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Wetland system for geothermal wastewater management: A Case Study in Pertamina Geothermal Energy Area Lahendong, North Sulawesi

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Abstract

The SFS-Wetland model used is the wastewater treatment tank belonging to Pertamina Geothermal Lahendong. Based on the slope of the existing land, it is possible to design twin gravity wetlands of a certain size. This study aimed to develop a Surface Flow System Constructed Wetland design model using Monocaria vaginalis, Salvania molesta and Colocasia esculenta, analyze stakeholder perceptions of the SFS-Wetland Model, and refine this model based on stakeholder perceptions. Stakeholders' perception of the SFS-Wetland model based on a priority scale is that the geothermal waste management system is acceptable and accountable from an environmental perspective, waste management is socially and culturally acceptable, accountable and economically feasible. The components of the SFS-Wetland Model that must be improved are land availability, utilization of other local plant potentials, final geothermal wastewater temperature ranging from 33-35oC, ease of operation/maintenance, and low and environmentally friendly operational costs. The SFS-Wetland model suggested by stakeholders to improve is the existing SFS-Wetland model by taking into account the stakeholders' perceptions of the components that must be improved, namely the expansion of land for wetland ponds as much as 2x8 = 16 pool plots with a size of 35x60m = 33600 M2. Development of the potential utilization of other aquatic plants which are located around the location. The required temperature is 25oC for plants to grow, ease of operation/maintenance (same aspects/supporting infrastructure that must be facilitated).

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1 Introduction

The Lahendong Geothermal Power Plant (PLTP) is one of the developing geothermal energy management areas. At Pertamina Geothermal Energy (PGE) Lahendang Area, the disposal of waste water remaining from geothermal fluids from PLTP has the potential to contain arsenic which pollutes the environment and human health. Arsenic in this wastewater has the potential to be generated from the stages of exploitation, operation, production, separation and condensation. The dynamics of arsenic in wastewater from PGE Lahendong Area's fluid which was monitored in the January-June period is known to fluctuate. The measured value for arsenic at monitoring points Cluster 4 and Cluster 7 was below the quality standard, while Cluster 5, Cluster 13, and Cluster 24 fluctuated above the set value (PGE Area Lahendong, 2012). Wastewater from Cluster LHD-24 is pumped to Cluster LHD-13, then pumped to the reinjection wells Cluster LHD-25 and Cluster LHD-7, but some is still wasted into the ambient environment (Fridleifsson, 2001; Rybach, 2003).

Disposal of PGE Lahendong waste water into the Kelong Watershed (DAS) into ambient water bodies from Cluster Lhd-5 has caused damage to the rice fields around Lake Linow since 2010 until now the rice fields cannot be processed, even though the farmers have received compensation. It is suspected that this pollution case could also endanger the ecosystem of Lake Linow in Lahendong Village, Tomohon City, because the Kelong watershed passes through Lake Linow. Disposal of PGE Lahendong waste water in Cluster Lhd-13 since 2006 has been dumped into the Maesem Watershed and used by the Leilem village community, Minahasa Regency for purposes; fisheries, livestock and washing needs. During the dry season, the waste water can seep into people's wells and pose a threat to human health. Water pollution by various substances caused by mining activities has now been reported in various areas and is known to pose a threat to the environment and human health. One of the harmful substances to human health produced from geothermal energy is arsenic (Prasasti et al., 2006). With the increasing exploitation of new energy from geothermal energy, the potential for arsenic as an environmental pollutant and endangering human health is known to be very large. Reksohadiprodjo & Brodjonegoro (2000), stated the need to make efforts to avoid hazardous waste disposal while tackling waste disposal or mitigation measures that have already entered the environment by utilizing existing technology (Bindu et al., 2010; Yanuwiadi & Polii, 2013).

