Effectiveness of Flood Management Through Pump Houses Based on Geographic Information Systems in the City of Surabaya

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Abstract. Floods or puddles hit several points in the city of Surabaya. The main factor that often becomes the problem of flooding is the infrastructure and environmental carrying capacity no longer following its designation. Floods cause ecological damage and have socio-economic impacts. Another solution in flood control is developing and placing pump house points based on geographic information systems (GIS). This study uses a qualitative descriptive approach. This paper aims to study how the construction of pump houses in Surabaya can solve the flood problem. Create a web-based GIS application for the development and placement of pump houses based on the parameters of the inundation area, length of inundation time, and average inundation height. The results of this study will determine the mapping of the distribution of pump points and detailed information on pump points to be used as a basis for policy-making by the Department of Water Resources and Highways in the development of new pump houses and the placement of pump house constructions. The policy results of this research are expected to be harmonious coordination between agencies. Performance achievements will continue to be improved to have flood prevention regulations.

Keywords: Effectiveness · Flood Control · Mapping of Pump House Points · Geographic Information Systems (GIS)

1 Introduction

Rain is a blessing to the earth. However, with excessive rain, poor drainage, and consequently flooding, some parties/people sometimes consider rain a disaster. Still, rain for other parties or some people, farmers, for example, is expected. Rain management is essential because humans cannot reduce or stop rain. In other words, how human efforts in managing or controlling rain and its consequences must be pursued. Because if it is wrong to control water problems, natural disasters will appear, namely floods. This natural disaster results from an imbalance of natural elements between water, soil, plants, and other natural ingredients. This natural imbalance is often triggered by human actions and behavior, with the reason that development is for the welfare of the citizens. But what usually happens is the opposite: floods, landslides, or droughts that cause forest

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fires. However, natural disasters are influenced and caused purely by natural forces, such as storms, earthquakes, and volcanic eruptions.

Natural disasters due to floods, landslides, and droughts hit Indonesia almost every season. In flood disasters, the events and processes are strongly influenced by natural factors such as abnormal rainfall and seawater tides (for tidal flooding). Meanwhile, human actions and behavior that play an essential role in causing this flood disaster result from land misuse. For example, mountain slopes are used as residential land, riverbanks are used as shelters, and throw garbage in rivers. Natural disasters such as hurricanes and typhoons do not cause as much damage in Indonesia as in other nations, such as the United States.

Similarly, floods in Indonesia are not nearly as catastrophic as in Bangladesh. However, a disaster is still a disaster. No matter how small a natural disaster is, there will still be both material and spiritual losses. Flood disasters in certain areas have become a subscription every rainy season, especially in the lowlands. Even on the north coast of Central Java Province, it has become a flood subscription influenced by tides, namely tidal flooding.

The history of flooding in Surabaya is caused by high rainfall. Heavy rains that continue to flush most areas of the city of Surabaya caused rivers to overflow and caused flooding in several regions of the city of Surabaya. Based on Indonesian Disaster Data and Information, the National Disaster Management Agency for floods in Surabaya occurred on: 1). December 18, 2013, with no casualties; 2). January 1, 2012, with no casualties; 3). March 28, 2011, no casualties; 4).On March 26, 2011, with no casualties. 5). February 1, 2011, with no casualties; 6). December 1, 2010, with no casualties; 7). November 1, 2010, with no casualties; 8). March 1, 2010, with no casualties; 9). March 11, 2009, with no casualties; 10). March 6, 2009, with no casualties; 11). December 12, 2008, with no casualties; 12). March 6, 2005, there were no casualties (Source: Data Compilation from Indonesian Disaster Data and Information, National Disaster Management Agency).

In the city of Surabaya, the flood disaster was also handled by the government. However, it was not the BPBD that handled it. Regional Disaster Management Agency (BPBD) is a non-departmental government agency that carries out disaster management tasks in both the Province and Regency/City areas by referring to the policies established by the National Disaster Management Agency. Because the Surabaya City Government does not yet have a BPBD, although it did not have a Surabaya City BPBD when Mayor Tri Rismaharini led it, according to this mayor, disaster management in Surabaya is better [1]. According to Mrs. Risma, flood handling must be done by looking at the needs of the City of Surabaya so that floods can be anticipated and handled. Through Erna Purnawati, Head of the Public Works Department of Highways and Pematuan Surabaya City, dealing with flooding in the City of Surabaya requires channeling improvements. The improvement of this channel began with dredging the canal and river, constructing box culverts at various points, and constructing pump houses. Another anticipation is that the Surabaya City Government will continue to expand its pump houses and increase its water pump capacity. Until now, in Surabaya, there are $\pm$ 59 pump houses scattered in various locations in the city of Surabaya. Each pump house has several water pumps with various capacities. Specifically for flood pumps with a capacity of 1–5 cubic meters

per second, there are 204 units, while Sludge pumps with a capacity of 0.25 cubic meters per second have 66 units [1]. But in reality, ± 59 pump houses built in Surabaya can still not solve the flood problem optimally.

In this study, the focus is on discussing the effectiveness of pump houses by adopting geographic information systems (GIS), which are one way to deal with flooding in Surabaya. With the aim of flood prevention efforts, primarily through pump houses, to deal with flooding in Surabaya efficiently and effectively.

2 Related Work

2.1 Policy Evaluation Concept

Public Policy Analysis is related to evaluation, which aims to assess the benefits of government policies that differ significantly in object specifications, measurement techniques, and analytical methods [2]. Public policy evaluation is a process for evaluating the results of government policies with significant differences in object description, measurement techniques, and analytical approaches. Consequently, all types of evaluation involve the act of specification, measurement, analysis, and suggestion.

