Community perceptions analysis of waste management in the Upper Citarum Watershed measured from attitudes, awareness, responsibilities, and norms using the SEM method

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Abstract. The Citarum River is a widely used river for community life; however, water pollution in the Citarum watershed, especially the upstream area, is increasing. Research shows that river water quality has decreased drastically, which has been heavily polluted and filled with various waste along the 127 km or 47.1% of the Citarum river. Waste and its management are now becoming an increasingly urgent problem in cities in Indonesia. It is feared that the high level of pollution in the upstream area of the Citarum watershed will impact the water quality conditions. Therefore, social analysis is needed. In this study, social analysis in the upstream region of the Citarum watershed was measured by the SEM (Structural Equation Modeling) method. This research is intended to analyze the community's perceptions in the upstream area of the Citarum watershed towards waste management, measured by attitudes, awareness, responsibility, and norms. The correlation results show a significant relationship between waste management dimensions, where the highest correlation or relationship between norms and a sense of responsibility is (0.6667). It can be concluded that community norms and responsibilities are the main factors in waste management.

1. Introduction
The Citarum River is a river that is widely used for community life along its watershed. Utilization of the Citarum River, among others, is in the fields of agriculture, livestock, hydropower, industry and household needs. The upstream of this river is in the Bandung Regency area [1]. Water pollution in the Citarum watershed, especially the upstream area, is increasingly being reported. Research shows that river water quality has decreased drastically, where along the 127 km or 47.1% of the Citarum river has been heavily polluted and filled with various garbage [2]. The Citarum River is a vital and strategic river, where people in the watershed consume 80% of it. If the river is polluted with garbage, this can cause health problems for the community [3].

Garbage and its management are becoming an increasingly urgent problem in Indonesia's cities because if it is not handled correctly, it will result in a change in the environmental balance that is detrimental or unexpected so that it can pollute the environment both soil, water and air. Therefore, to overcome this pollution problem, it is necessary to handle and control waste [4]. Handling and control will become increasingly complex and complicated with the complexity of the type and composition of waste in line with culture advancement. Therefore, handling waste in urban areas is relatively more difficult than in villages. Problems that often arise in handling municipal solid waste are high operational costs and the difficulty of proper space for disposal [5].
In order to obtain a high level of effectiveness and efficiency in the handling of waste in the upstream area of the Citarum watershed, its management must be sufficiently feasible to be implemented simultaneously accompanied by efforts to utilize it so that it is expected to have advantages in the form of added value. It is necessary to choose the right method and technology, and it is essential to have community participation to achieve optimal results. It requires measuring attitudes, awareness, responsibilities and norms of the upstream Citarum community. The Citarum River contributes greatly to the economic activities of the people of Bandung Regency. Various kinds of activities or interests exist in the Citarum River area, such as the majority of the people in the Upper Citarum watershed using the land for agricultural activities, tourism and industrial activities. It is feared that the high human activity in the upstream area of the Citarum watershed will impact pollution on the water quality conditions. Therefore a social analysis is needed in the upstream area of the Citarum watershed. In this study, people's perceptions were measured by the SEM method. One hundred samples were taken from the community in the upstream area of the Citarum watershed. This research is intended to analyze the community's perceptions in the upstream area of the Citarum watershed towards waste management, measured by attitudes, awareness, responsibilities, and norms.

2. Methodology
The method used to analyze primary data in this research is the qualitative method with the Structural Equation Modelling (SEM) method with Linear Structural Relationship (LISREL) software version 8.7 for Mac. The SEM method will be used to analyze the relationship between key variables in the research. The structural model built using the SEM method will describe non-linear relationships between variables that affect the socio-hydrological system's resilience. However, SEM is generally used to analyze linear relationships between variables. The basic concepts in using the SEM method are as follows:

There are two main stages in SEM [6]:
1. Validating the measurement model and secondly adjusting it to the structural model. The first step is completed with confirmatory factor analysis,
2. The model is resolved through path analysis with latent variables. Model development begins with specifying a model based on theory. Each variable in the model is conceptualized as a latent variable measured by several indicators. At least three indicators are followed for each latent variable after the confirmation factor analysis is carried out. The number of samples used should be large enough, above 100 (n> 100). Then, factor analysis is used to determine that the indicators will measure the latent variables, related and represented by several factors. The process of developing a structural model can be continued if the measurement model has been validated. Two or more models are compared in the model's suitability to measure whether the covariance predicted by the model is related to the observed covariance in the data.

