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The Effect of Socio-Economic Factors and Crop Cultivation Techniques on the Increase in Shallot Plant Productivity Using SEM Method

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Abstract:- The success of farmers in obtaining productive yields of shallot plants from stable and adaptive superior varieties plays a crucial role in increasing plant productivity. Technological innovations are conducted by examining the Socio-Economic Factors and Technical Factors of Shallot Plant Cultivation. However, merely considering the Socio-Economic Aspects and Technical Cultivation Factors (TCF) of shallot plants is insufficient in selecting stable and adaptive superior varieties. Hence, this research combined the Analysis of Moment Structure (AMOS) method and SEM (Structural Equation Modeling). Through SEM-AMOS, the modeling of socioeconomic factors and Crop Cultivation Techniques was conducted while considering the physiological processes of growth and development of genotypes, which explained the interrelation of Socio-Economic Factors and Crop Cultivation Techniques (CCT) with yield components and their effect on the Increase in Shallot Plant Productivity. The results of the AMOS Modeling. If the Probability value (P) > 0.05, then H0 is accepted, and H_1 is rejected; if the Probability value (P) < 0.05, then H_0 is rejected, and H_1 is accepted.

Cultivation of Shallot Plants - Socio-Economic Aspect: It was observed that the P-value was 0.094, which is < 0.05. This value is significantly lower than 0.05; therefore, H_1 is accepted. Hence, it can be said that socio-economic factors have a positive and significant effect on the cultivation of shallot plants.

Cultivation of Shallot Plants - Crop Cultivation Techniques: It was observed that the P-value was 0.019, which is < 0.05. This value is significantly lower than 0.05; therefore, H_1 is accepted. Hence, it can be said that there is a positive and significant effect of Crop Cultivation Techniques on Shallot Plants.

Keywords:- *AMOS, Shallot, Socio-Economic Factors, Crop Cultivation Techniques, SEM.*

I. INTRODUCTION

The increasing demand for shallots is accompanied by the growth in population and purchasing power. From 2011 to 2015, the national consumption growth rate of shallots was 3.30% annually. It must be balanced with the production quantity to ensure the demand is consistently met. The availability of quality and sustainable seeds is one of the determining factors for the success of shallot farming (Arsanti and Böhme, 2013;

Hardana et al., 2019). Farmers still use shallot bulbs from previous plantings that have been set aside. Using such bulb seeds often reduces the yield because the quality of bulb seeds is not guaranteed. Pathogenic diseases such as Fusarium sp., Colletotrichum sp., Alternaria sp., and viruses from previous plants are often carried by bulb seeds (Hadiwiyono, Sari, and Poromarto, 2020; Hindarti and Maula, 2020). Central Sulawesi is one of Indonesia's provinces with great agricultural potential. This potential is supported by good soil fertility, availability of groundwater and rainfall, and suitable climate conditions. One of the agribusiness commodities (Mujiyo et al., 2022; Serrani et al., 2022) cultivated in Central Sulawesi is shallot, a leading horticultural commodity in the region. Central Sulawesi, especially in Sigi Regency, has a considerable land potential, amounting to 84,175 hectares, with 109.32 thousand hectares of dry land, a potential shallot development area [3]. This indicates the significant opportunities for shallot farmers to increase shallot production to meet the demand and consumption needs (Amiri et al., 2021; Swamy and Veere Gowda, 2006).

Shallot (Allium ascalonicum L) is a horticultural crop commodity with high economic value and is widely consumed by humans as a cooking spice alongside chili. (Lawande, 2001; Wahyudin, Maksum, and Yuliando, 2015) Shallots are also sold in processed forms such as shallot extract, powder, essential oil, fried shallots, and as ingredients in medicines to lower cholesterol levels and blood sugar, prevent blood clotting, reduce blood pressure, and improve blood circulation. As a horticultural commodity widely consumed by the community, the potential for shallot development is still wide open not only for domestic needs but also for international markets (Ogra et al., 2005; Setyadjit and Sukasih, 2015).