This explains that policy assessment is a process that assesses or measures the benefits of a government policy or program implemented through a series of sub-policies. Measurement methodologies, analytical approaches, and policy advice are part of the policy assessment operation. In terms of evaluation activities, specifications are an essential component and trigger action among the various activities in the policy assessment. This is because the objectives or criteria used to evaluate the policy are identified during the definition process.

In the meantime, the measurement techniques used to evaluate the government's policies or programs include some impressionistic (observative impressions), scientific, and systematic. All of these techniques adhere to very specific rules. The analytical method in policy evaluation is a way of using the information collected, which will then be used to determine whether the programs implemented by the government are effective or ineffective and have positive or negative impacts, according to Jones, who stated later that the analytical method is a way of using the information collected. Jones stated that this method is a way of using the information collected. The policy evaluation process concludes by formulating recommendations for actions that should be taken throughout the subsequent period.

Jones goes on to say that policy evaluation can be used for two purposes, namely based on the previous definition of policy evaluation:

- To check what happens during the policy process. Policy assessment is a method for examining, predicting, and assessing all progress that can be achieved by developed and implemented government policies.
- It is a systematic approach to evaluating the benefits of various government programs. It attempts to establish systematic ways of assessing government projects, such as experimentation, comparison, replication, and cost-benefit analysis.

Policy evaluation is essential in determining whether flood management policies align with policy objectives by constructing pump houses. After that, we will suggest developing a model to improve the performance of the pump house building.

Table 1. Evaluation criteria.

Criteria type	Question	Illustration
Effectiveness	Was the desired result achieved?	· Service units · Provides effectiveness · Punctuality
Efficiency	To what extent can the results achieve solve the problem?	· Unit cost · Program advantages · Program benefits
Adequacy	To what extent does achieving the desired result solve the problem?	· Fixed cost · Fixed effectiveness
Equity	Are costs and benefits distributed evenly among different groups of people?	· Pareto criteria · Kaldor-Hicks Criteria · Rawis Criteria
Responsiveness	Do the policy outcomes contain the preferences/values of the group and satisfy them?	Consistency with a citizen survey
Accuracy	Were the results achieved useful?	Public programs must be equitable and efficient to all levels of society entitled to receive it.

Evaluation is the generation of Knowledge about the values or benefits of policy outcomes, all related to policy evaluation [3]. They contribute to the goals and objectives of evaluators in particular and other users in general when they are valuable and useful for assessing problem-solving. When the role of policy evaluation is well fulfilled, it is rewarding and rewarding. Because depending on a single sign alone is dangerous and can produce evaluation results that are inconsistent with reality, multiple indicators need to be developed to determine whether or not a policy has been successful.

Evaluation is a simple policy evaluation concerning the production of information about the values or benefits of policy outcomes [3]. When they are valuable and helpful in assessing problem-solving, they contribute to goals and objectives for evaluators and general users. This is valuable and useful when the policy evaluation function is fulfilled correctly. Because using a single indicator will be risky, in the sense that the evaluation results be skewed from the actual one, multiple indicators need to be produced to determine whether or not a policy has successfully achieved its goals. The criteria or indicators for assessment developed by William N. Dunn. Table 1 has six different indications utilized as criteria for evaluation [3, 4].

2.2 Effectiveness

Effectiveness is defined as the capacity to choose goals while using appropriate facilities and infrastructure to achieve those goals correctly and quickly, with either success or failure. According to Sutrino (2010), the level of effectiveness or effectiveness is the number of goals that have been obtained or goals that have been successfully achieved,

and the more goals that have been obtained or goals that have been successfully achieved, the greater the level of effectiveness or effectiveness. Effectiveness is used as a metric to compare the effectiveness of plans and processes with results. It is, therefore, important to measure efficacy to determine whether a program is beneficial or not.

The most prominent effectiveness measurements are program success, target success, satisfaction with the program, input and output levels, and overall goal achievement [5]. The operational ability to carry out work programs in accordance with predetermined objectives can be used to increase program effectiveness [6].

- Program Success. The program's effectiveness can be demonstrated through operational capabilities in carrying out work programs following the objectives set. The field's process and mechanism of activity can be used to assess the program's success.
- Target Success. The program's effectiveness can be demonstrated through operational capabilities in carrying out work programs following the objectives set. The field's process and mechanism of activity can be used to assess the program's success.
- Satisfaction with the Program:. Satisfaction is an effectiveness metric that measures how well the program meets the demands of its users. Users express their satisfaction with the product or service they receive. The higher the quality of the products and services provided, the higher the satisfaction felt by users, which can lead to benefits for the institution.
- Input and Output Level. The effectiveness of input and output levels can be seen by comparing the input (input) with the output (output). When output exceeds input, the process is considered efficient; when the input exceeds the output, the process is said to be inefficient.
- Achievement of Overarching Goals. The extent to which an organization fulfills its responsibilities to achieve its objectives. This is a general assessment with as many single criteria as possible in this scenario, which results in a general assessment of the organization's effectiveness. Overall, effectiveness can be said to be the level of an institution's ability to achieve predetermined goals or targets so that program effectiveness can be assessed based on its operational capabilities in implementing programs following predetermined objectives.