To overcome the problems mentioned above, the application of wetland technology can be used as an alternative to geothermal wastewater management which contains arsenic which is relatively cheap, efficient and environmentally friendly. Wetland construction is an artificial wetland system surface runoff which is a wastewater management process that imitates the water purification process that occurs in wetlands, where the hydrophytes that grow in the area play an important role in the natural recovery process of wastewater quality (Supradata, 2005). Furthermore, according to Hammer (2014), the wastewater treatment system of the wetland system is defined as a treatment system that includes the main factors, namely: (a) an area that is inundated with water and supports the life of aquatic plants such as hydrophytes. (b) the growing medium is soil that is always flooded with water (wet). (c) the media can also be not soil, but media saturated with water. Wetland construction wastewater treatment can be defined as man-made, specially engineered paddy fields designed for the purpose of treating wastewater by optimizing physical, chemical, and biological processes occurring in a natural wetland ecosystem. Wetland construction can provide an economic value for waste, in place of effective and aesthetic waste management, (El-Khateeb & El-Bahrawy, 2013). Euis Nurul & Wahyu (2010), said that the wastewater treatment process with wetland construction technology can occur through chemical, physical, and biological processes which are interactions between microorganisms. Wetland construction is divided into two types, namely constructed wetland - emergent plants and floating plants. The characteristics of constructed wetlands - emergent plants are that they have a very shallow depth, in the range of 0.1 – 0.6 meters. While the constructed wetland floating plants can reach a depth of 0.5 – 1.8 meters. Based on the average climatic conditions in Indonesia, which have the potential to support plant growth and transpiration throughout the year, the treatment of waste water containing hazardous toxic materials (B3) is a pollutant. Using the SSF-Wetlands construction system, it is predicted that it will run optimally. In addition, the low cost of construction and operational costs is one of the determining factors for the success of wastewater treatment efforts in a sustainable manner (Supradata, 2005). This study aims to (1) develop a Surface Flow System Constructed Wetland - SFS-Wetland design model with monocaria vaginalis, salvania molesta and colocasia esculenta plants, (2) analyze stakeholder perceptions of the SFS-Wetland Model and (3) refine the SFS-Wetland Model based on stakeholder perceptions (Zott & Amit, 2010; Duda et al., 1981).

2 Materials and Methods

This research is related to the AHP method, starting from collecting data to analyzing it by capturing stakeholder perceptions through a series of presentations or socialization activities, and stakeholder interviews with a list of questions compiled according to the AHP method. Strategic issues in geothermal waste water management are obtained from the results of identifying problems and then making a matrix using the SWOT method. The AHP method was applied in formulating the improvement of the geothermal management model so that the application of priority targets by weighting can be carried out. In other words, the use of the weighted value of the results of the AHP analysis can make the criteria and alternatives that are of higher priority have a greater chance of being selected than the criteria and alternatives that are of lower priority. The criteria are the goal of the geothermal wastewater management model with the wetland system, while the alternative is to minimize the occurrence of environmental pollution and human health pollution (Pandey et al., 2015; Susarla et al., 2002).

3 Results and Discussions

The results of the preparation of the wetland design model were obtained by adapting or implementing the wetland design model with a wastewater management tank belonging to Pertamina Geothermal Lahendong. Based on topography and soil contours, it is possible to design twin gravity wetlands according to the size of the pond is 35 m x 65 m. The results of the analysis of stakeholder responses to the wetland system were taken by conducting a series of presentations, socializing the results of previous research, and question and answer forums as well as distributing questionnaires to respondents according to their respective positions and main tasks (He & Jiang, 2008; Sonune & Ghate, 2004).

