DETERMINING FACTORS IN IRRIGATION MANAGEMENT IN BANTAENG DISTRICT IN SOUTH SULAWESI, INDONESIA

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ABSTRACT

Irrigation management in Indonesia is one of the essential factors in achieving community welfare. Irrigation infrastructure, which is government investment, is very urgent to be maintained and maintained to ensure food security both locally and nationally. This study reveals various factors influencing irrigation management by distributing questionnaires to 300 farmers in Bantaeng Regency, South Sulawesi, Indonesia. After going through three stages of data analysis, the researcher found that the availability of irrigation water is the most crucial variable in irrigation management. Furthermore, irrigation management is characterized by good network operations and irrigation management human resources competence. Meanwhile, the optimal use of irrigation water and the guarantee of water distribution throughout the paddy fields are essential factors in maintaining water availability. Therefore, the best strategy in developing the quality of irrigation services is to increase the capacity of farmer associations and the competence of farmers to manage irrigation water optimally and reduce the risk of water use conflicts.

Keywords: Water Availability; Farmer Association; Irrigation Network.

INTRODUCTION

As an agricultural country, Indonesia prioritizes agricultural development to increase people's welfare (Syafri et al., 2020). Irrigation which is the primary supporting technology of farming activities, is not only formed by the availability of irrigation facilities but also by various other supporting factors such as the professionalism of the workforce, water discharge, and management of water conflicts (Ma'Mun et al., 2021; Hos et al., 2021). Developing critical infrastructure in agricultural services requires a large budget, so that farmer associations and local governments try to maintain their serviceability. Practically, irrigation management activities include the operation and maintenance of canals which are the responsibility of local governments and farmer associations (Dhakal et al., 2018). Therefore, irrigation management is a complex system and is very influential on the success of farming and indirectly affects the community's welfare.

The main problem in irrigation management is the decreasing supply of clean water and the increasing demand for food which has an impact on the expansion of agricultural land. As a result, it is estimated that almost half of the total world population faces little food due to water

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scarcity (Rosa et al., 2020). Rockstrom et al. (2010) reported that the availability of irrigation water is only about a quarter of the water requirement for food worldwide. With these limitations, several countries have developed patterns of water supply in irrigation systems through rainfed agricultural arrangements. Furthermore, Pramod & Eckstein (2012) describe that the farming sector employs large amounts of human resources, providing the basis for the development other economic fields. So that the need for sustainable water availability for both the agricultural sector and other sectors arranges an optimal irrigation system has a significant role in regional economic growth.

The development of irrigation systems in several world regions has contributed to regional economic growth. The water-saving irrigation systems at the local level will have complex impacts on agricultural production, farmer welfare, exploitation, and utilization of water resources (Alauddin et al., 2020). Furthermore, irrigation water has a tremendous economic value in agricultural production factors. The existence of irrigation infrastructure requires high costs both in construction and maintenance (Hassani et al., 2019). Therefore, the use of irrigation with an optimal system is a determinant of the economic development of a region.

With the increasing demand for agricultural commodities, the irrigation areas in the world need to be increased and the development of modernization of irrigation management (Plusquellec, 2009). Increasing pressure on water and energy resources concerns irrigated agriculture the primary water-consuming sector in many semiarid regions. Significant efforts to modernize irrigation worldwide have shifted from open channels to pressurized distribution networks (Ahmad & Khan, 2017). Modernization of agricultural irrigation systems (usually from surface to sprinkler/drip irrigation) has increased irrigation efficiency (Playan et al., 2013) but has drastically increased energy consumption (Soto-García et al., 2013).

Nationally, irrigation policies cover irrigation technology, financing, human resources, and farmer participation in irrigation maintenance. Irrigation technology depends on the amount of flow and reliability throughout the year. Water potential triggers the formation of food security as an indicator of the prosperity of a region.

Specifically, agricultural activities in Bantaeng Regency are highly dependent on irrigation management. The development of irrigation networks aims to support local and national food security acceleration. Agricultural productivity in this region supports national food security, with annual rice production increasing due to the intensification of agricultural technology. Therefore, we are interested in studying the crucial factors influencing irrigation management. The study results become the basis for determining policies to maintain agricultural land productivity.

Entrepreneurship Passion

Irrigation management is a series of activities that include operations, maintenance, and rehabilitation of irrigation networks. There are five functions of irrigation management, namely (1) programming and information systems; (2) operation and maintenance control; (3) irrigation security; (4) knowledge center and human resource development; and (5) the function of extension and water use (Moraitis et al., 2022). Irrigation management is one form of institution that regulates agreements in using and regulating ownership of water resources. By empowering social capital at various levels (micro, meso, and macro), sustainable management and reliability of irrigation water supply can be improved. In the long term, social capital will function as an investment (incentive) and is expected to reduce damage, especially those under the authority of

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local governments, including at the farm level. Irrigation management is essential so that water resources can be sustainably maintained, both from natural resources, socio-economic factors, and community institutions using water (Huang et al., 2010).

