the plants that can produce sugar which is cultivated in tropical to sub-tropical areas. Sugarcane plants have a plant age of up to 16 months which in Indonesia is generally harvested at the age of about 12 months. Sugarcane plants have optimal growth characteristics with the planting phase before the rainy season, the stem extension phase together in the rainy season and the ripening phase in the dry season (Ghani, 2022)[13].

　　　Sugarcane cultivation standards are currently facing different environmental conditions and soil fertility, therefore the principles & criteria for cultivation must be adjusted. Optimum cultivation stages include land management, use of superior seeds, application of fertilizers as needed, plant maintenance, irrigation, pest control, Kletek, gulud and TMA management (Ghani, 2022)[14]. Supply chain is the most important factor in increasing competitiveness since the biggest cost of a product is in the supply chain (Fitri Ikhatrinasari Z. et al., 2020) [15]. The development of supply chain performance measurement system needs to take into account the specific characters of the supply chain that will be measured (Hasibuan S & Dzikrillah N, 2018) [16]

The framework of thought is a logical framework that places the research problem within the relevant theoretical framework.

Figure III. Framework
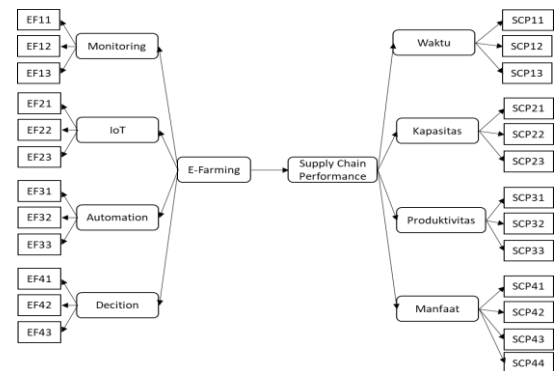
III.　　METHOD

　　　The research method used is a quantitative method. Of the two types of quantitative methods (experimental methods and survey methods), this study uses a survey method through questionnaires to e-farming actors/users at PTPN X. Survey research is research conducted on large or small populations, but the data studied is a sample of the population. The population in this study were permanent employees of the Plant Division and the QA Divisionat PT. Perkebunan Nusantara X.

　　　Based on MPP (Man Power Planning) Holding Perkebunan, PTPN X data obtained as of January 2022, the permanent employees in the Plant Division was 492 employees and the QA Division permanent employees were 118 employees. The sample is part of the population to be studied or part of the number of characteristics possessed by the population (Hidayat, 2012)[15].Sampling technique when all members of the population are used as samples. Another term for a saturated sample is a census, where all members of the population are sampled. So the author uses a saturated sampling technique, so the sample is taken as many as 352 permanent employees of the Plant Section and the QA Section in the work unit of PT. Nusantara X Plantation.

　　　The analytical method used in testing the hypothesis is the structural equation model (SEM) measured by the PLS (Partial Least Square) model using SmartPLS software. The PLS approach is used for predictive analysis with a weak theoretical basis and the data do not meet the SEM assumptions based on covariance. With the PLS technique, it is assumed that all variance measures are useful to explain. SEM-PLS is able to handle

problems that arise in covariance-based SEM analysis. In SEM, in addition to the characteristics of the model being estimated, the sample size should be increased under the following circumstances: (1) data deviates from multivariate normality, (2) sample-intensive estimation techniques (e.g., ADF) are used, or (3) missing data exceeds 10 percent.

IV. RESULT AND DISCUSSION

a. Variable E-farming Implementation

Table 2. Variable E-farming Implementation

Kode	N	Minimum	Maximum	Average
EF11	352	6	10	8.28
EF12	352	4	10	8.12
EF13	352	5	10	8.60
EF21	352	3	10	8.23
EF22	352	5	10	8.24
EF23	352	3	10	8.26
EF31	352	3	10	8.26
EF32	352	4	10	7.91
EF33	352	6	10	8.23
EF41	352	5	10	8.28
EF42	352	5	10	8.24
EF43	352	1	10	8.01
Average				**8.22**

Source : data is processed from the results of the 2022 questionnaire

Based on the table above, the highest average value for variable E-farming Implementation is found in the Monitoring dimension for EF13 statements, namely using E-Farming provides ease of monitoring and the lowest average value is found in the EF43 statement with a statement whether there is an E-Farming development strategy in improving. Thus, it can be known that from each indicator on the variable E-farming Implementation standard deviation smaller than the mean indicates a small distribution of the data indicators or the absence of a sufficiently large gap of each lowest and highest indicator. As for the average score of the variabel E-Farming of 8.22, which means that the average respondent tends to agree with the questions in the questionnaire.

