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Glapan Weir Irrigation System Optimization Strategy to Increase Agricultural Yield

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Abstract

This study aims to identify the constraints and problems that exist in the irrigation system and to develop an optimization strategy for the Glapan Dam irrigation system in Gubung District, Grobogan Regency. This type of research uses descriptive quantitative. The data collection technique in this study used a questionnaire distributed to key persons who had been determined by purposive sampling. The analysis used is Analytical Hierarchy Process (AHP) then processed using Expert Choice software. The results show that the obstacles and problems that are still faced in the management of the irrigation system in Glapan Weir are the sedimentations of the Tuntang River which causes a reduction in water supply, and the lack of availability of tools such as pumps, sluice gates, and water flow measuring devices. The most prioritized criteria in the strategy of optimizing the irrigation system in Glapan Dam to increase agricultural yields is the money criterion with a weight value of 0.520 and the first priority alternative in the irrigation system optimization strategy to increase agricultural yields is an alternative government fund with a weighted value of 0.211.

Keywords: ***Irrigation System, Analytical Hierarchy Process (AHP), Agriculture Production***

Abstrak

Penelitian ini bertujuan untuk mengidentifikasi kendala dan permasalahan yang ada pada sistem irigasi serta menyusun strategi optimasi sistem irigasi Bendung Glapan di Kecamatan Gubung, Kabupaten Grobogan. Jenis penelitian ini menggunakan deskriptif kuantitatif. Teknik pengumpulan data dalam penelitian ini menggunakan kuesioner yang dibagikan kepada key person yang telah ditentukan secara purposive sampling. Analisis yang digunakan adalah Analytical Hierarchy Process (AHP) kemudian diolah menggunakan software Expert Choice. Hasil penelitian menunjukkan bahwa kendala dan permasalahan yang masih dihadapi dalam pengelolaan sistem irigasi di Bendung Glapan adalah sedimentasi Sungai Tuntang yang menyebabkan berkurangnya pasokan air, dan kurangnya ketersediaan alat seperti mesin pompa, pintu air, dan alat pengukur debit air. Kriteria yang paling diprioritaskan dalam strategi optimalisasi sistem irigasi di Bendung Glapan untuk meningkatkan hasil pertanian adalah kriteria uang dengan nilai bobot 0,520 dan alternatif prioritas pertama dalam strategi optimalisasi sistem irigasi untuk peningkatan hasil pertanian adalah alternatif dana pemerintah dengan nilai bobot 0,211.

Kata Kunci: Sistem Irigasi, Analytical Hierarchy Process (AHP), Produksi Pertanian

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INTRODUCTION

As an agricultural country, agriculture is a very influential field in supporting the economy of the country where the majority of Indonesian people work as farmers. However, the desired agricultural output has not been maximized, this is evidenced by the insufficient agricultural produce to cover the country's basic needs, especially rice because rice is an important staple for the Indonesian people, to increase domestic agricultural production, an irrigation system is needed. Irrigation is one of the important factors for increasing agricultural yields.

To meet water needs, especially for water needs on agricultural land, it is necessary to build an irrigation system. The irrigation system has a meaning, namely efforts to provide and regulate irrigation water in supporting water needs for agricultural land whose water is taken from reservoirs, rivers by weirs, and groundwater. The purpose of building an irrigation system is to utilize the water available in reservoirs and rivers properly and correctly so that agricultural yields can be maximized according to farmers' expectations.

The irrigation system in Indonesia relies on water from reservoirs, river dams, and groundwater. However, dependence on groundwater irrigation is very risky for the sustainability of groundwater sources so it can disrupt the environmental balance. Whereas development efforts must be in line with nature conservation. One of the efforts to increase agricultural yields is to provide water for agricultural land in accordance with the required portion, namely by water source dams (Pujiati, et al., 2020).

The need for food as one of the important roles in the agricultural sector is a formidable task so the Grobogan district government has determined that rice, corn, and soybeans are the main food commodities that are given special attention in achieving the target of sustainable self-sufficiency so that an action is needed to achieve this goal.

One of the media to fulfill water needs in agriculture is irrigation networks that need to be managed properly and correctly. There are ways to manage underground water and water from rivers optimally, but it is necessary to use the right system or method in its application, for example, underground water using pumps distributed to the fields according to the water capacity. For flow from rivers, it is necessary to make open irrigation canals in dry land and wetland.

