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# Optimation Budgeting DistributionModel for Maintaining Irrigation Scheme

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**Abstract** - *Utilization of palm oil by-product such as palm fronds, leaves, empty fruit bunches (EFB), fiber fruit juice (FFJ), palm to maintenance of irrigation structures are the activities carried out routinely in irrigation areas in order to obtain optimum performance. Required costs of maintenance is provided by government based on the commanding area of irrigation area without taking into account the characteristics of each irrigation area. On the other hand the fund which is provided by the government for the purpose of maintenance of irrigation assets amounting to 40 % of the required, so that necessary special tips is needed to take optimum result of the limited funds to choose which priority irrigation structures. While this selection irrigation structures are maintained/repaired just based on policy of decision makers only. The purpose of this research was to develop an optimization model for distribution of irrigation maintenance cost allocation for the irrigation areas and make selection to priority irrigation structures for maintenance in order to get optimum results. Location of the research is the Pondok Irrigation Area (IA) which located in East Java province. This irrigation area is part of the region Central River Region Solo. Pondok IA. consist of 4 irrigation areas, namely: Dero IA., Sambiroto IA., Padas IA. And Plesungan IA. The study was conducted in two stages : Stage 1 with the aim of allocating the cost of maintenance for each irrigation area in Pondok IA., which are Dero IA., Sambiroto IA., Padas IA. And Plesungan IA. Stage 2 with the aim of making choice for the priority irrigation structures are maintained/repaired on Dero IA., Sambiroto IA., Padas IA. And Plesungan IA. The method used is multi criteria analysis by Analytical Hierarchy Process (AHP) with using a soft ware expert choice 2000. To complete Stage 1used multiple criteria analysis of three levels, with the top level is Pondok IA., then the second level is below, named criterias which consists of four criterias, namely: Level of Urgency, Productivity, Commanding Area and Cost with in ratio of 4: 3: 2: 1. The lowest level is named alternatives which consisted of four irrigation areas, namely Dero IA., Sambiroto IA., Padas IA., and Plesungan IA. The data used in this research is PAI Solo data in 2011. Stage 2 of this study is selection priority structures in each irrigation area for maintenance / repair. In this analisis is used multi-criteria analysis also, where as the top level is the name of each irrigation area. As criteria there are three criterias, namely: Productivity, Service area, Cost of structure with the weight of each: 3: 2: 1. As the lower level is alternative, which here are the name of the proposed structures. The proposed structures and their specifications are taken from PAI Bengawan Solo data in 2011. The structures which analysed are the structures which in very urgent and urgent condition only. The result is a list of priority irrigation structures which would be maintained from each irrigation area. Results of the research Stage 1 : From costs available for Pondok IA. IDR 749,880,000.-. Dero IA., receive IDR 216,715,320.-; Sambiroto IA., receive IDR 207,716,760.-; Padas IA., receive IDR 173,222,280.-; and Plesungan IA., receive IDR 151,475,760.-. Results of the Stage 2 study is priority structures which would be maintained on each irrigation areas, namely: Dero IA., the name of the structures are: SSDOKa11, BDOKi1, BDOKa6, BDOKa15, SSDOKa14, SSDOKa15, SSDOKa17, SSDOKi1, SSDOKi2.*

**Keywords**—*AHP, irrigation structures, maintenance costs, multicriteriaanalysis*

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## I. INTRODUCTION

Indonesia is an agricultural country, where most people have a livelihood as farmers and are dependent on agriculture. With an area of paddy fields, which reached 7,145,168 ha. million ha [32], of the total area is divided into three responsibility namely, the central government, provincial and regency/city governments. Total irrigation area the responsibility of the central government there is about 2,374,521 ha. This time from the area there are about 734,820 ha of tertiary irrigation networks damaged. Repair of irrigation be the priority of government to increase the national food production, especially rice. Rice cultivation is contributing to 85 percent of national rice production in 2009 and 2010.

Maintenance of irrigation scheme for the whole of Indonesia requires substantial costs annually, which allocation has been provided either from the central government and local governments have not been able to meet the cost requirements for maintenance of irrigation scheme from each Irrigation Area (IA). The government can only provide maintenance funds portion of the total cost of maintenance. In accordance with existing standards, the Government through the Ministry Public Works and People Housing (PUPERA) provide funds needed for asset maintenance of irrigation per year, amounting to IDR 160,000, - / ha / year in which this number is smaller than that required in the amount + IDR 250,000 / ha / year. Based on data from the Directorate General of Water Resources Development that the provision of funds for irrigation management in 2006-2009 amounted to IDR 12,836 billion from central government, IDR 45,695 billion from provincial and IDR 254,175 billion from regency so that the irrigation management is only allocated at IDR 46,675. - / ha [31] whereas Operation and Maintenance requirements (O and M) is IDR 150,000 - IDR 250,000 per hectare ± 25% of the average OM needs around IDR 200,000. / ha [11].

Urgency level of irrigation there are four categories, namely: [14]

- "Extremely Urgent" that need to be implemented within 1 (one) or two (2) years after inventory
- “Urgent" that need to be implemented in the handling of three (3) years after the inventory
- "Less Urgent" that can be implemented in the handling of 4 (four) years after the inventory; and
- "Long Term" is that it can be implemented in the handling of five (5) years after inventory.

Another disadvantage of limited maintenance fund management, is the decline in the fund only broad-based irrigation area without taking into account the characteristics of each irrigation area. This led to inequality in the field. Inequality is irrigated areas with a large area, will receive greater funding though the channel maintenance and the number of the structure a little short. Conversely large irrigated areas smaller services, will receive little maintenance funds though the irrigation area has a long line with a number of structures more. When in fact the area irrigated by the channel length and number of structure more although the area is small, it will require more maintenance costs than irrigated areas which the area is vast but short channel and the number of the structures slightly.

Another thing that has not been taken into consideration when determining the amount needed in maintenance costs is the level of urgency, productivity, and cost required. Structure with more urgency level is very urgent priority in the maintenance of the degree of urgency than structure long-term improvement.

High productivity of the structure will be a priority for the maintenance comparing with the structure in low productivity. One large structure with large funding needs maintenance will absorb most of the funds for maintenance of the several small structures that require less maintenance costs. Other imbalances that occur are large irrigated areas with fewer structures will receive maintenance funds larger than the smaller irrigation areas with more number of structures.

