

Interaction effect between alternatives and public involvement affecting the overall quality of EIA reports for development cooperation projects

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Abstract: The purposes of this study are to clarify that alternatives analysis and public involvement are determinants of the overall quality of EIA reports for development cooperation projects, and the interaction effect between the two processes affects the overall report quality. The quality of EIA reports is fundamental to making good decisions, and alternatives analysis and public involvement are very important processes in ensuring their quality. The study examined quality grade data for 160 reports prepared by the Japan International Cooperation Agency dating from 2001 to 2016, using cluster analysis, decision tree analysis, and regression analysis. The study shows that the two processes are determinants and their positive interaction effect affects the overall report quality. The just satisfactory grade of alternatives and public involvement at the scoping stage and draft reporting stage are the thresholds for satisfactory EIA reports.

Key Words: Interaction effect, Alternatives analysis, Public involvement, EIA report quality

Introduction

The environmental impact assessment (EIA) report is an output of the EIA process - the quality of the report is fundamental for making good decisions and an indication of the effectiveness of the EIA system (Sandham and Pretorius 2008; Pölonen et al. 2011). But the low quality of EIA reports in developing countries has been pointed out (Ruffeis et al. 2010; Rathi 2017). Major factors influencing the quality of EIA reports in developing countries are: the experience of EIA practitioners, the type or size of the project and the availability of information and guidance (Kabir and Momtaz 2012; Sandham et al. 2013; Gwimbi and Nhamo 2016). But these factors are noted as major constraints in developing countries (Clausen et al. 2011; Coşkun and Turker 2011; Betey and Godfred 2013; Rathi 2017). It therefore appears to

be very difficult to improve the quality of EIA reports in developing countries under the present constraints. On the other hand, alternatives analysis and public involvement could be key factors for improving report quality (Kamijo and Huang 2016). These two processes may interact to determine the overall quality. However, little is known about the interaction effect between the two processes, on the overall quality of EIA reports.

1. Data and methods

1.1 Selection of sample and assessing report quality

The study examined the quality of EIA reports prepared by the Japan International Cooperation Agency (JICA) from 2001 to 2016, to identify the time series changes in report quality by introduction of JICA mandatory EIA guidelines in

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2004 and 2010 (JICA 2004 and 2010) and to examine the interaction effect between alternatives and public involvement. A total of 160 reports – 10 per year for 16 years – were randomly selected from a list of reports of each year through the JICA library website using a random number table. The quality of EIA reports was reviewed by following the Lee-Colley review package (Lee et al. 1999). A certified professional EIA engineer in Japan, who is familiar with the JICA guidelines, conducted the review. The review criteria of the Lee-Colley review package are divided into three categories, namely, area, category, and subcategory. At the top, there are four areas and under each area, there are categories, and under each category, there are subcategories. The review starts with subcategories, then moves upwards to categories and areas, and finishes with overall quality. Alphabetic symbols (A, B, C, D, E, F, and N/A) are used to grade the quality (Table 1).

Table 1 Assessment symbols

Symbol	Explanation
A	Relevant tasks well performed, no important tasks left incomplete.
B	Generally satisfactory and complete, only minor omissions and inadequacies.
C	Can be considered just satisfactory despite omissions and/or inadequacies.
D	Parts are well attempted but must, as a whole, be considered just unsatisfactory because of omissions or inadequacies.
E	Not satisfactory, significant omissions or inadequacies.
F	Very unsatisfactory, important tasks poorly done or not attempted.
N/A	Not applicable. The review topic is not applicable or it is irrelevant in the context of the statement.

Source : Lee et al. 1999.

Table 2 Data matrix

No.	Level	Alt	PI	No. Alt	No. Crt	No. PI	Area 1 grade	Area 2 grade	Area 3 grade	Area 4 grade	Overall quality
1	EIA	yes	yes	16	7	2	B	C	B	B	B
2	IEE	yes	yes	3	7	1	C	D	D	C	C
3	EIA	yes	no	2	0	0	D	D	D	D	D
4	IEE	yes	no	3	13	0	D	D	D	D	D
5	EIA	no	no	0	0	0	C	D	D	D	D

Note: Alt: alternatives, PI: public involvement, Crt: criteria

1.2 Cluster analysis, decision tree analysis, and regression analysis

Cluster analysis and decision tree analysis was used to analyze 160 reports from the period 2001 to 2016, and a data matrix was prepared (Table 2). Key explanatory variables effective for good quality were selected according to previous studies, such as report level (EIA or initial environmental examination (IEE)), the presence and absence of alternatives and public involvement, and the number of alternatives, evaluation criteria, and public involvement stages. Three periods of public involvement (PI3) means: public involvement at the scoping stage, the intermediate stage between the scoping and draft reporting, and the draft reporting stage; two (PI2) refers to public involvement at the scoping stage and the draft reporting stage; one (PI1) means public involvement only at the draft reporting stage; and zero time (PI0) refers to no public involvement at any stage. It was assumed that the effect of public involvement would increase with an increase in the number of public involvement stages.