The channel is made into a reservoir with a gravity system that is able to flow through agricultural land with a debit calculation system and water requirements for plants according to the growing season and the types of plants that are optimally developed, so that optimization is achieved. The need for the application of irrigation networks that consider aspects of water availability, and the implementation of a sustainable irrigation system, also requires a very large role for farmers for more efficient results in applying the gravity method.

The agricultural sector in Grobogan Regency, precisely in the Gubug sub-district, with an irrigation system located in a dam called the Glapan Weir, the weir system relies on rainfall that is accommodated on the weir, in contrast to reservoirs that store water. Aspects of weir irrigation systems are usually less than that of reservoirs. And in Glapan Dam, there are only 2 water pumps, namely East Glapan and West Glapan.

The eastern part of the Glapan dam aims to supply the Primary channel which is to the east of the dam, while the West Glapan dam is to supply water to the water channel in the western part of the dam. The Glapan weir was built in 1852-1859 in the form of a stone masonry threshold with a long plunge plane so that it forms a sloping channel.

The Glapan weir functions to irrigate the irrigation area located in Gubug District, irrigating the irrigation area with two sides taking from the Glapan weir to irrigate the left intake for the West Glapan irrigation area (10,113 Ha) while the right intake for the East Glapan irrigation area (8,627 Ha), thus the total area according to data from BPSDA is 18,740 Ha.

Table 1. Channel Data and Area of West Glapan Irrigation

No	Channel Names	Length (km)	Wiretapping Area (ha)	No	Channel Names	Length (km)	Wiretapping Area (ha)
1	West Glapan main channel	18.059	2,171.00	11	Coral market secondary channel	3,511	325.00
2	Gubug secondary channel	24,729	2,162.00	12	Kejawan secondary channel	1,792	153.00
3	Brass secondary channel	1.059	279.00	13	Gebangan secondary channel	4,594	540.00
4	Kunjeng secondary channel	2,160	249.00	14	Ketitang secondary channel	5,347	763.00
5	Pranten secondary channel	2.012	345.00	15	Glapan Setu secondary channel	9,037	550.00
6	Baturan secondary channel	2,243	276.00	16	Krandon secondary channel	2,593	279.00
7	Curug secondary channel	2,520	326.00	17	Loireng secondary channel	1,408	226.00
8	Bull's secondary channel	5.035	762.00	18	Babadan secondary channel	1,215	247.00
9	Shell secondary channel	0.97	237.00				
10	Secondary channel Kramat	1,775	202.00		TOTAL	90.06	10.002.00

Source: Channel Measurement Results and Map Updating PT. Create a Plan

And from the results of updating the Glapan Dam map, the left take is for the West Glapan irrigation area (10.002 Ha) while the right take is for the East Glapan irrigation area (8,606

Ha), thus the total area according to the latest data is 18,698 Ha. Previous research on efforts to develop irrigation systems has been carried out by several researchers but still produces different concepts.

Optimization of the irrigation system can be done by optimizing aspects of human resource participation (Ardiansah et al., 2018), management methods and human resource competencies (Berliandaldo, M. & Hidayat, A., 2017), maintenance, finance, and technology (Pangabean & Wiryawan, 2016), and improvement competence of human resources (Mahendradhata et al., 2014).

The existence of different concepts from several previous studies provides an opportunity for further research related to the strategy of optimizing the irrigation system to increase agricultural yields. This study aims to identify the obstacles and problems that exist in the Glapan Weir irrigation system. In addition, this study also aims to develop a strategy for optimizing the Glapan Weir irrigation system in Gubung District, Grobogan Regency.

RESEARCH METHODS

The location of research was conducted in the District of Gubug. This was done because Gubug District is an agricultural area whose irrigation channels utilize the Tuntang River and underground water. Regarding the description of the location, the survey was conducted in every village that implemented an irrigation system and did not implement an irrigation system in the Gubug sub-district, Grobogan district.

There are two types and sources of data used in this study, namely primary data and secondary data. Primary data was obtained based on interviews with several farmers in Gubug sub-district, Grobogan district. As well as other key persons who play a role in this research, namely extension workers and several related agencies to obtain data information.

