The Performance Index Model of Farmers' Association for Water Users

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ABSTRACT

This research intends to build the performance index model of farmers' association for water users (P3A). This research is conducted in Malang Regency that is in 10 irrigation areas which have the institutions of water users' farmers' association (P3A). The research object is assessment of performance index on the P3A (farmers' association for water users) institutions at irrigation areas in Malang Regency. The field study is carried out in Malang Regency by carrying out the direct observation to the available problems. The 10 irrigation areas consist of Sido Makmur, Sumber Makmur, Makmur Gelanggang, Gemah Ripah, Tirta Tani, Dewi Ratih, Pasir Jaya, Langgeng, Rukun Tani, and Tani Rasa. The methodology consists of literatures collecting and data analysis, SEM-PLS method for determining the factors that are influencing the performance index, and GRG method for building the performance index model. Data that are used in this research is secondary data that are influencing the institutions of water users' farmers' association (P3A) in Malang Regency. Based on the analysis, the result of the performance index model of water users' farmers' association (P3A) is as follows: 17.9% X1 (organization) + 33.6% X2 (funding) + 26.5% X3 (planning) + 22.0% X4 (implementation) due to the NSE = 0.74 that means the model validation is good.

Keywords: Performance Index, Model, Farmers' Association for Water Users (P3A), SEM-PLS, GRG

INTRODUCTION

According to Pramulia in Sigit (2014), farmers' association for water users (P3A) is an institution that is grown by farmers and the farmers obtain the direct benefit from the water management (Hayatuddin et.al, 2025; Alaerts, 2020; Rolbiecki et.al, 2019) on the irrigation network, surface water, small dam/ dam, ditch, and groundwater including livestock, plantation, and horticulture farmer groups that utilize the irrigation water/ shallow groundwater/ surface water and water as the result of conservation/ small dam (Andayani et.al, 2023; Rudnick et.al, 2020). The P3A is formed by the aim to increase the prosperity of members with focusing on the water management and irrigation system (Polomski and Wiatkowski, 2025; Langoswski, 2025) in the tertiary irrigation for irrigated agriculture rice field. The authority includes the management of tertiary irrigation network, the development of independent solution for the problem that is related with irrigation water (Abbasi, 2021; Hakim et.al, 2022; and makes sure the availability of irrigation water (Ahyadi et.al, 2018; Biro et.al, 2020).

In the irrigated agriculture area, the existence of good irrigation network becomes as one of the important factors (Nawiyanto et.al, 2024; Rudnick and Wisniewski, 2021) in determining the success of agriculture cultivation (Jabar and Ati, 2025; Yuldashev et.al, 2020; Cabezas Burbano et.al, 2024). At this time, the condition of irrigation network in Indonesia is about ±50% experience the damage due to the limitation of government human resources that carry out the activities of operation and maintenance (OM) and rehabilitation of irrigation network (Idris et.al, 2019). The existences of participation and collaboration are as the proof of attendance the human resource's role

on the irrigation network management. The active role of P3A is a reference in the operation and maintenance activity of irrigation that is carried out together (Nasri et.al, 2022). On the contrary, if the participation of P3A on the irrigation network has not been formed, the maintenance of irrigation network is only carried out by operation and maintenance staff (Muharni et.al, 2018).

The P3A is hoped to be able to increase the irrigation management that will give the positive impact in the planting productivity (Putri et.al, 2020), the existence of farmers society institution in Malang Regency in the function implementation of the irrigation system management that is not completely and perfectly implemented even very less in order the condition of technical irrigation that is beginning from weir, the main channel as primary, secondary, and tertiary channel. Sulaeni et.al (2023) expressed that participation is a society involving form in the process of irrigation network management (maintenance, operation, and rehabilitation) that is started from planning, implementation, utilization, and maintenance based on the consciousness itself (in accordance with the rights and obligations) and it is not influenced by the other parties. In addition, participation in this context is seen as an effort to decrease the conflict in managing the irrigation network. The participation will support the government effort through the rehabilitation activity effort of physical infrastructure for maintaining the value of IKSI so it is not far decreasing (Cindy et.al, 2022). The collaboration and participation of P3A can be seen in the activity of routine or periodically maintenance like weed removal in the channel and channel border, and also garbage cleanup in the channel, sediment normalization in the channel, maintenance of water gate etc.