According to Duncan's idea of effectiveness in Asfriqi Machfiroh, the effectiveness metrics are as follows [7]:

- Achieving Goals. The total effort to achieve the goal should be understood as a process. Therefore, phasing is needed to ensure the achievement of the final goal, both phasing in the completion of its parts and phasing in terms of its periodization. The success of a goal depends on several elements, including time and concrete targets.
- Merger. The ability of an organization to socialize, develop consensus, and communicate with other organizations is measured by integration. The term "integration" refers to the process of socialization.
- Adaptability. The ability of an organization to adapt to its environment is known as adaptation. As a result, benchmarks for improving drainage and constructing pump housings were used. The amount of effectiveness should be measured using this idea.

The effectiveness of drainage improvements and the construction of pump houses is an issue in this case [7].

This effectiveness theory measures the targets that have been achieved in efforts to reduce flood disasters through the construction of pump houses in the city of Surabaya in the last ± 3 years.

2.3 Disaster Management

A disaster is described as "an incident, natural or man-made, abrupt or progressive, which impacts with such severity that the impacted community has to respond by taking exceptional measures" [8].

Meanwhile, according to the United Nations International Strategy for Disaster Reduction (ISDR-UN Agency), a natural disaster is an event that occurs suddenly or slowly, caused by nature or human activities. It results in the loss of human life and property or environmental damage. This incident occurred beyond the capacity of the community with all its resources [9].

A flood is a natural disaster, but its handling and mitigation are the responsibility of the state and government because the process and impact of natural disasters endanger the community's safety. As a result, the presence of the state is needed for the prevention, handling, and management of natural disasters. In other words, the state or government must play a direct role in disaster mitigation efforts because natural disasters are a public safety issue, not a private one. On this basis, the government drafted and ratified the Law on Disaster Management Number 24 of 2007.

In addition, the government established the National Disaster Management Agency following the mission of Law Number 24 of 2007, Article 10. This non-departmental entity, established under Presidential Regulation No. 8 of 2008 concerning the National Disaster Management Agency, serves as a key sector in the country's response to natural disasters.

Furthermore, following the mandate of law number 24/2007 Article 10, the government establishes the National Disaster Management Agency. This non-departmental institution established through Presidential Regulation Number 8 of 2008 concerning the National Disaster Management Agency acts as a leading sector in handling natural disasters in Indonesia.

The disaster management and management problem are under the regional government's scope, following the government decentralization concept and regional autonomy. Therefore, there is a need for synchronization of disaster mitigation cooperation between the central and regional governments. It is necessary to synchronize coordination between the central and regional governments in disaster mitigation, as regulated in Law Number 24 of 2007, which states that the Government and Regional Governments are responsible for implementing disaster management. Provisions for establishing the Regional Disaster Management Agency are also made for this purpose. Article 18 of Law Number 24 of 2007 explicitly states this.

Along with the spirit of government decentralization and regional autonomy, disaster management and management issues are also the responsibility and authority of local governments. Thus, there is a need for synchronization of coordination between the

central and regional governments in disaster mitigation as mandated by Law Number 24 of 2007 in Article 5 that the Government and Regional Governments are responsible for implementing disaster management. For this purpose, provisions for establishing the Regional Disaster Management Agency (BPBD) are also stipulated. This is explicitly stated in Law Number 24 of 2007, Article 18.

Each province is required to establish a Provincial BPBD following the provisions. BPBDs can be established by districts/cities based on workload, financial capacity, and needs. If the Regency/City Government does not establish the BPBD, disaster management is handled by the relevant Regional Work Units (SKPD). As a result, BPBD can be described as a non-departmental government agency that handles disasters at both the provincial and district/city levels. This means that local governments are responsible for disaster management within their jurisdiction and can do so [10].

2.4 Management Information System

Management information systems receive and analyze data before turning it into meaningful information for management users. Management information system indicators are needed to clarify the implementation of management information systems. Davis [11] recommends the following management information system indicators:

- Knowledge. Information is the result of data processing, but not all data processing results are information; data processing that does not provide meaning or use for someone is not information for that person.
- Humans as Data Processing Machines. Humans play an important role in providing accurate, timely, relevant, and complete information. The man's professionalism determines the quality of the information produced.
- System Concept. The system is a kind of harmonious cooperation of parts/components/subsystems that are interconnected with other parts or components or subsystems to achieve a goal.
- The Concept of Decision-Making. The act of a leader choosing one of many options to overcome the difficulties he faces in the organization he leads is known as decision making.
- Importance of Data. A choice can be influenced by new information. The change in the result value will determine the information. The information must be in the cor-rect size so that later it can be used as input by the leadership.

As a result of the above understanding, a Management Information System can be defined as a comprehensive and coordinated collection of information subsystems that transform data into valuable information for users. The flood area information system in the city of Surabaya will be used in this study to inform the Public Works Department of Highways and Pematus about the location of the pump house construction.

2.5 Geographic Information System

A geographic Information System or GIS is a new technology currently essential in storing, manipulating, analyzing, and displaying natural conditions with the help of attribute and spatial data (graphics) [12]. GIS is an information system that works with

spatial data sources, meaning having a geographic coordinate system [13]. GIS is a database system with special capabilities to handle spatially referenced data along with a set of work operations [14].

2.6 Drainage and Pump House

Some land in the city of Surabaya has changed its function. According to a survey conducted by the Surabaya City Development Planning Agency to prepare the 2018–2038 Master Plan [15] as written in the Surabaya Drainage Master Plan Final Report 2018–2038, "Construction of buildings to meet community needs will result in a land conversion." Changes in land use will increase the impermeable layer on the soil surface, reducing the seepage of rainwater into the soil and causing more surface runoff to be charged to drainage channels.