Description of SFS-Wetland Model

Wetland design or the use of wetlands for the cleaning process of heavy metals or hazardous compounds becomes harmless. The runoff system is designed to simulate natural wetlands, with water flowing across the ground surface in shallow puddles (Tchobanoglus et al., 2003). The cost basis is much lower than for competing concrete and steel technologies, by a factor. The pond is filled with coral media 5 mm to 10 mm in diameter. 80 cm high/thick. Planted with aquatic plants mixed with several different types of coral. Spaced quite tightly, by perforating a layer of coral media as deep as 40 cm for plant stands. Wastewater is drained as thick as 70 cm by adjusting the level (height) of the outlet which allows the media to always be inundated 10 cm below the coral surface. The design of the pond area is based on the BOD load that enters each days divided by the loading rate in general, North America = 32.10 kg BOD/Ha per day. For the tropics, it is approx. = 40 kg BOD/Ha per day (Tchobanoglus et al., 2003). According to Rani et al. (2011), designing the SFS-Wetland model is important at this stage of the implementation process. Due to the nature of the wetlands themselves, mistakes made in the early stages of construction will be fatal and very expensive to repair (Zedler, 2000; Woodward & Wui, 2001).

Standard Operating Procedure used is geothermal wastewater management with wetland system and its treatment. Regulation of the Minister of Environment Nu. 19 of 2010 concerning geothermal activities stipulates the quality standard for arsenic content of 0.5 mg/L and PerMenLH Nu. 82 of 2001 concerning water quality management and water pollution control stipulates that the quality standard for arsenic content is 0.05 mg/L; the implementers must have a wastewater management flow, must use personal protective equipment (PPE), must evaluate and report on activity results at all times. Wetland construction also facilitates the deposition of particles so as to reduce the toxicity of pollutants which are then deposited on the sediment surface. The oxidation-reduction process will then allow the pollutant to be adsorbed by the soil, microbial populations and plants contained in the wetland construction (Reddy & DeLaune, 2008). According to Fujita & Mori (2005), the wetland construction is designed to reduce the concentration of suspended solids, biochemical oxygen demand, nitrogen, phosphorus, and coliform bacteria up to 8%. Wetland construction model and scalability function are very effective for waste treatment (Calderero et al., 2018; Simpen et al., 2018).

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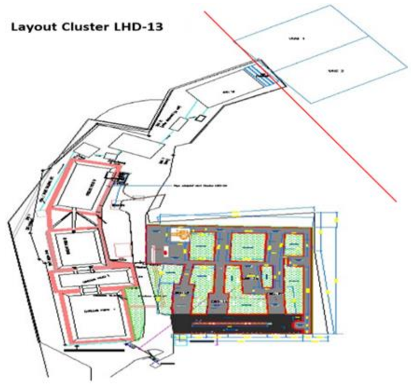

Figure 1. Lahendong PGE Area Wastewater Management Lay Out in Cluster LHD-13

Stakeholder Perception

The stakeholders are environmental experts who come from BLH Tomohon City and BLH Minahasa Regency according to its position and main tasks and functions. Perceptual data is needed to support the results of research on geothermal wastewater management with a wetland system, as well as for the completeness of the data collected as validation of the geothermal waste management model. The hierarchical arrangement for the wetland design consists of six levels; the first level is the main goal (Goal), namely the selection of prevention of pollution from geothermal wastewater management in the wetland system. The second level is the level I criteria. There are three kinds of level I criteria (Level of Objectives), namely phytotechnology (phytoremediation), economics and the environment. Each criterion consists of level II criteria (Factor Level). Level II criteria occupy the third level, where the criteria for phytotechnology consist of water hyacinth, pistia and water taro; The economic criteria are expensive and cheap; Environmental criteria consists of ecosystems, human health and environmental sustainability. Level III criteria (Actor Level) are PGE Lahendong, BLH Regional Government and the surrounding community. Level IV criteria (Alternative Level) occupies the fifth level, each level III criteria consists of minimizing waste water, reusing wastewater and improving WWTP performance. The sixth level is occupied by alternative prevention options, namely prevention of environment pollution and human health pollution (Hossain et al., 2005; Mulyono & Keputusan, 1996).