The key person in this study consists of the Academic, Government, Business, and Community (AGBC) components, namely academics the key person is the UNNES development economics lecturer, the government key person is the DPR RI P3 and self-sufficient extension workers, the business key person is a middleman or skipper, the community key person is a farmer. The key person selection technique in this research is using a purposive sampling technique. As for the purposive sampling technique, considerations are needed to select and determine the sample, namely choosing a sample that is considered to know the problem being studied as well as to understand what is expected in the study.

In this study, the questionnaire that was carried out was distributed as the Analytical Hierarchy Process (AHP) questionnaire in which there were questions and statements made by researchers to get answers from predetermined key persons. This study uses the Analytical Hierarchy Process (AHP) method with the aim of finding which criteria must be prioritized or prioritized in an effort to improve the Dark Weir irrigation system for increasing agricultural yields in the Gubug sub-district, Grobogan district.

The use of the Analytical Hierarchy Process is formulated based on references to previous research, interviews, and questionnaires with selected key persons. The criteria and alternatives in this study were obtained from literature studies and also interviews with several related keypersons. The explanation of the variables in this study is in figure 1.

Variable Analytical Hierarchy Process (AHP) is used to determine strategic priorities or

policy alternatives, with the aim of irrigation strategies to increase agricultural yields. In this study, before analyzing the strategy formulation, the researcher first identified the variables/criteria needed in formulating the strategy. The basis for taking this variable first is based on a literature study of several relevant previous studies.

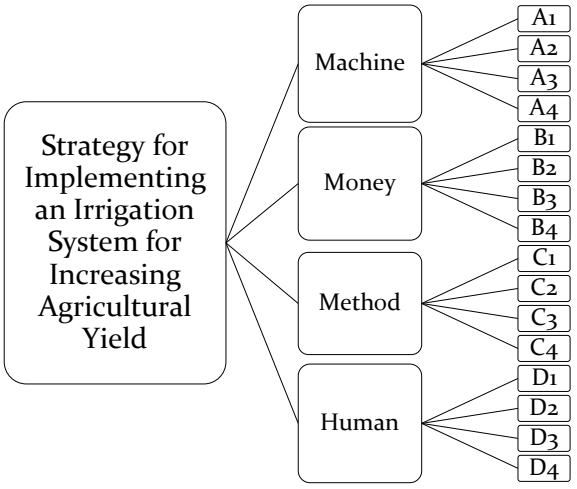

Figure 1. Analytical Hierarchy Process (AHP) Model

RESULTS AND DISCUSSION

Irrigation facilities are an important factor in agriculture, but in irrigation, there are also many obstacles in the implementation of irrigation operations and maintenance. As in Glapan Dam irrigation, which irrigates 21 villages by relying on water discharge from the Tuntang River and rain. From the results of interviews I conducted with extension workers and the *DPRD* P3 agriculture sector, Glapan dammed the first obstacle for the villages assisted by irrigation areas, namely the lack of cooperation between farmers and other villages when distributing water, from government policies on water distribution. Priority is given to downstream first, but farmers upstream often clog the floodgates, this water struggle often occurs, especially in the second planting season.

In addition to the struggle for water between farmers, the sediment in the Tuntang River is very high because the quality of irrigation water from above is not good due to a large number of riverside land conversions to be used as agricultural land, resulting in landslides caused by river currents, so the financing for Glapan weir irrigation is very high because within one year the Tuntang River was dredged twice, not only sedimentation but lack of maintenance in the tertiary canal in the village also hampered the flow of water to the rice fields.

The amount of waste is also an obstacle to the performance of irrigation operations in the Gubug sub-district. Meanwhile, for villages located above irrigation weirs, namely Penadaran, Glapan, and Ginggangtani villages, the obstacle is that because agricultural land is located above irrigation weirs, the main obstacle is equipment. Because to irrigate rice fields, farmers have to use water pumps. And the cost of the pump is not cheap.

Dam irrigation system implementation strategy Glapan is the goal (goals) in this review. The use of irrigation water does not always run smoothly and there will be obstacles or obstacles and those who know the problems of using water in the field are farmers. The implementation of this research begins with fieldwork, interviews, and distribution questionnaires. When going into the field, there are things that must pay attention to research parameters, such as water flow and water requirements consisting of dredging, sedimentation, irrigated waste, water quality, and water distribution.