The grades of the four areas and the overall quality were added together. The area 1 is description of the development and the environment; the area 2 is identification and evaluation of key impacts; the area 3 is alternatives and mitigation; and the area 4 is communication of results. The ordinal scale from A to F was converted to rank scores like 6, 5, 4, 3, 2, and 1. Similarly, the qualitative variables like EIA or IEE, and yes or no, were converted into dummy variables. The cluster analysis and the decision tree analysis were performed using Ward's method (popular hierarchical cluster analysis algorithms) and the rpart package of the free statistical software R version 3.2.3 (2015-12-10).

One scatter diagram with the grade of alternatives on the X axis and the overall quality grade on the Y axis was prepared for all 160 reports, and regression lines based on the number of public involvement stages were added to identify any interaction effect between alternatives and public involvement affecting the overall report quality. The regression analysis was used to test

for the presence of any interaction effect. The model outcome was: $Y = d + ax_1 + bx_2 + c(x_1 \times x_2)$; where variable Y , x_1 , x_2 , and $x_1 \times x_2$ represented the overall quality (Y), and the grade of alternatives (x_1), the number of public involvement stages (x_2) and the interaction effect between alternatives analysis and public involvement ($x_1 \times x_2$), respectively. The significance of the regression coefficient of interaction was tested. Finally, the ordinal scale from A to F was converted to rank scores like 6, 5, 4, 3, 2, and 1. Centering was applied to x_1 and x_2 before multiplication, as it can reduce problems with multi collinearity. The difference with $*p < .05$ and $**p < .01$ was considered significant.

2. Results

2.1 Review results of report quality

The review results show that no reports are well performed (A), 21 are generally satisfactory (B), 40 are just satisfactory (C), 80 are just unsatisfactory (D), 19 are poorly attempted (E), and no reports are very unsatisfactory (F). The satisfaction levels (A to C) show that the tendency toward improvement is: 23% in 2001-2004, 37% in 2005-2010, and 50% in 2011-2016. The statistical difference was determined by the Kruskal-Wallis test and the p -value is .047*. Multiple comparisons between three periods by the Steel-Dwass test also show a significant difference with $*p < .05$ between 2001-2004 and 2011-2016 (Table 4). It could be said that JICA guidelines in 2004 and 2010 resulted in improved quality of EIA reports and the introduction effect of JICA guidelines was recognized.

2.2 Results of cluster analysis and decision tree analysis

The cluster dendrogram is divided into four clusters based on the interpretation. The two clusters locate in the lower right consist of good quality reports (Figure 1). The decision tree is applied to the results of the cluster analysis and indicates the branching conditions to the two clusters of good quality reports (Figure 2). The

reports with the presence of alternatives proceed to the lower left from the top node and the reports with the presence of public involvement go down to the right (Cluster 1 and Cluster 4). At the end, IEE level reports down to the left (Cluster 1) and EIA level reports go down to the right (Cluster 4). Cluster 1 and Cluster 4 are of good quality reports. The decision tree shows that the presence of alternatives and public involvement is the determinant of good quality reports.

Table 3 Report quality and three periods

Period	A	B	C	D	E	F	Total	A-C (%)	D-F (%)
2001-2004	0	0	9	26	5	0	40	23	77
2005-2010	0	10	12	30	8	0	60	37	63
2011-2016	0	11	19	24	6	0	60	50	50
Total	0	21	40	80	19	0	160	38	62

