A Path Analysis of Sustaining Small Scale Fishing Industry in Indonesia

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Abstract: The over exploitation of the international fishing activities does affect the sustainability of the local small-scale fishing industry. The small scale fishing industry sectors especially economic, social, ecological, and governance in Indonesia has not been well managed. The objective of this paper is therefore to analyze the causal relationships between the four variables using a path analysis technique. The results of this analysis showed that the economic factor has the largest effect on the small-scale fisheries system. Future studies should emphasized more on the economic variable to sustain the local fishing industry in Indonesia.

Keywords: Sustainability; fishing industry; path analysis; small scale fisheries

1. Introduction

Sustainability is the keyword in the development of the local fishing industry. It is expected to improve the resources, well-being and social activities of the local fishermen. The potential of the fish resources in an area will assure that the fishing activities and its future development be sustained (Masyahoro, 2006). The concept of sustainable development, optimize four aspect, comprises the economic, social, environmental, and governance aspects so that fishery resources management in Indonesia is a very complex system. There have been so many concerns on the increasingly stressed environmental sustainability, especially on its social well-being (Rice, 2014).

In addition, Moldan (2001) in Kocmanová *et al*. (2011) stated that the environmental aspect focuses on environmental protection, specifically its improvement and prevention of the ever exhausted and limited natural resources. The quality of environment in turn strongly affect the quality of life of the population, in particular the social aspect.

Small-scale fisheries has contributed to the local food security, livelihoods and poverty (Barnes *et al*., 2013), yet to date the economic value of small-scale fisheries is rather low due to poor management. The small scale fisheries communities face numerous local and global threats and social vulnerability to these pressures places at risk the livelihoods, food security, well-being, and traditional lifestyles of coastal communities and cultures (Kittinger, 2013). In an effort to increase the standard of living of small-scale fishermen, it is critically important that a sustainable fishing practices be adopted. In this case, it would require some intensive studies on the sustainability factors and their relationships involving small-scale fishermen (Chesson *et al*., 1999). Such implementation is not easy and will experience some problems since the principles of ecologically sustainable development can impose a complex potentially conflict in small scale fisheries (Hannesson, 2008).

The reduction of sustainable small-scale fisheries is perhaps due to the non-social and slow technological advancement in the local fishing industry. However, it is clear that the small-scale fisheries continue to be relevant in Indonesia from a social, environmental, cultural, and economic perspective (Sharma, 2011). The critically important aspect and sub-aspect involved in sustainable development theory includes the economic, social, ecological, and governance factors. The theory of sustainable development has been widely applied in fishing capture effort management and even up to the deployment stage. Unfortunately, no significant relationships between the variables or sub-variable in the implementation of sustainable development theory have been studied. Therefore, it is timely that a critical path analysis being done to determine the relationship between variables and sub-variables in sustainable fisheries development concept and to point the biggest contributing indicators in sustainable fisheries need to be carried out.

A Path Analysis is very effective for conceptualizing research and for linking theory and the real world in which this analytical technique used to analyze the causal relationships value between the independent variables and dependent variable (Douglas, 1983). By the theory, Path Analysis extends multiple regression analysis, but while regression gives the best or closest prediction of the response variable based on the given causal factors by the method of least squares, path analysis goes further by providing probable interpretation of the relationships between and within the contributing causal factors to the observed effects (Akintude, 2012). One of the difficulties of this approach might result in multi-co linearity of variables, which can lead to some difficulties in the interpretation of the actual contribution of each variable (Aminpanah *et al.,* 2011). In order to avoid misinterpretation, the relationship between the variables is done individually without

involving the other variables. Path analysis focused on the problem of interpretation and does not support to be a method for discovering causes (Duncan, 1966). The independent variables (IVs) in this context is the sustainable development factors defined by FAO as economic, social, ecological, governance aspects. The dependent variable (DV) is the implementation of sustainable fisheries (Sarwono, 2012).

2. Materials and Methods

2.1 Sample

A small scale fishing activities in PPI Cisolok using traditional fishing technology was selected as the study area of small-scale fisheries. Data was collected in two stages. The first stage was by interviews and surveys based on the data requirements that have been previously determined. The second stage was through interviews and surveys based on closed questionnaires that have been designed before. A purposive sampling and snowball method were used for the questionnaire survey.

