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The Estimation Model of Mineral Mining Control and Management in Realizing a Sustainable Environment: Application of Confirmatory Factor Analysis

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Individual behaviour can develop into social behaviour, which is a behaviour with a higher level because social behaviour is addressed explicitly to other people. This research aims to measure the validity and reliability of each indicator, that is a measurement variable (manifest variable) for each variable that cannot be measured directly (latent variable). From the method of implementation, this research is survey research. Survey research is used to solve large-scale issues with a substantial population, so considerable sample size is required. This research was carried out for 4 months, from June 2020 to September 2020. The research location was planned to be conducted in Barru Regency, South Sulawesi Province. The sampling technique was purposive random sampling with a sample of 200 respondents consisting of people who carry out mineral mining as their main livelihood. The data analysis used confirmatory factor analysis (CFA) which was processed through the IBM AMOS 22 programme. The goodness of fit results (CMIN/DF, GFI, RMSEA, CFI, PNFI), composite reliability (CR) and loading factor of the measurement model has met the minimum recommended requirements. The research model's measurement of validation and reliability shows that the indicators that make-up the behavioural, attitude and knowledge variables are reliable. Managing mineral resources requires a strategy for maintaining the settlement environment, formed through environmental knowledge, attitudes and motivation.

KEYWORDS

Confirmatory factor analysis, Self-assessment, Sustainable development, Human behaviour

1. INTRODUCTION

Sustainable development requires wise resource management. On the other hand, mineral resources pose a risk of environmental damage. Therefore, environmental control measures are an effort that must be considered in sustainable development planning. In the concept of sustainable development, policy collisions between the need to explore natural resources to fight poverty and hunger to prevent environmental degradation need to be avoided as far as possible in a balanced manner [1]. Sustainable development also requires meeting the community's basic needs and providing broad opportunities for community members to pursue the ideals of a better life without compromising future generations [2,3]. The development of concept of sustainable development needs to consider socially and culturally suitable needs, disseminate values that create different consumption standards within the limits of the environment's capabilities and that everyone is naturally able to aspire to them. However, there is a tendency that the fulfilment of these needs will depend on the need to realize economic growth or production needs at a maximum scale. Sustainable development requires economic growth where the primary needs cannot be consistent with economic growth if the content of change reflects sustainability principles. However, the reality is that high production activity can co-occur with widespread poverty. This condition can harm the environment. So sustainable development requires that people's needs are met by increasing their production potential and at the same time, ensuring

equal opportunities for everyone. The government certainly needs a realistic policy strategy that can be implemented and accompanied by an appropriate control system. Exploiting natural resources is recommended, preferably replaceable natural resources, to maintain the ecosystem or environmental design [4].

The main problem in managing these mineral resources is environmental damage. Topographical changes in the post-mining landscape cause open land and holes [5]. During the dry season, the land causes much dust from mining holes. Another impact is that local people's livestock can be trapped in these holes and causing social conflicts. In addition, the open land and fixes used by mining have damaged the aesthetics of the landscape and made environmental management difficult. During the rainy season, the ex-mining land will be filled with water and can cause puddles of water that can damage the environment. In addition, this mining has a high potential for erosion and landslides [6,7]. Irresponsible and disorganized management of mineral resources creates the risk of environmental and social threats [8]. Mining management in rivers impacts river morphology damage, lateral erosion, which causes widening of the river body, vertical erosion, which causes river deepening and landslides on river banks [9]. Environmental damage on land and rivers is the rationale for environmental control measures in managing mineral resources [10]. This study begins with the level of community knowledge on mineral resource management in Barru Regency. Community knowledge related to mineral resource management is knowledge of mineral resource potential, mineral resource management methods, the impact of mineral resource management and environmental control. The knowledge aspect is thought to influence the community's behaviour in managing mineral resources [11].

The mineral resources of the Barru Regency area consist of metal minerals, non-metallic minerals and rocks. Metallic minerals are chromite, galena and gold. Non-metallic minerals are kaolin, limestone, quartz, sand and clay. Rocks are peridotite, sandstone, river sand, river rock and embankment soil [12]. Human behaviour results from experiences and human interactions with their environment manifested in knowledge, attitudes and actions [3,13,14]. In other words, behaviour is an individual's response/reaction to stimuli from outside or within himself. This response can be passive (without action: think, opinion, behave) or active (act). Following this limitation, health behaviour can be formulated as a form of individual experience and interaction with the environment, especially regarding knowledge and attitudes about health. Dynamic behaviour can be seen, while passive behaviour is invisible, such as knowledge, perception or motivation. Some experts distinguish forms of behaviour into three domains, namely knowledge, attitudes and actions or we often hear the terms knowledge, attitude and practice. Meanwhile, Clayton suggests external and internal factors contribute to pro-environmental behaviour [15].