To reduce the risk of inundation and flooding, this must be adjusted to the capacity of the existing drainage channel. In the next years, the growth plan for the City of Surabaya will need to be modified to manage flooding and inundation better. Another factor contributing to inundation and flooding in Surabaya is the city's relatively flat topography, which causes runoff to take longer to reach the nearest drainage system. Surabaya is located at the mouth of the Brantas River. Therefore, many factors must be considered in dealing with it to build an adequate drainage system. Repair and improvement of drainage in Surabaya City becomes an urgent topic in this condition because drainage is a water control problem.

The drainage system is a series of operations that create an effort to drain surface water (runoff) and groundwater (underground water), from an area, according to the conventional definition of drainage. The drainage system of a residential area is quite important. A well-organized residential area must be accompanied by the installation of a drainage system that functions to minimize or remove excess water from an area or land so that waterlogging does not interfere with community activities or cause waterlogging which will cause socio-economic losses, especially those related to the health of the housing environment [16].

Furthermore, the Surabaya City Government has carried out drainage improvements based on the Master Plan, one of which is the construction of a pump house. The Master Plan survey team also reported the utilization of the pump house by stating Margomulyo Channel is an artificial channel with a concrete slab made in 2005 with dimensions: channel width (b) = 5 m, channel height (h) = 1.47 m. This water channel experiences a lot of sedimentation, so it becomes muddy, and a lot of garbage gets into it. Because the Balong Pump House manages it, this channel still functions well. According to residents, the existence of the Balong Pump House is beneficial in reducing flood inundation [15].

The Semarang City Government also uses pump houses to deal with flooding. Due to tidal flooding, the pump house regulates the water level in the East Semarang area. The function of the pump is to move water from a lower place to a higher place [17]. Pumps are used to reduce flooding in Japan, and there are two types of pumps: pump house (pump station) and pump gate (pump gate).

The difference lies in the level of efficiency and efficacy caused by the scale and location of the flood (space). In recent years, pump gates have been attracting attention because they require a small construction site and can thus be used as a countermeasure

against inundation in urban areas where it is challenging to acquire new installation space [18]. According to Wang et al., who conducted a study in Beijing, the Importance or role of pump houses in dealing with floods is as follows: "Pumping stations play an essential role in flood mitigation in metropolitan areas. The urban drainage system is facing the great challenge of fast-rising peak flow resulting from urbanization and climate change. Therefore, many scholars are committed to flood control by optimizing the operation of pumps.

Pumping stations play an essential role in flood mitigation in metropolitan areas. Urban drainage systems face major challenges with peak flows that are rapidly increasing due to urbanization and climate change. Therefore, many scholars are committed to flood control by optimizing pump operation [19]. When it comes to operating pump houses in Surabaya and other Indonesian cities, everything is still done manually. On the other hand, the pump buildings in the Philippines (both in Pasay and Makati) are automated. Some pump houses have been remotely controlled. The authors report how the pump house is controlled via an android application [20].

The government has built a pump house with 204 pumps in 59 houses and supported by 111 generators to deal with flooding in Surabaya by using a pump house architecture [21] which must be connected between the pump houses of several pumps and the house. Pumps, but not all of them. According to Kusnan et al., the success of this connection between pump houses in dealing with flooding has been studied. This research suggests a model for the prevention of flooding that uses the connectivity of the pump house system. This model aims to reduce waterlogging, speed up the water flow process, and still maximize the operation and function of existing reservoirs. This study proposes a flood mitigation model using an interconnected pump house system to reduce waterlogging, speed up the water flow process, and still optimize the operation and function of the existing reservoir."

2.7 Regulation

The regulations governing flood management in the city of Surabaya are as follows:

- Surabaya City Regional Regulation Number 12 of 2014 Article 36 (5) concerning the management of the drainage system is implemented to reduce and overcome flooding and inundation, which is carried out through the construction of sluice gates and pump houses, the implementation of normalization and channel maintenance activities as well as the development of reservoir retention and detention areas or boezem.
- Surabaya Drainage Master Plan 2018–2038 based on this Master Plan, the construction of a pump house is one of the efforts to improve drainage and solve flood problems in Surabaya.

3 Research Methods

The proposed research framework refers in Fig. 1. The preliminary study conducted in this study was by conducting an empirical study by looking at several points in the city of Surabaya that were hit by floods or puddles. Floods cause environmental damage and have a socio-economic impact, so the development and placement of pump houses are

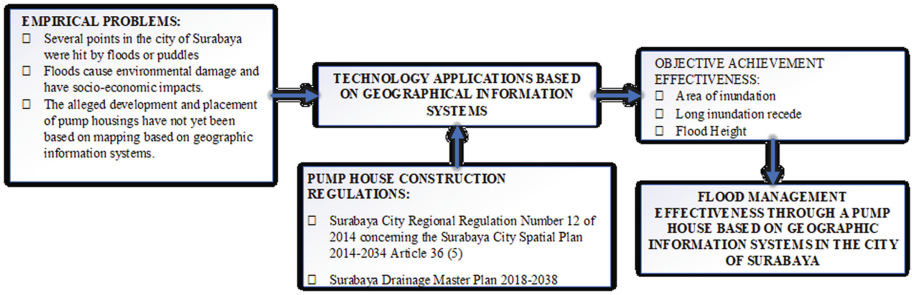

Fig. 1. Research framework.

suspected to be still not based on mapping based on geographic information systems. The effectiveness of achieving the objectives is based on the parameter data of the inundation area, the duration of inundation at low tide, and the inundation height. The regulations for the construction of pump houses are the Surabaya City Regulation Number 12 of 2014 concerning the Surabaya City Regional Spatial Plan 2014–2034 Article 36 (5) and the 2018–2038 Surabaya Drainage Master Plan.

