Abstract: Indonesia as an archipelago country with 2nd longest coastal line in the world mostly has routine disaster such as flood. Jakarta as capital and economic center of Indonesia has flooding problem every year. To minimize the impact, the government of DKI Jakarta already constructed 36 polder systems since 1973. In the future there are 11 polders planned to construct. Those 36 built up polders need maintenance to keep its function. Budgeting system of polder’s maintenance cost not yet available, so to allocating budget for polder’s maintenance based on previous amount and it found ineffective. This research analyzes indicators that can be used for indexing the service of polders as an initial research. As an object of this research, 8 polders in DKI Jakarta are chosen, they are Polder Grogol, Polder Telak Gong, Polder Melati, Polder West Setiabudi, Polder South Sunter, Polder Tomang, Polder North Sunter, and Polder Pulomas. Probably indicator affecting polder’s capacity analyze using Principal Component Analysis (PCA) and resulted there are 24 indicators that can be used for analyzing polder system service level. Those indicators are separated into 2 aspects, technical and non-technical aspects.

Keywords: polder, indicator, service index, retention pond

I. INTRODUCTION

Human activities give many impacts on the ecosystems that have long been recognized [1]. However, human activities have been mostly documented as one of the urgent and simultaneous changes of driving forces in natural environments [2]. In further, the availability of ecosystem goods and services [3], the spatial pattern of a landscape [4][5], and the increase vulnerability of regional biomes and human well-being to the climate change [6]. The problems of flooding are more critical to change in climate in general and rainfall pattern/intensity particularly [7]. During the monsoon months that are from June to September, all these kinds of rivers are in spate with bank-full discharges and it causes the flooding and inundation in several parts [1][8].

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The Government of DKI Jakarta Province has built polders as effort to preventing floods damage besides some regular maintenance such as canals normalization (dredging), flood and rob embankment, retention pond, and drainage system revitalization (Public works Agency of DKI Jakarta, 2012). Currently, in some cases the polder service could not reach the designed service target (Water Resources Agency of DKI Jakarta, 2018). During 2018, based on the data from Water Resources Agency of DKI Jakarta, there were 70 inundations areas happened inside the polder system with 10 - 50 cm in height and 30 minutes to 1 hour for duration of flood. These may occur due to ineffectiveness of the maintenance of the polders which are not based on the service of each polder. There are no available guidelines to determine the service level of the polders, result in not proper budget allocation for revitalizing polders and not planned based on priority scale. In order to standardize the criteria of polder’s condition, the Model of Polder System Service Index which collaborate technical aspects and non-technical aspects for prioritize polder maintenance are urgently needed. Either technical or non-technical aspects are integrated to support water resources management in future [11]. Technical aspects could be used to see the function of polders, meanwhile non-technical aspects, such as organizational, budgeting, economic aspect, social and legal aspects could be used to see the polders service [15] also the participation of stakeholders and the community lives in the polders [16].

Main purpose of this research is to indicate which factors that affecting the polder’s capability in function and services. By knowing the polder’s service capability, Water Resources Agency of DKI Jakarta can make decision and take action easily in order to maintain and optimize polder’s function as it should be. As a location of study, DKI Jakarta Province was chosen because as a capital of Indonesia, this city has a lot of problems due to water management, including access to clean water and flood mitigation during rainy weather. The Government of DKI Jakarta Province has built polders as effort to preventing floods damage. Totally, there were 36 polders built in and developed. Management of those polders are divided in 3 regions, they are western region, central region and eastern region. In this research eight polders used as an object which has a pond inside the polder systems. Those polders are Polder Grogol, Polder Teluk Gong and Polder Tomang in West region, Polder West Setiabudi and Polder Melati in Central Region, Polder Pulomas, Polder North Sunter and Polder South Sunter in East Region.