Individual intentions influence mineral resource management behaviour and personal purposes are formed from subjective attitudes and norms [16]. One of the influencing variables, namely attitude, is controlled by the results of actions that have been carried out in the past. Meanwhile, subjective norms will be influenced by beliefs in the opinions of others and the motivation to obey the beliefs or opinions of others. Simply put, people will act if it has a positive value from existing experiences and the action is supported by the individual's environment [17]. Then the attitude itself is influenced by beliefs about the results of past actions. Subjective norms are influenced by faith in the opinions of others and the motivation to obey those opinions. More simply, this theory says that a person will act if he views the action positively and if he believes that other people want him to do it. In addition, the knowledge factor that influences the behaviour and attitudes of the community, every business plan or activity that has the potential to cause a meaningful impact, requires environmental management efforts so that the environment can tolerate the effects that arise. For this reason, the initiator is obliged to carry out ecological management at each stage of its activities according to the type of impact that occurs. Environmental management uses socio-economic, institutional and technological approaches to develop positive effects and prevent negative consequences. The purpose of the research is to measure the validity of the indicators of the research variables in the form of knowledge, attitudes and behaviour of the community.

2. MATERIAL AND METHOD

2.1 Research approach

A quantitative research approach is a research approach that primarily uses the post-positivist paradigm in developing knowledge (such as thinking about cause and effect, reduction of variable heads, hypotheses and specific questions, using measurement and observation and theory testing), using research strategies, such as experiments and surveys that require statistical data [18]. From the method of implementation, this research is survey research. Survey research is used to solve

Figure 1. *Map of study location*

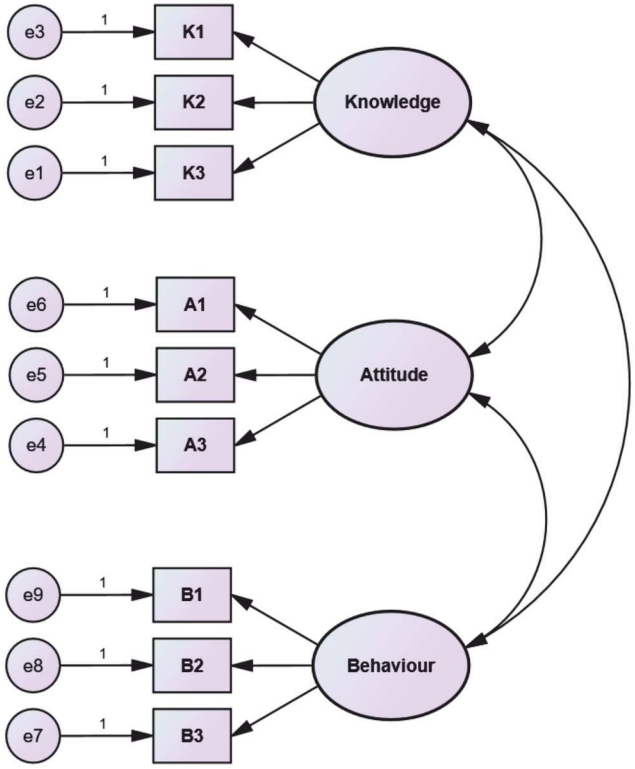

Figure 2. *Research model of confirmatory factor analysis*

large-scale issues with a substantial population, so considerable sample size is required. Collecting data using a questionnaire as the primary data source [19,20]. In survey research, respondents are asked to provide short answers that have been written in a questionnaire and then the responses from all respondents are processed using specific quantitative analysis techniques [21].

2.2 Study area

This research was carried out for 4 months, from June 2020 to September 2020. The research location was planned to be conducted in Tanete Riaja district and Pujananting district, Barru Regency, South Sulawesi Province. This research site is given in figure 1. The Barru Regency area has significant mineral resource potential. The potential of mineral resources is a gift that needs to be managed to provide benefits for the welfare of the people, especially the surrounding community. The management of mineral resources in Barru Regency has not had a significant effect on improving welfare and impacts the environment. The two locations are where the local community carries out mineral mining as their main livelihood.