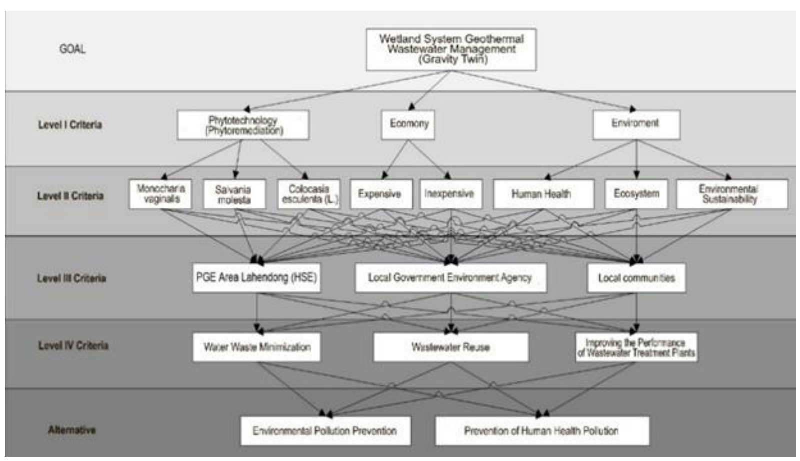

Figure 2. Hierarchical structure for the refinement of the SFS-Wetland Model

Respondents BLH Tomohon City

This research was conducted by involving 5 respondents who are experts in their fields related to preventing pollution of geothermal wastewater management in the wetland system and 5 people from BLH Tomohon City, North Sulawesi Province (Rangkuti, 1998; Saaty, 1994).

Table 1
Respondents' Data by Position and Main Tasks

No	Position
1	Head of the Tomohon City Environment Agency
2	Secretary of the Tomohon City Environment Agency
3	Head of Environmental Management and Environmental Impact Analysis
4	Head of Environmental Damage Control and Recovery Bidang
5	Head of Environmental Law Enforcement and Communication

AHP analysis of respondents used the weight of the criteria in determining the priority of preventing pollution from geothermal wastewater management in the wetland system. From the results of the AHP analysis, the results are based on level I criteria, the economic criteria have the largest weight, namely 44.3%. The second position is occupied by phytotechnology criteria with a weight of 37.2%. The environmental criteria have the smallest weight, which is 18.4%. Judging from the Level II Criteria for Phytotechnology Sub-criteria, the pistia criteria have the largest weight, which is 39.1%. The second position is occupied by the water hyacinth criteria with a weight of 35.1%. The criteria for water taro have the smallest weight, which is 25.9%. Judging from the Level II Criteria of Economic Sub-criteria, the cheap criterion has the largest weight, which is 65.4%. The expensive criterion has the smallest weight, which is 34.6%. Judging from the Criteria level II for Environmental Criteria, the ecosystem criteria has the largest weight, namely 47.7%. The second position is occupied by environmental sustainability criteria with a weight of 30%. Human health criteria have the smallest weight, which is 22.3% (McCutcheon et al., 2003; Smith et al., 1998; Willey, 2007).

Table 2
Priority of Level IV Criteria (Alternative Level)

Level IV Criteria	Alternative	
	Environmental Pollution Prevention	Prevention of Human Health Pollution
Wastewater Minimization	0.641	0.359
Wastewater Reuse	0.596	0.404
Improving the Performance of Wastewater Treatment Plants	0.392	0.608

From Table 2, it can be seen that based on the minimization of waste water and reuse of wastewater, alternative prevention of environmental pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with priority values of 64.1% and 59.6%, respectively. In terms of improving the performance of WWTPs, the alternative of preventing human health pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority of 60.8% (Bindu et al., 2010; Yanuwiadi & Polii, 2013).

Table 3
Priority Criteria Level III (Actor Level)

Level III Criteria	Alternative	
	Environmental Pollution Prevention	Prevention of Human Health Pollution
PGE Area Lahendong	0.580	0.420
Local Government Environment Agency	0.527	0.473
Local communities	0.489	0.511

From Table 3, it can be seen that in terms of the Lahendong Area PGE and the BLH local government, alternative environmental pollution prevention becomes an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with priority values of 58% and 52.7%, respectively. Judging from the surrounding community, the alternative to preventing environmental pollution is an alternative priority for preventing pollution from geothermal wastewater management in the wetland system with a priority of 51.1%.