Although the degree of urgency of the assets of irrigation in irrigated areas that wider is actually not urgent, compared with a more narrow irrigation area. These things had not been taken into consideration in determining the allocation of the cost of maintenance and the selection of the structures. Given the many weaknesses that occur in the field in the distribution of funds for the maintenance of irrigation assets, it would require a new method of managing asset maintenance costs of irrigation with multicriteria analysis. The research is expected to create new method in allocation of maintenance funds from Government better to each irrigation area. Determination of selected structures to be repaired / maintained, according to the funds available, priority handling of irrigation assets with different variables existing funds will obtain optimal performance.

## II. Research objectives

The research objective is to do things as follows:

1) Conduct analysis of multi criteria for the allocation of asset maintenance costs of irrigation to each irrigation area, taking into account the level of urgency, productivity, extensive services and the cost of each irrigation area
2) Conduct analysis of multi criteria for selection of priority maintenance of each irrigation area by considering factors: productivity, extensive service and cost needed at each irrigation area in accordance with existing funds.
3) Develop a funding allocation modeling and sensitivity analysis for routine maintenance of irrigation areas with Pondok Irrigation Area.

## III. Reference study

Irrigation Asset Management (PAI).

Irrigation Asset Management (PAI) is an irrigation method to inventory the data used for the purpose of maintenance or repair work on an irrigation net work in specific Irrigation Area. Irrigation asset management itself is done by using software. The software used is PDSDA-PAI (BBWS Solo 2011, Final Report of Phase II PAI Semen Krinjo IA. and Pondok IA.

Succes Indicator of Maintenance Activity.

Success indicators of the Maintenance Activity: [14]

a) The fulfillment of the channel capacity in accordance with the design capacity.
b) Maintaining the condition of structures and channels:
   - Good condition if the level of damage <10 % of the initial condition of the structure and the channel, required regular maintenance.
   - Lightly damaged condition if the level of damage 10-20 % of the initial condition of the structures and the channel, required periodic maintenance.
   - Conditions damaged if the level of damage 21-40 % of the initial condition of the structures and the channel, the necessary repairs.
   - The condition severely damaged if the level of damage > 40 % of the initial conditions, structures and ducts, needed heavy repairs or replacement.

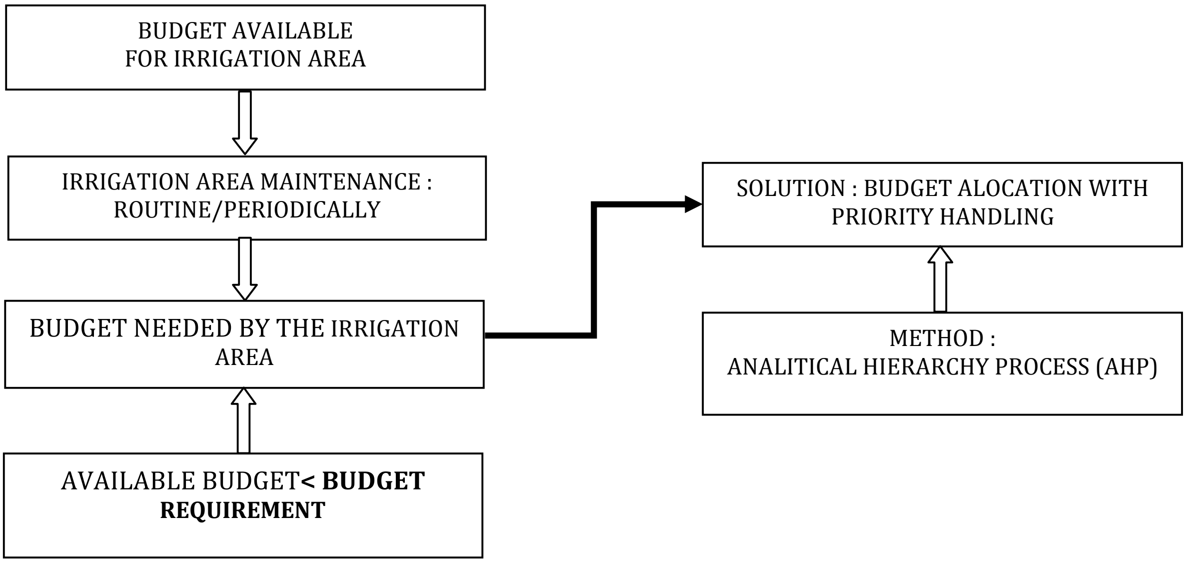


Figure 1. Flow chart for disaster problem.

O &M does not show the true costs involved in an irrigation area. The challenge now is to maintain the existing infrastructure and to fix it in terms of water use efficiency and cost-effectiveness [12]. Good maintenance can help prevent losses due to reduced production, effectively extending the irrigation system and delay the need for new investment in the rehabilitation or modernization [23]. Irrigation problems in Thailand is: Do not respond to the needs of farmers, poor system maintenance, water allocation is insufficient, the water supply is not at an appropriate time [20] .The Chalenge now is to maintain the existing infrastructure and to fix it in terms of water use efficiency and cost effectiveness. [12].

Irrigation management is limited by changes in land use and watershed characteristics, population increase in irrigated areas and lead to fragmentation of land, as well as increased intra-sectoral (sectors such as agriculture) and the demands of a cross-sectoral [30]. In principle, Japanese farmers pay operating and maintenance costs and a portion of capital recovery for district land and irrigation officers serving basic level is a semi-autonomous regency [19].

Different with other developing countries where the activities of O & M channel implemented by the government, that in Japan O & M network of irrigation water is done entirely by the farmers, with the aim of spurring self-reliance of farmers in irrigation asset management. In the implementation, farmers in each region (chiku) making organization that aims to regulate and manage the assets named Land Improvement District (tochikairyouku) or LID. This organization, a sort of farmer water user associations WUA or (P3A) in Indonesia, but the wider the scope responsibilities include O & M network, including water distribution arrangements [1].

Asset Management Plan is a life document, so that this document should be reviewed and updated every year [24].