3.1 Research Type

Research on the effectiveness of pump houses in flood prevention uses a descriptive-qualitative approach. Because this type of research is generally carried out on research in the form of case studies that focus on a particular unit of various phenomena, this research is exploratory to deeply understand various social variables.

3.2 Research Focus and Location

This research focuses on the effectiveness of disaster management through pump houses in Surabaya. The effectiveness parameter is the extent to which the pump house can contribute according to the objectives listed in the Surabaya Drainage Master Plan 2018–2038 in the master plan, namely being able to solve the flood problem. Three parameters can measure success in solving the flood problem here: area of inundation, long inundation recedes, and flood height. In addition, researchers developed a geographic-based information system or mapping of flooded areas in the city of Surabaya [22, 23], further recommending GIS as the basis for future policies for building pump houses in Surabaya.

3.3 Research Location

The location for this research is the Public Works Department of Highways and Pematus Surabaya City, as well as ten pump houses in Surabaya. To be precise, these are urban flood-prone areas, namely Dukuh Setro Village, Mulyorejo District (1 pump house), Tidal Flood Hazard Area, Keputih Village, and Sukolilo District (3 pump houses). The four pump houses are included in the East Surabaya area. Meanwhile, the other six pump houses are spread out in Central Surabaya (1 pump house), West Surabaya (2 pump houses), North Surabaya (1 pump house), and South Surabaya (1 pump house) in Surabaya. For more details, the location of the pump house can be seen in Table 2.

Table 2. Pumphouse research locations.

Areas	Pump house address	Number of pump houses
East Surabaya	1) P.A. Mulyorejo 2) P.A Semolowaru II 3) P.A Mulyosari (Ring Road ITS 4) P.A. Medokan Semampir	4
Central Surabaya	5) P.A. Pesapen	1
West Surabaya	6) P.A. Asem Jaya 7) P.A. Gunung Sari II	2
North Surabaya	8) P.A. Jemur Andayani	1
South Surabaya	9) P.A. Jagir 10) P.A. Bratang	2

3.4 Data Collection Techniques

Data were collected through observation, in-depth interviews, documentation studies, and Focus Group Discussions (FGD). Initial observations were made and went directly to the field to see the effectiveness of flood prevention through the construction of pump houses in Surabaya. Documentation studies are not limited to documents in physical form but also documents in the form of digital files, such as photos, videos, presentation slides, application programs, databases, coding systems, and operating systems. To collect field data from two students who are members of the research team. The FGD was used to explore problems from a wider and deeper perspective and verify the data and information obtained from the observation and interview methods.

3.5 Technical Data Analysis

The data analysis technique in this qualitative research is a compilation or process to collect data by obtaining data from interviews, documentation, field studies, and literature studies. After getting the results of several kinds of data collection results from the collection. Because this research is descriptive and qualitative, the data collection results will be described in words to describe the results of data collection. In qualitative research, conceptualization, categorization, and description are developed based on events obtained during field activities. Therefore, data collection and analysis activities cannot be separated. Both take place simultaneously, the process Miles and Huberman (1992:20) describe the process of analyzing qualitative research data as shown in Fig. 2.

- Step 1: Data Reduction. Data reduction is selecting, focusing on simplifying, abstraction, and transforming raw data that emerges from written notes in the field. This process continues throughout the research, even before the data is collected, as seen from the conceptual research framework, study problems, and the data collection approach chosen by the researcher. Data reduction includes summarizing data, coding, tracing themes, and creating clusters.

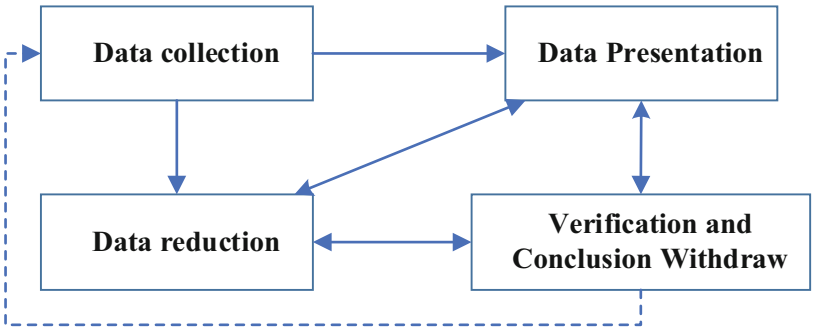

Fig. 2. Qualitative data analysis process.

- Step 2: Presentation of Data. Presentation of data is an activity when a collection of information is compiled, thus giving the possibility of drawing conclusions and taking action. Qualitative data can be narrative text in field notes, matrices, graphs, networks, and charts. These forms combine information arranged in a coherent and easily accessible form, making it easier to see what is going on, whether the conclusion is correct, or otherwise carry out a re-analysis.
- Step 3: Conclusion Drawing/Verification. Attempts to conclude are carried out by researchers continuously while in the field. From the beginning of data collection, the qualitative researcher begins to look for the meaning of things, noting regular patterns (in the theoretical record), explanations, possible configurations, causal pathways, and propositions. These conclusions are handled loosely and remain open and skeptical, but conclusions are already provided.