Table 4
Priority of Level II Criteria (Factor Level)

Level II Criteria	Alternative	
	Environmental Pollution Prevention	Prevention of Human Health Pollution
Monocharia Vaginalis	0.529	0.471
Salvania Molesta	0.512	0.488
Colocasia Esculenta (L.)	0.467	0.533
Expensive	0.507	0.493
Inexpensive	0.482	0.518
Ecosystem	0.532	0.468
Human Health	0.510	0.490
Enviroment Sustainability	0.505	0.495

From Table 4, it can be seen that in terms of water hyacinth and pistia, alternative prevention of environmental pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with priority values of 52.9% and 51.2%, respectively. In terms of water taro, the alternative of preventing human health pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority of 53.3%. Judging from the expensive criteria, the alternative for preventing human environmental pollution is an alternative priority for preventing pollution from geothermal wastewater management in the wetland system with a priority of 50.7%. In terms of cheap economics, alternative prevention of human health pollution is an alternative priority for preventing pollution from geothermal wastewater management with a priority of 51.8%. In terms of ecosystems, human health and environmental sustainability, alternative prevention of environmental pollution is an alternative priority for prevention for pollution of geothermal wastewater management with wetland systems with priorities of 53.2%, 51% and 50.5% respectively.

Table 5
Priority of Level I Criteria (Level of Goal)

Level I Criteria	Alternative	
	Environmental Pollution Prevention	Prevention of Human Health Pollution
Phytotechnology (Phytoremediation)	0.506	0.494
Economy	0.491	0.509
Enviroment	0.491	0.509

From Table 5 it can be seen that in terms of Phytotechnology (Phytoremediation), alternative prevention of environmental pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority value of 50.6%. From an economic and environmental point of view, the alternative for preventing human health pollution is an alternative priority for preventing pollution from geothermal wastewater management in the wetland system with a second priority of 50.9%.

Table 6
Main Priority

Goal	Alternative	
	Environmental Pollution Prevention	Environmental Pollution Prevention
Wetland System Geothermal Wastewater Management	0.502	0.498

From Table 6, it can be seen that overall, alternative prevention of environmental pollution is an alternative priority for preventing pollution from geothermal wastewater management in the wetland system with a priority value of 50.2%. This means that more attention needs to be paid to preventing environmental pollution from geothermal wastewater management in the Wetlands system in Tomohon and Minahasa compared to preventing pollution of human health, although the proportion of importance of the two is almost the same.

Minahasa Regency BLH Respondents

This research was conducted by involving 5 respondents who are experts in their fields relating to the prevention of pollution from geothermal wastewater management in the wetland system, 5 people from BLH Minahasa Regency, North Sulawesi Province.

Table 7
Respondent's Data by Position and Main Duties

No	Position
1	Head of the Minahasa Regency Environmental Agency
2	Secretary of the Minahasa Regency Environmental Agency
3	Head of Environmental Management and Environmental Impact Analysis
4	Head of Environmental Damage Control and Recovery Bidang
5	Head of Environmental Law Enforcement and Communication

Judging from the level I criteria, the environmental criteria have the largest weight, which is 48.6%. The second position is occupied by phytotechnology criteria with a weight of 31.3%. The economic criteria has the smallest weight, which is 20.2%. Judging from the level II Criteria for Phytotechnology Sub-criteria, the pistia criteria have the largest weight, which is 89%. The second position is occupied by the water taro criteria with a weight of 9.9%. The criteria for water hyacinth have the smallest weight, which is 1.1%. Judging from the Level II Criteria for Economic Sub-Criteria, the cheap criterion has the largest weight, which is 90%. The expensive criterion has the smallest weight, which is 10%. Judging from the Criteria level II for Environmental Sub-criteria, the criteria for environmental sustainability have the greatest weight, namely 43.7%. The second position is occupied by sustainability and ecosystems which have the same proportion of 28.2%.