Purposive sampling method is sampling technique that was performed deliberately by a specific purpose. This consideration was based on the characteristics of the sample that to be taken. In the first stage, respondents or sample are the important or main actors from small-scale fisheries in PPI Cisolok. The respondents must represents all the actors and stakeholders in PPI Cisolok such as the head officer of PPI Cisolok, one person from the fisheries business actor, one person staff of UPTD Palabuhanratu, and one leader from fishermen community in PPI Cisolok. In the second stage, a sample of 40 respondents (10% of the 399 total fishermen) found in PPI Cisolok region. Snowball sampling is a special non probability method for developing a research sample where existing study subjects recruit the next subjects from among their acquaintances (Katz, 2006). This method is commonly used to obtain some specific information to subject who are not known or cannot be mapped in sampling frame and usually begin with determining the subject who the most understand about the information that is needed and have many links. In addition, the advantage of this method is to provide convenience in tracking social networks within a social science community and context for easier handling of sample respondents (Noy, 2008).

2.2 The calculation of combined effect value of independent variable (x) against small-scale fisheries sustainability in PPI Cisolok as dependent variable (y)

The calculation of combined effect value is a calculation aimed to see the combined effect of the independent variable (x) that composed of economic, social, ecological and governance against sustainability of small-scale fisheries in the PPI Cisolok (y) that seen on R square value. R square value will describe the combined effect values of independent variables against sustainability of small-scale fisheries in the PPI Cisolok as dependent variable.

2.3 The calculation of partial effect of sustainable aspect value (x) against small-scale sustainable fisheries in PPI Cisolok as dependent variable(y)

The calculation of the partial effect value against sustainability aspects in this

study was aimed to determine the partial effect of sustainable aspects as independent variable (x) against small-scale fisheries sustainability in PPI Cisolok as dependent variable (y) as *Beta* value in standardized Coefficients of *Beta.*

2.4 The calculation of independent variable partial effect to the sustainability of small-scale fisheries in PPI Cisolok (y)

The calculation of independent variables partial effect in this study was aimed to determine the effect values of indicators namely economic, social, ecological and governance aspect as independent variables (x) partially against sustainability of small-scale fisheries in PPI Cisolok as dependent variable (y) in standardized beta coefficients.

2.5 The calculation of relationship between the variables inside sustainability aspects

The calculation of relationship between sustainability aspects (x) was aimed to evaluate the relationship of sustainability variable with the other sustainability aspects. The relationships between independent variables can be seen in the results of the analysis using SPSS software as the Pearson correlations.

3. Results and Discussion

3.1 Combined effect of independent variables (x) on fisheries sustainability in PPI Cisolok (y)

Based on the results of path analysis, Table 1 shows that the value of R^2 is 0.963. It can be transformed into a percentage by calculating the determination coefficient (KD) with the following formula.

$KD = R^2 \times 100\%$

$KD = 0.963 \times 100\%$

$KD = 96.3\%$

The determination coefficient is 96.3% that can be described as the effect of all independent variables (IV) (x) on the small-scale fisheries sustainability (y). The other factors (error value, e) can be calculated by the following formula:

$e = 1 - R^n 1 - R^n$

$e = 1 - 0.963 \quad 1 - 0.963$

$e = 0.037$ or 3.7%

The error value (e) is 3.7% which showed the value of other factors of IV (x) in this model. In other words, the fisheries sustainability variable can be explained in this study are 96.3% and 3.7%, respectively were caused by the other external variables beyond the scope of this study.

Table 1. The partial effect of partial aspects of sustainability to the sustainability of fisheries in Cisolok

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	-16.927	.833		-20.330	.000
	Economic	3.112	.192	.623	16.213	.000
	Social	1.393	.130	.414	10.738	.000
	Ecology	1.888	.218	.330	8.666	.000
	Governance	1.075	.096	.435	11.195	.000
a. Dependent Variable: sustainability						

3.2 The effect value of sustainable aspect (x) partially against small-scale fisheries sustainability in PPI Cisolok as dependent variable (y)

The sustainable factor that affect partially against the sustainability of small scale fisheries can also be referred to in Table 1 above. The effect of sustainable aspects (x) partially/separately against sustainability of small-scale fisheries as dependent variable (y) can be seen in *Beta* coefficients as standardized in the *Beta* column. Based on Table 1, the effect of sustainability aspects (x) against sustainability of small-scale fisheries (y) was analyzed separately.

