Development of weighting value for ecodrainage implementation assessment criteria

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Abstract. This research aim to generate weighting value for each factor and find out the most influential factor for identify implementation of ecodrain concept using loading factor and Cronbach Alpha. The drainage problem especially in urban areas are getting more complex and need to be handled as soon as possible. Flood and drought problem can’t be solved by the conventional paradigm of drainage (to drain runoff flow as faster as possible to the nearest drainage area). The new paradigm of drainage that based on environmental approach called “ecodrain” can solve both of flood and drought problems. For getting the optimal result, ecodrain should be applied in smallest scale (domestic scale), until the biggest scale (city areas). It is necessary to identify drainage condition based on environmental approach. This research implement ecodrain concept by a guidelines that consist of parameters and assessment criteria. It was generating the 2 variables, 7 indicators and 63 key factors from previous research and related regulations. the conclusion of the research is the most influential indicator on technical management variable is storage system, while on non-technical management variable is government role.

Keywords: criteria, cronbach alpha, ecodrain, loading factor, sustainable

1. Introduction
Sustainable development is a concept that emphasizes the conservation and preservation of natural resources. It is comprehensive and is therefore not limited to certain activities, and it is closely related to the continuation of human life on earth. Sustainable development concerns three primary categories: economic, social, and environmental. These three elements are interconnected to create security, harmony, and prosperity. Sustainable development seeks to balance human needs and demands with the environment’s capacity to cope with human consumption and industry [1]. For assuring local sustainability in the form of shaping sustainable human settlements an appropriate sustainable management on a local level is necessary to be carried out. In the process of operationalization of sustainable development an important part is represented by developing innovative models for sustainable land management [2].

Water is the source of life, and anyone can’t survive without water. Urban drainage presents a classic set of modern environmental challenges: the need for cost-effective and socially acceptable technical improvements in existing systems, the need for assessment of the impact of those systems, and the need to search for sustainable solutions. There are numerous techniques and approaches known around the world how to support sustainable rainwater management, especially in the urban areas, where the storm water can cause significant damages [3].
In urban areas, the drainage problem consist of flood, drought and water pollution are getting more complex and need to be handled as soon as possible. Flood caused by incapability of river in collecting actual water discharge (river overflow) while inundation occurs when runoff and local inflow cannot be drained into the nearest drainage channel or river. Drought caused by the decreasing of groundwater level and water supply especially in the dry season. There are 2 method of drainage on water resources engineering, the conventional method adopt “hard engineering principle” and the recent one known as “ecodrain”. The principle of conventional method is to drain runoff flow as faster as possible to the nearest drainage area while the principle of Ecodrain is increase water infiltration and storage to decrease runoff discharge. The conventional drainage design approach does not address sustainability issues. Moving forward, an ecodrain approach using green infrastructures is recommended. In addition to flow and flood management provided by the conventional methods, green infrastructures can bring multiple benefits such as increased amenity value and groundwater recharge. The main advantage of the sustainable approach is the additional benefits such as environmental improvement, natural groundwater recharge, runoff reduction as well as energy savings [4].

For the optimal result, ecodrain should be applied in smallest scale (domestic scale) to the biggest scale (city areas). Ecodrain can be implemented if the drainage infrastructure meets the criteria and indicators. Therefore, it is necessary to identify drainage condition based on environmental approach. For identify the implementation of ecodrain concept, it use a guidelines that consist of ecodrain criteria and indicators. According to researchers [5], [6], there are 2 variables, 7 indicators and 63 key factors for identify the implementation of ecodrain concept, consist of: technical and non-technical management as variables, technical management consist of infiltration system, drainage system, complementary building system, storage system, and pump system as indicators, while non-technical management consist of government role and community participation as indicators. From those indicators, 63 key factors was generated (type and channel dimension, water quality, sediment transport, monitoring evaluation existence, etc [5], [6].

Based on researcher [7] and Indonesia’s related regulation, there are several factors that influenced implementation of ecodrain concepts, such as:

- Separation between drainage and waste water network for urban areas.
- Masterplan with area more than 10 hectare should be built retention ponds, rainwater subreservoir and absorption wells
- Groundwater recharge, rainwater reuse and recycle and low impact development concept.
- River has function as natural drainage channel.
- Development area plan should have at least 30% of total area which used as retention areas
- etc

For non technical management variables, researcher [8] was mentioned that public perception toward cultural attraction will give the tremendous boost to any development. The groups identified as the most influence and affected individual are the local authorities, local communities, and the tourists [8]. Therefore, government role and community participation is used as non technical management variables. This research aim to develop the weighting value for 2 variables (technical and non technical), 7 indicators and 63 key factors using SPSS. From this research, the most influenced indicator and factor can be determined. Further, the most influenced factor should be prioritized by government and community to implement ecodrain concept.