The Irrigation network is all buildings and canals that function to channel irrigation water from agricultural land water sources and dispose of excess water on agricultural land. In addition to directing irrigation water and removing the excess water in plots, network exploitation is expected to be able to utilize the available water effectively and efficiently, distribute it fairly and equitably, and give it to tertiary land plots in an appropriate manner, time and amount, according to the needs of plant growth. and can avoid the negative consequences arising from excessive water (Khaeez & Shahdany, 2021).

The operation of the irrigation network is determined by two things, namely the management and the physical function of the network. The Irrigation network plays a role in draining water from water sources (weirs, reservoirs, rivers) to land that needs water. The irrigation network consists of the main building, carrier canals, regulatory structures, and complementary buildings (Alexiou & Tsouros, 2017). The main building is a facility designed to divert water into the canal network to be used for irrigation purposes. The main building can reduce excessive sediment content and measure the amount of water entering. The facilities consist of weirs, sluice gates, flushing structures, mud bags, river reinforcement structures, and complementary structures (Gorse et al., 2012).

Furthermore, the irrigation network includes complementary buildings consisting of barriers to protect the irrigation area from flooding, filter grids to prevent blockage of towers (at siphons/culverts), bridges, and connecting roads from the village for resident's needs. In addition to the central and auxiliary buildings, there are control buildings for tapping, plunge buildings, gutters, sloped drains, siphons, water level risers, dump buildings, and inspection roads (Gyasi-Agyei, 2003).

Efforts to continue to create efficient and equitable management of water resources require the role of irrigation associations from the government, private sector, and farmers in irrigation management. From the government side, irrigation management is expected to present policies and create programs that can encourage sustainable irrigation management from various levels according to their authority (Valverde et al., 2015).

Farmers' associations or institutions encourage the formation of participation in irrigation management. The involvement of farmers in irrigation management is multi-sectoral, related to water and the physical and social structures that control it. When irrigation structures capture, channel, and distribute water to support plant growth, they are visible and impressive. Their apparent success in sustaining agriculture in conditions were insufficient rainfall would limit or prevent production makes irrigation a central physical process (Bakhshianlamouki et al., 2020).

Regulation of irrigation water is an activity that includes the distribution, provision, and utilization/use of irrigation water. Distribution of irrigation water is the activity of dividing water in buildings into primary and secondary networks; furthermore, provision is the activity of distributing a certain amount of water from primary or secondary networks to tertiary plots, while utilization/use of irrigation water is an activity of utilizing water from tertiary actions to irrigate the land. agriculture when needed (Ali, 2011, Greenland et al., 2018).

The distribution of water in the operation of the irrigation network is based on the determination of the planting plan and the calculation of the amount of the water distribution plan. In preparing the water distribution plan, the Irrigation Service branch must analyze field conditions (upstream, middle and downstream, as well as the experience of the manager, which

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will facilitate the implementation of water distribution. Suppose there is sufficient river flow and farmers carry out planting according to the plan (time and area). In that case, the water supply is adequate, and there is no conflict (Matyakubov et al., 2020; Koech & Langat 2018).

The irrigation water distribution depends on the management pattern or irrigation water arrangement. In addition, the risk of farmer conflict is also very high. The number of disputes over irrigation water is also an indicator that needs to be monitored periodically and evaluated at the end of each planting or year-end (Si et al., 2020; Zeitoun et al., 2020).

Table 1
INDICATORS OF ENTREPRENEURSHIP PASSION

Indicator	Compliance with farming activities
Emotions and moods. Aspects that affect a person to expand resources	The farmer's desire to expand the land, to use superior seeds and to increase labor.
Management of venture growth	The spirit of farmers to maintain the land area, the quality of land and the quality of agricultural machinery.
The financing decision for production cost	Farmers' consideration in investing the cost of protecting land.
The financing decision for risk protection	Farmers’ consideration to face the risk of floods and landslides.