II. MATERIALS AND METHODS

A. Logical Framework

This research uses the previous research indicators as a secondary data, compiled with experience and survey for primary data, will decide indicators that can be used for analyze polder’s service index in further research. From previous research and experience, indicators that mostly used for indexing service polder is presented as in the Table- I.
| No. | Aspects                          | Variables                                                  | Indicators                                      | Definition                                                                 |
|-----|----------------------------------|------------------------------------------------------------|------------------------------------------------|---------------------------------------------------------------------------|
| 1   | Technical                        | Flow pattern (T1)                                          | Time of concentration (t₁a)                    | Faster concentration time causes lower service of polder                 |
|     |                                  |                                                            | land cover (t₁b)                               | Increased built-up area causing changes in time concentration become faster than before |
|     |                                  | Condition and capacity of structure and equipment in polder (T₂) | Capacity of polders in (t₂a)                   | If the pond has no optimal capacity, the pond will not be able to accommodate the volume of water from the catchment area of the polder. This condition will cause inundation in polder area that lower polder service |
|     |                                  |                                                            | Condition of sluice gate (t₂b)                 | In good condition, sluice gate can be easily to operate, so while water in sea or river higher than water level in the pond, back water that caused inundated in polder area can be prevented |
|     |                                  |                                                            | Condition of pump (t₂c)                        | If condition of the pump is not in a good condition, it will reduce the speed of pump capacity to move the water, and causes inundation in polder area during heavy rain |
|     |                                  |                                                            | Age of pump (t₂a)                              | Longer age of pump with low maintenance can causes delaying time of pumping, then it causes inundation and decreasing polder service |
|     |                                  |                                                            | Condition of Trash-rack (t₂d)                  | Condition of trash-rack affects optimization of the performance of trash rack to filter waste in the polder pond/reservoir. |
|     |                                  |                                                            | Condition of Generator set (t₂e)               | Condition of the generator set will affect the performance of the pump when the electricity goes out |
|     |                                  |                                                            | Rate of land use change (t₂f)                  | The rate of land use change that is increasing every year will affect the speed of water seeping into the soil, this condition causes inundation |
| 2   | Inundation (T₃)                  | Inundation area (t₃a)                                     | The wider the inundation indicates the decreasing of polder service. |
|     |                                  |                                                          | Inundation depth (t₃b)                         | The higher the inundation indicates the decreasing of polder service. |
|     |                                  | Inundation duration (t₃c)                                  | The longer the inundation indicates the decreasing of polder service. |
|     |                                  | Frequency of inundation occurs (t₃d)                      | More frequent inundates occur indicate that there are components in the polder that are not working optimally |
| 3   | Technical economics (T₄)         | Operating cost (t₄a)                                      | allocation of operating costs, which are less than the allocation needed, will affect the decline in the performance of the components contained in a polder |
|     |                                  | Maintenance cost (t₄b)                                    | allocation of maintenance costs, which are less than the allocation needed, will affect the decline in the performance of the components contained in a polder |
|     |                                  | Age of the polders (t₄c)                                  | if it is not balanced with the needed operational and maintenance costs, the function of the polder that has been built for a long time tends to decrease |
| No. | Aspects                  | Variables                                      | Indicators                                                                 | Definition                                                                                                                                                                                                                                                                                                                                 |
|-----|--------------------------|-----------------------------------------------|---------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2   | Non-technical            | Institutional (NT₁)                           | Organization Type and Structure (nt₁₄)                                    | The organization is a tool for implementing management. Success or failure of a management depends on the type, structure and management of the organization.                                                                                                                                                                                                                                                                 |
|     |                          | Decision making (nt₁₅)                         |                                                                           | A prolonged decision-making process will cause delays in handling a polder and causes inundation                                                                                                                                                                                                                                                                                                      |
|     |                          | Human Resources (nt₁₆)                         |                                                                           | suitability of the number and ability of the operators with the needs is closely related to the assessment of the services of a polder                                                                                                                                                                                                                                                                 |
|     |                          | Supervisory Agency (nt₁₇)                      |                                                                           | The presence of a supervisory body can help polder managers to monitor and evaluate the performance of the manager in managing the polder every year, then will guide the polder manager to maintain the polder for optimal result                                                                                                                                                                                                 |
|     |                          | Standard Operation Procedure (SOP) (nt₁₈)     |                                                                           | Standard Operation Procedure (SOP) provides guidance for polder managers in carrying out the operation and maintenance of the polder                                                                                                                                                                                                                                                                     |
|     |                          | Master Plan (nt₁₉)                             |                                                                           | Using polder master plan, polder managers can review the capabilities of a polder                                                                                                                                                                                                                                                                                                                |
|     | Role Management          | Community Forums (nt₂₀)                        |                                                                           | Participation of the community in the operation and maintenance can help maintain and improve the service of the polder                                                                                                                                                                                                                                                                          |
|     | NT₂                      | Public and private participation (nt₂₁)       |                                                                           | Participation of the private sector in the operation and maintenance can help maintain and improve the service of the polder                                                                                                                                                                                                                                                                     |
|     | Law and Regulation       | Monitoring of laws and regulations (nt₃₄)      |                                                                           | By monitoring of laws and regulations, everything related to the polder management efforts can be carried out properly, so the polder service is maintained                                                                                                                                                                                                                                                                 |
|     | NT₃                      | Law enforcement (nt₃₅)                         |                                                                           | Law enforcement efforts will minimize the occurrence of offenses committed by the community that can disrupt the sustainability and function of the polder, so that the polder service is maintained                                                                                                                                                                                                                     |
|     |                          | Reward to community (nt₃₆)                     |                                                                           | Reward for the community will increase the spirit of the community to participate in the management of the polder                                                                                                                                                                                                                                                                                    |
|     | Socio-cultural and       | Education level (nt₄₄)                         |                                                                           | The higher level of education from the community around the polder, the community awareness will be higher in managing the polder                                                                                                                                                                                                                                                                   |
|     | economic (NT₄)           | Income level (nt₄₅)                            |                                                                           | The higher level of income of the community lives in polder area, the community awareness to contribute to manage the polder will be even higher                                                                                                                                                                                                                                                     |
No. | Aspects | Variables | Indicators | Definition |
--- | --- | --- | --- | --- |
 | Economic activity near polder (nt<sub>4c</sub>) | | | More economic activities carried out in the polder area, the more problems will arise, such as garbage problems, illegal houses and environmental pollution which will affect the sustainability of polder function |
 | Flood Losses (NT<sub>5c</sub>) | Flood losses (nt<sub>5a</sub>) | A good polder system service will minimize losses due to inundation in an area, which in turn will provide feedback on the performance of the polder system itself |