The Napu Plain, divided into three districts, is a dominant vegetable-producing area in the Poso Regency, covering Lore Utara, Lore Tengan, and Lore Timur. The predominant types of vegetables produced include shallots, chili, potatoes, cabbage, Chinese cabbage, and other types of vegetables, with productivity ranging from 0.402 to 56.626

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Kw per year (BPS Poso Regency, 2019). The vegetable production from these three districts is the leading supplier for vegetable needs in Central Sulawesi province.

Research on the Effect of Socio-Economic Factors and Crop Cultivation Techniques on Shallot Plants. This study used SEM-AMOS analysis on shallot plants, considering various aspects from site selection to post-harvest (Dash and Paul, 2021; Jain and Raj, 2016). Additionally, this research also analyzed the factors influencing production in shallot plants (Firmansyah and Bhermana, 2019; Triyono et al., 2021)

Below is the graph showing shallot farmers' responses to Socio-Economic Factors and Crop Cultivation Techniques in the Napu Valley area, as shown in Figure 1.

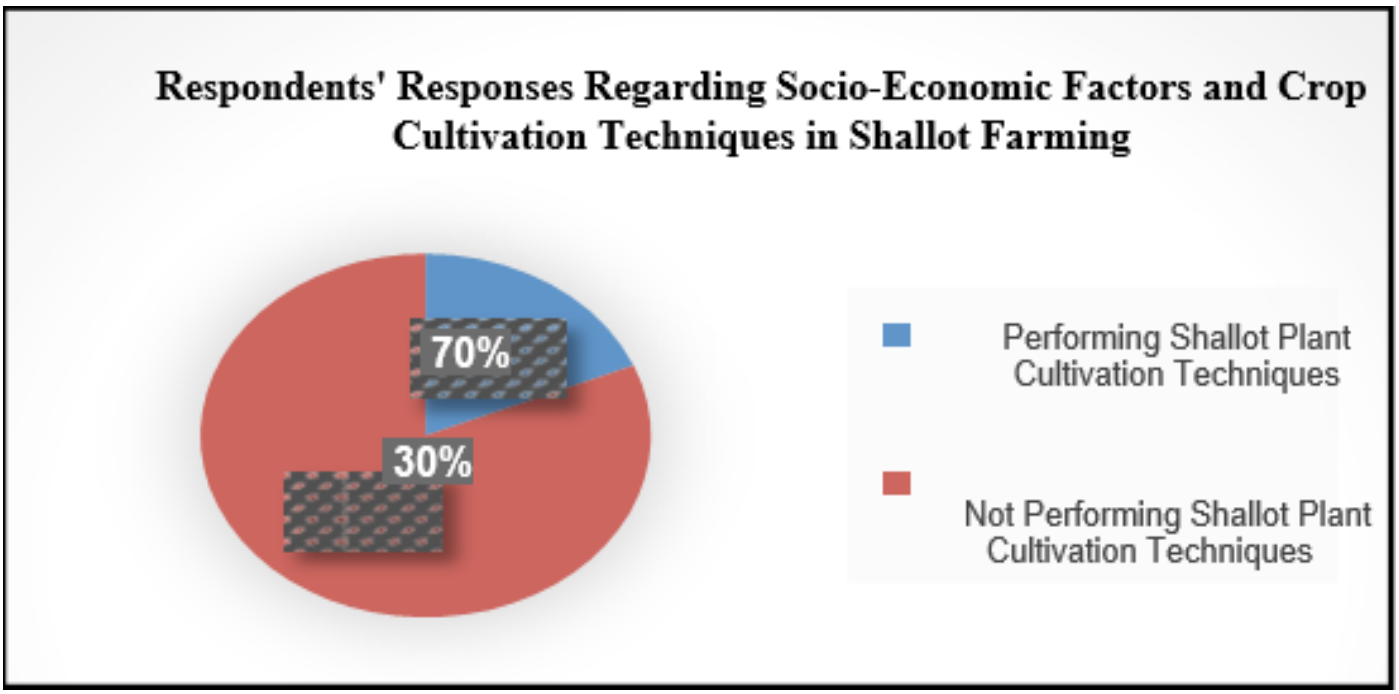

Fig 1 Respondents' Responses Regarding Socio-Economic Factors and Crop Cultivation Techniques in Shallot Farming
Source: Software Excel, 2022

Figure .1 shows that out of 250 respondents, 105 farmers (40%) do not practice Vegetable Plant Cultivation Techniques (BTS). This indicates that the majority of shallot farmers in the Napu Valley area have not implemented Shallot Plant Cultivation Techniques.