b. **Variable Supply Chain Performance**

Table 3. Description of VariableSupply Chain Performance

Kode	N	Minimum	Maximum	Average
SCP11	352	2	10	8.28
SCP12	352	2	10	8.31
SCP13	352	5	10	8.41
SCP21	352	4	10	8.30
SCP22	352	5	10	8.38
SCP23	352	2	10	8.16
SCP31	352	2	10	8.29
SCP32	352	5	10	8.32
SCP33	352	4	10	7.93
SCP41	352	2	10	8.13
SCP42	352	4	10	8.31
SCP43	352	1	10	8.16
SCP44	352	5	10	8.45
Average				**8.26**

Source : data is processed from the results of the 2022 questionnaire

Based on the table above above, the highest average value for the Supply Chain Performance variable is found in the Dimension of Benefits for SCP44 statements, namely the use of applications that facilitate monitoring and evaluation of work and other events that should be presented and the lowest average value is contained in the SCP33 statement with a statement sugarcane productivity is better by monitoring the progress of garden work in the application. Thus, it can be known that from each indicator on the Variable Supply Chain Performance standard a deviation smaller than the mean indicates a small spread of the data indicator or the absence of a sufficiently large gap of each indicator's lowest and highest. As for the average value of the Supply Chain Performance variable of 8.26, which means that the average respondent tends to agree with the questions in the questionnaire.

c. *Convergent Validity*Test

Convergent Validity aims to determine the validity of each relationship between indicators and their latent constructs or variables. The convergent validity of the measurement model with reflexive indicators is assessed based on the correlation between the item or component score and the latent variable score or construct score estimated by the PLS program. The following is a picture of the calculation results of the SEM PLS model, then look at the loading value of the indicators factor on each variable
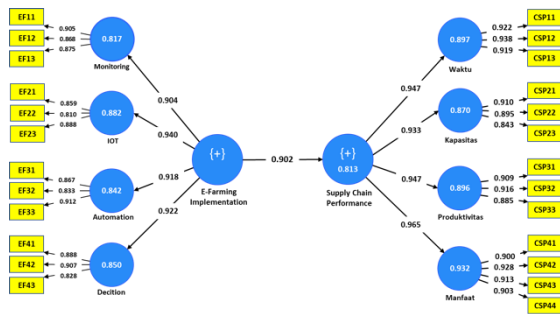
Figure 5. Sem PLS model calculation results

The measurement will be considered valid if the loading factor is above 0.70 and the AVE is above 0.50 for each variable (Hair et al., 2014). The actual result of the external charge is as follows:

Table 4. *Loading Factors*

Variable	Indicators	LoadingFactors	Result
E-farming Implementation (X)	EF11	0,905	Valid
	EF12	0,868	Valid
	EF13	0,875	Valid
	EF21	0,859	Valid
	EF22	0,810	Valid
	EF23	0,888	Valid
	EF31	0,867	Valid
	EF32	0,833	Valid
	EF33	0,912	Valid
	EF41	0,888	Valid
	EF42	0,907	Valid
	EF43	0,828	Valid
Supply Chain Performance (Y)	SCP11	0,922	Valid
	SCP12	0,938	Valid
	SCP13	0,919	Valid
	SCP21	0,910	Valid
	SCP22	0,895	Valid
	SCP23	0,848	Valid
	SCP31	0,909	Valid
	SCP32	0,916	Valid
	SCP33	0,885	Valid
	SCP41	0,900	Valid
	SCP42	0,928	Valid
	SCP43	0,913	Valid
	SCP44	0,903	Valid

Source: data processed from the results of the 2022 questionnaire

Variable E-Farming Implementation and Supply Chain Performance have a loading more factor value greater than 0.70. Thus the indicator is declared validin measuring variables of E-farming Implementation and Supply Chain Performance. The validity of convergence can not only be seen through the loading factor, but also known through the Average Variance Extracted (AVE). An instrument is said to meet the convergent validity test if it has an Average Variance Extracted (AVE) above 0.5. The results of the presented convergent validity test in the participating table:

Table 5. Convergent Validity Test Results

Variable	AVE
E-Farming Implementation	0,642
Supply Chain Performance	0,741

Source: data processed from the results of the 2022 questionnaire

Based on the table, it can be seen that the variableE-F arming and Supply Chain Performance resulted in an Average Variance Extracted (AVE) value greater than 0.5. Thus, the indicators measuring the E-F arming and Supply Chain Performance variables are declared reliable. The test criteria state that if composite reliability is greater than 0.7 and Cronbach's alpha is greater than 0.6 then the construct is said to be reliable. The results of the calculation of composite reliability and cronbach alpha can be seen through the summary which is presented in the following table:

Calculation *composite reliability* dan*cronbach alpha result* can be seen through the summary presented in the following table:

Table 6. Calculation Results of *Cronbach's Alpha* and *Composite Reliability*

Variable	Cronbach's Alpha	Composite *Reliability*
E-Farming Implementation	0.949	0.955
Supply Chain Performance	0.971	0.974

Source: data processed from the results of the 2022 questionnaire

Based on the table above, it can be seen that the composite reliability value on the E-Farming implementation and Supply Chain Performance variables is greater than 0.7. Thus, based on the calculation of composite reliability, all indicators that measure the E-Farming Implementation and Supply Chain Performance

variables are declared reliable. Furthermore, the Cronbach Alpha value on the E-farming Implementation and Supply Chain Performance variables is greater than 0.6. Thus, based on the Cronbach Alpha calculation, all indicators measuring the E-Farming Implementation and Supply Chain Performance variables are declared reliable.