The approach to developing SEM models is to develop a measurement model and a structural model. The measurement model produces convergent validity and discriminant validity. Meanwhile, the structural model produces predictive validity. To develop the model, required data to be processed and analyzed. The data is in the form of a covariance matrix from empirical research data. Furthermore, this data will be used as the basis for producing the covariance matrix of population estimates.

SEM is very suitable for use in [6]:
1. Confirm the unidimensionality of various indicators for the construct/concept/factor;
2. To test the suitability/accuracy of a particular model based on existing empirical data; and
3. To test the model's suitability and analyze the causal relationship between the factors built into the model.

The stages of developing the SEM model are as follows:
1. Development of theory-based models;
2. Development of flowcharts to show causality relationships;
3. Conversion of flowcharts into a series of structural equations and specification measurement models;
4. Selection of the input matrix (input) and estimation techniques for the built model;
5. Assess problem identification;
6. Evaluating the model;
7. Interpret and modify the model.

The criteria for testing the suitability of the model consist of:

1. Model fit test and statistical test in SEM there is no single statistical test tool to measure or test the hypotheses of the model made, including:
2. Model testing is done using Chi-Square, provided that the smaller the Chi-Square value, the better the model is being made.
3. Root Mean Square Error of Approximation (RMSEA) if the RMSEA value is 0.08 or less, this value indicates an index for the acceptance of the model created.
4. The value of the alignment index (goodness of fit index), whose magnitude ranges from 0 - 1. If the value is close to 0, then the model has low compatibility; while the value is close to 1, the model has a good fit.
5. Adjusted Goodness of Fit Index (AGFI) provides that the AGFI value is equal to or greater than 0.9. If the value is greater than 0.9, the model has a good overall model fit.
6. The minimum sample discrepancy function (CMNF), which is the statistical value of Chi-Square divided by the value of the degree of freedom (df), is also called relative Chi-Square with a value of less than 0.2 with tolerance below 0.3, which is an indicator of the acceptance of a model and data fit.
7. The Tucker Lewis Index (TLI) is defined as the acceptance of a model equal to or greater than 0.95. If the value is close to 1, then the model shows a very high fit.
8. Comparative Fit Index (CFI) with a value between 0 - 1 provided that if the value is close to number 1, then the model created has a very high, moderate fit. If the value is close to 0, then the model does not have a good fit.

3. Results and discussion

The waste management model is as follows:

![Research model](image_url)

**Figure 1.** Research model.

PLS-SEM analysis is used to measure how much the contribution of attitude, awareness, sense of responsibility and norms in measuring waste management. The following are the results of PLS-SEM processing.
Table 1. Contribution of attitudes, awareness, sense of responsibility and norms in waste management.

| Dimension                        | Loading Factor | Standard Error | T Statistic | Contribution |
|----------------------------------|----------------|----------------|-------------|--------------|
| Waste_Management -> Norms        | 0.793          | 0.075          | 10.528      | Significant  |
| Waste Management -> Awareness    | 0.786          | 0.070          | 11.153      | Significant  |
| Waste_Management -> Attitude     | 0.839          | 0.049          | 17.065      | Significant  |
| Waste_Management -> Responsibility| 0.859          | 0.036          | 24.178      | Significant  |

The processing results show that attitude, awareness, sense of responsibility, and norms significantly contribute to waste management in the upstream area of the Citarum watershed. From the four dimensions, it can be seen that the dimension of sense of responsibility has the highest LF (0.859) compared to other dimensions or has a contribution (0.859² = 74%), which means that in waste management, the sense of responsibility contributes 74%. Next is the attitude with LF = 0.839 or contributing 70.4%, norm with LF 0.793 or contributing 62.9% and conscious with LF = 0.786 or contributing 61.7%.

Table 2. Contribution of indicators attitudes, awareness, sense of responsibility and norms in waste management.