This study aims to determine the effect of Socio-Economic Factors of Farmers and Shallot Plant Cultivation Techniques on Shallot Vegetable Plants in the Napu Valley area, Poso Regency.

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II. RESEARCH METHODOLOGY

➢ *Research methodology refers to the steps taken in conducting research. The stages can be seen in Figure 2.*

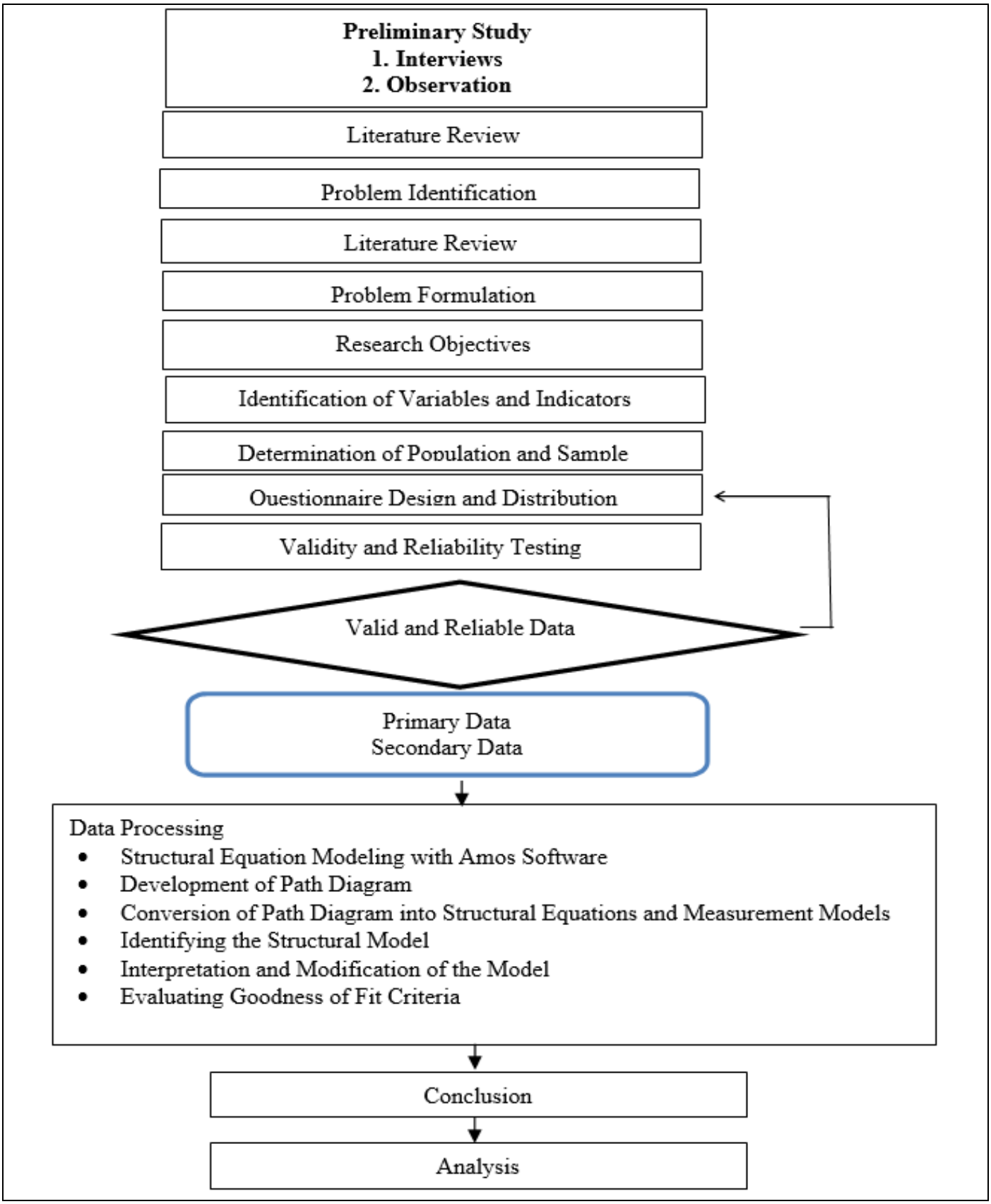

Fig 2 Research Flowchart

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III. RESULTS AND DISCUSSION

➢ *Development of Path Diagram*

The theoretical model that has been developed is then depicted in a path diagram to facilitate researchers in observing the causal relationships they want to test. A path diagram is a visual representation of a model that illustrates all the relationships between the variables within it. The development of the Path Diagram can be seen in the following figure:

