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Tetsuya Kamijo and Guangwei Huang

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JICA Research Institute

JICA Research Institute
10-5 Ichigaya Honmura-cho
Shinjuku-ku
Tokyo 162-8433 JAPAN
TEL: +81-3-3269-3374
FAX: +81-3-3269-2054

Determinants of the EIA Report Quality for Development Cooperation Projects: Effects of Alternatives and Public Involvement

Tetsuya Kamijo[*] and Guangwei Huang[†]

Abstract

The quality of environmental impact assessment (EIA) reports is fundamental to making good decisions and the low quality of EIA reports is a constraint in developed and developing countries. In developing countries, it appears to be very difficult to improve the quality of reports under present constraints such as limited funding, human resources, and information. The purposes of this study are to identify determinants of the overall quality of EIA reports for development cooperation projects that Japan International Cooperation Agency has supported, and to propose benchmarks for satisfactory quality reports under the present situation in developing countries. The study reviewed the quality of 160 reports from 2001 to 2016 and examined factors influencing the overall quality of reports using statistical tests, cluster analysis, and decision tree analysis. The study clarified that the two processes of alternatives and public involvement were determinants and their linkage affected the quality of reports. The study concludes that the just satisfactory grade of alternatives and public involvement at the scoping and draft reporting are the benchmarks for satisfactory EIA reports. Further verification through comparative studies and case studies, is needed to confirm how two processes have an effect on the quality of reports.

Keywords: EIA report quality; alternatives; public involvement; statistical tests; cluster analysis; decision tree analysis

[*] Research Fellow, JICA Research Institute (Kamijo.Tetsuya@jica.go.jp)
[†] Professor, Graduate School of Global Environmental Studies, Sophia University (huanggwx@sophia.ac.jp)

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Introduction

An environmental impact assessment (EIA) report is an output of the EIA process. The quality of an EIA report is a degree or grade of excellence or worth of the accuracy and the suitability of information contained in EIA report prepared in accordance with terms of reference. The quality of these reports is fundamental for making good decisions and is an indication of the effectiveness of the EIA system (Wende 2002; Sandham and Pretorius 2008; Heinma and Põder 2010; Pölönen et al. 2011). The quality of EIA reports reflects the procedural and transactive effectiveness and is fundamental for substantive and normative effectiveness (Sadler 1996; Cashmore et al. 2004; Theophilou et al. 2010; Momtaz and Kabir 2013; Loomis and Dzuedzuc 2018). The high quality of an EIA report is likely to have a positive effect on mitigation (Wende 2002; Gwimbi and Nhamo 2016).

Extensive research has been conducted to review the quality of EIA reports. The low quality of reports has been reported in both developed and developing countries (Pinho et al. 2007; Tzoumis 2007; Jalava et al. 2010; Peterson 2010; Ruffeis et al. 2010; Badr et al. 2011; Kabir and Momtaz 2012; Barker and Jones 2013; Sandham et al. 2013; Chanthy and Grünbühel 2015; Anifowose et al. 2016; Gwimbi and Nhamo 2016). The low quality of EIA reports is a growing concern in developing countries (ECA 2005; Nadeem and Hameed 2008; Hydar and Pediaditi 2010; Panigrahi and Amirapu 2012; Kamijo 2017; Rathi 2017). Previous studies clarified factors influencing the quality of EIA reports in developing countries. They include the experience of EIA practitioners, the project scale, the availability of information and guidance, and adequate funds. At the same time a lack of experience, information, guidance, and funding are noted as major constraints of EIA in developing countries (Wood 2003; Zeremariam and Quinn 2007; Clausen et al. 2011; Coşkun and Turker 2011; Wayakone and Inoue 2012; Betey and Godfred 2013; Aung 2017). Therefore, it appears to be very difficult to improve the quality of EIA reports under the present constraints in developing countries.

The consideration of alternatives represents the heart of EIA (CEQ 1978). However, it has been one of the weak aspects to the quality of EIA reports for a long time (Barker and Wood 1999; Cashmore et al. 2002; Gray and Edward-Jones 2003; Badr et al. 2004; Pinho et al. 2007; Jalava et al. 2010; Peterson 2010; Badr et al. 2011; Kabir and Momtaz 2012; Sandham et al. 2013). Public involvement is also a key EIA process and can help to improve the quality of EIA reports (Glasson et al. 2012, p. 144). However, previous studies revealed the drawbacks of public involvement. They include no involvement due to a lack of knowledge about EIA (Diduck and Sinclair 2002); fundamental problems in the participation culture (Purnama 2003); a lack of recognition for early participation (Doelle and Sinclair 2006); a gap between legal processes and poor practice (Okello et al. 2009; Mwenda et al. 2012; Panigrahi and Amirapu 2012); a knowledge imbalance between communities and project proponents (Lostarnau et al. 2011); and a lack of understanding of the processes (Wiklund 2011).