Listiani (2011) explained that in the public sector, the service that is given by organization can be compared with the standard that has been determined and can be as the benchmarks of the best commitment to society mainly the organization of the farmers' association of water users (P3A) in the irrigation managers group (KPI). The method for evaluating the performance that is produced by an organization can be used as a tool. One of them that can be used for measuring the level of organization success in implementing the performance is Balanced Score (BSc) concept. The BSc is different with conventional assessment instrument that only measures the performance of financial aspect. Through BSc, the organization performance is measured through four perspectives that are financial, internal business process, customer, learning and growth.

Related with the performance that is produced by an organization, there is a factor that influences such as the performance of management. Management performance is an organization effort for increasing the sustainable individual and team performances for achieving the aim. According to Armstrong and Baron (1998), management performance is influenced by the factors of individual, leadership, team, system, and situational. Basically, the individual factors like skill, knowledge, behavior, and willingness are often as the reference of someone success for achievement in their work. However, in real, there are still many other factors that influence someone performance in an organization. According to Armstrong and Baron (1998), besides skill, knowledge, and ability, the others performance of determination factors are leadership, team, system, and contextual/ situational. Through the approach of management performance, the efforts of performance management can be better carried out.

The system control of irrigation network operation is started from the main structure of weir and the other completion structures like water gate and channel that is one of the factors which influences the institution performance of P3A (farmers' association of water users) in Malang Regency that is carried out through consensus model which does not give the accurate result and not responsible, so it is needed a performance index model based on the scientific study (ranking) (May, 2025 and Kholida et.al, 2025) as a role model that intends as part of irrigation system performance index in supporting the modernization of irrigation. The performance index model in this research is a dynamics model and can be developed in accordance with the developments of civilization and social degree of society.

Based on the discussion above, this research has a target to build the performance index model as a role model (Pentewati et.al, 2024; Sudiarti et.al, 2024; Trimartinni et.al, 2025) with some variables and indicators that are more appropriate with the real condition of P3A (farmers' association of water users) institution such as on the aspect of organization administrative, funding aspect of some factors that are getting developed, and aspects of facility and infrastructure in irrigation network and management.

MATERIALS AND METHODS

Research Location

This research is conducted in the irrigation area on P3A (farmers' association for water users) institutions that are spreading in Malang Regency. The research object is assessment of performance index on the P3A (farmers' association for water users) institutions at irrigation area in Malang Regency (Figure 1). The field study is carried out in Malang Regency by carrying out the direct observation to the available problems. In addition, the literature study is also carried out for obtaining the information that is related with the research topic.
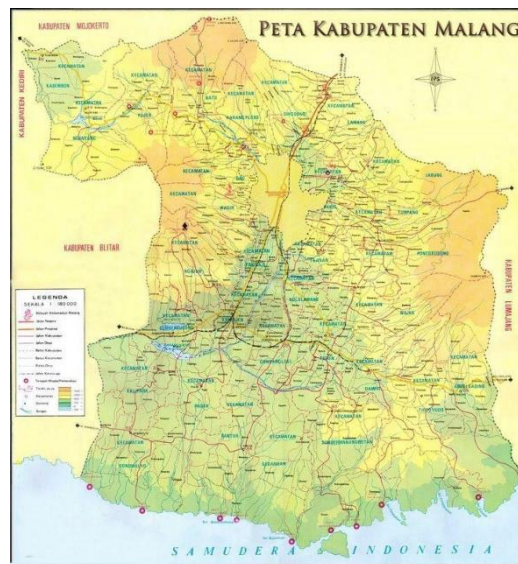
Figure 1 Administration Map of Malang Regency (Fauzi et.al, 2025)