The question that often arises when doing the design of irrigation projects or feasibility studies is how the maintenance required for the system and how much it costs to be incurred [7]. Problems faced by the irrigation system in China is a decrease in channel conditions, shortage of funds, the decline in concern for farmers to economize water. While the problems faced by the irrigation system in Vietnam is irrigation officer must find additional revenue, which is impacting on the effectiveness in the work [5]. Deterioration of irrigation infrastructure in developing countries has long been identified as a serious impediment to sustainable development. The annual funds available for maintenance only about 1% of the construction costs, and these funds are totally inadequate to halt the deterioration in the long term [16].

Irrigation assets will gradually decline and massive action must be taken to replace damaged equipment in the life of servants [29].

Application of efficiency can be varied within the system, caused by [10]:

-The difference in design, maintenance and management of the system
-Environmental factors such as soil type, crop development stages, time of year and climate conditions
- Availability of water and potential value for other purposes
- Economic factors such as commodity and fuel prices.

The irrigation system consists of a set of inter connected sub systems and is connected physically and functionally. This connection hierarchically continuously until the water channelled to the level of the fields, as the final users. So that every level of interdependent sub systems to meet the next level for best operation [30]. Necessary maintenance of irrigation and drainage systems are adequate for the sustainability of irrigation water delivery and dispose of the excess. It is necessary for the organization of management to the success of maintenance and also needed an efficient and effective technology for the solution [6].

Physical causes of poor quality of irrigation networks can be divided into 2 categories:

1) the existence of infrastructure damage,
2) as a result of the design.

Resources available to perform maintenance or repair, or due to changes in the surrounding environment or the upstream region so that the irrigation network inmthe region damaged [27].

Operation and maintenance of adequate infrastructure facilities of irrigation will make sustainable irrigation networks, reducing the cost of repairs, help systems can be longevity of service, and maintain irrigation efficiency at the design level [18]. Management of network assets at Cimanuk IA. still not up, this is caused by the lack of concern of the government and the surrounding community irrigation network (GP3A / P3A), also with budget constraints and limited human resources are an important factor. Problems of O & M of irrigation of paddy fields in the humid tropics of Asia is feared will make people behave resistance and can potentially lead to anarchy and chaos, when the design standards O &M plunged [10].

Irrigation management is one of the main supporters of the sector for the successful development of agriculture, especially in order to increase food production, especially rice. But in its development of irrigation management performance has decreased due to several reasons such as: the maintenance activities; repair or maintenance of irrigation networks were delayed (divert maintenance); damage due to man-made and natural disasters [22]. Condition of irrigation networks in various regions in Indonesia damaged and poorly functioning before the age of the structures runs out. Operation and maintenance of irrigation has not shown the quality of irrigation water services are fair and equitable [28]. Almost all of the assets under management is aiming to maintain in order to achieve standards of care [26]. In Yemen, like other developing countries, not all O & M needs sufficient and consequently cause a few problems and obstacles [8]. ). Currently, the availability of funds operation and maintenance of irrigation networks has reached less than 50% of needs, so a lot of irrigation networks be maintained and the consequences are more expensive because of the irrigation network must be rehabilitated [4].

Society at the regency level to worry because obscurity opportunity to obtain operational and maintenance costs of irrigation are enough [2]. The construction of dams and reservoirs in Japan on one side benefit, but on the other hand bring the problems associated with funding for the purpose of operation and maintenance of irrigation. In different to developing countries that O & M channel implemented by the government, O & M of water network in Japan left entirely to farmers, with the aim of spurring self-reliance of farmers in irrigation asset management [1]. This is now required maintenance of irrigation and drainage systems are adequate to deliver water that is needed and can be sustained [6]. The performance indicators indicated by the number of irrigation water supply to water users [13]. Irrigation a development process is quite complex, requiring a monitoring and evaluation mechanism [25].

Sustainability of the irrigation system embodied in the asset management carried out by the government as the owner of the irrigation network [31]. Management of irrigation networks greatly influenced by infrastructure and field workers [17].

Problems that occur in the operation of irrigation canals that may be indicative of a channel with low productivity, is the low efficiency of water distribution, especially at the tertiary channels. This happens due to inaccurate implementation of the operational management of channels which can create conflict. Compared with Vietnam, to the Regional Irrigation Cu Chi cost to repair / rehabilitation varies between US $ 41.00 / ha and US $ 28.00 / ha where the interest rate in the range of 3% and 9%.

As for the Regional Irrigation Dan Hoai varies between US$ 33.00/ha and US$ 22.50/ha. [15]. The most important obstacle faced to spur growth in food production, especially Rice land is the decline in capacity caused by over-intensification in paddy fields and irrigation quality degradation [27]. The performance of the irrigation system is determined by five indicators, namely: overall consumption, relative water supply, removing chunks, lack of water plants, and relative evaporation [13].

## IV. RESEARCH HYPOTESIS

Phase 1 of this study is the method of multi criteria analysis will be generated allocating irrigation asset maintenance costs for each irrigation area more equitable and realistic. This happens because it takes into account the level of urgency, productivity, extensive services and the cost of each irrigation area. In the Phase 2 study with multi criteria will be selected method of priority structures to be maintained / repaired. In this analysis there are three criteria, namely: productivity, extensive service and cost. This second phase of analysis performed on each irrigation area, so there are 4 analysis with 4 results. In this paper presented analysis for Dero IA.

Situation of the Administrative Area BBWS Bengawan Solo is shown in Figure 2 and Pondok Irrigation Area is shown in Figure 3.

Table 1. Maintenance Budget Recapitulation for Irrigation Area in BBWS Bengawan Solo.

| No. | IA. Name | Budget Plan(Rp) (IDR) | VAT. (10%) (IDR) | Total Cost (IDR) | Rounded (IDR) |
|---|---|---|---|---|---|
| 1 | **Pondok IA.** | **681,709,297.08** | **68,170,929. 1** | **749,880,226.78** | **749,880,000.00** |
| 2 | Gombal Dupok IA. | 110,381,473.59 | 11,038,147.36 | 121,419,620.95 | 121,419,000.00 |
| 3 | Sungkur IA. | 716,570,582.59 | 71,657,058.26 | 788,227,640.85 | 788,227,000.00 |
| 4 | Prijetan IA. | 123,863,378.29 | 12,386,337.83 | 136,249,716.12 | 136,249,000.00 |
| 5 | Beron IA. | 26,047,793.09 | 2,604,779. 1 | 28,652,572.40 | 28,652,000.00 |
| 6 | Semen Krinjo IA. | 104,171,306.12 | 10,417,130.61 | 114,588,436.74 | 114,588,000.00 |
| | | | Total Maintenance Cost | | 1,939,015,000.00 |

Source : PAI Bengawan Solo Report, 2011.