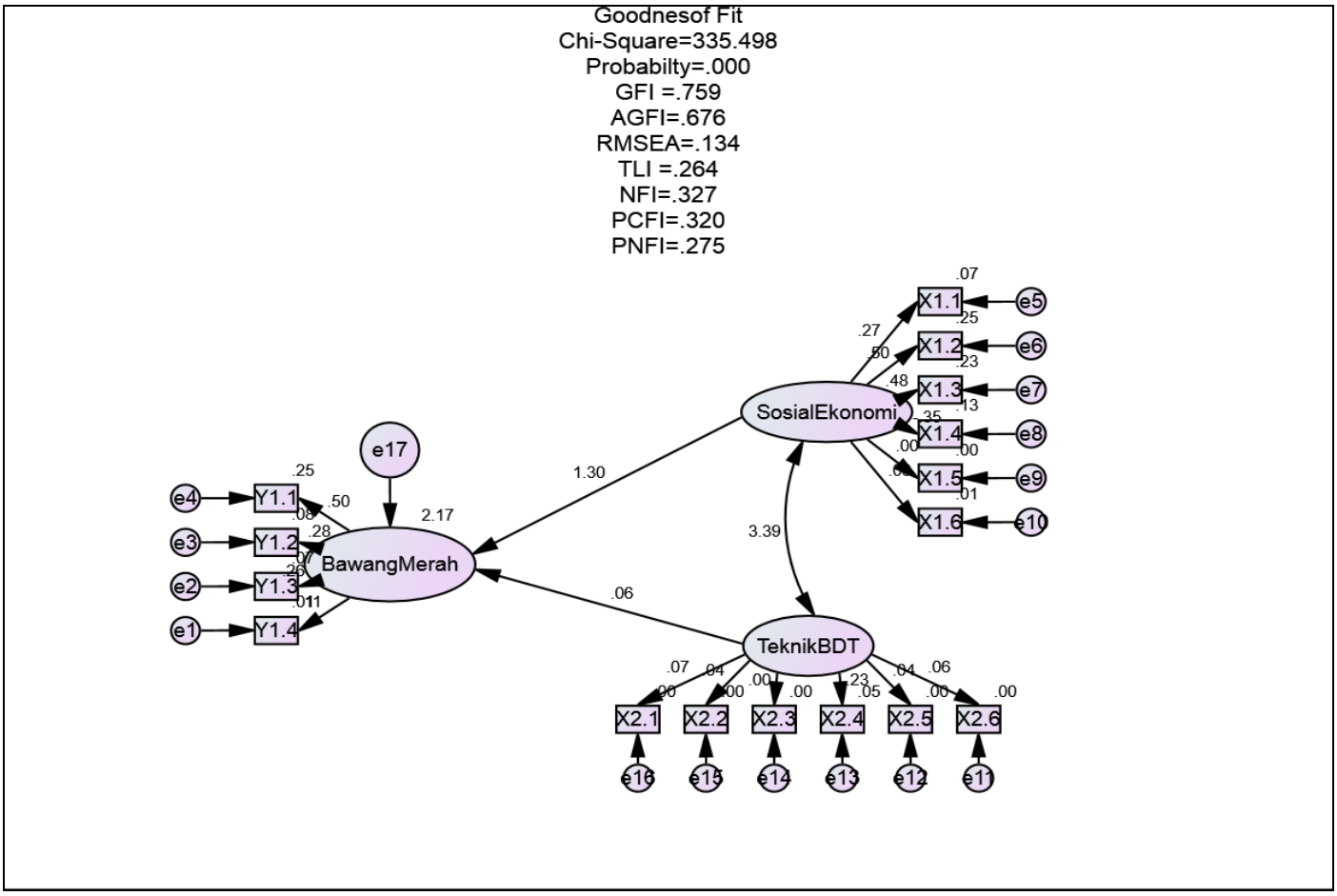

Fig 3 Development of Path Diagram

Note: relationship Socio-Economic; = Shallot Plant; = Cultivation

➢ *Conversion of Path Diagram into Structural Equations and Measurement Models*

- *Structural Equations*

The structural equation in this study is:

Vegetable Plant Yield = β1 Natural Factors + β2 Crop Cultivation Techniques + β3 Vegetable Plants + Z1

- *Measurement Model*

The Measurement Model in this study is Table 1 Measurement Model for Exogenous Concepts (Socio-Economic)

Table 1 Continuation of Measurement Model for Exogenous Concepts (Socio-Economic Factors)

Exogenous Concept
X1 = λ1 Socio-Economic Factor + e1
X2 = λ2 Socio-Economic Factor + e2
X3 = λ3 Socio-Economic Factor + e3
X4 = λ4 Socio-Economic Factor + e4
X5 = λ5 Socio-Economic Factor + e5
X6 = λ6 Socio-Economic Factor + e6

(Source: Data Processing, 2023)

Table 2 Measurement Model for Exogenous Concepts (Crop Cultivation Techniques)

Exogenous Concept
X1 = λ1Crop Cultivation Techniques + e7
X2 = λ2 Crop Cultivation Techniques + e8
X3 = λ3 Crop Cultivation Techniques + e9
X4 = λ4 Crop Cultivation Techniques + e10
X5 = λ5 Crop Cultivation Techniques + e11
X6 = λ6 Crop Cultivation Techniques + e12

(Source: Data Processing, 2023)

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- *Below is the Table of Measurement for the Endogenous Concept (Shallot Plant Productivity):*

Table 3 Measurement Model for Endogenous Concept (Shallot Plant Productivity)

Exogenous Concept
Y1 = λ1 Shallot Plant + e13
Y2 = λ2 Shallot Plant + e14
Y3 = λ3 Shallot Plant + e15
Y4 = λ4 Shallot Plant + e16

(Source: Data Processing, 2023)

Table 4 Initial Model Degrees of Freedom Value. Since the Degree of Freedom value is Positive, the model is Overidentified, and Testing on the Model can be Conducted

Number of distinct sample moments:	136
Number of distinct parameters to be estimated:	62
Degrees of freedom (136 - 62):	74

➢ *Interpreting and Modifying the Model*

The modification of the model aims to see if the changes made can reduce the chi-square value, as we know that a smaller chi-square value indicates a better fit of the model to the available data. An indicator shows significant convergent validity if it has a critical ratio value of >2. This indicates that the indicators used validly measure what should be measured in the model (Mahieu et al., 2021; Peker and Kubat, 2021).