Respondents from this review include AGBC (Academy, Government, Business,

Community) in which the distribution of questionnaires to 15 respondents who are lecturers, DPRD P3 agricultural division and independent agricultural extension workers, middlemen or skipper, and farmers, questionnaires are distributed from 19 August 2021 until August 23, 2021. Where the contents of the questionnaire take into account 4 criteria according to the conditions in the field.

Table 2. AHP Outputs

Machine	0.176
Money	0.520
Method	0.203
Human	0.100
Inconsistency with 0 missing judgments	0.070

Source: Primary data processed, 2021

Criteria are media to achieve goals that are supported by 4 criteria, namely machines, money, methods, and humans. Money is the most important criterion compared to the other 3 criteria because money can control the other criteria. The priority value of the four criteria can be seen from the size of the value according to the value weighting that the author uses the AHP method, the results of the priority assessment can be explained in table 2.

Based on table 2, it can be seen that the most prioritized criteria in the strategy of implementing an irrigation system for increasing agricultural yields is the money criterion with a weighted value of 0.520. The results of the AHP analysis of all these criteria can be said to be consistent because the inconsistency value is only 0.07 <0.1.

In the criteria, the highest priority value is money because it plays an important role in the maintenance, maintenance, rehabilitation of irrigation networks and facilities, and infrastructure. The priority value of the criteria for this machine can be seen in the amount of value according to the weighting of the values that the authors do use the AHP method, the results of the priority assessment can be explained in table 3 as follows:

Table 3. AHP Criteria Machine Output

Tool Help	0.156
Tool Needs	0.405
Tool Condition	0.127
Tools	0.312
Inconsistency with 0 missing judgments	0.040

Source: Primary data processed, 2021

Based on table 3, it can be seen that the most prioritized alternative in the engine criteria is an alternative tool requirement with a weight value of 0.405. The results of the AHP analysis of all these criteria can be said to be consistent because the inconsistency value is only 0.04 < 0.1.

The priority value of this money criteria can be seen from the size of the value according to the value-weighted by the author using the AHP method, the results of the priority assessment can be explained in table 4 below:

Table 4. Output AHP Criteria Money

Government Funds	0.424
Voluntary Funds	0.157
Member Fees	0.333
Enough Cost	0.086
Inconsistency with 0 missing judgments	0.090

Source: Primary data processed, 2021

Based on table 4, it can be seen that the most prioritized alternative in the money criteria

is an alternative to government funds with a weighted value of 0.424. The results of the AHP analysis of all these criteria can be said to be consistent because the inconsistency value is only 0.09 <0.1.

In terms of money criteria, the value the most prioritized is government funds because, in irrigation networks, government funds play an important role in maintaining, managing, and operating irrigation networks to increase agricultural yields.

Table 5. Output AHP Criteria Method

Availability of Water	0.205
Network Maintenance	0.338
Water Distribution	0.169
Water Sharing	0.288
Inconsistency with 0 missing judgments	0.020

Source: Primary data processed, 2021

The priority value of the criteria for this method can see in the size of the value according to the value-weighted by the author using the AHP method, the results of the priority assessment can be explained in table 5.

Based on table 4, it can be seen that the most prioritized alternative in the method criteria is the network maintenance alternative with a weight value of 0.338. The results of the AHP analysis of all these criteria can be said to be consistent because the inconsistency value is only 0.02 <0.1.

In the priority value method, the highest priority value is network maintenance, because the smooth running of irrigation water depends on network maintenance, if the network is not maintained there will be many obstacles, such as garbage covering sluice gates and leaks that can reduce water discharge and so on.

The priority value of the criteria for this method can be seen in the amount of value according to the value-weighted by the author using the AHP method, the results of the priority assessment can be explained in table 6. Based on table 6, it can be seen that the most prioritized alternative in the human criteria is the collaboration alternative with a weight value of 0.497. The results of the AHP analysis of all these criteria can be said to be consistent because the inconsistency value is only 0.04 <0.1.

Table 6. Human Criteria AHP Output

Willingness	0.319
Care	0.119
Teamwork	0.497
Initiative	0.065
Inconsistency with 0 missing judgments	0.040

Source: Primary data processed, 2021

In the priority value of human criteria, the highest priority value is cooperation, because, in irrigation, cooperation is the main key to smooth water. Especially cooperation between farmers. Based on the calculation of the analytical hierarchy process on all alternative strategies for implementing irrigation systems to increase agricultural yields with the Expert Choice 11 program.