METHODS

This quantitative with descriptive and correlational approaches are used in this research. The questionnaire as an analytical tool uses five answer choices which are quantified with a value of 1, value 2, value 3, value 4, and value 5. The population in this study are all farmers who manage land in irrigated areas in Bantaeng Regency. Determination of the sample using the Sampling Cluster so that the number of pieces is 300. This study consists of four variables, namely three independent variables and one dependent variable. The independent variable is Irrigation Network (X1), Farmer Association (X2), and Irrigation Water Availability (X3), while the dependent variable is Irrigation Management (Y). The three stages of analysis are descriptive analysis of indicators and variables, inferential statistical analysis, and structural model analysis. The technical analysis used is the Structural Equation Model (SEM).

Descriptive Analysis

The descriptive analysis includes an analysis of the frequency of respondents' answers and the categories of each variable and indicator. The calculation results of the average respondent's assessment become a guide for determining the category (Table 1) (Decker & Menrad, 2015).

Inferential Statistical Analysis

The inferential statistical analysis aims to find the influence between variables or regression analysis. This analysis test refers to the results of the SPSS test or the value of Sig.

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Suppose the value of Sig is smaller than the probability value. In that case, there is an influence between the independent and dependent variables. The probability value in this study is 0.05 (White & Gorard, 2017).

Table 2
RESPONDENT'S ASSESSMENT

Average answer score	Category
1.00-1.79	Very low
1.80-2.59	Low
2.60-3.39	Medium
3.40-4.19	High
4.20-5.00	Very high

Structural Equation Model

Structural Equation Model Test using AMOS is a complete modeling analysis that comprehensively describes the relationship between variables and the position of each indicator on the variables. The test results are in the form of an image of the relationship chart between variables and how much the value of the regression weight is. This value is a sign that the indicator is part of the latent variable if its value is more significant than 0.5 (Ong & Puteh, 2017).

This study used a quantitative approach that includes three variables, namely the characteristics of farmers, entrepreneurship passion, and management of river banks. The sample was 70 farmers selected by incidental sampling method. The farmers as research subjects have cultivating experience for ten years. Methods of data collection using questionnaires consisting of a number of statements containing information about the research variables and using a Likert scale to enable statistical methods. Researchers recapitulated respondents' answers to the questionnaire for the easer analysis. Comparative analysis to examine differences in entrepreneurship passion on various characteristics of farmers is done by the "t" test. Furthermore, the relationship between two variables was analyzed by ANOVA test to get the relationship between variables. Both statistical analyzes are supported by SPSS software.

RESULTS AND DISCUSSION

The respondents involved in the study were 300 people who worked as farmers in irrigated rice fields. Most of the respondents were men aged between 37-46 years. Respondents generally graduated from high school, and only a small proportion had attended college. Farmers generally cultivate paddy fields of 1-1.5 ha.

Description of Respondents' Assessment of Irrigation Networks, Farmers' Associations in Irrigation Management, availability of irrigation water, and Irrigation Management

The results of the descriptive analysis of the irrigation network showed that all respondents considered that the irrigation network was in good condition. However, no one believes that the state of this infrastructure is in perfect condition (Table 2). These results follow the description in Table 3 that the average value of answers about this variable is 3.80. Furthermore, Table 4 shows that generally, respondents understand the distribution of networks

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based on their classification, which gets an assessment of 4.55 or a very high category. Meanwhile, the lowest rating is on the existence of irrigation supporting infrastructure with a score of 2.60 or the medium type. The series of assessment results indicate that farmers know about irrigation management according to the network classification, but they are aware of the poor quality of the sluice gates and drainage networks.

Furthermore, the respondent's assessment of farmer associations in irrigation management shows a very high category, or there are 86% of respondents think that farmers are very intensive in managing irrigation (Table 3). This is in line with Table 3, which finds that the average value of the variable is 4.03 or indicates a high category. This assessment is supported by the association's ability to maintain the reliability of irrigation systems with a score of 4.35 (Table 4). These results indicate that generally, farmers belonging to an association carry out irrigation management to optimize the irrigation system's reliability.

These results indicate that the role of irrigation associations fosters the desire of farmers to participate in conducting inspections on the use of irrigation canals. In addition, farmers' organizations also often carry out control to prevent water use conflicts.

The water availability variable shows the dominant category rating is high, namely 53%. Respondents generally considered that irrigation water was available according to the needs of agricultural activities (Table 3). This result is following the variable value of 4.06, indicating the high category (Table 3). The inconsistent assessment results from the average value of the three indicators, namely water usage of 4.29 with a high category, water distribution with a value of 4.21, and handling farmer conflicts of 3.69 (Table 4). These results illustrate that water in the irrigation network is well available because farmers can optimize water use and ensure even water distribution for all farmers. With good water availability, conflicts over water use will not be a problem in managing the irrigation system.