The first step was to develop the hypothesis for each partial analysis that was tested. H_0 indicates that there is no linear relationship between sustainability aspects (x_n) with sustainability of small-scale fisheries in PPI Cisolok (y). Meanwhile, H_1 indicates any linear relationship between sustainability aspects (x_n) with sustainability of small-scale fisheries in PPI Cisolok (y). The next step is to determine the t-value and t-table value, where t-value was listed. The Coefficients in columns t and t table value or critical value obtained using a table t with significance level 0.05 and a Degree of Freedom (DF)/degrees of Freedom/DK = n-2, or 4-2 = 2. The t-table value from this provision is 4.302. The final step is to test and validate the hypothesis testing and testing of significant t-value. Percentage of the effect in each sustainable aspect (x) against small-scale fisheries sustainability and a significance level effect of each sustainable aspect (x) against small-scale fisheries sustainability (y) were shown in Table 2.

Table 2. The effect of sustainability aspects (x) against small-scale fisheries sustainability

Sustainable aspect (X)	Decision	Effect between X & Y	Significance
Economic	Rejected H0	62.3%	significant
Social	Rejected H0	41.4%	significant
Ecology	Rejected H0	33.0%	significant
Governance	Rejected H0	43.5%	significant

Based on the results, sustainability has a linear relationship to the sustainability of small-scale fisheries, but with varying values. The biggest significant ($p<0.05$) effect is on the economic factor (62.3%), followed by governance (43.5%), social (41.4%) and ecological (33.0%). Therefore, the sustainable small-scale fisheries management should be focused on the economic aspect because it has the greatest influence in the sustainability of small-scale fisheries in PPI Cisolok.

3.3 The effect of independent variable (x) in sustainability aspects against sustainability of small-scale fisheries (y)

There are four variables (x) of effect values that cannot be displayed due to the constant or variable that has no relation to the sustainability of small-scale fisheries. These variables were conflict, culture/traditions of fishing, the direct impact of fishing gear on habitat, and the capacity to organize/manage (performance fisheries). The effect of the independent variable (x) in economic,

social, ecological and institutional partially/ separately against the dependent variable (y) can be seen in the *Coefficients* where the effect of the independent variable (x) against sustainability of small-scale fisheries (y) was analyzed separately.

Table 3 showed the effect of the independent variable (x) in partially against sustainability of small-scale fisheries (y).

(a) Economic Aspect

There were nine independent variables (x) which are included in the economic aspect which have a linear relationship to the sustainability of small-scale fisheries. However, there was one independent variable (x) that did not has a linear relationship against sustainability of small-scale fisheries (y), i.e the independent variable, income of fishermen. Such an income variable is considered not affecting the sustainability of small-scale fisheries.

The effect of independent variable (x) against sustainability of small-scale fisheries (y) is the catch variable that has the largest effect of 22.2% ($p<0.05$). The smallest independent variable influence (x) against sustainability variable of small-scale fisheries (y) is the fishermen income of 7.8% ($p>0.05$).

(b) Social Aspect

The three independent variables (x) which were included in the social aspect have a linear relationship against sustainability of small-scale fisheries. However, the workforce

Table 3. The effect of independent variable (x) partially to the sustainability of small-scale fisheries (y)