4 Results and Discussion

4.1 The Effectiveness of Pump Houses as an Effort to Overcome Floods in the City of Surabaya

The construction of a pump house, as mandated by the 2018–2038 Drainage Master Plan, has the intention of being one of the efforts to solve the flood problem in the city of Surabaya and although the solution to solving the flood problem is not only the construction of pump houses but also the construction of canals, including box culverts, dredging rivers and canals, building the Lamong River embankment, repairing and raising floodgates, building reservoirs, and increasing green open spaces. In this study, the focus is on flood prevention through pump houses, not others.

The pump house is expected to be essential in preventing flooding in Surabaya. This is because the pump house can anticipate the rainy season with high rainfall for 24 h. After all, this infrastructure is monitored and guarded for 24 h anyway. As of 2020, the number of pumps is 204, located in 59 pump house points and equipped with 111 generators [24]. The existence of this pump house is spread in various areas of Surabaya. Both secondary and primary channels and outlets directly lead to the sea. The facility's function is important, namely ensuring no obstacles while accelerating the disposal of overflowing rainwater to the boezem or the sea.

Furthermore, has the pump house solved the flood problem in the city of Surabaya. The answer is still incomplete, but gradually it has been able to reduce the area of the inundated area, the faster the inundation recedes and the lower the inundation. For more details, the following researchers present data in the field, both primary and secondary, from interviews and data taken by researchers from the web, mass media, and electronic media.

Success in solving the flood problem here can be measured by 3 (three) parameters, namely:

- *Area of Inundation:* The data in the DPUBMP shows that the inundation area has decreased. In 2020, 462.64 ha were recorded as inundated. It decreased drastically compared to the previous year, which reached 688.96 ha during the last year (2019). Table 3 is data on the area of flooded areas during the last 3 (three) years.

- *Length of Inundation Time:* The length of time inundation occurs when it rains, especially when it rains heavily for several hours, which will disrupt the activities of residents and road users. Undeniably, the problem of flooding and inundation in Surabaya is because too many flood points have not been handled or resolved, for example, in the areas around Gubeng and Jambangan. However, this does not mean that the flood control efforts that have been carried out so far, including the construction of pump houses, have not succeeded in dispelling the inundation or at least shortening the inundation time. Table 4 shows the length of inundation in the last three years. Table 3 shows that the average inundation time of 22 min has receded. This is much better than in 2016, and the inundation only receded for 52.98 min.

- *Average Inundation Height:* A more than 40 cm water level is classified as a flood. Of course, do not let the inundation height reach 40 cm. The Surabaya City Government has made various efforts with related agencies. The availability of 59 pump houses,

Table 3. Areas of flooded areas during the last 3 (three) years.

Year	Inundation area (ha)
2018	697,79
2019	688,96
2020	462,64

Table 4. Length of inundation in Surabaya in the last three years.

Year	Time (minutes)
2018	22,43
2019	22,01
2020	22,01

with 204 pumps and 111 generators equipped with CCTV, is a form of implementation. The hope is that this will not only overcome floods in the short term, but the Surabaya City Government has also prepared a scheme to overcome the threat of flooding in the long term. Although it is undeniable that high rainfall still occurs in quite high puddles that need to be watched out for, including the area of Major General Sungkono, Front Darmo Park, the puddle height reaches 20 cm. As a result of the inundation, the traffic flow in the area of Mayjen Sungkono highway has stalled in both directions. The speed of the vehicle prefers to reduce its speed. All vehicles choose not to cross the puddle area. In the future, this situation must be overcome so that the people of Surabaya City are free from flooding or at least reduce it. The flooding of the city of Surabaya will cause socio-economic impacts not only on the city of Surabaya but also on other cities in the vicinity, such as Sidoarjo Regency, Mojokerto Regency, Gresik Regency, and also other regencies/cities. This is because Surabaya is a metropolis, the center of the city in East Java. But slowly, the average height of the inundation has decreased. Although in other places, the inundation height exceeds 30 cm, as happened on November 25, 2021, there were three sub-districts were affected by heavy rains, as described in Table 5.

In recent years, the average inundation height during the rainy season or river overflow has declined to less than 20 cm. This is in accordance with the answers to questions related to the height of inundation during the rainy season in the city of Surabaya from various key informants. From the interview results, it can be concluded that the success of house construction in flood prevention in the City of Metropolis Surabaya can be measured by the lower the inundation height. If a data table is made for the area of flooded areas in the last three years, as shown in the data described in Table 6.

The drainage system management policy is implemented to reduce and overcome flooding and inundation with the construction of sluice gates as stipulated in the Surabaya City Regional Regulation Number 12 of 2014 Article 36 (5) and the Surabaya Drainage Master Plan of 2018–2038. The policy that forms the basis for the construction of a pump house is very strong and has a very noble goal of reducing flooding in the city of Surabaya. Policies that have been running will, of course, continue to be evaluated for results to measure the performance of the policies. The analytical method in policy evaluation is how to use the information collected, which will then be used to determine

Table 5. Areas in three districts affected by floods.

Subdistrict	The exact location of the flood
Sambikerep District	a. Beringin Village k. Lontar Highway
Benowo District	a. Sememi Highway (in front of Wachid Hasyim High School) b. Tengger Kandangan Highway (in front of SMPN 61 Surabaya)
Pakal District	a. Pakal Village b. Benowo Village c. Babat Jerawat Highway (in front of the Pakal Koramil)

Table 6. Average inundation height in Surabaya in the last three years.

Year	Time (minutes)
2018	12,49
2019	9,2
2020	10,92

conclusions about whether the programs implemented by the government are effective or ineffective and have positive or negative impacts [2]. Recommendation as the final stage of policy evaluation is the determination of what should be done in the next period. This study wants to measure whether the pump house construction policy has effectively reduced, overcame, and solved the flood problem in Surabaya.