However, the names of farmers' association of water users (P3A) that are as the research objects are spreading di some Malang Regency areas as follows:

1. Budi Daya, Tawang Argo Village, Karangposo District, in the Irrigation Area of Sumber Tlebung with the area is 34 ha.
2. Sumber Makmur, Banjarsari Village, Ngajum District, in the Irrigation Area of Sumber Wedus with the area is 106 ha.
3. Makmur Glanggang, Glanggang Village, Pakisaji District, in the Irrigation Area of Sumber Wedus with the area is 128 ha.
4. Gemah Ripah, Ngantru Village, Ngantang District, in the irrigation area of Banu with the area is 85 ha.
5. Tirta Tani, Pandanrejo Village, Pagak District, in the irrigation area of Pandanrejo with the area is 117 ha.
6. Dewi Ratih, Sukoanyar Village, Pakis District, in the irrigation area of Tumpang with the area is 191 ha.
7. Pasir Jaya, Sumberpasir Village, Pakis District, in the irrigation area of Sumber Pasir with the area is 90 ha.
8. Langgeng, Ngebruk Village, Poncokusumo District, in the irrigation area of Sumber Pring with the area is 128 ha.
9. Rukun Tani, Ngroto Village, Pujon District, in the Irrigation Area of Ngroto with the area is 56 ha.

Methodology

The methodology consists of literature collecting and data analysis. Secondary data are used in this research that are influenced the performance of the farmer society of water users' farmers' association in Malang Regency. This process uses the SEM-PLS method that works to make easy in screening the variables until the sub-indicators. The re-establishment system of performance index variables by using SEM-PLS method has several stages process for obtaining the recommendation result of the best alternative, in this case is determination of new variables in the evaluation of performance index. The first stage is to determine the criteria that are used in determining the performance index variables. The criteria that are used is based on the combination of the Ministry Rule of General Work and Public Housing No 12 (2015) about exploitation and maintenance of irrigation network and Directorate of Regional Structure (2022) about the aspects of institution, technical (irrigation and agriculture), financial, and economy.

Farmers Association of Water Users (P3A)

P3A (Farmers Association of Water Users) is an organization for water users' farmers in a service area/ tertiary plot or village that is democratically formed by water users' farmers including local institution of irrigation management (Ministry Rule of General Work and Public Housing No. 30/PRT/M/2015). The formation of P3A institution is intended to utilize and manage the irrigation water potency according to agreement of irrigation management members to realize the farmer society prosperity. P3A has the boundary of work area that is tertiary plot, pump irrigation area, and village irrigation area. P3A is a social activity that is formed on the principle of mutual cooperation and it is completed by articles of association and by laws. The main responsibility of P3A organization is to carry out the operation and maintenance the irrigation network in tertiary plot. In addition is also to discuss the problem about irrigation water management, to determine and to implement the rules in the

tertiary plot based on the deliberation (Anonymous, 2019). All of activities that are implemented by P3A for water utilization, maintenance, improvement of irrigation network as well as the other activities are funded by the P3A. The funding source of P3A consists of member fee, contribution and the others.

Partial Least Square (PLS)

Ghozali and Latan in Kurniawan (2021) expressed that Partial Least Square (PLS) is a powerful analysis method and also mentioned as soft modeling because it negates the assumptions on the technical of Ordinary Least Square (OLS) like distribution and residual that must not multivariate normal distributed. In addition, in the PLS samples must not be big, the measurement scale is categorical, interval and ordinal can be used in the same model. In addition, Esteves et.al in Kurniawan (2021) also explained whether there is a relationship or not between latent variables (predictions). However, the PLS can also be used for confirming a theory.