Sustainable aspect	Independent variable (x)	Decision	effect value of x against y	Significantly
Economic	Profit	Reject H0	15,6%	significant
	Catch	Reject H0	22,2%	significant
	Catch values	Reject H0	19,2%	significant
	Investment in fishing activity	Reject H0	13,6%	significant
	Cost	Reject H0	14,3%	significant
	Number of fishery workers	Reject H0	20,0%	significant
	Income of fishermen	Reject H1	7,8%	not significant
	Fuel consumption	Reject H0	13,3%	not significant
	Subsidy	Reject H0	19,2%	significant
Social	Workforce/participation	Reject H1	4,4%	not significant
	Education level	Reject H0	12,8%	significant
	Family role	Reject H0	32,7%	significant
Ecological	Catch composition	Reject H1	9,8%	not significant
	Catch size	Reject H0	18,1%	significant
	Exploitation level (catching trip)	Reject H0	18,5%	significant
	Exploitation level (fishing gear)	Reject H1	12,3%	not significant
	Direct impact on non-target fish species	Reject H0	14,2%	significant
Governance	Compliance to the government system	Reject H0	36,2%	significant
	Transparency and participation	Reject H0	21,4%	significant

or participation independent variable (x) does not have a linear relationship against sustainability of small-scale fisheries (y). The largest significant effect ($p<0.05$) of independent variable (x) to the sustainability of small-scale fisheries (y) is the roles of family (32.7%).

(c) Ecological aspect

Based on the five independent variables (x) of ecological aspect, almost all the variables have a linear relationship against sustainability of small-scale fisheries. However, there are two independent variables (x) that did not have a linear relationship against sustainability of small -scale fisheries (y) namely, the composition of the catch and exploitation rates (fishing gear).

The largest independent variable (x) that significantly ($p<0.05$) influenced the sustainability of small-scale fisheries(y) was the rate of catch trip (18.5%). On the other hand, the smallest influence of the independent variable (x) against sustainability of small -scale fisheries (y) is composition of the catch (9.8%).

(d) Governance aspect

All that variables have a linear relationship against sustainability of small-scale fisheries in the PPI Cisolok. The largest significant ($p<0.05$) effect of independent variable (x) against sustainability of small-scale fisheries (y) complied with the system of government (36.2%). The least significant ($p>0.05$) variable effect (x) against sustainability of small-scale fisheries in PPI Cisolok (y) was the transparency and participation of 21.4%.

3.4 The calculation of the relationship between aspects of sustainability

The relationships between sustainability aspects can be seen in Table 4. The results show that correlation between economic and social is -0.042. Correlation value by -0.042 between economic and social aspect of sustainability in small-scale fisheries is classified into very weak correlation and not in same correlation direction because the correlation value is negative. Calculation of the relationship/ correlation between economic and ecological is -0.014. Correlation of -0.014 between aspects of economic and ecological aspects of sustainability in small-scale fishery is classified into a very weak correlation and not in same correlation direction because the correlation value is negative.

There was a weak correlation between the economic and governance aspects are 0.199. Correlation between social and ecological aspects was -0.151. Correlation of -0.151 between aspects of social and ecological aspects of sustainability in small-scale fishery was classified into a very weak correlation. A weak correlation between social and governance aspects was 0.144. Correlation between ecological and governance aspects is 0.004. Similarly, a weak correlation of 0.007 was evident between the aspects of ecological and governance aspects of sustainability in small-scale fishery.

Table 4. The relationship between sustainability aspects

		Sustainability	Economic	Social	Ecological	Governance
Pearson Correlation	Sustainability	1	0.688	0.4	0.261	0.621
	Economic	0.688	1	-0.042	-0.014	0.199
	Social	0.4	-0.042	1	-0.151	0.144
	Ecological	0.261	-0.014	-0.151	1	0.007
	Governance	0.621	0.199	0.144	0.007	1
Sig.(1-tailed)	Sustaiability	.	0	0.005	0.052	0
	Economic	0	.	0.398	0.466	0.109
	Social	0.005	0.398	.	0.176	0.187
	Ecological	0.052	0.466	0.176	.	0.484
	Governance	0	0.109	0.187	0.484	.
N	Sustaiability	40	40	40	40	40
	Economic	40	40	40	40	40
	Social	40	40	40	40	40
	Ecological	40	40	40	40	40
	Governance	40	40	40	40	40

To interpret the value of coefficient correlation used criteria (Sarwono 2006), namely:

= 0	: Zero correlation
> 0-0.25	: Weak correlation
> 0.25-0.5	: Enough correlation
> 0.5-0.75	: Strong Correlation
> 0.75 to 0.99	: Very strong correlation
= 1	: Perfect correlation