2.3 Population and samples

The population in this study is a community that manages mineral resources (mineral mining) in Barru Regency, South Sulawesi. This study used the maximum likelihood (ML) model estimation with the proposed sample size of 100 – 200 samples [22,23]. In the implementation, it is considered. However, seeing that there will be outlier data when conducting the analysis later, the number of samples used was 200 samples. From the type of population that has been known and determined, the appropriate sampling technique for this research was purposive random sampling. The sampling technique using purposive random sampling is part of the non-probability sampling technique, namely the sampling technique, which does not provide equal opportunities for each member of the population to be selected as a sample member [18,24].

2.4 Data analysis

Confirmatory factor analysis (CFA) or factor analysis, is used to test dimensions of theoretical construct and is often called testing the validity of a hypothesis [25]. Before carrying out structural model analysis, research-

Table 1. *Characteristic respondents (N = 200)*

Category	Frequency	Percent (%)
Gender		
Man	200.00	100.00
Women	0.00	0.00
Age		
< 20 years	0.00	0.00
20 - 30 years	7.00	3.50
30 - 40 years	42.00	21.00
40 - 50 years	79.00	39.50
> 50 years	72.00	36.00
Length of work		
< 5 years	3.00	1.50
5 - 10 years	21.00	10.50
10 -15 years	64.00	32.00
15 - 20 years	89.00	44.50
> 20 years	23.00	11.50
Education		
Primary school	12.00	6.00
Junior high school	63.00	31.50
Senior high school	101.00	50.50
University level	24.00	12.00

ers must first measure model (measurement model) to test the validity of the indicators forming the construct or latent variables using CFA (Figure 2). In this study, the first-order CFA model was used, whereas, in the first-order CFA model, the indicators were implemented in items that directly measure the construct. Testing using CFA, the indicator is said to be valid if the loading factor is 0.70. The loading factor of 0.50-0.60 can still be tolerated in research that has not been established. As for managing the primary data obtained from the sampling results, the IBM AMOS 22 for Windows programme was used. The programme can simultaneously analyse indicators and variables comprehensively.

3. RESULT AND DISCUSSION

3.1 Characteristic respondents

Characteristics of respondents are used to determine the diversity of respondents based on gender, age, work experience and education. This is expected to provide a reasonably clear picture of the condition of the respondents and their relation to the problems and objectives of the research. Table 1 shows several categories of respondents who were sampled in the study. The male gender dominated respondents in the survey. This happens because the type of work carried out is mineral mining which requires physical energy. The respondent's age is dominated by the age 40-50 years (39.50%), which means that at that age, all respondents already have dependents (wife and children) whom they reason must finance and any work can be done if it can provide results and according to their abilities in this case, namely only requires energy and physique. Most respondents' work experience in mining minerals is between 15-20 years, amounting to 44.50%. This work is the primary source of income for them to support their family. The lack of available types of work makes the miners only depend on this work for their lives. The education level of many respondents is high school graduates, as much as 50.50% of the total sample. The high cost of continuing education to the university level and the lack of job security after completing education have caused many high school graduates to work as mineral miners.

Table 2. *Goodness of fit test result*

Criteria	Threshold	Value	Result
CMIN/DF	≤2.000	0.813	Fit
GFI	≥0.900	0.951	Fit
RMSEA	≤0.080	0.004	Fit
CFI	≥0.900	0.982	Fit
PNFI	≥0.500	0.527	Fit

3.2 Goodness of fit

The goodness of fit (GOF) of a statistical model which describes how well the model fits a series of observations made. The goodness of fit measure usually summarizes the difference between the observed and expected values in the model. The goodness of fit (GOF) criteria that are often presented in publications are Chi-square (CMIN/DF), root mean square error of approximation (RMSEA), Parsimony normed fit indices (PNFI) and comparative fit index (CFI) [26-29]. Garson recommends reporting only the size of the fit model from CMIN/DF, RMSEA, one or more of the incremental fit indices (CFI, IFI, NFI, RFI, TLI), one of the parsimonious fit indices (PNFI, PCFI, PGFI) and one or more of the information theory (AIC, BIC, CAIC, BCC, ECVI, MECVI). Table 2 shows the result of the goodness of fit analysis which shows all the criteria for obtaining good results (fit). The proposed model can be analysed

Table 3. *Loading factor test result*

	Estimate	S.E.	C.R.	Prob. (p)	Loading factor
Knowledge → Conceptual (K1)	0.198	0.087	2.275	0.007	0.657
Knowledge → Factual (K2)	0.185	0.058	3.190	0.000	0.785
Knowledge → Procedural (K3)	0.566	0.176	3.216	0.000	0.736
Attitude → Conative (A1)	0.234	0.103	2.272	0.001	0.725
Attitude → Affective (A2)	0.445	0.138	3.225	0.000	0.890
Attitude → Cognitive (A3)	0.161	0.072	2.236	0.005	0.822
Behaviour → Cognitive (B1)	0.292	0.143	2.042	0.011	0.744
Behaviour → Affective (B2)	0.375	0.139	2.698	0.006	0.765
Behaviour → Psychomotor (B3)	0.311	0.115	2.704	0.004	0.788

Table 4. *Construct reliability test result*

Variables	Construct reliability
Knowledge	0.863
Attitude	0.838
Behaviour	0.797

at the next stage with these results.