Alternatives and public involvement are weak in EIA report quality in developing countries (Clausen et al. 2011; Coşkun and Turker 2011; Kahangirwe 2011; Khadka and Shrestha 2011; Marara et al. 2011; Niyaz and Storey 2011; Panigrahi and Amirapu 2012; Wayakone and Inoue 2012; Kengne et al. 2013; Al-Azri et al. 2014; Heaton and Burns 2014; Sainath and Rajan 2015; Zuhair and Kurian 2016; Aung 2017). A recent study showed that alternatives and public involvement could be key factors for improving the overall report quality (Kamijo and Huang 2016). Some studies explained a linkage effect between alternatives and public involvement. Stakeholder engagement had a great impact on the selection of alternatives (Slotterback 2008). The selection of alternatives in turn had an impact on the attitudes of participating stakeholders (Cuppen et al. 2012). Public involvement functioned better when public influence was greater during the alternatives development and analysis phase (Hoover and Stern 2014). The degree of public involvement in the strategic environmental assessment (SEA) process and environmental performance had a positive correlation, and some of the main benefits of this were new insights into possible alternatives (Rega and Baldizzone 2015).

Stakeholders who discussed alternatives had a high sense of public involvement (Kamijo and Huang 2017).

Previous studies pointed out many factors influencing the quality of reports. However, their effects and the determinants of EIA report quality are not well known. It is necessary to analyze the effects of factors influencing the report quality, and identify the determinants of the overall quality of EIA reports. To perform the examination, the effects of factors influencing the report quality are tested using statistical tests. The determinants of report quality are identified among factors using a cluster analysis and a decision tree analysis. At the end, scatter diagrams are used to see the effects of determinants on report quality. The purposes of this study are to identify the determinants of the overall quality of EIA reports for development cooperation projects that Japan International Cooperation Agency (JICA) has supported, and to propose benchmarks for satisfactory reports under the present situation in developing countries. The study results could be very useful for JICA, other donor agencies, and developing countries to prepare satisfactory EIA reports.

Environmental impact assessment of JICA

JICA is the executing agency of Japan's official development assistance (ODA), and introduced mandatory EIA guidelines in 2004 (JICA 2004). ODA loans and grant aid merged with JICA in 2008 and JICA fully covers the project cycle from the preparation phase to monitoring phase. JICA revised the guidelines in 2010 and widened the range of the EIA process in the project cycle from the screening stage to the monitoring stage (JICA 2010). JICA prepares EIA reports at the EIA level on large-scale projects likely to have significant adverse impacts on the environment and the society, and at the initial environmental examination (IEE) level on small-scale projects likely to have less adverse impacts. The EIA process at both levels are the same. JICA guidelines require alternatives and public involvement for large-scale projects and recommend them for small-scale projects. Before 2004, these two processes were applied on a

voluntary basis and their implementation was insufficient. JICA discloses EIA reports to the public via the website in order to maintain its accountability and transparency.

1. Literature review

The low quality of EIA reports has been identified as one of the constraints of the EIA system in developing countries for a long time (MacDonald 1994; Hennayake et al. 1997; Lohani et al. 1997; Mokhehle and Diab 2001; Ahmad and Wood 2002; Turnbull 2003; Hadi 2003; Doberstein 2003; Ramjeawon and Beedassy 2004; El-Fadl and El-Fadel 2004; ECA 2005; Nadeem and Hameed 2008; Haydar and Pediaditi 2010; Ruffeis et al. 2010; Panigrahi and Amirapu 2012). It's helpful to examine the experience of developed countries and the factors that contribute to the quality of their EIA reports. In the United Kingdom these factors were the size of projects; experience of consultants and local authority; the length of EIA; standardized procedures and formats; communication of information; a review system; legislation and guidelines; and development types (Lee and Dancey 1993; Glasson et al. 1997; Hickie and Wade 1998; Gray and Edwards-Jones 2003; Badr et al. 2004; Barker and Jones 2013). In the United States, the factors were information and resources; the practical ability of consultants; a review system; and feedback on the monitoring results (Tzoumis and Finegold 2000; Tzoumis 2007). In Australia, the factors producing good quality EIA reports were available time and financial resources; public or community pressure; and the expectations of EIA regulators (Morrison-Saunders et al. 2001). In Greece the factors were project types; the length of EIA; consultants; and the experience of EIA authority (Cashmore et al. 2002; Androulidakis and Karakassis 2006). The factors for Portugal were the regulation and technical guidance; the institutional arrangements; financial resources and technical skills; environmental awareness of project proponents; public involvement; and the type and size of the project (Pinho et al. 2007). In Finland, the factors influencing the quality of EIA reports were the knowledge and expertise of reviewers (Jalava et