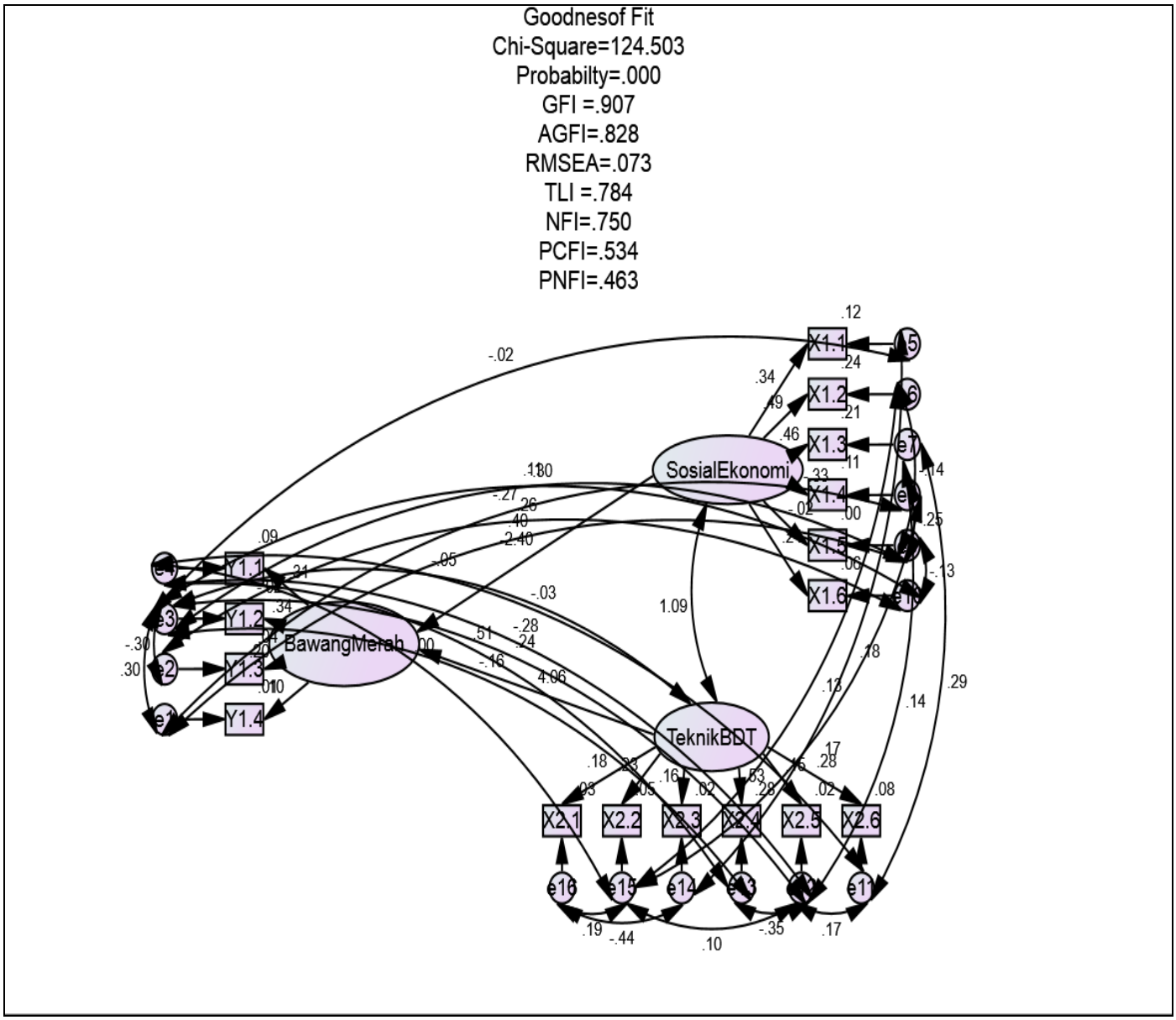

Fig 4 SEM Model After Modification. Figure 4 shows the SEM model after modification. It can be seen that the chi-square value after modification is 124.503, while the chi-square value before modification is 975.456. This means that the chi-square value after modification is smaller or decreased compared to before.

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Table 5 Regression Weights after Modification of the Results Regression Weights As in Fig 4. Above,it can be seen that all Indicators are Significant, Marked as scuh Critical ratio >2 and P < 0,005.