Furthermore, it will provide suggestions or recommendations to determine the next steps so that the program or activity achieves its objectives as mandated by the laws and regulations to the fullest. In this context, Surabaya can truly escape from flooding or reduce inundation area, accelerate inundation and reduce inundation height. In his book Fundamentals of Public Policy [3, 4]. Policy evaluation is simply concerned with producing information about the values or benefits of policy outcomes. When they are valuable and useful for assessing problem-solving, they contribute to goals and objectives for evaluators, in particular, and other users in general. With the construction of 59 pump houses in 2020, and 204 pumps equipped with 111 generators and CCTV, the city government hopes this is one of the best solutions to make the City of Metropolis free from flooding. Floods here cause not only material losses but also cause environmental damage.

Duncan in Asfriqi Machfiroh, one of the parameters of a program or activity, is said to be effective in achieving its goals. The total effort to achieve the goal should be understood as a process. The existing conditions show that the city of Surabaya has not been completely free from flooding. It can not be said to be flooded in some places because the flood inundation limit is the size of the inundation height of 40 cm. In some places, there are still inundations, such as Major General Sungkono, Front Darmo Park, Lontar, Wiyung, and Lebak Permai in Gading villages and several other sub-districts. However, data shows that the average inundation area is decreasing from year to year, the time of inundation receding is also getting faster, and the average inundation height is getting shorter. According to research, the effectiveness based on achieving the pump house construction objectives in solving the flood problem has been effective, although not yet maximized. In addition, researchers also agree that the current achievement of flood control in Metropolis City is not only a contribution from the management of the drainage system through the construction of pump houses but the synergy of various other efforts for flood prevention, including 1) Building channels, including box culverts 2) Dredging Rivers and Channels; 3) Build the Lamong River Embankment, Repair and Elevate the Sluice Gate; 4) Build reservoirs as well; 5) Increase Green Open Space.

In the future, it is agreed with previous research from Bolusan et al. (2015: 1) that a pump house in the Philippines has been developed that can be remotely controlled by remote control, controlled via an android application. Meanwhile, in Surabaya, all

pump houses are still controlled manually. In this study, trying to contribute ideas to the development and construction of pump houses in the future based on geographic information systems so that the placement of pump houses is precisely in areas that, according to regional mapping, include flood-prone areas, so that disaster management through the construction of pump houses is more effective.

4.2 GIS-Based Technology Application Development Model

The effectiveness of flood control through pump houses continues to improve by developing and placing pump houses based on geographic information systems or mapping of flood-prone areas. This is so that the achievements so far in the form of narrowing the inundation area, quickly receding inundation when rainfall increases and the lower inundation is more leverage and the dream of the city of Surabaya being free from flooding becomes a reality. The city of Surabaya can dispel floods because of the various efforts made by cross-agency, so there must be harmonious coordination between agencies so that the achievements will continue to be improved, and the city of Surabaya will be free from flooding.

Based on the data distribution in Table 2 regarding the specifications of pump houses in Surabaya, it can be used as a reference to develop an application model of technology application models based on geographic information system mapping of pump points in Surabaya in Fig. 3.

The mapping of the distribution of pump points in Fig. 3 and detailed information on pump points in Fig. 4 can be used as a basis for policy-maker by the Public Works Department of Highways and Pematusan in the development of new pump houses and the placement of pump house construction in the City of Surabaya in the following year by looking at the supporting parameters. The addition of a new pump point house as a development effort can be done by the admin, as shown in Fig. 5.

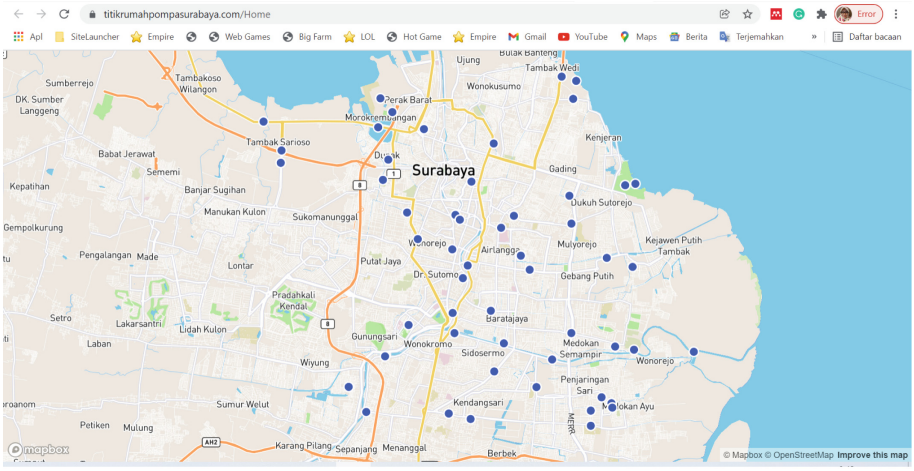

Fig. 3. Mapping of pump point distribution in Surabaya.