Based on figure 2, it can be seen that the most prioritized alternative in the strategy of implementing an irrigation system to increase agricultural yields is an alternative to government funds with a weight value of 0.211. The results of the AHP analysis of all these criteria can be said

to be consistent because the inconsistency value is only 0.07 <0.1.

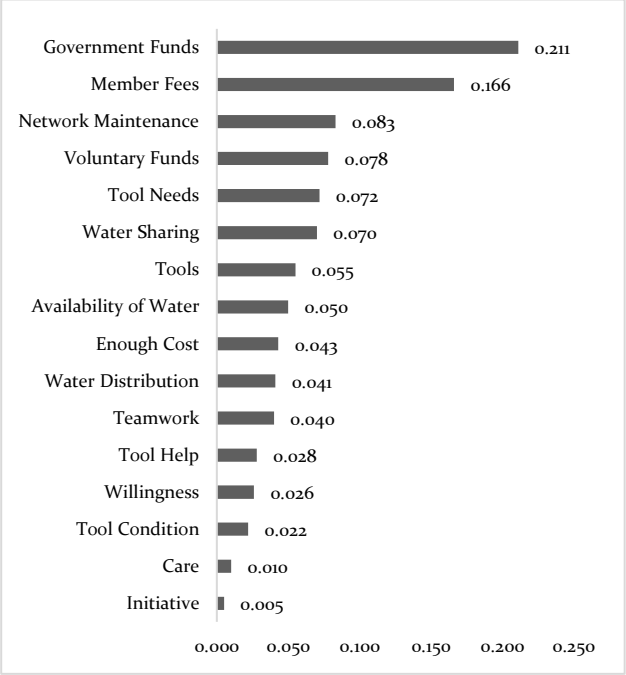

Figure 2. AHP Output Against All Alternatives
Source: Primary data processed, 2021

The Glapan Dam is one of the water sources that have a major contribution to the economic activities of the people in the Grobogan Regency. The agricultural sector is one sector that has a high dependence on the smooth irrigation system in the Glapan Dam. Located in Gubug District, of course, Glapan Weir provides a source of water for agriculture in the surrounding villages.

As we know that the Glapan Weir itself is a channel from the Tuntang River originating from Rawa Pening, so the smooth running of the irrigation system also depends on the upstream side of the weir. In recent years, the Tuntang has been silted up due to the increasing sediment. As a result, the supply of water to the Glapan Dam is experiencing problems, especially during the dry season. The agricultural sector in Grobogan Regency itself mostly depends on water supply from the irrigation system, so that when the dry season arrives and the irrigation system experiences problems, it will disrupt agricultural production.

The lack of supporting equipment in the irrigation system in the Glapan Weir is also an obstacle, especially for the agricultural sector whose land is above the Glapan Weir. The agricultural land requires irrigation canals that must be assisted by pumps from the glapan weir. The management of Glapan Dam itself is also not optimal. Lack of coordination between stakeholders makes its management not effective and efficient.

The distribution of water to agricultural land is often uneven and even agricultural land located at the end of the irrigation canal does not get water. In addition, many operational officers do not routinely carry out routine checks so waterways are often disturbed. Aspects of human resources are often an obstacle in the management of irrigation systems. As explained by research by Ardiansah et al., (2018) which explains that the quality of human resources is an important aspect in supporting the smooth running of the irrigation system.

Efforts to optimize irrigation channels in Glapan Weir are also constrained by supporting facilities and infrastructure, such as sluice gates, water flow meters, and water pumps. The operational costs of the irrigation system have also not been managed properly so they often experience difficulty in funding when they are going to carry out maintenance or repairs or procure supporting equipment. As explained by Pangabedan & Wiryawan (2016) that finance is an aspect that is often an obstacle in irrigation management. Inefficient financial management is a serious obstacle that causes the irrigation system to not run smoothly.

Based on the results of the AHP analysis, it is explained that the most prioritized criteria in the strategy of optimizing the irrigation system in Glapan Weir are the money criterion with a weight value of 0.520. Finance is an important aspect of irrigation management. In the implementation of irrigation management, of course, requires operational costs both to support operator performance, purchase tools, and maintain facilities and infrastructure.