2. Research Method

Methods used in this research are:

a) Developing factors validity and indicators reliability using SPSS. The validity of all factors has been tested by determining loading factor meanwhile the reliability of all indicators has been tested by using Cronbach alpha. All factors and indicators are valid if the value of loading factor and Cronbach alpha close to 1.

b) Developing weighting value for all factors and indicators from percentage of the loading factors and Cronbach alpha value. From the weighting value, it can be conclude the most influential factor and indicator to identify the implementation of ecodrain concept in an area.
3. Results and Discussion

The result of this research consist of:

a) All indicators (Infiltration system, drainage channel system, complementary system building, storage system, pump system, government role and community participation) from 2 variable (technical and non technical) meets the reliability requirement with Cronbach Alpha value 0.732-0.838

b) All key factors from 7 indicators fulfil the validity test with loading factor value 0.428-0.748.

The recapitulation of evaluation results on validity and reliability evaluation can be seen in Table 1.

| Indicator                                      | Code | Validity | Reliability | Description                   | Weighting Value |
|------------------------------------------------|------|----------|-------------|--------------------------------|-----------------|
| Infiltration System (A1)                       | A1   | 0.732    | Reliable    |                               | 13.19           |
| Type of infiltration system selection          | A11  | 0.553    | Valid       |                               | 1.55            |
| Determination of infiltration system number and capacity | A12  | 0.561    | Valid       |                               | 1.57            |
| Determination of infiltration system location  | A13  | 0.534    | Valid       |                               | 1.5             |
| Waste management in infiltration system        | A14  | 0.617    | Valid       |                               | 1.73            |
| Water quality management in infiltration system| A15  | 0.597    | Valid       |                               | 1.67            |
| Sediment management in infiltration system     | A16  | 0.683    | Valid       |                               | 1.91            |
| Vegetation management in infiltration system   | A17  | 0.695    | Valid       |                               | 1.95            |
| The existence of monitoring evaluation system  | A18  | 0.468    | Valid       |                               | 1.31            |
| Drainage Channel Systems (A2)                  | A2   | 0.747    | Reliable    |                               | 13.46           |
| Type of drainage channel selection             | A21  | 0.524    | Valid       |                               | 1.46            |
| Determination of drainage channel dimension and capacity | A22  | 0.688    | Valid       |                               | 1.92            |
| Determination of drainage channel location     | A23  | 0.638    | Valid       |                               | 1.78            |
| Waste management in drainage channel system    | A24  | 0.535    | Valid       |                               | 1.49            |
| Water quality management in drainage channel system | A25  | 0.532    | Valid       |                               | 1.48            |
| Sediment management in drainage channel system | A26  | 0.665    | Valid       |                               | 1.85            |
| Vegetation management in drainage channel system | A27  | 0.678    | Valid       |                               | 1.89            |
| The existence of monitoring evaluation system  | A28  | 0.571    | Valid       |                               | 1.59            |
| Complementary System Building (A3)             | A3   | 0.789    | Reliable    |                               | 14.21           |
| Type of complementary system building selection| A31  | 0.517    | Valid       |                               | 1.45            |
| Determination of complementary system building dimension and capacity | A32  | 0.711    | Valid       |                               | 1.99            |
| Determination of complementary system building location | A33  | 0.688    | Valid       |                               | 1.93            |
| Waste management in complementary system building | A34  | 0.582    | Valid       |                               | 1.63            |
| Indicator                                                                 | Code | Validity | Reliability | Description                                                                 | Weighting Value |
|--------------------------------------------------------------------------|------|----------|-------------|-----------------------------------------------------------------------------|-----------------|
| Water quality management in complementary system building                | A35  | 0.63     | Valid        | Valid                                                                       | 1.76            |
| Sediment management in complementary system building                     | A36  | 0.67     | Valid        | Valid                                                                       | 1.88            |
| Vegetation management in complementary system building                   | A37  | 0.669    | Valid        | Valid                                                                       | 1.87            |
| The existence of monitoring evaluation system                            | A38  | 0.608    | Valid        | Valid                                                                       | 1.7             |
| Storage Systems (A4)                                                    | A4   | 0.829    | Reliable     | Valid                                                                       | 14.93           |
| Type of storage system selection                                         | A41  | 0.596    | Valid        | Valid                                                                       | 1.64            |
| Determination of storage system number and capacity                      | A42  | 0.672    | Valid        | Valid                                                                       | 1.85            |
| Determination of storage system location                                 | A43  | 0.72     | Valid        | Valid                                                                       | 1.99            |
| Waste management in storage system                                       | A44  | 0.673    | Valid        | Valid                                                                       | 1.86            |
| Water quality management in storage system                               | A45  | 0.624    | Valid        | Valid                                                                       | 1.72            |
| Sediment management in storage system                                    | A46  | 0.743    | Valid        | Valid                                                                       | 2.05            |
| Vegetation management in storage system                                  | A47  | 0.717    | Valid        | Valid                                                                       | 1.98            |
| The existence of monitoring evaluation system                            | A48  | 0.667    | Valid        | Valid                                                                       | 1.84            |
| Pump Systems (A5)                                                        | A5   | 0.81     | Reliable     | Valid                                                                       | 14.59           |