Ghozali and Latan in Kurniawan (2021) explained the analysis in SEM-PLS that included measurement model or outer model, structural model, or inner model and weight relation which the value of latent variable can be estimated. The method of estimation or parameter estimation in PLS uses the least square methods, so the identification model is no problem for the recursive model (has one way causality) and to avoid the non-recursive model or reciprocal between variables. Henseler et.al in Kurniawan (2021) explained the analysis process by iteration which the iteration will be stopped if it has been achieved the convergent condition.

RESULTS AND DISCUSSION

Identification of Initial Model

The initial model describes the relation between organization, funding, planning, and implementation to the performance. The performance in this initial model is the performance score based on the Ministry Rule of General Work and Public Housing No 30/PRT/M/2015 that consists of four components that are organization (institution), facility and infrastructure of irrigation, infrastructure of agriculture, and funding. This initial model will be analyzed into two models that are reflective and formative outer models.

Development Model of Performance Index

Figure 2 presents the development model of performance index. The performance index equation is as follows: 0.247 organizations + 0.412 funding + 0.346 planning + 0.339 implementation with $R^2 = 0.994$. Table 1 presents the path coefficient of performance index development model.
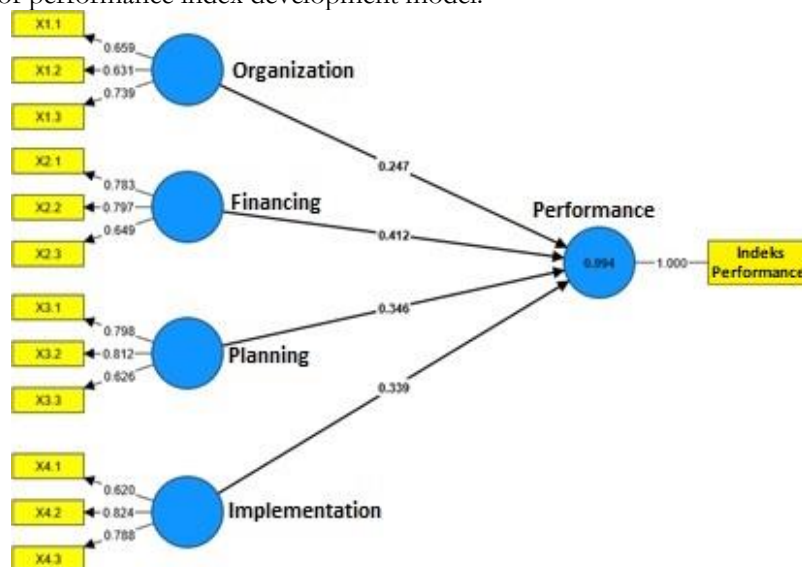
Figure 2. Development of Performance Index Model

Table 1 Path Coefficient of Performance Index Development Model

	Original sample (O)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Organization -> Performance	0.247	0.032	7.787	0.000
Funding -> Performance	0.412	0.030	13.961	0.000
Planning -> Performance	0.346	0.028	12.380	0.000
Implementation -> Performance	0.339	0.036	9.447	0.000

The coefficient of organization is 0.247 (p < 0.01), it is significantly tested to the performance. Good organization management administratively and physically will increase the performance. The coefficient of funding is 0.412 (p < 0.01), it is significantly tested to the performance. Funding and finance are as fee, partnership cooperation, and business unit that are well managed, will increase the performance. The coefficient of planning is 0.346 (p < 0.01) that is significantly tested to the performance. Good work program, good network map, and planned controlling will increase the performance. The coefficient of performance is 0.339 (p < 0.01), it is significantly tested to the performance. The active role to good implement, good maintain, and good evaluate the irrigation network will increase the performance. From the fourth variables, the variable of funding is the biggest contribution for the performance.

The performance equation of PLS model result cannot be directly used for analyzing the performance index. The path coefficient on each variable will be transformed as weight that will be used for analyzing the performance index. Table 2 presents the correlation matrix between variables.