Table 3
THE PERCENTAGE OF THE RATING CATEGORY

Variable	Rating Category (Percentage)				
	Very Low	Low	Medium	High	Very High
Irrigatin Network	0%	0%	0%	100%	0%
Farmer Association	0%	0%	0%	86%	14%
Water Availability	0%	0%	0%	53%	47%
Irrigation Management	0%	0%	67%	33%	0%

Table 4
THE AVERAGE VALUE OF THE RESPONDENT'S ASSESSMENT FOR VARIABLE

Variable	Mean	Category
Irrigation Network	3.80	High
Farmer Association	4.03	High
Water Availability	4.06	High
Irrigation Management	3.13	Medium

Irrigation management as the key to the sustainability of agricultural cultivation gets a different assessment from the previous three variables. Table 3 shows that 67% of respondents

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think that irrigation management is in the moderate category. This analysis also follows the description in Table 4 that the respondent's assessment of this variable is 3.13, which also shows an estimate in the medium category. Table 4 describes that the weakness of irrigation management is generally caused by the low capacity of human resources (score 2.94) and funding for operations and maintenance (score 2.91).

Table 5
THE AVERAGE VALUE OF THE RESPONDENT'S ASSESSMENT OF THE INDICATOR

Variable	Indicator	Mean
Irrigation Network	Canal condition	3.82
	Security of canal and building	ta
	The function of canal and building	4.3
	Network classification	4.55
	Availability of irrigation infrastructure	2.60
Farmer Association	Evaluation and management	4.22
	Reliability and sustainability of irrigation systems	4.35
	The role of farmers in the maintenance of irrigation buildings	3.52
Water Availability	Water usage	4.29
	Water distribution	4.21
	Conflict handling	3.69
Irrigation Management	Network operation	3.53
	Human resource profesioalism	2.94
	Funding for operational and maintenance	2.91

Inferential Statistical Analysis

The regression test results found probabilistic values and decisions about the influence between variables (Table 5).

Table 6
REGRESSION ANALYSIS

	Probabilities	T Statistic	T Table	Descriptive
Irrigation Network→Irrigation Management	0.041	0.079	1.652	H_1 Accepted
Farmer Association→Irrigation Managemen	0.000	0.317	1.652	H_1 Accepted
Water Availability→Irrigation Management	0.000	0.746	1.652	H_1 Accepted

The basis for decision making is if the probability value (p) <0.05, then H1 is accepted, and if the probability value (p) is >0.05, then H_1 is rejected. Based on the results, the probability value (p) for the irrigation network (X1) is 0.041<0.05. These results illustrate that the irrigation network affects irrigation management and contributes to irrigation management in 7.9%. Furthermore, the probability value (p) for farmer associations (X2) is 0.000< 0.05, which means that irrigation associations have an effect on irrigation management and contribute 31.7%. The result of probability analysis (p) for irrigation water (X3) is 0.000<0.05, which means that

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irrigation water has a direct effect on irrigation management with a contribution of 74.6%. The results illustrate that the availability of irrigation water is the most crucial variable in irrigation management compared to the existence of irrigation networks and the activities of farmer associations.

Structural Equation Model

Structural Equation Modeling (SEM) analysis as an analysis involving variables and indicators is revealed in Table 7.

Table 7
STANDARDIZED REGRESSION WEIGHTS OF IRRIGATION NETWORK

			Estimate
Condition of irrigation canal	←	Irrigation network	0.386
Protection of irrigation canals and buildings	←	Irrigation network	1.00
Functions of irrigation canals and buildings	←	Irrigation network	0.865
Classification of irrigation networks	←	Irrigation network	0.856
Completeness of irrigation infrastructure	←	Irrigation network	0.424

Table 7 describes the results of the calculation of the regression weight indicator for irrigation networks. This analysis shows three indicators with an estimated value greater than 0.5. Indicators of securing irrigation canals and buildings, functions of irrigation canals and structures, and classification of irrigation networks are part of the irrigation network. Meanwhile, the condition of the building and its equipment is not an essential indicator of the irrigation network.

Table 8
STANDARDIZED REGRESSION WEIGHTS OF FARMER ASSOCIATION

			Estimate
Evaluation and management	→	Farmer association	0.883
Efforts to maintain the reliability and sustainability of the irrigation system	←	Farmer association	0.884
The role of farmers in the construction and maintenance of irrigation structures	←	Farmer association	0.285

Table 8 shows the estimated value of three indicators on farmer association variables. The analysis results show that evaluation, management, and activities to maintain the reliability and sustainability of irrigation are essential markers of irrigation associations. Meanwhile, the role of farmers in channel maintenance does not indicate a latent variable because the estimated value is smaller than 0.5.