| Indicator          | Loading Factor | Standard Error | T Statistic | Contribution |
|--------------------|----------------|----------------|-------------|--------------|
| NORMA1 <- Norms    | 0.955          | 0.020          | 48.667      | Significant  |
| NORMA2 <- Norms    | 0.931          | 0.057          | 16.481      | Significant  |
| RS_JAWAB1 <- Responsibility | 0.905       | 0.033          | 27.800      | Significant  |
| RS_JAWAB2 <- Responsibility | 0.874       | 0.042          | 20.650      | Significant  |
| RS_JAWAB3 <- Responsibility | 0.680       | 0.132          | 5.145       | Significant  |
| RS_JAWAB4 <- Responsibility | 0.805       | 0.034          | 23.748      | Significant  |
| SADAR1 <- Awareness | 0.858          | 0.073          | 11.686      | Significant  |
| SADAR2 <- Awareness | 0.920          | 0.046          | 20.184      | Significant  |
| SADAR3 <- Awareness | 0.933          | 0.049          | 18.988      | Significant  |
| SIKAP1 <- Attitude  | 0.925          | 0.024          | 38.530      | Significant  |
| SIKAP2 <- Attitude  | 0.921          | 0.016          | 58.327      | Significant  |
| SIKAP3 <- Attitude  | 0.895          | 0.026          | 34.126      | Significant  |
| SIKAP4 <- Attitude  | 0.759          | 0.126          | 6.046       | Significant  |
| SIKAP5 <- Attitude  | 0.231          | 0.194          | 1.191       | Not Significant |
| SIKAP6 <- Attitude  | 0.243          | 0.190          | 1.280       | Not Significant |

3.1. Norms
Indicators of norms are "NORMA1 = Morally, I am aware of sorting waste in my household and NORMA2 = I must be aware that if I do not sort the waste in my household, there will be environmental pollution" has a high LF of 0.955 and respectively. 0.931, which indicates that the community has high norms for sorting household waste.

3.2. Responsibility
Of the 4 (four) indicators that describe responsibility, the highest contribution can be seen in the first indicator, namely: I am partially responsible for preventing plastic pollution in the Citarum River with LF = 0.905. The second indicator is "I am partially responsible for improving the community's quality of life." These results indicate that the community has a high sense of responsibility in preventing the Citarum river's pollution and a sense of responsibility in improving the quality of life of the community.
3.3. Awareness
There are three indicators for measuring awareness. Overall, they have a high LF, meaning that people have an awareness of the environment, especially the third indicator with the highest LF of 0.933, namely "Waste separation can improve the quality of life in Bandung Regency." Citarum river pollution from plastic pollution and waste sorting activities is also perceived as important in shaping awareness of the environment.

3.4. Attitude
There are six indicators that measure attitudes where indicators 1 and 2 have the highest contribution, namely LF = 0.925 and LF 0.921. Even though there is or does not have a waste collection system from the government for the environment where I live, I consciously will continue to sort the waste. And even though there is or does not have a private waste collection system, I will consciously continue to sort out the waste.

The 5th and 6th indicators are insignificant. If I see a garbage collection system provided by the government in the neighborhood where I live, I will sort the waste in my household. And only if I see a garbage collection system provided by a private company in my neighborhood, I will sort the waste in my household.

From the estimation model results, it can be concluded that the relationship between waste management and norms, awareness, attitudes, and responsibilities. The relationship between the dimensions of waste management can be seen in table 3:

|                   | Norms  | Awareness | Attitudes | Responsibility |
|-------------------|--------|-----------|-----------|----------------|
| Norms             | 1      |           |           |                |
| Awareness         | 0.4069** | 1         |           |                |
| Attitudes         | 0.6263** | 0.5296** | 1         |                |
| Responsibility    | 0.6667** | 0.6445** | 0.5199** | 1              |

** Significant in alpha 5%

The correlation results show a significant relationship between waste management dimensions, where the highest correlation or relationship between norms and a sense of responsibility is (0.6667).
3.5. Ways to increase societal norms and responsibilities
There are norms that regulate waste management, both written and unwritten. Written norms are in the
form of standard operational work procedures, while unwritten norms are in the form of services to the
community regarding waste management. These norms can strengthen the rules in achieving the
community's goals to stay organized and move according to their functions. Related to the norms that
apply in the community in waste management, there are several social sanctions for the community,
including the norm of not littering, the norm of prohibiting throwing garbage on riverbanks, and the
norm for planting trees in the yard as urban farming. Aspects of norms have led to society's rules that
have created awareness and participation that all citizens must have [7]. The most effective way to
enhance societal norms and responsibilities is with clear policies [8].

4. Conclusion
Norms and responsibilities have the most significant relationship with waste management. In other
words, community norms and responsibilities are the main factors in waste management in the upstream
area of the Citarum watershed. Related to the norms that apply in the community in waste management,
there are several social sanctions for the community, including the norm of not littering, the norm of
prohibiting throwing garbage on riverbanks, and the norm for planting trees in the yard as urban farming.
Aspects of norms have led to society's rules that have created awareness and participation that all citizens
must-have. Clear policies are the most effective way to increase social awareness about waste
management.

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