Goodness of fit Model used to determine the magnitude of the variable ability to exogenous explains the diversity of endogenous variables, or in other words to know the magnitude of the contribution of exogenous variables to endogenous variables. The goodness of fit model in the PLS analysis is laid out using the coefficient of determination (R-S quare) and Q-Square predictive relevance (Q2). The results of the goodness of fit model are summarized in the following table.

Table 7. Summary Results of *Goodness of fit model*

Variabel	R Square	R Square Adjusted
Supply Chain Performance	0.814	0.813

Source: data processed from the results of the 2022 questionnaire

The R-square of Supply Chain Performance is 0.814 or 81.4%. This can be pointed out that the diversity of Supply Chain Performance capable of explained by E-Farming Implementation is 81.4%, or in other words the contribution of E-Farming Implementation to Supply Chain Performance is 81.4%, while the remaining 18.6% is the contribution of other factors that not discussed in this study. Direct influence hypothesis testing is used to test whether or not there is a direct influence of exogenous variables on endogenous variables. The test criteria state that if the path coefficient is positive and the p values value the level of significance (alpha = 5%) then it is stated that there is a positive and significant influence of the exogenous variable on the endogenous variable. The results of hypothesis testing can be known through the following table:

Table 7. Summary of Hypothesis Testing Results

	Original Sample (O)	Sample Average (M)	Standar Deviasi (STDEV)	T Statistik (|O/STDEV|)	P Values
EF_Implementation -> Automation	0.918	0.919	0.010	92.633	0.000
EF_Implementation -> Decition	0.922	0.922	0.010	95.190	0.000
EF_Implementation -> IOT	0.940	0.940	0.008	120.324	0.000
EF_Implementation -> Monitoring	0.904	0.904	0.013	69.017	0.000
EF_Implementation -> SC_Performance	0.902	0.902	0.020	45.221	0.000
SC_Performance -> Kapasitas	0.933	0.933	0.010	89.793	0.000
SC_Performance -> Manfaat	0.965	0.965	0.005	190.471	0.000
SC_Performance -> Produktivitas	0.947	0.948	0.008	114.180	0.000
SC_Performance -> Waktu	0.947	0.948	0.009	103.601	0.000

Source: data processed from the results of the 2022 questionnaire

From the above results, it shows that all paths are positive and significantly marked with T-Statistics > 1.96 and P-Values < 0.05. As for hypothesis testing, then the results can be explained as follows:

Hypo thesis	Description	Estimate	T Test	1-Tailed P	Conclusion
H$_1$	E-FarmingImplementation has a positive influence on Supply Chain Performance	0,902	45,22	0,000	**H1 Accepted (Significant)**

Based on the summary table of hypothesis testing above, the results can be explained as follows:
H1: *E-Farming Implementation* has a positive and significant effect on *Supply Chain Performance.*This can be proven by the value of the Effect of *E-Farming Implementation* on *Supply Chain Performance* resulting in a t-test regression coefficient of 45.22 while the table-t of 1,966 for N=352 with a p values of 0.000. The results of the test showed that the coefficient was positive because t statistically > t of the table and the value of p value <*the level of significance* (alpha = 5%). This means that in this study *E-Farming Implementation* has a positive and significant effect on *Supply Chain Performance*. This study is in accordance with previous researchers Putri et al., (2019), with the results of the study showing that a positive influence on supply chain practice on competitive advantages and supply chain performance. This research is supported by according to Georgr J. et al., (2018) where management decisions influenced by supply chain structure, availability and policies have a positive effect on supply chain performance. The results of this study support previous research conducted by Munizu M., (2017) which stated that better

information technology can encourage increasing supply chain performance, IT implementation in general is believed to be the main factor and become a necessity in optimizing supply chain performance.

V.   CONCLUSIONS

Based on the phenomenon, problem formulation, hypothesis, research results and discussion, the following conclusions can be drawn: There is a positive and significant influence of *E-Farming Implementation* on *Supply Chain Performance*. This means that to improve *Supply Chain Performance* is necessary to increase the role of *E-Framing Implementation* technology, especially if application *tools* can be developed to improve the effectiveness of the company's business processes.

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