Table 9
STANDARDIZED REGRESSION WEIGHTS: FOR IRRIGATION WATER VARIABLE

			Estimate
Use of irrigation water	←	Irrigation water	0.922
Water distribution	←	Irrigation water	0.950
Handling of complaints and conflicts on irrigation water regulation in the field	←	Irrigation water	0.892

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Table 9 shows that the three indicators show values greater than 0.5, or all three are essential indicators for irrigation water. In other words, the quality of irrigation water is characterized by optimal use of water according to land needs, equitable distribution of water, and the presence of water conflict management.

Table 10
STANDARDIZED REGRESSION WEIGHTS ON IRRIGATION MANAGEMENT VARIABLE

			Estimate
Irrigation network operation	←	Irrigation management	0.962
The professionalism of workers in irrigation management	←	Irrigation management	0.767
Fund for irrigation operation and maintenance	←	Irrigation management	0.458

Table 10 shows that irrigation management is characterized by two indicators: the irrigation network's operation and the irrigation manager's professionalism. Both hands have estimated values above 0.5.

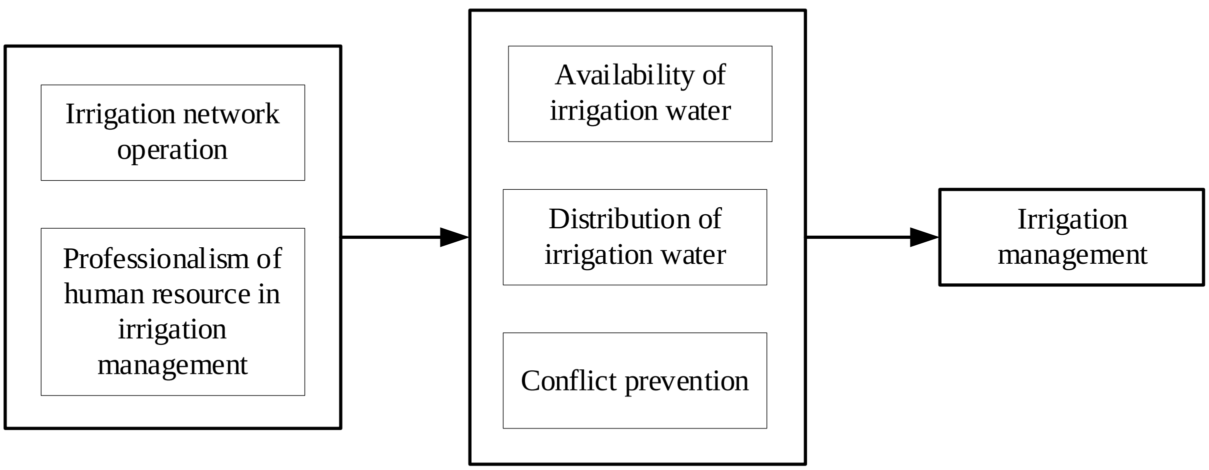

FIGURE 1
DETERMINANTS OF IRRIGATION MANAGEMENT

Based on the series of analyzes above, the results of the study found that irrigation water is the most critical factor in irrigation management. Furthermore, irrigation association becomes the second important factor, and irrigation network has a minor contribution to irrigation management. In determining the optimal irrigation management strategy, essential indicators of irrigation water are the focus of attention. These indicators are irrigation water use, water distribution, and conflict management. In detail, the determinants of the factors are described in the Figure1.

CONCLUSION

The availability of irrigation water is the most crucial variable in irrigation management. This variable also has the most significant correlation value with irrigation management. SEM analysis shows that irrigation management is characterized by good network operations and irrigation management human resources competence. Meanwhile, the optimal use of irrigation

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water and the guarantee of water distribution throughout the paddy fields are essential factors in maintaining water availability. Therefore, the best strategy in developing the quality of irrigation services is to increase the capacity of farmer associations and the competence of farmers to manage irrigation water optimally and reduce the risk of water use conflicts.

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Received: 08-May-2022, Manuscript No. JMIDS-22-11940; **Editor assigned:** 10-May-2022, PreQC No. JMIDS-22-11940(PQ); **Reviewed:** 24-May-2022, QC No. JMIDS-22-11940; **Revised:** 27-May-2022, Manuscript No. JMIDS-22-11940(R)**; Published:** 31-May-2022

Citation Information: Badrun, B., Pallu, M.S., Salim, A., & Abduh, M.N. (2022). Determining factors in irrigation management in Bantaeng district in South Sulawesi, Indonesia. *Journal of Management Information and Decision Sciences, 25*(5), 1-11.