| Type of pump system selection                                            | A51  | 0.705    | Valid        | Valid                                                                       | 1.95            |
| Determination of pump system number and capacity                          | A52  | 0.725    | Valid        | Valid                                                                       | 2               |
| Determination of pump system location                                    | A53  | 0.73     | Valid        | Valid                                                                       | 2.02            |
| Waste management in pump system                                          | A54  | 0.688    | Valid        | Valid                                                                       | 1.9             |
| Water quality management in pump system                                  | A55  | 0.435    | Valid        | Valid                                                                       | 1.2             |
| Sediment management in pump system                                       | A56  | 0.687    | Valid        | Valid                                                                       | 1.9             |
| Vegetation management in pump system                                     | A57  | 0.626    | Valid        | Valid                                                                       | 1.73            |
| The existence of money system                                            | A58  | 0.685    | Valid        | Valid                                                                       | 1.89            |
| Government Role (B1)                                                     | B1   | 0.838    | Reliable     | Valid                                                                       | 15.1            |
| Determination of O&M organization                                       | B11  | 0.509    | Valid        | Valid                                                                       | 0.92            |
| Determination of supporting personnel O&M organization                   | B12  | 0.61     | Valid        | Valid                                                                       | 1.1             |
| Determination of supporting personnel number                            | B13  | 0.653    | Valid        | Valid                                                                       | 1.18            |
| O&M drainage infrastructure on regular schedule                          | B14  | 0.537    | Valid        | Valid                                                                       | 0.97            |
| Determination of local government support on O&M budget                 | B15  | 0.508    | Valid        | Valid                                                                       | 0.91            |
| Determination of local government support on O&M development and rehabilitation budget | B16  | 0.597    | Valid        | Valid                                                                       | 1.08            |
| Determination of development and rehabilitation priority                 | B17  | 0.668    | Valid        | Valid                                                                       | 1.2             |
| Formation coordination organization among stakeholder                     | B18  | 0.572    | Valid        | Valid                                                                       | 1.03            |
| Giving reward to local government                                       | B19  | 0.428    | Valid        | Valid                                                                       | 0.77            |
| Indicator                                                                 | Code | Validity | Reliability | Description                                                                 | Weighting Value |
|--------------------------------------------------------------------------|------|----------|-------------|------------------------------------------------------------------------------|-----------------|
| The existence of local laws and regulations & policies that support ecodrain concept | B110 | 0.667    | Valid       | 1.2                                                                          |
| Application of punishment/penalty                                         | B111 | 0.503    | Valid       | 0.91                                                                        |
| Socialization of local laws / regulations, policies and penalty to the community | B112 | 0.657    | Valid       | 1.18                                                                        |
| Involvement of customary institutions in socialization                    | B113 | 0.513    | Valid       | 0.92                                                                        |
| Follow up on community complaints                                        | B114 | 0.494    | Valid       | 0.89                                                                        |
| Determination of ecodrain master plan                                     | B115 | 0.467    | Valid       | 0.84                                                                        |
| **Community Participation (B2)**                                          | **B2** | **0.806** | Reliabile   | 14.52                                                                       |
| Community Participation on drainage infrastructure regular maintenance     | B21  | 0.6      | Valid       | 1.65                                                                        |
| The community's active role on reporting drainage infrastructure breaking/failure | B22  | 0.68     | Valid       | 1.87                                                                        |
| The community's active role on reporting inundation                        | B23  | 0.676    | Valid       | 1.86                                                                        |
| The community's active role on giving post development impact data         | B24  | 0.748    | Valid       | **2.06**                                                                    |
| Community Participation on drainage infrastructure planning and construction process | B25  | 0.685    | Valid       | 1.89                                                                        |
| The community's active role on infiltration wells construction             | B26  | 0.629    | Valid       | 1.73                                                                        |
| Community understanding about ecodrain concept                            | B27  | 0.65     | Valid       | 1.79                                                                        |
| Community's ability to finance infrastructure damage                       | B28  | 0.606    | Valid       | 1.67                                                                        |

Based on Table 1 (weighting value result), it can be seen that the most influential indicator on technical management variable is storage system while on non-technical management variable is government role. The most influential factor from each indicator can be seen on Figure 1.

![Figure 1. Most influential indicator and factor for ecodrain assessment.](image)

4. Conclusion
It can be conclude that the most influential indicator on technical management variable is storage system while on non-technical management variable is government role. For storage system, the most
influential factor for ecodrain assessment is Sediment management in storage system (with weighting value of 2.05) and for government role the most influential factor for ecodrain assessment is Determination of development and rehabilitation priority (with weighting value of 1.20). Therefore, the most influential factors should be prioritized to identify the implementation of ecodrain concept in an area.

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