Those indicators are arranged in questionnaire and distributed to sub-district offices and village offices surrounding polders area with total 160 samples. Based on those questionnaires, each indicator from each sample is scored and analyzed using Principal Component Analysis (PCA).

Principal Component Analysis (PCA) is a multivariate statistical technique that can find hidden data characteristics. It can be used to reduce the dimensions or size of a data without significantly reducing the characteristics of the data. This method can transform origin variables that are correlated into new variables that are not correlated with each other by reducing a number of these variables so that they have smaller dimensions but can explain most of the diversity of the original variables.

### III. RESULTS AND DISCUSSION

Questionnaire that consist those indicators were distributed and analyzed in 8 chosen polders using scoring method. Number of sample for analyze is 160 sample. For technical aspect, result of investigation compiled with secondary data. To reduce those variable (technical and non-technical) based on its correlation used PCA. KMO value as seen on table 3 founds 0.710 it means there’s enough sample for service polder index in this research. Number of Berlet Test of Sphericity is 408.216 at significant of 0.000. It means that in this research there is the correlation between each variable. Table- II presents the measure of sampling

| KMO – Measure of Sampling |   |
|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | .710 |
| Bartlett’s Test of Sphericity |   |
| Approx. Chi-Square | 408.216 |
| Df | 78 |
| Sig. | .000 |