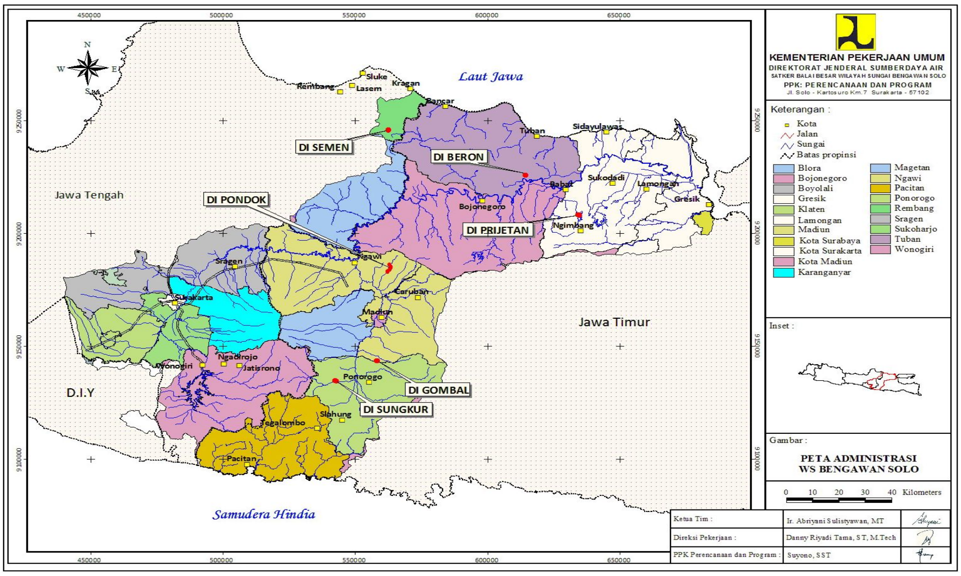


Figure 2. Administrative Area of BBWS Bengawan Solo. *Source : PAI, 2011.*

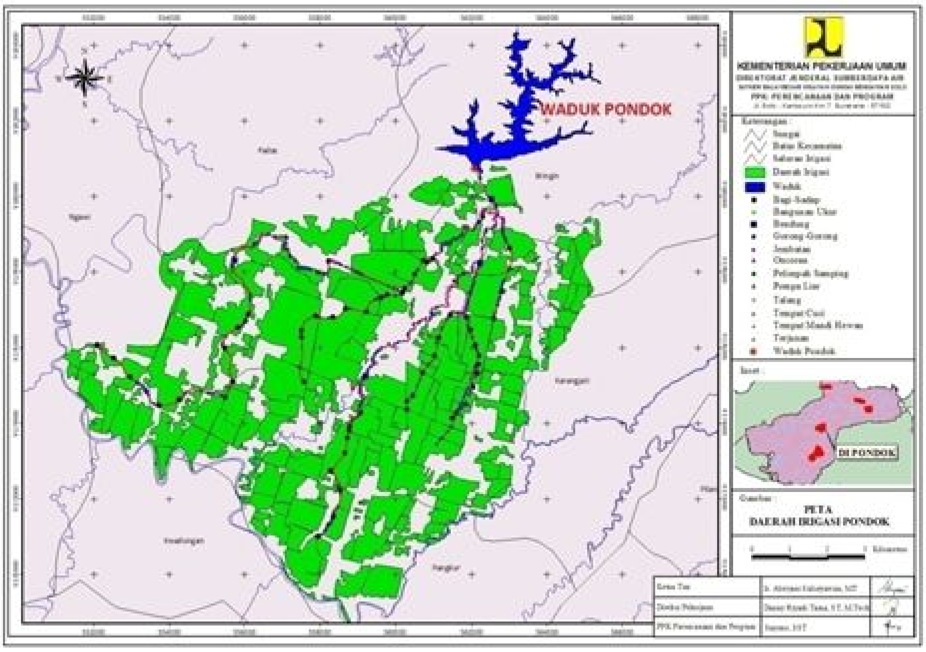


Figure 3. Pondok Irrigation Area Map.

*Source : BBWS Bengawan Solo, Final Report PAI Phase 2, 2011.*

From the allocation of funds for Pondok IA. IDR 749, 880, 000. - should be distributed on four irrigation areas, the Dero IA. , Sambiroto IA., Padas IA., and Plesungan IA. proportionately. The amount of funds for the maintenance of each irrigation area of the Pondok IA. is dependent on the policy determinants of River Region Great Office Solo River (BBWS Bengawan Solo). The information / data obtained from the Asset Management of Irrigation (PAI) is a type of asset, structures names, nomenclature, condition of structures, functions, costs of necessary maintenance, service area, the level of urgency and productivity. Types of assets consists of three kinds, namely: weir, secondary channels and distribution structures.

The condition of the structures is based on a visual assessment of structures, consisting of Good (B), Light Damaged (RR), and Heavy Damage (RB). The function of the structures is based on the level of service the structures is composed of: Good (B), Less Good (KB) and Not Working (TB). Total maintenance cost required is the result of PAI based on the estimated percentage of damage to structures in the value of assets. Extensive irrigation service area is structures, which is divided into: Long Term (JP), Less Urgent (KU), Urgent (U) and Very Urgent (SU).