			Estimate	S.E.	C.R.	P	Label
Socio-Economic	<-->	CropCultivationTechniques	.031	.018	1.675	.094	par_16
e15	<-->	e16	.027	.012	2.345	.019	par_17
e14	<-->	e16	-.017	.004	-4.605	***	par_18
e12	<-->	e15	.033	.025	1.308	.191	par_19
e12	<-->	e13	-.114	.036	-3.149	.002	par_20
e11	<-->	e12	.125	.068	1.836	.066	par_21
e9	<-->	e10	-.042	.027	-1.526	.127	par_22
e8	<-->	e15	.022	.012	1.879	.060	par_23
e8	<-->	e9	-.055	.021	-2.620	***	par_24
e7	<-->	e12	.057	.042	1.369	.171	par_25
e7	<-->	e11	.084	.034	2.464	.014	par_26
e6	<-->	e15	.025	.019	1.290	.197	par_27
e6	<-->	e9	-.046	.032	-1.469	.142	par_28
e5	<-->	e14	.006	.003	2.037	.042	par_29
e4	<-->	e15	.000	.008	.012	.990	par_30
e4	<-->	e13	.061	.017	3.635	***	par_31
e4	<-->	e12	-.103	.036	-2.906	.004	par_32
e4	<-->	e11	-.009	.019	-.461	.645	par_33
e3	<-->	CropCultivationTechniques	-.005	.011	-.454	.650	par_34
e3	<-->	e13	-.026	.018	-1.490	.136	par_35
e3	<-->	e12	.124	.042	2.938	.003	par_36
e3	<-->	e10	-.092	.028	-3.316	***	par_37
e3	<-->	e9	.029	.025	1.176	.240	par_38
e3	<-->	e5	-.005	.017	-.274	.784	par_39
e2	<-->	e10	.075	.028	2.722	.006	par_40
e2	<-->	e3	-.072	.024	-2.986	.003	par_41
e1	<-->	e9	.153	.036	4.290	***	par_42
e1	<-->	e8	-.080	.026	-3.106	.002	par_43
e1	<-->	e3	.106	.029	3.657	***	par_44

➢ *Evaluation of Goodness of Fit Criteria*

The evaluation of the model is conducted through suitability and statistical tests, as well as reliability tests. Suitability and statistical tests are performed using several Fit Indexes to measure the accuracy of the proposed model (Althoff and Rodrigues, 2021; Zárate-Contreras et al., 2022). The evaluation results of each modified model are compared to the statistical boundaries set in the SEM procedure (Ndoung, Figueiredo, and Ramos, 2021; Jain and Raj, 2016). The results of the Goodness of Fit Indexes test in this study are as follows:

➢ *Results of Structural Equation Modeling (SEM) Testing*

Hypothesis testing is conducted to determine whether exogenous variables affect endogenous variables or not. This hypothesis can be accepted if the probability value is P < 0.05 and the Critical Ratio (CR) value is > 1.96. Table 4.6 shows Regression Weights Estimates using AMOS 20 Software

Table 6 Results of Structural Equation Modeling (SEM) Testing

	C.R	P
Crop Cultivation Techniques of Shallot Plants – Socio-Economic Factors	1,675	.094
Crop Cultivation Techniques of Shallot Plants – Crop Cultivation Techniques	2,345	.019

(Source: Primary Data Processing, 2023)

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➢ *Decision Basis:*

If the Probability value (P) > 0.05, then H_0 is accepted and H_1 is rejected. If the Probability value (P) < 0.05, then H_0 is rejected and H_1 is accepted.

➢ *Based on Table 4.5, the results of Hypothesis Testing are as follows:*

- *Crop Cultivation Techniques of Shallot Plants* –

Socio-Economic Factors: The Probability value (P) is 0.001 < 0.05. This value is significantly below 0.05. Therefore, H_1 is accepted. It can be concluded that socio-economic factors have a positive and significant effect on the cultivation techniques of shallot plants.

- *Crop Cultivation Techniques of Shallot Plants* –

Crop Cultivation Techniques: The Probability value (P) is 0.000 < 0.05. This value is significantly below 0.05. Therefore, H_1 is accepted. It can be concluded that there is a positive and significant effect of Crop Cultivation Techniques on Shallot Plants.

➢ *Analysis of Model Development Based on Theory*

The model development based on theory aims to examine the theoretical relationships between existing variables. In this study, four variables with 20 indicators were obtained, where each variable has six indicators for Input Variable 1 (Socio-Economic), six indicators for Input Variable 2 (Crop Cultivation Techniques), and four indicators for Output Variable (Shallot Plants). Although, in reality, many factors affect these variables and indicators, it is expected that the existing factors can represent the actual conditions.

➢ *Analysis of Path Diagram Development*

After connecting between independent variables and dependent variables, the causal relationships between each variable to other variables and indicators to construct variables can be observed. Each construct or indicator is assigned an error value, where the assignment of error values aims to provide tolerance for possible errors that may occur. These errors or deviations may be caused by indicators that have not been able to represent and reflect the actual conditions in the field.