Table- III presents the result of PCA

| Rotated Component Matrix<sup>a</sup> | Component |
|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| NT1a | .572 | .227 | .106 | .134 | -.353 | .436 |
| NT1b | -.287 | .613 | .220 | .240 | .141 | -.208 | .266 |
| NT1c | .105 | .504 | .228 | .203 | -.154 | -.315 |
| NT1d | -.289 | .589 | .299 | .129 |   |   |
| NT1e | .561 | .116 | .116 | .168 |   |   |
| NT1f | .470 |   | -.391 | .192 | -.409 |   |
| NT2b | .163 | -.320 | -.355 | .204 | -.300 | .237 | -.440 | .181 |
| NT3a | .170 | .182 | .367 | .173 | .155 | -.453 | -.160 |   |
| NT3b | .373 | -.241 | .342 | .360 |   |   |   |   |
| NT3c | .252 | .389 | -.468 | .277 | -.238 | .308 | .147 |   |
| NT4a | -.366 |   | -.387 | .268 | -.114 |   |   |   |
| NT4b | -.395 | -.234 | -.240 | -.531 | -.311 | -.117 |   |   |
| NT4c | .432 | -.260 | .485 | -.406 |   | -.242 | -.104 |   |
| NT5a | -.256 | .241 |   | -.381 | -.245 | .533 | .230 |   |

<sup>a</sup>Values above 0.50 or below -0.50 are considered to have a significant relationship.
In this PCA analysis, all indicators and variables in technical aspect and non-technical aspect are compared to reduce or add another necessary variable used for service index polder analysis. From the result of PCA, loading number < 0.3 can be reduced from further analysis, and the rest of that can be used for further analysis. From 32 analyzed indicators, there are 8 indicators with loading number < 0.3. They are time of concentration (t1a), sluice gate condition (t2b), inundation area (t3a), inundation depth (t3b), community forums (nt2a), public and private participation (nt2b), reward to community (nt3c), education level (nt4a), and income level (nt4b). For further purpose, analysis of those 9 indicators is not needed.

IV. CONCLUSION

To sum up, there are 23 indicators that can be used for analyzing polder system service level. Those indicators are separated into 2 aspects, technical and non-technical aspect, as shown in the Table- III and Table- IV respectively.

Table- III. Technical Aspects Variable and Indicator for Assessment of Polder’s Service

| No | Variable          | Indicator                                      |
|----|-------------------|------------------------------------------------|
| 1  | Flowing Pattern (T1) | Land cover (%) (t1b)                           |
| 2  | Structural Condition and Capacity (T2) | Storage capacity (m³) (t2a)  
|    |                   | Pump condition (m³/s) (t2b)  
|    |                   | Pump’s age (years) (t2c)  
|    |                   | Trash-rack condition (% of broken) (t2d)  
|    |                   | Generator set condition (% of broken) (t2e)  
|    |                   | Speed of land-use changing (% per year) (t2f) |
| 3  | Inundated (T3)     | Average duration of inundated (hours) (t3a)  
|    |                   | Frequent of inundated (times) (t3b)          |
| 4  | Technical Economic (T4) | Operation cost (rupiah) (t4a)  
|    |                   | Maintenance cost (rupiah) (t4b)              
|    |                   | Polder’s age (t4c)                            
|    |                   | Increasing value of polder’s assets (t4d)    |
Table IV. Non-Technical Aspects Variable and Indicator for Assessment of Polder’s Service

| No | Variable                              | Indicator                                      |
|----|---------------------------------------|------------------------------------------------|
| 1  | Organization (NT₁)                    | Organization Type and Structure (nt₁a)         |
|    |                                       | Decision making (nt₁b)                         |
|    |                                       | Human resources / operator (nt₁c)              |
|    |                                       | Supervisory Agency (nt₁d)                      |
|    |                                       | Standard Operation Procedure (SOP) (nt₁c)      |
|    |                                       | Master Plan (nt₁f)                             |
| 3  | Law and Regulation (NT₃)              | Monitoring of laws and regulations (nt₃a)       |
|    |                                       | Law enforcement (nt₃b)                         |
|    |                                       | Economic activity near polder (nt₃c)            |
| 5  | Flood disadvantages (NT₅)             | Inundation disadvantages (nt₅c)                 |

For further purposes, further research is needed to create a polder system service index model.

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