Table 2 Correlation Matrix between Variables

	Performance	Organization	Funding	Planning	Implementation
Performance	1.000	0.721	0.810	0.763	0.644
Organization	0.721	1.000	0.558	0.511	0.200
Funding	0.810	0.558	1.000	0.425	0.334
Planning	0.763	0.511	0.425	1.000	0.341
Implementation	0.644	0.200	0.334	0.341	1.000

To obtain the weight on each component so it will be analyzed the size of effective contribution (SE) and relative contribution (SR). The effective contribution of each variable is the multiplication between path coefficient and correlation coefficient to the performance index. Therefore, the summation results of each effective contribution will be the same with the determination coefficient that is 0.994 or 99.4%.

$SE(X_1) = 0.247 \times 0.721 = 0.178$ or 17.8%
$SE(X_2) = 0.412 \times 0.810 = 0.334$ or 33.4%
$SE(X_3) = 0.346 \times 0.763 = 0.264$ or 26.4%
$SE(X_4) = 0.339 \times 0.644 = 0.218$ or 21.8%

Then, there is analyzed the relative contribution (SR) and analyzing the proportion of each effective contribution (SE) to the determination coefficient (R^2). Therefore, the summation results of relative contribution are 1.00 or 100% and will be as the weight for each variable.

$SR(X_1) = 0.178 / 0.994 = 0.179$ or 17.9%
$SR(X_2) = 0.334 / 0.994 = 0.336$ or 33.6%
$SR(X_3) = 0.264 / 0.994 = 0.265$ or 26.5%
$SR(X_4) = 0.218 / 0.994 = 0.220$ or 22.0%

So, the development model of performance index in this research is as follows:
Performance Index = 17.9% organization + 33.6% funding + 26.5% planning + 22.0% implementation

Table 3 Total and Relative Score

	Total score				Relative score			
Group	X_1	X_2	X_3	X_4	X_1	X_2	X_3	X_4
1	11.0	9.0	10.0	8.2	91.7	75.0	83.3	68.3
2	10.0	8.2	9.2	7.8	83.3	68.3	76.7	65.0
3	11.2	9.4	10.0	8.8	93.3	78.3	83.3	73.3
4	11.0	7.6	10.0	7.6	91.7	63.3	83.3	63.3
5	9.4	7.2	9.4	9.0	78.3	60.0	78.3	75.0
6	11.8	9.0	10.8	8.2	98.3	75.0	90.0	68.3
7	11.0	8.8	10.2	8.2	91.7	73.3	85.0	68.3
8	11.0	7.6	9.0	9.4	91.7	63.3	75.0	78.3
9	10.2	8.0	8.8	9.6	85.0	66.7	73.3	80.0
10	10.2	8.4	10.4	8.6	85.0	70.0	86.7	71.7

Explanation: X_1 = organization; X_2 = funding; X_3 = planning; X_4 = implementation

Table 3 presents the total and relative score. Analysis of performance index for farmers association uses the relative score of each variable that is the average of total score for every variable, and then it will be divided with 12. The number of 12 is the summation of the highest score for 3 items in every variable due to 1-4 scaled. For instance, for analyzing the performance index for farmers association No 1 is as follows:

Performance index= 17.9% (91.7) + 33.6% (75.0) + 26.6% (83.3) + 22.0% (68.3)

$$= 16.41 + 25.20 + 22.17 + 15.03$$
$$= 78.81$$

Table 4 Category of P3A Performance Evaluation

Evaluation Result	Category of evaluation
< 22.50	Has not been developed (BB)
22.50 – 55.82	To be going to develop (SB)
55.82 – 89.16	Developed (B)
89.16 - 100	Independent (M)

Table 4 presents the category of P3A performance evaluation. Assessment category of institution performance index (IKK) – P3A remains grounded on the Ministry Rules of General Work and Public Housing No.30/PRT/M/2015. There are 4 assessment categories that have not been developed (BB), to be going to develop (SB), developed (B), and independent (M). Table 5 presents the comparison of existing performance index (IKK existing) and performance index of development model (IKK development model).