Table 8
Priority Criteria Level VI (Alternative Level)

Level VI Criteria	Alternative	
	Environmental Pollution Prevention	Prevention of Human Health Pollution
Wastewater Minimization	0.853	0.147
Wastewater Reuse	0.147	0.853
Improving the Performance of Wastewater Treatment Plants	0.853	0.147

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From Table 8, it can be seen that based on the minimization of wastewater, alternative prevention of environmental pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority value of 85.3%. Judging from the reuse of wastewater, the alternative of preventing human health pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority of 85.3%. In terms of improving the performance of WWTPs, alternative prevention of environmental pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority of 85.3%.

Table 9
Priority Criteria Level III (Actor Level)

Level III Criteria	Alternative	
	Environmental Pollution Prevention	Environmental Pollution Prevention
PGE Area Lahendong	0.225	0.775
Local Government Environment Agency	0.309	0.691
Local communities	0.225	0.775

From Table 9 it can be seen that in terms of PGE Lahendong Area, alternative prevention of human health pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority value of 77.5%. Viewed from the BLH Regional Government, the alternative for preventing human health pollution is an alternative priority for preventing pollution from geothermal wastewater management in the wetland system with a priority of 69.1%. Viewed from the surrounding community, the alternative of preventing human health pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority of 77.5%.

Table 10
Priority Criteria Level II (Factor Level)

Level II Criteria	Alternative	
	Environmental Pollution Prevention	Environmental Pollution Prevention
Monocharia Vaginalis	0.3	0.7
Salvania Molesta	0.3	0.7
Colocasia Esculenta (L.)	0.3	0.7
Expensive	0.257	0.743
Inexpensive	0.3	0.7
Ecosystem	0.266	0.764
Human Health	0.288	0.712
Enviroment Sustainability	0.3	0.7

From Table 10, it can be seen that in terms of water hyacinth, the alternative of preventing human health pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority value of 70%. Judging from Pistia, the alternative for preventing pollution of human health is an alternative priority for preventing pollution from geothermal wastewater management in the wetland system with a priority of 70%. In terms of water taro, the alternative of preventing human health pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority of 70%. From an expensive perspective, the alternative of preventing human health pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority of 74.3%. In terms of low cost, alternative prevention of human health pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority of 70%. Judging from the ecosystem, the alternative of preventing human health pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority of 76.4%. In terms of human health, the alternative of preventing human health pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority of 71.2%. Judging from the ecosystem, the alternative for preventing pollution of human health is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority of 70%.

Table 11
Priority Criteria Level I (Level of Goal)

Level I Criteria	Alternative	
	Environmental Pollution Prevention	Environmental Pollution Prevention
Phytotechnology (Phytoremediation)	0.3	0.7
Economy	0.296	0.704
Enviroment	0.287	0.713

From Table 11, it can be seen that in terms of Phytotechnology (Phytoremediation), the alternative of preventing human health pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority value of 70%. From an economic point of view, the alternative of preventing human health pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority of 70.4%. In terms of the environment, the alternative of preventing human health pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority of 71.3%.

Table 12
Main Priority

Goal	Alternative	
	Environmental Pollution Prevention	Environmental Pollution Prevention
Wetland System Geothermal Wastewater Management	0.293	0.707

From Table 12, it can be seen that overall, alternative prevention of human health pollution is an alternative priority for preventing pollution of geothermal wastewater management in the wetland system with a priority value of 70.7%. This means that more attention is needed to prevent pollution of human health on the management of geothermal wastewater in the Minahasa Regency wetland system.

AHP Result Formulation

1. Strategic issues in the management of Lahendong geothermal waste water that is discharged into ambient water bodies so far only uses the Wastewater Treatment Plant system which has 1 unit of water disposal without any treatment, this can endanger the environment. Therefore, we need a better model of geothermal wastewater management SFS-Wetland system to prevent environmental pollution and pollution to human health.
2. The aim of AHP in improving the existing SFS-Wetland Model is to assist in analyzing for the formulation of improved geothermal wastewater management models. In other words, the use of the weighted value of the results of the AHP analysis can make the criteria and alternatives that are of higher priority have a greater chance of being selected than the criteria and alternatives that are of lower priority.