The model has many "1" numbers, which will appear automatically when adding an error variable. Thus, all error variables will be assigned the parameter values that have been determined or called fixed parameters, namely 1.

➢ *Analysis of Converting Path Diagram into Structural Equations and Measurement Model*

- *Structural Equation*

The Crop Cultivation Techniques Equation (BTS) = β1 Socio-Economic + β2 Crop Cultivation Techniques + β3 Shallot Plant Production + Z1 is a structural equation variable, where in its process, the values of β1 and β2 are constants from the Natural Factor and Farmer Performance variables will constantly affect the Crop Cultivation Techniques of Vegetables variable. Also, the assignment of error values will affect the results to be obtained later. However, the assignment of error values is only a precautionary step or tolerance if there is a deviation or error, as mentioned in the previous points.

- *Measurement Model Equation*

The purpose of the measurement model equation is to assess the extent of the relationship between variables and their respective indicators, which will be observed based on their output. For example, equation X1 = λ1 Socio-Economic + e9, where this equation represents the relationship between the Socio-Economic variable (input1). The magnitude of the λ value in the equation will also affect the decisions to be made, and it is necessary to determine how this relationship value should proceed through several stages.

➢ *Analysis of Interpretation and Model Modification*

Model modification is performed by connecting error levels according to the instructions from the AMOS software output. Model modification is made to facilitate adjustments to the Modification indices. Its function is to make it easier to modify the SEM model so that it can be adjusted to the SEM model that has been previously created. For example, e15 is connected to e9; therefore, the chi-square value in the SEM model can be reduced after modification. After modification, the chi-square value decreases by 487.037 from 975.458, meaning that the chi-square value after modification is smaller or reduced compared to before.

Based on the modified Regression Weights output, all indicators are already categorized as valid or significant, so it can be concluded that the significant indicators mean that respondents understand and comprehend the statements presented in the questionnaire.

➢ *Analysis of Goodness of Fit Criteria*

This analysis of goodness of fit criteria will be conducted on the chi-square value, probability, degrees of freedom (df), CMIN/DF, GFI, TLI, IFI, RMSEA, and NFI. The chi-square value is a measure that describes the level or condition of the research being conducted. All the test results show a good fit because most of the fit tests indicate that the model fits. Therefore, it can be concluded that the model used in this research can be the basis for analyzing the issues in this study.

IV. CONCLUSION

➢ *Based on the Research and Data Processing Results, the following Conclusions can be drawn:*

- For the variable X, Socio-Economic Factors have a very significant relationship with Shallot Plant Cultivation in the Napu Valley area. These Socio-Economic Factors provide positive value and have a significant opportunity to affect the results of Shallot Plant Cultivation in the surrounding area. Therefore, Shallot Farmers should always utilize their income and

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capital to develop these cultivation techniques. By purchasing quality superior seeds available at agricultural stores, they can enhance the production yield of Shallots they obtain, compared to before.

- The variable Cultivation Techniques (TBT) has a very significant relationship with Shallot Plant Cultivation in Napu Valley. The Cultivation Techniques variable provides a positive value and has a very high chance of adding value to Shallot Plant Cultivation in the Napu Valley. This is because farmers engage in good land processing, utilize both organic and inorganic fertilization to increase shallot plant production, and consistently evaluate the plants every week to observe the growth rate of shallot plants.

- Improvement design in this research aims to provide good suggestions to enhance the participation and interest of Shallot Plant farmers in implementing Shallot Plant Cultivation Techniques. The proposed improvement design for farmers in the Napu Valley area, as suggested by the researchers for Shallot Plant Cultivation in the Napu Valley area, is as follows:

✓ Shallot farmers utilize their available capital to purchase high-quality seeds, thereby enhancing the production of shallot plants. Capital is one of the supporting factors for success in farming.
✓ Implementing advanced care for shallot plants, including weeding the planting area before the first and second fertilization processes, controlling pests, and using pesticides according to recommended doses and volumes.
✓ Each shallot farmer utilizes personal capital sources to obtain the best quality seeds and regularly checks shallot plants to ensure that the results correspond to the quality of the seeds and the cultivation techniques applied, which often yield results in the shallot plants.

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