Financial management must be really effective and efficient. Pangabedan & Wiryawan (2016) in their research explain that sources of funds in irrigation management must be obtained from various parties. Farmers should not only depend on the government because sometimes government assistance is not always available and given on time. Farmers should have the initiative to raise funds for the operation and maintenance of irrigation systems.

In this financial criteria, the most prioritized alternative is government aid funds with a weight of 0.424. These results indicate that the availability of funds for the operation of the irrigation system in Glapan Weir is still very dependent on government assistance funds. There needs to be an initiative from managers and farmers to find alternative sources of funds so they don't always depend on the government.

The second priority criterion in the irrigation system optimization strategy in Glapan Weir is the method criterion with a weight of 0.203. In this case, the method of management and maintenance is one of the important aspects in optimizing the irrigation system. As explained in the research of Berliandaldo, M. & Hidayat, A (2017) that the management of the irrigation system must be based on the principle of cooperation where all related parties must equally contribute in managing irrigation channels properly. This is intended so that the operation of the irrigation system can run as expected and can be sustainable.

In the criteria of this method, the most prioritized alternative is network maintenance with a weight value of 0.338. As we know that maintenance and care is one aspect that is often neglected in the management of irrigation systems. This is due to the lack of awareness from various parties to feel ownership so they tend to be ignored. Sometimes there is also a lack of coordination between the parties which causes the throwing of responsibilities on each other so that the maintenance and maintenance of irrigation canals cannot run properly.

The third priority criterion in the strategy of optimizing the irrigation system in Glapan Weir is the machine criterion with a weight value of 0.176. The machine is one of the important facilities and infrastructure in supporting the management of the irrigation system. Pangabean & Wiryawan (2016) explained that the machine is an important technology in supporting the effectiveness and efficiency of irrigation system management.

The existing machinery and equipment in the Glapan Weir are still minimal, so additional procurement is needed, such as a water pump machine to help distribute water to agricultural land above the Glapan Weir. In the engine criteria, the most prioritized alternative is the need for tools with a weight value of 0.405.

The need for irrigation system support equipment in Glapan Dam is still very high. The equipment needed for pumps, sluice gates, soil hoes, discharge gauges, and other equipment still needs to be added. In order to procure the

equipment, it is necessary to have coordination between interested parties so as not to throw responsibilities at each other.

The fourth priority criterion in the strategy of optimizing the irrigation system in Glapan Weir is the human criterion with a weight value of 0.100. Human resources are an aspect that cannot be ignored in the management of irrigation systems. The quality of human resources has an important role in the management of the irrigation system.

As explained in the research of Mahendradhata et al. (2014) that the quality and competence of human resources will affect the success of irrigation system management. So far, the quality of human resources in managing irrigation systems in Glapan Weir is still limited and dominated by elderly farmers. Their competence is also minimal, so they need training and assistance.

The most prioritized alternative on the human criteria in collaboration with a weight value of 0.497. Cooperation and coordination of human resources in the Glapan Weir irrigation system is very important. This is intended so that irrigation management can run effectively and efficiently. There needs to be a division of tasks and responsibilities as well as guarantees of equal rights to water so as not to throw responsibilities at each other and minimize conflicts.

CONCLUSION

Based on the results and discussions that have been described, it can be concluded that the Glapan Dam irrigation system in Gubung District, Grobogan Regency has not been running optimally due to various obstacles and problems. The first obstacle is the silting of the Tuntang River due to sedimentation as the upstream part of the Glapan Dam, thereby reducing the water supply. The second obstacle is the lack of availability of operational funds in the management of the irrigation system.

The third obstacle is the lack of availability of supporting tools and facilities such as pump machines, sluice gates, and discharge measuring devices. While the fourth obstacle is the lack of cooperation and coordination between relevant stakeholders. Based on AHP analysis, the most prioritized criteria in the strategy of optimizing the irrigation system in Glapan Weir for increasing agricultural yields is the money criterion with a weighted value of 0.520. The second priority criterion is a method with a weight of 0.203 and a last priority criterion is a machine with a weight value of 0.176.

While the first priority alternative in the strategy of optimizing the irrigation system for increasing agricultural yields is an alternative to government funds with a weighted value of 0.211. The second priority alternative is membership dues with a weighted value of 0.166. While the last priority alternative is the human resource initiative with a weight value of 0.005. The suggestions that can be given in this study are that irrigation problems in Glapan Weir are the joint responsibility of related parties from the government, private sector, and farmers.

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