Table 5 Comparison of Existing Performance Index (IKK existing) and Performance Index of Development Model (IKK development model)

Name of P3A	IKK existing		IKK development model	
	IK (%)	Category	IK (%)	Category
1. Budi Daya	90	M	78.81	B
2. Sumber Makmur	55	SB	72.57	B
3. Makmur	65	B	81.33	B
4. Gemah Ripah	65	B	73.79	B
5. Tirta Tani	50	SB	71.52	B
6. Dewi Ratih	70	B	81.78	B
7. Pasir Jaya	75	B	78.69	B
8. Langgeng	60	B	74.87	B
9. Rukun Tani	55	SB	74.72	B
10. Tani Rasa	65	B	77.56	B

Model Validation by Using NSE

The method of NSE (Nash-Sutcliffe Efficiency) shows how good the plot of observation value from measurement than the prediction value or simulation with the value range ∞ to 1. The getting closer to 1, so the NSE value is getting good.

$$NSE = 1 - \frac{\sum_{i=1}^{N}(Pi - Qi)^2}{\sum_{i=1}^{N}(Pi - \overline{Pi})^2}$$

Where:

Pi = observation data (actual data)

Qi = estimation data (estimation result data)

$\overline{Pi}$ = average of observation data

N = number of data

Table 6 presents the criteria of NSE and Table 7 presents the analysis of NSE.

Table 6 Criteria Of Nash – Sutcliffe Efficiency (NSE)

Value of NSE	Interpretation
0.80 < NSE ≤ 1.00	Very good
0.70 < NSE > 0.80	Good
0.50 < NSE < 0.70	Satisfied
NSE ≤ 0.50	Not satisfied

Source: Abesingha et al. (2015)

Table 7 Analysis of NSE

No	Pi	Qi	(Pi - Qi)²	(Pi-Pi mean)²
(1)	(2)	(3)	(4)	(5)
1	90.00	78.81	625.00	180.63

2	55.00	72.57	100.00	464.83
3	65.00	81.33	0.00	133.63
4	65.00	73.79	0.00	133.63
5	50.00	71.52	225.00	705.43
6	70.00	81.78	25.00	43.03
7	75.00	78.69	100.00	2.43
8	60.00	74.87	25.00	274.23
9	55.00	74.72	100.00	464.83
10	65.00	77.56	0.00	133.63
	Total		1200.00	4225.00
Mean	65,00	76,56		
			NSE=	0.72

Explanation:

Column (1): number of P3A
Column (2): Pi = existing performance index of P3A (consensus result)
Column (3): Qi = model development performance index
Column (4): (Column (2) – Column (3))^2
Column (5): (Column (2) – 65.00)^2
NSE = 1 – (1200.00/4225.00) = 0.72
 Based on the criteria in Table 6: NSE = 0.72 is included as good category, so the resulted model can be concluded to be good validated.

CONCLUSION

 The operation system control of irrigation network is started from the main structure: weir and the other completed structures like water gate and channel. One of the factors that influences is institution performance of P3A (Farmers Association of Water Users). The performance index of P3A in Malang Regency is carried out through the consensus model that does not give the accurate result and not responsible, so there is needed the performance index model based on the ranking as the role model that intends as the part of irrigation system performance index in supporting the program of irrigation modernization.

 This research is conducted in irrigation area on the institution of P3A (Farmers Association for Water Users) that are spreading in Malang Regency. The research subjects consist of P3A data in 10 areas that are irrigation areas which have the institution of P3A (Farmers Association of Water Users). The 10 irrigation areas consist of Budi Daya, Sumber Makmur, Makmur Gelanggang, Gemah Ripah, Tirta Tani, Dewi Ratih, Pasir Jaya, Langgeng, Rukun Tani, and Tani Rasa. Based on the analysis above, the performance index model of P3A (Farmers Association of Water Users) is 17.9% X_1 (organization) + 33.6% X_2 (funding) + 26.5% X_3 (planning) + 22.0% X_4 (implementation) with NSE = 0.74 and it means valid and good predicate.

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