Productivity is the percentage of the service level of the structures. From the results obtained PAIfunding needs of each structures, the amount of the overall cost of maintenance is needed on the funding needs of the irrigation area PAI, based on he results of 2011. The funding requirements for each irrigation area of The Pondok IA, is as follows:

Table 2. Budget Requirement Recapitulation for maintenance in Pondok IA. based on PAI 2011

| Dero IA. | Sambiroto IA. | Padas IA. | Plesungan IA. | Total |
|---|---|---|---|---|
| (IDR) | (IDR) | (IDR) | (IDR) | (IDR) |
| 232,626,668 | 514,745,119 | 1,003,284,614 | 25,833,547 | 1,787,170,038 |

*Source : PAI Bengawan Solo Report, 2011* [3]
*Notes : Maintenance budget above is for Secondary Channels and Distribution structures only, not inculded Weir, Foot Bridges, Washing steps and Drain primary channels.*

Here we can see that the allocation of maintenance funds available from the government amounting to IDR749.88 million, -for maintenance is insufficient compared to the needs of maintenance funds, which amount is derived from PAI IDR 1,787,170,038. In such circumstances must be taken policy of how to organize the distribution of the available funds in order to obtain optimum results.

To finish this case will be solved in two stages, namely:

- Phase 1: determine the distribution of the allocation of funds from the Government to each irrigation area.
- Phase 2: determining the order of priority buildings to be repaired from each irrigation area and decided to sequence where the structures will be repaired in accordance funds obtained for each irrigation area.

To finish Phase 1 Multi Criteria Analysis model was used, with four criteria, namely: Level of Urgency, Productivity, and Cost Service Area. For the assessment of the four criteria are used weights from 1 to 4: Level of Urgency weight 4, Productivity weights 3, Service area weigts 2 and Cost weights1. The basis of this weighting is based on the results of the questionnaire are interpreted by researcher.

The urgency level is divided into four levels, namely:
- Long Term (JP), weight: 1
- Less Urgent (KU), weight: 2
-Urgent, (U), weight: 3
-Extremely Urgent, (U) weight: 4.

In this study assessment for each irrigation area , weirs is not taken into account by assuming almost the entire weirs is in condition and in Long Term (JP) urgency level, except under conditions weir Plesungan Urgent (UR). For Padas IA., the primary drainage channel was not analyzed, for PlesunganIA., foot bridges, and washing steps were not analyzed.

As criteria for Phase 1 are: Level of Urgency weight 4, Productivity weight 3, Service area weight 2 and Cost weight 1. The result of the highest allocated budget is Dero IA., and than Sambiroto IA., Padas IA. and Plesungan IA. Results from Phase 1 is the coefficient of the cost of maintenance for each irrigation area. The coefficient multiplied by the maintenance costs of the government will result in maintenance costs for each irrigation area.

To finish Phase 2 is used also models Multi Criteria Analysis for each irrigation area. As a criterion in this phase are: Productivity, Service Area, and the Cost for each structure in the irrigation area. Productivity criteria value, the service area criteria at the ost criteria of this alternative is based on the results of PAI in each irrigation area. As alternative in Phase 2 is the name of each structure on each irrigation area in conditions Very Urgent SU) or Urgent(UR) and Very Urgent (SU) only, with consideration of the structures in a state of Long-Term (JP) and Less urgent (KU) are not urged to be maintained / repaired given the limited.

From the order of priority the maintenance of structures obtained from Phase 2 is to be determined until the bottom of the order which, structures on the irrigation area can be maintained / improved in accordance with existing funds from the Government.

## V. Research sampling

The design of the sample used in this research is data from the Irrigation Asset Management data of Pondok IA. which has been done in 2011, coupled with the respondent considered able to give their opinions and ideas relating to the profession and expertise.

Respondents are managers of irrigation in the BBWS Bengawan Solo, which is a determinant of policy implementation of the operation and maintenance of irrigation networks. As the calibration is real data from the use of the proposed maintenance costs in 2011 for maintenance irrigation area.

Phase 1 in this analysis as the top is the distribution of maintenance funds in Pondok IA. Diagram of the process of the analysis as shown in Figure 4.

Next Phase 2 is to determine structures that is the priority ranking gets maintenance costs. The composition of the ranking of the structures that receives the maintenance costs will be stopped according the allocation of existing maintenance budget on the irrigation area. Diagram of the process of the analysis as shown in Figure 5.

## VI. Multi criteria Analysis Phase 1

Performed the analysis process Phase 1 Multi criteria using Expert Choice 2000 with four criteria, namely: Level of Urgency, Productivity, and Cost Service Area. Alternatively whereas there are four, namely: Dero IA, Sambiroto IA, Padas IA, and Plesungan IA. Result obtained from this analysis is the weight distribution of maintenance costs of each irrigation area. Display results of running the multi-criteria analysis as shown in Figure 6 and Figure 7.

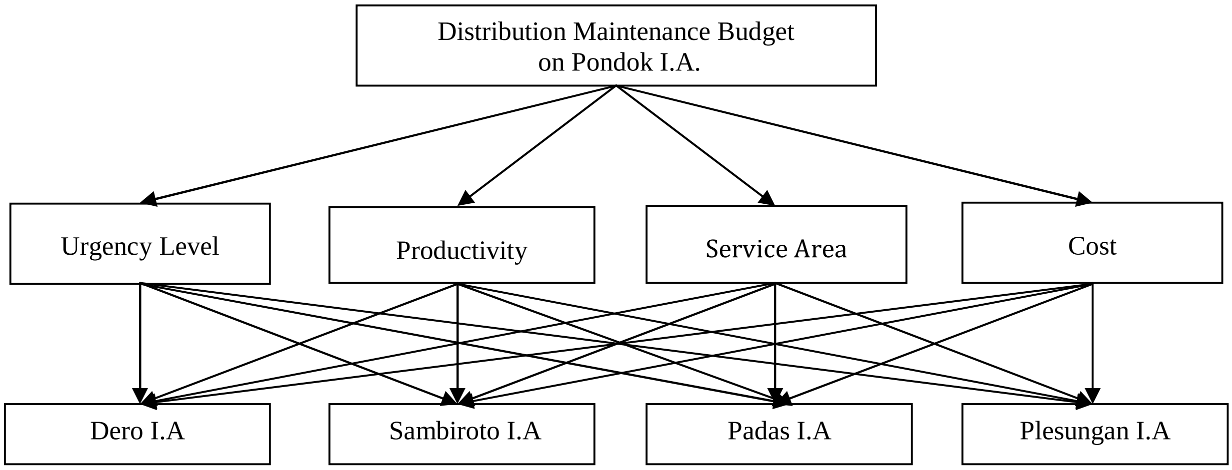


Figure 4. Hierarchy Structure Model for Maintenance Budget Distribution on Pondok IA.
(Multi criteria Analysis Phase 1)