3.3 Loading factor

The loading value describes the relationship between the research variables and their indicators. The indicator on a variable is the one that has the most significant loading value because it indicates higher relationship between the indicator and the research variable. In most references, a factor weight of 0.500 or more is considered strong enough validation to explain the latent construct/indicator [25]. The loading factor value obtained in table 3 shows that all indicators in the research variable have a strong validation value, as seen from most of the average values obtained is 0.700, which means that it has met the requirements recommended by several previous researchers.

3.4 Composite reliability

The composite reliability (CR) factor load is calculated using maximum likelihood method following a normal distribution and it is possible to obtain a negative factor charge. This will cause an error in the calculation results, where the reliability value will be small, which can mean that the indicators used do not describe the variable being observed, even though it could be that the indicator can define the variable being observed. The indicators used in research are usually designed to be homogeneous, but one indicator and another may have different weights, which can cause inhomogeneity. This can also lead to errors in composite reliability (CR) results. The formula used to obtain the composite reliability (CR) is as follows:

$$CR = \frac{(\Sigma \text{ Loading factor})}{(\Sigma \text{ Loading factor})} + \Sigma Ej \quad ...(1)$$

$$\Sigma Ej = 1 - (\text{Loading factor}) \quad ...(2)$$

Composite reliability can be calculated using a specific formula, where the calculation method is squaring each factor load and dividing it by sum of squared each factor load and error variance associated with each indicator variable. If calculation result is less than 0.70, it can be interpreted that composite reliability is unacceptable. Composite reliability can provide erroneous information because it is affected by negative factor loads (sum of the numerator of all factor loads before squared). The results obtained indicate that the reliability is acceptable because the value obtained has met the minimum requirements that is CR > 0.700 (Table 4). The behavioural model, although very simple, provides a basis for considering the possible relationships that exist between environmental knowledge, environmental awareness and attitudes and how this might translate to action or inaction. Good knowledge about environmental variables does not necessarily mean good and sustainable environmental behaviour. On the other hand, a lack of environmental knowledge or awareness may also not necessarily imply bad environmental practices. Knowledge alone is not enough to act responsibly towards the environment. While knowledge of some individuals about environment and its regulations can encourage them to do good attitudes that can be translated into good intentions to act, other individuals can

go through internal and external controls, such as being influenced by actions of others [30]. Others hold fast to the belief to act right despite the efforts of others to the environment. Although the separate constructs of attitude, control centre and intention to work may not be sufficient to create a choice to act, united under one overarching concept, they form the basis on which tendencies for pro-environmental behaviour are formed [31].

In addition, the knowledge factor that influences people's behaviour, every business plan or activity that has the potential to cause a significant impact, requires environmental management efforts so that the environment can tolerate the results that arise. For this reason, the initiator is obliged to carry out environmental management at each stage of its activities according to the type of impact that occurs. Environmental management uses socio-economic, institutional and technological approaches to develop positive effects and prevent negative consequences. Alongwith managing mineral resources in Barru Regency, a strategy for maintaining the settlement environment is needed, formed through environmental knowledge, attitudes and motivation. Individual behaviour can develop into social behaviour, which is a behaviour with a higher level because social behaviour is addressed explicitly to other people. Pro-social behaviour is exemplary and is considered to create a clean, lasting and healthy social order. Families can teach children to be wise consumers from childhood. Parents can be role models for children in action. The surrounding environment, namely friends, school and society, can influence personal norms within the individual [32]. Pro-social behaviour can take the form of ecological behaviour, which includes paying attention to the impact of the products consumed, saving energy, recycling, buying organic and other products and using them wisely.

4. CONCLUSION

From the objectives described at the outset, it can be concluded that the measuring instruments measured in this study are relatively consistent and will tend to give pretty same results if repeated on the same object. The research model's measurement of validation and reliability shows that the indicators that make-up the behaviour, attitude and knowledge variables are reliable. It will be more complex in subsequent studies by adding motivational variables to complement the existing variables. As a measuring tool, the instrument used can be adapted to the conditions of the research area so as not to cause lousy prejudice for the community or respondents who will later be sampled in the study.

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