3. The criteria of this research are based on the geothermal wastewater management model with the wetland system. From the results of the AHP analysis, the results are based on the criteria of utilizing phytotechnology (phytoremediation) to improve the existing SFS-Wetland which has the largest weight, which is 39.5%. The second position is occupied by the criteria for paying attention to environmental conditions with a weight of 32.3%. The economic value consideration criteria has the smallest weight, which is 28.2%.
4. Phytotechnology (phytoremediation) Sub-criteria, the sub-criteria in utilizing pistia plants has the largest weight, which is 72.6%. The second position is occupied by the water taro sub-criteria with a weight of 19.7%. The sub-criteria for water hyacinth has the smallest weight, which is 7.6%. Judging from the Level II Criteria for Economic Sub-criteria, the cheap criterion has the largest weight, which is 80.5%. The expensive criterion has the smallest weight, which is 19.5%. Judging from the sub-criteria for the Environmental criteria, the criteria for paying attention to ecosystems have the largest weight, which is 37.4%. The second position is occupied by the criteria for preserving the environment with a weight of 37%. Human health criteria have the smallest weight, which is 25.6%.
5. The actors responsible for managing geothermal wastewater are PGE Lahendong as the developer company, the local government (BLH) as the supervisor of the implementation of regulations and the affected surrounding communities. From the results of the AHP analysis in terms of actors; PGE Lahendong Area, as an alternative to preventing human health pollution, is an alternative priority for preventing pollution from geothermal wastewater management in the wetland system with a priority value of 56.9%. Judging from the Regional Government (BLH), the alternative to preventing human health pollution is an alternative priority for preventing pollution from geothermal wastewater management with a priority of 54.1%. Reviewing from the surrounding community, the alternative for preventing human health pollution is an alternative priority for preventing pollution from geothermal wastewater management in the wetland system with a priority of 54%.
6. Stakeholders related to the improvement of the existing SFS Wetland Model are the government (BLH) of Tomohon City and Minahasa Regency, North Sulawesi Province, and the community around the location. It is hoped that there will be elements of higher education as well.
7. Alternatives related to the improvement of the existing SFS Wetland Model which is an alternative, namely minimizing the occurrence of environmental pollution and pollution of human health. In terms of utilizing phytotechnology (phytoremediation), as an alternative to preventing human health pollution, it is an alternative priority for preventing pollution from geothermal wastewater management systems with a priority value of 54.4%. Judging from the economic value, alternative prevention of human health pollution is an alternative priority for preventing pollution from geothermal wastewater management with a priority of 56.6%. In terms of the environment, the alternative for preventing human health pollution is an alternative priority for preventing pollution from geothermal wastewater management in the wetland system with a priority of 54.1%.

4 Conclusion

1. Description of SFS Wetland Model is wetland design or use of wetlands for the process of cleaning metals (As) or hazardous compounds into harmless. The runoff system is designed to simulate natural wetlands, with water flowing over the ground surface in shallow puddles. This wetland model is designed with very low operating and maintenance costs. It facilitates monitoring, maintenance of access roads and embankments, maintenance of pretreatment.
2. Stakeholders' perception of the SFS-Wetland model based on a priority scale is that the geothermal waste management system is acceptable and accountable from an environmental perspective, waste management is socially and culturally acceptable and accountable, and economically feasible.
3. The components that must be repaired or considered are; land suitability allows processing of compensation, utilizing the potential of other plants, the final geothermal wastewater temperature ranges from 33-35oC, ease of operation/maintenance, and low operating costs and environmentally friendly.

Conflict of interest statement
The author declared that he have no competing interest.

Statement of authorship
The author have a responsibility for the conception and design of the study. The author have approved the final article.

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