3. Conclusion

The significant influence of all independent variables against sustainability of small-scale fisheries in PPI Cisolok was 96.3%. The balance of 3.7% can be explained by the other factors outside this study. The economic aspect is the most affecting sustainability aspects in sustainability development of small-scale fisheries (62.3%). The aspect of sustainability were influenced by each variable, in particular the important variable in economic is the catch variable (22.2%). Another important variable of social aspect is the role of family (32.7%), catching trip (18.5) %, and compliance of government system (36.2%). Economic aspects have a close relation with governance aspect with a correlation of 0.199. The social aspect has a close relation with ecological aspects with correlation value of -0.151. Governance has a significant relation with economic (0.199). Future work on the scale fisheries on should be focused on the need to give an effect to improve management of small-scale fisheries and to support sustainability.

References

1. Akintunde, A. N. (2012). Path Analysis Step by Step Using Excel. Journal Of Technical Science And Technologies, 1(1): 9-15.
2. Aminpanah, H., Sharifi, P. (2011). Sequential Path Analysis for Determination of Relationships Between Yield-Related Characters with Yield in Rice (*Oryza sativa* L.). African Journal of Agricultural Research, 6(28): 6100-6106.

3. Barnes, M. M., Kirsten L. L., Olesona, Zafindrasilivononac, B. (2013). The Total Economic Value of Small-Scale Fisheries with Acharacterization of Post-Landing Trends: an Application in Madagascarwith Global Relevance. Fisheries Research, 147: 175-185.
4. Chesson, J., Clayton, H., and Whitworth, B. (1999). Evaluation of Fisheries Management Systems with Respect to Sustainable Development. ICES Journal of Marine Science, 56: 980-984.
5. Douglas, J. T. (1983). The Path Analysis Technique in Educational Research: Bridging The Theory-Empiricism Gap. Journal of Educational Administration, 21(1): 40-51.
6. Duncan, O. T. (1966). Path analysis: Sociological Example. The American Journal of Sociology, 72(1):1-16.
7. Hannesson, R. (2008). Sustainability of Fisheries. The Electronic Journal of Sustainable Development, 1(2) Bergen, Norway.
8. Katz, H. (2006). Global Surveys or Multi-National Surveys? on Sampling for Global Surveys, Thoughts for the Globalization and Social Science Data Workshop. Israeli Center for Third-sector Research (ICTR) and Dept of Business Administration Ben Gurion University of the Negev. Available at: *http://www.global.ucsb.edu/orfaleacenter/conferences/ngoconference/Katz_for-UCSB-data-workshop.pdf.*
9. Kittinger, J. N. (2013). Human Dimensions of Small-Scale and Traditional Fisheries in the Asia-Pacific Region. Pacific Science, 67(3): 315-325.
10. Kocmanová, A., Hřebíček, J., and Dočekalová, M. (2011). Corporate Governance and Sustainability. Economics and Management. Kaunas University of Technology, 16: 543.-550.
11. Masyahoro, A. (2006). Analisis Kebijakan Pengembangan Perikanan Purse Seine Dengan Metode Analytical Hierarchi Process (Ahp) di Perairan Kabupaten Parigi Moutong. Journal Agroland 13(3): 275-281 *(in Indonesian)*.
12. Noy, C. (2008). Sampling Knowledge: The Hermeneutics of Snowball Sampling in Qualitative Research, International Journal of Social Research Methodology, 11(4): 327-344.
13. Rice, J. (2014). Evolution of International Commitments for Fisheries Sustainability. ICES Journal of Marine Science, 71: 157-165.
14. Sarwono, J. (2012). Path Analysis. Teori Aplikasi, Prosedur Analisis untuk Riset Skripsi, Tesis dan Disertasi (Menggunakan SPSS). Jakarta: Elex Media Komputindo *(in Indonesian)*.
15. Sharma, C. (2011). Securing Economic, Social and Cultural Rights of Small-Scale and Artisanal Fisherworkers and Fishing Communities. International Collective in Support of Fishworkers, 10(2): 41-61.

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