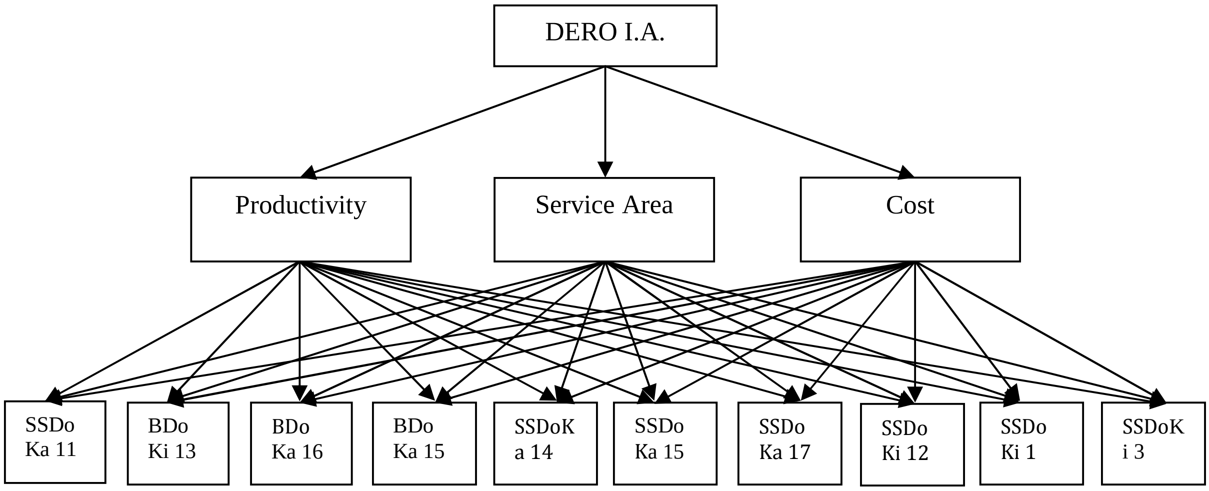


Figure 5. Hierarchy Structure Model for structure maintenance priority of Dero IA.
(Multi criteria Analysis Phase 2).

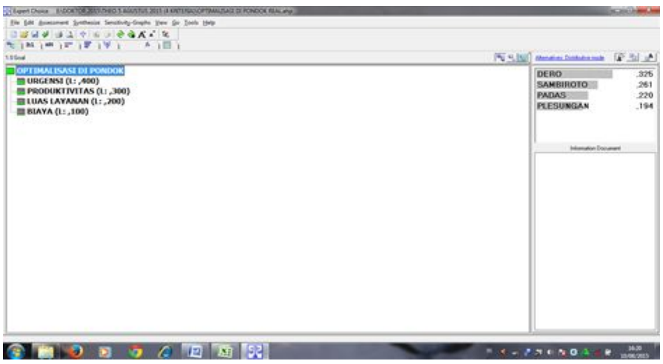


Figure 6. Display of Urgency, Productifity, Service Area, and Cost in ratio 4 : 3 : 2 : 1.

Display the results of running the 2000 Expert Choice for optimizing asset maintenance Pondok IA. Phase 1, which is to determine the allocation of funds to four irrigation areas. The number of criteria there are four, namely: Level of Urgency, Productivity, Total Service, and Cost with a ratio of 4: 3: 2: 1. On the left side is a comparison of the level of urgency, Productivity, Area Services, and cost. Level of Urgency 0.400, Productivity 0.300; Services spacious 0.200; and Costs 0.100.

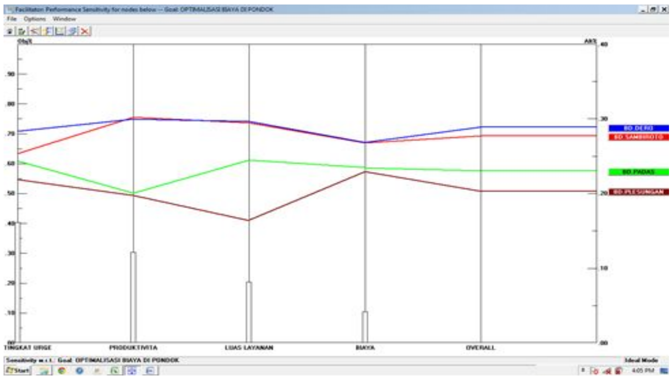

Figure 7. Sensitivity display of maintenance budget distribution for Pondok IA. asset based assumption Urgency level : Productivity : Service Area : Cost = 4:3:2:1 for four (4) irrigation areas, Dero, Sambiroto, Padas and Plesungan IAs.

Criteria weighting display and Alternative Distribution Maintenance Cost Optimization Model Irrigation of Expert Choice 2000 software, with running Phase 1 results presented in Figure 5.3. Alt% marked right axis shows the weight of alternative elements, while the left axis is marked Obj% weighting criteria. The intersection of alternate lines with vertical bars indicate the weight alternative to these criteria, and is read from right axis labelled Alt%. Weighting the criteria indicated by the peak rod, read from left axis labelled %Crit.

The overall weight of each alternative is shown on the trunk OVERALL. OVERALL legible on the weight of the largest budget allocation is Dero IA.

From the figure above shows that the funding available is only about 42% of the requirement. Further allocations of funds obtained for each of the irrigated area analyzed by the method of multiple criteria for each irrigation area, so there are four processes of analysis is to Dero IA., Sambiroto IA., Padas IA., Plesungan IA. which is an analysis of the Phase 2.