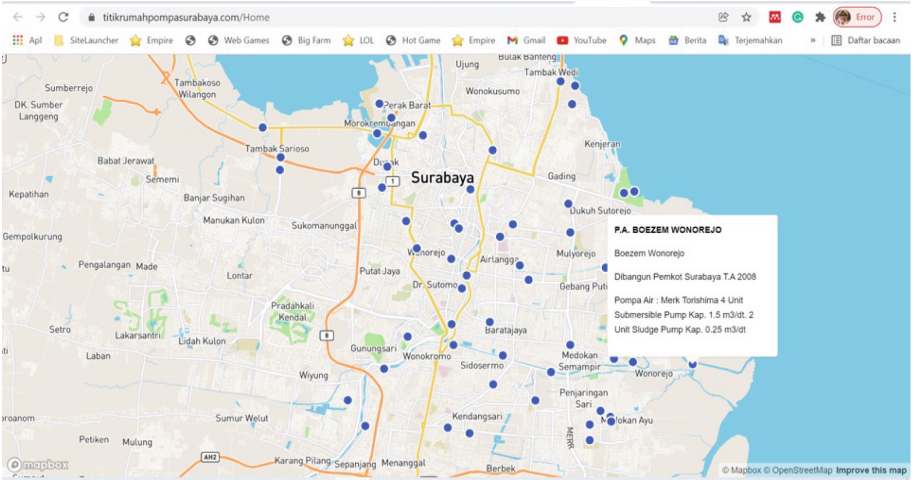

Fig. 4. Detailed information on the distribution of pump points in Surabaya.

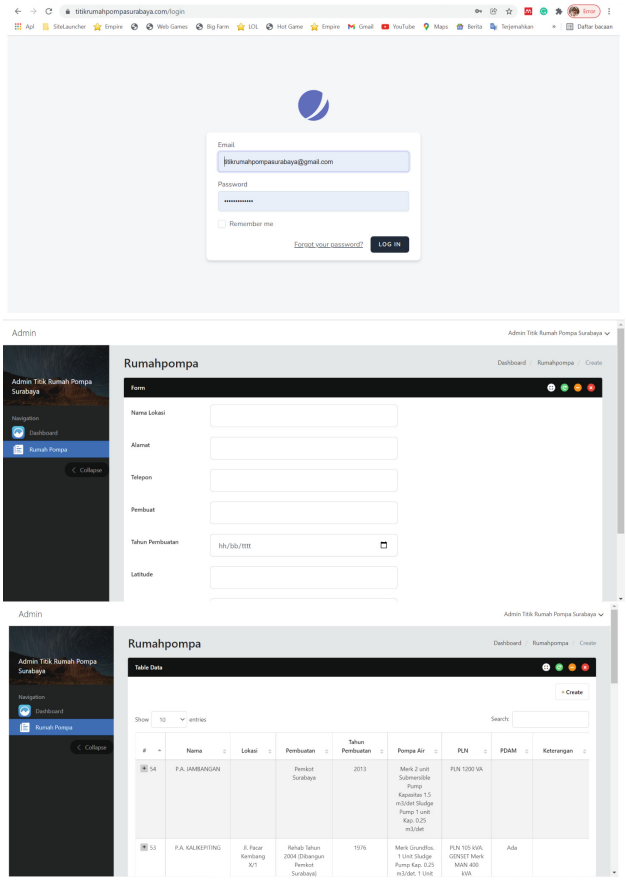

Fig. 5. Addition of new pump point data.

5 Conclusion

The construction of pump houses as one of the flood prevention efforts has not been fully achieved. Because of the existing conditions, some places are still subject to inundation, such as Major General Sungkono, Front Darmo Park, Lontar, Wiyung and Lebak Permai (Kelurahan Gading), and also in several other sub-districts. Finally, in Sambikerep, Pakal, and Benowo sub-districts. However, data from interviews with key informants show that from year to year, the average inundation area decreases, the inundation receding time is also getting faster, and the average inundation height gets shorter. According to research, the effectiveness based on achieving the pump house construction objectives in solving the flood problem has been effective, although not yet maximized.

Researchers agree that the achievement of controlling floods in the City of Metropolis today is not only the contribution of the management of the drainage system through the construction of pump houses but the synergy of various other efforts for flood prevention, including building channels, including box culverts, dredging rivers and channels, building embankments. Kali Lamong, repair and elevation of floodgates, build reservoirs and increase green open space.

Mapping the distribution of pump points and detailed information on pumping points can be used as a basis for policy making by the Public Works Department of Highways and Pematusan (DPUBMP) in the construction of new pump houses and the placement of pump house construction in the city of Surabaya in the following year by looking at the supporting parameters.

The next research that can be developed is that the researcher believes that if the city of Surabaya has been able to prevent flooding because of the various efforts made by cross-agency or agency, then there must be harmonious coordination between agencies or agencies so that the achievements so far will continue to be improved, namely the city of Surabaya is free from flooding. Community participation in flood control by protecting the surrounding environment, not littering, community service by working together to clean channels, cutting dangerous trees, and various other efforts need to become a habit and be carried out regularly, especially before the rainy season. High awareness that environmental sustainability is a shared responsibility is a motivation to always keep the surrounding environment sustainable and safe from flooding. The effectiveness of flood control through pump houses continues to improve by developing and placing pump houses based on GIS or on mapping flood-prone areas. This is so that the achievements so far in the form of narrowing the inundation area, quickly receding inundation when rainfall increases and the lower inundation is more leverage and the dream of the city of Surabaya being free from flooding becomes a reality. In the future, the city of Surabaya will have a regional regulation for flood prevention. The Regional Regulation will be included in the planning instrument for forming Regional Provincial Regulations, which are prepared in a planned, integrated, and systematic manner as a regional regulation initiated by the Regional People's Representative Council. This is so that flood disaster management has a stronger legal framework so that in terms of implementation, it is also easier to establish harmonization between bureaucratic structures.

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