Table 4 Steel-Dwass test results

Period	2005-2010	2011-2016
2001-2004	2.054	3.901*
2005-2010		1.712
2011-2016		

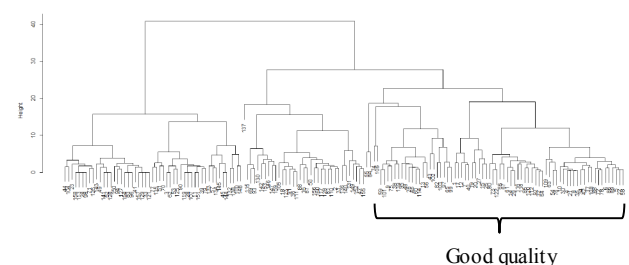


Figure 1 Cluster dendrogram for 160 reports

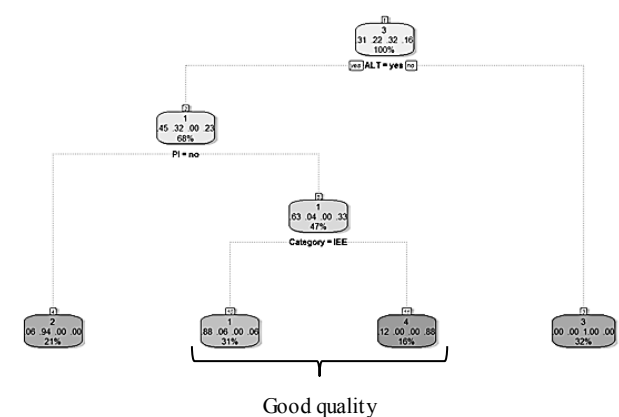


Figure 2 Decision tree for 160 reports

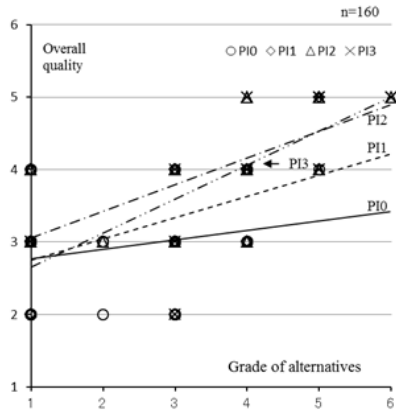


Figure 3 Interaction between alternatives and public involvement affecting overall quality

2.3 Interaction effect between alternatives and public involvement

The overall report quality is improved when improving the grade of alternatives, and increasing the number of public involvement stages. And the increase of PI0, PI1, PI2, and PI3 is different (Figure 3). The effect of alternatives is different by the effect of public involvement. These different increases indicate the interaction effect between two processes in the scatter diagram. The interaction effect is positive in enhancing the overall report quality. In the next place, the calculated multiple regression formula is : $Y = 2.273 + 0.276 X_1 + 0.248 X_2 + 0.092 (X_1 \times X_2)$ and the coefficient of the determination (R^2) is 0.54 with ** $p < .001$. The p -value of regression coefficient of the interaction is .004**. The interaction effect between two processes to the overall report quality is considered to be significant.

3. Discussion

3.1 Determinants improving the report quality

According to the results of the decision tree analysis, the key factors influencing the overall report quality are alternatives, public involvement, and the report level. The first factor is alternatives analysis, the second one public involvement, and the third one the report level in this study. This study clarifies that alternatives analysis and public involvement could be determinants in the

improvement of JICA report quality at the EIA and IEE levels.

3.2 Moderator effect of public involvement

It is possible to interpret the interaction effect in two different ways. The effect of alternatives to the overall report quality is moderated by the effect of public involvement or the effect of public involvement is moderated by the effect of alternatives. EIA is a process to select a good alternative from plural alternatives taking public view into account. The consideration of alternatives represents the heart of environmental impact statement (CEQ 1978). Based on the above, the public involvement can be interpreted as the moderator effect to the effect of alternatives. In other words, the effect of alternatives would be moderated by the effect of public involvement.

3.3 Larger interaction effect

PI0, PI1, PI2, and PI3 increase in overall report quality when the grade of alternatives is enhanced, but in comparison with PI0 and PI1, the increase of PI2 is larger. The effect of public involvement is different depending on the grade of alternatives and it is larger at Alt 4 (grade C of alternatives). The interaction effect can become larger in the case of public involvement at scoping and draft reporting (PI2) and the grade C (just satisfactory) of alternatives (Alt4).

3.4 Grade of alternatives for increasing the effect of public involvement

The effects of PI0, PI1, PI2, and PI3 affecting the report quality are low and the difference is not recognized at the stages of Alt1, Alt 2, and Alt3 (grade F, E. and D). Public involvement does not have an impact on the unsatisfactory grade of alternatives. Thus, the inadequate analysis of alternatives may have no potential to improve overall quality despite the effect of public involvement. The grade C of alternatives (Alt4) increases overall quality when increasing the effect of public involvement. The public involvement has an impact on grade C of alternatives.

3.5 Guidance for preparing satisfactory reports

The scatter diagram and regression lines can give guidance for the preparation of satisfactory reports. The intersection point of grade C of the alternatives (Alt4) and the two periods of public involvement (PI2), mark the point four (grade C) of overall report quality. Thus, grade C of alternatives and two periods of public involvement at the stages of scoping and draft reporting could be the thresholds (benchmarks) for grade C in the overall quality of JICA reports. This group consists of 12 reports (two reports at EIA level on large scale projects and ten reports at IEE level on small scale projects). These thresholds would also be useful for preparing satisfactory reports at IEE level on small scale projects.

Conclusions

This study clarifies that alternatives analysis and public involvement are determinants in the improvement of the overall quality of the EIA reports for development cooperation projects. At the same time the interaction effect between these two processes affects the overall report quality. The adequate analysis of alternatives increased the effect of public involvement. The grade C level of alternatives and public involvement at the scoping stage and draft reporting stage are the thresholds for achieving satisfactory reports. The satisfactory percentage (grades A to C) would increase from 50 % in 2011-2016 by this guidance

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