Table 3. Maintenance Budget distribution from Government and Required Budget from PAI :

| Budget Distribution based on each weight of weirs (MC. Analisis) | | | Required Budget (PAI) |
|---|---|---|---|
| DERO Weir | 0.289 * IDR 749,880,000 = | IDR 216,715,320.- | IDR 232,626,668.- |
| SAMBIROTO Weir | 0.277 * IDR 749,880,000 = | IDR 207,716,760.- | IDR 514,745,119.- |
| PADAS Weir | 0.230 * IDR 749,880,000 = | IDR 173,222,280.- | IDR 1,005,284,614.- |
| PLESUNGAN Weir | 0.203 * IDR 749,880,000 = | IDR 151,475,760.- | IDR 34,513,637.- |
| | TOTAL | IDR 749,880,000.- | IDR 1,787,170,038.- |

## VII. MULTI CRITERIA ANALYSIS PHASE 2

Analyzing the Phase 2 was conducted 4 times, according to the number of irrigation areas, namely Dero IA., Sambiroto IA., Padas IA. and Plesungan IA. with alternative according to the number of structures that were analysed in each irrigation area.

Table 4. Channels and Structure Productivity matrixs of Dero IA.

| BIAYA | BDOKA15 | BDOKA16 | BDOKI13 | SS DO Ka 11 | SS DO Ka 14 | SS DO Ka 15 | SS DO Ka 17 | SS DO Ki 1 | SS DO Ki 2 | SS DO Ki 3 |
|---|---|---|---|---|---|---|---|---|---|---|
| BDOKA15 | 1,000 | 3,000 | 3,993 | 9,709 | 81,375 | 5,941 | 1,985 | 33,998 | 1,679 | 8,096 |
| BDOKA16 | | 1,000 | 11,979 | 3,236 | 244,125 | 1,980 | 1,511 | 11,333 | 5,038 | 2,699 |
| BDOKI13 | | | 1,000 | 38,768 | 20,379 | 23,723 | 7,926 | 135,757 | 2,378 | 32,326 |
| SS DO Ka 11 | | | | 1,000 | 790,055 | 1,634 | 4,891 | 3,502 | 16,304 | 1,199 |
| SS DO Ka 14 | | | | | 1,000 | 483,453 | 161,531 | 2766,623 | 48,459 | 658,773 |
| SS DO Ka 15 | | | | | | 1,000 | 2,993 | 5,723 | 9,976 | 1,363 |
| SS DO Ka 17 | | | | | | | 1,000 | 17,128 | 3,333 | 4,078 |
| SS DO Ki 1 | | | | | | | | 1,000 | 57,092 | 4,200 |
| SS DO Ki 2 | | | | | | | | | 1,000 | 13,594 |
| SS DO Ki 3 | | | | | | | | | | 1,000 |

Productivity weighting for the structures of Dero IA., then made pairwaise matrix. There are 10 structures that were analysed were in a state of very urgent (SU) and urgent (UR), namely: BDOKa15, BD0Ka16, BDOKi13, SSDOKa11, SSDOKa14, SSDOKa15, SSDOKi17, SSDOKi1, SSDOKi2, SSDOKi3.

Table 5. Service area matrix of Channels and Structures in Dero IA.

| BIAYA | BDOKA15 | BDOKA16 | BDOKI13 | SS DO Ka 11 | SS DO Ka 14 | SS DO Ka 15 | SS DO Ka 17 | SS DO Ki 1 | SS DO Ki 2 | SS DO Ki 3 |
|---|---|---|---|---|---|---|---|---|---|---|
| BDOKA15 | 1,000 | 1,176 | 11,912 | 1,235 | 2,267 | 1,000 | 2,235 | 14,706 | 14,265 | 11,912 |
| BDOKA16 | | 1,000 | 10,125 | 1,050 | 2,667 | 1,176 | 1,900 | 12,500 | 12,125 | 10,125 |
| BDOKI13 | | | 1,000 | 9,643 | 27,000 | 11,912 | 5,329 | 1,235 | 1,198 | 1,000 |
| SS DO Ka 11 | | | | 1,000 | 2,800 | 1,235 | 1,810 | 11,905 | 11,548 | 9,643 |
| SS DO Ka 14 | | | | | 1,000 | 2,267 | 5,067 | 33,333 | 32,333 | 27,000 |
| SS DO Ka 15 | | | | | | 1,000 | 2,235 | 14,706 | 14,265 | 11,912 |
| SS DO Ka 17 | | | | | | | 1,000 | 6,579 | 6,382 | 5,329 |
| SS DO Ki 1 | | | | | | | | 1,000 | 1,031 | 1,235 |
| SS DO Ki 2 | | | | | | | | | 1,000 | 1,198 |
| SS DO Ki 3 | | | | | | | | | | 1,000 |

Size of the weighting for structures services Dero IA., then made pairwaise matrix. There are 10 structures that were analyzed were in a state of very urgent (SU) and urgent (UR), namely: BDOKa15, BD0Ka16, BDOKi13, SSDOKa11, SSDOKa14, SSDOKa15, SSDOKi17, SSDOKi1, SSDOKi2, SSDOKi3.

Tabel 6. Cost Matrix of Channels and Structure Dero IA.

| BIAYA | BDOKA15 | BDOKA16 | BDOKI13 | SS DO Ka 11 | SS DO Ka 14 | SS DO Ka 15 | SS DO Ka 17 | SS DO Ki 1 | SS DO Ki 2 | SS DO Ki 3 |
|---|---|---|---|---|---|---|---|---|---|---|
| BDOKA15 | 1,000 | 1,000 | 1,775 | 1,250 | 1,250 | 1,333 | 1,333 | 2,000 | 1,500 | 1,333 |
| BDOKA16 | | 1,000 | 1,775 | 1,250 | 1,250 | 1,333 | 1,333 | 2,000 | 1,500 | 1,333 |
| BDOKI13 | | | 1,000 | 1,420 | 1,420 | 2,367 | 2,367 | 1,127 | 1,183 | 2,367 |
| SS DO Ka 11 | | | | 1,000 | 1,000 | 1,667 | 1,667 | 1,600 | 1,200 | 1,667 |
| SS DO Ka 14 | | | | | 1,000 | 1,667 | 1,667 | 1,600 | 1,200 | 1,667 |
| SS DO Ka 15 | | | | | | 1,000 | 1,000 | 2,667 | 2,000 | 1,000 |
| SS DO Ka 17 | | | | | | | 1,000 | 2,667 | 2,000 | 1,000 |
| SS DO Ki 1 | | | | | | | | 1,000 | 1,333 | 2,667 |
| SS DO Ki 2 | | | | | | | | | 1,000 | 2,000 |
| SS DO Ki 3 | | | | | | | | | | 1,000 |

Size of the weighting for structures services Dero IA. , then made pairwaise matrix. There are 10 structures that were analyzed which in a state of very urgent (SU) and urgent (UR), namely: BDOKa15, BD0Ka16, BDOKi13, SSDOKa11, SSDOKa14, SSDOKa15, SSDOKi17, SSDOKi1, SSDOKi2, SSDOKi3.

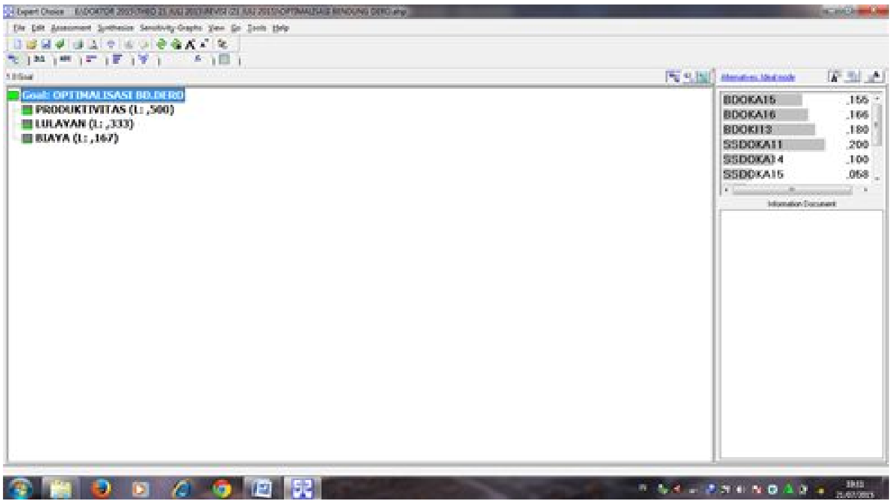


Figure 8. Optimalization of Dero IA. asset manitenance with 3 criteria : Productivity, Service Area, Cost of structure in ratio 3:2:1

Display the results of running the Expert Choice 2000 for optimizing asset maintenance Dero IA., with 3 criterias of Productivity, Area Services, and Cost with a ratio of 3: 2: 1. On the left side is a comparison of productivity, service area, and the cost written Productivity 0.5; Services area 0.333; and the Cost of 0.167.

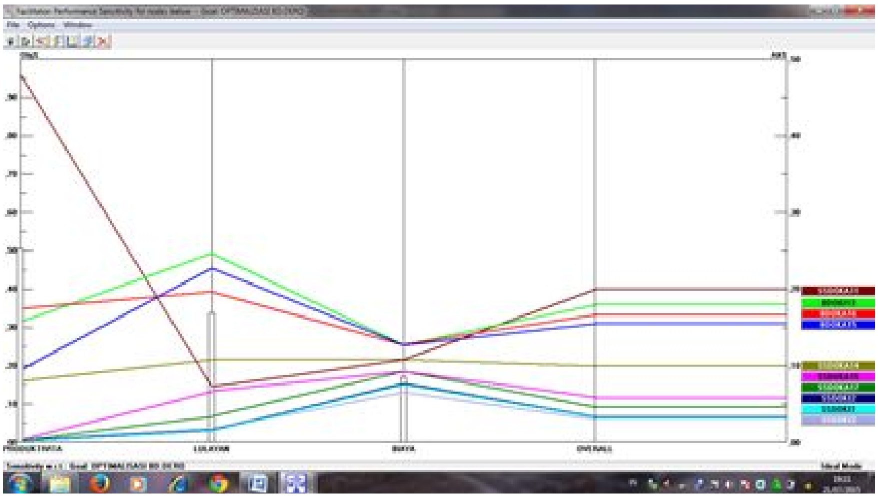

Figure 9. Optimalization Maintenance Asset Weight Distribution in Dero IA, in 3 criteria : Productivity, Service area, Cost in ratio = 3 : 2 : 1.

Criteria weighting display and Alternative Distribution Maintenance Cost Optimization Model Irrigation of Expert Choice 2000 software, the running results are presented in Figure 9. Alt% marked right axis shows the weight of alternative elements, while the left axis is marked Obj% weighting criteria. The intersection of alternate lines with vertical bars indicate the weight alternative to these criteria, and is read from right axis labelled Alt%. Weighting the criteria indicated by the peakrod, read from left axis labeled% Obj. The overall weight of each alternative is shown on the trunk OVERALL.

From the results of this analysis are obtained building could be maintained / repaired and were not handled in accordance with the estimated maintenance cost obtained from PAI, shown in Table 7.

Table 7. Required Fund for each structures and channels of Dero IA.

| No. | Structures/ Channels Name | Weight | PAI Budget (IDR) | Cumulative (IDR) |
|---|---|---|---|---|
| 1 | SSDOKA11 | 0.200 | 32,934,243 | |
| 2 | BDOKI3 | 0.180 | 849,528 | 33,783,771 |
| 3 | BDOKA16 | 0.166 | 10,176,600 | 43,960,371 |
| 4 | BDOKA15 | 0.155 | 3,392,200 | 47,352,571 |
| 6 | SSDOKA15 | 0.058 | 20,153,224 | 67,547,481 |
| 7 | SSDOKA17 | 0.046 | 6,733,561 | 74,281,042 |
| 9 | SSDOKI1 | 0.033 | 115,329,463 | 189,610,504 |
| 10 | SSDOKI2 | 0,033 | 2,020,070 | 191,630,574 |
| 11 | SSDOKI3 | 0.031 | 27,461,600 | 219,092,174 |
| | TOTAL | 1.0 | 219,092,174 | |
| | Available Budget IDR 216,715,320.- | | | |
| | SSDOKI3 could not be repaired | | | |

From the analysis, the result that the secondary channel SSDOKi 3 untreated, because it exceeds the allocation of maintenance Dero IA., according to the results as follow : IDR 216, 715, 320. -.

## VIII. Conclussion

The allocation of funds to each irrigation area is Dero IA, Sambiroto IA, Padas IA and Plesungan IA. is authorized decision makers from BBWS Solo. In order to obtain optimum results from the allocation of funds to each irrigation area, multi-criteria analysis model was applied.

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