al. 2010). In European countries, the factors were: date of the EIA report; legal EIA requirements; existence of scoping, alternatives, and public participation; experience of proponent, consultant and competent authority; lengthe of the EIA report and cost of the EIA and nature and size of the projects (Barkers and Wood 1999).

According to previous studies about the report quality in developing countries, the factors influencing quality were quite similar to those in developed countries. The factors influencing the quality of EIA reports for South Africa were the experience of EIA practitioners (consultants, authorities, and stakeholders); the size of projects; availability of guidance; a political will; research into report quality; and EIA practitioners independent from developers (Sandham and Pretorius 2008; Sandham et al. 2013). In Egypt the factors were project types; the length of EIA; and the quality of consultants (Badr et al. 2011). The factors for Bangladesh were study time; baseline data and access to data; the attitude of consultants and proponents; the number of EIA experts; the service procurement process; adequate funds; terms of reference; and the composition of EIA team (Kabir and Momtaz 2014). The factors for Cambodia were legislative procedure to review the report quality; political influence; study time; access to baseline data; consultant experience; financial constrants; and trust in consultants by proponents (Chanty and Grünbühel 2015). The ownership of project proponents was most important for the quality of EIA reports in Georgia and Ghana (Kolhoff et al. 2016).

Previous studies identified many factors for improving the quality of EIA reports based on professional perspectives or interview results. However, the effects of factors and the determinants of report quality have not been examined based on data analysis and a practical solution for improving the report quality is unclear. Therefore, it could be very useful to test the effects of factors, to identify the determinants of quality from among the factors, and to obtain an optimum solution for improving the report quality using statistical analysis. The qualitative studies could not indicate the effects of factors nor identify the determinants of EIA report quality. On the other hand, statistics analysis can show their effects and identify the determinants

through evidence data. A few studies indicated the effects of the factors on the report quality using statistics such as the length of EIA (Badr et al. 2011) and improvement in reports over time (Anifowose et al. 2016). However, the effects of other factors, determinants, and the optimum solution for improving the quality of EIA reports are not well known.

2 Data and methods

2.1 Selection of sample

The study examined the quality of JICA EIA reports prepared from 2001 to 2016, to identify the time series changes in report quality following the introduction of JICA mandatory EIA guidelines in 2004 and 2010. A total of 160 reports – 10 per year for 16 years – were selected using a random number table. The population derived from a list of yearly reports pulled from the JICA library website. Random sampling produces an unbiased estimate and a larger sample reduces the variability of statistics from random sampling (Moore et al. 2017, p. 288). A sample size of 100 environmental statements was sufficient to draw meaningful conclusions (DETR 1997). According to random sampling, the possibility of collecting biased samples is small and the possibility of collecting samples close to the population structure is large even if the number of yearly EIA reports by different sectors, regions or size of project scales is unknown. A random sample means to be an unbiased representation of the population, and it is reasonable to generalize from the results of the sample back to the population.

The sample size was decided with reference to the previous report quality studies, which examined 130 reports in Sri Lanka (Samarakoon and Rowan 2008), 112 in European countries (Wood et al. 1996), 89 in the United Kingdom (Gray and Edwards-Jones 2003), 72 in Greece (Cashmore et al. 2002), 50 in Estonia (Peterson 2010), 30 in Bangladesh (Kabir and Momtaz 2012), 28 in South Africa (Sandham and Pretorius 2008), 22 in Zimbabwe (Gwimbi and Nhamo 2016), 19 in Nigeria (Anifowose et al. 2016), and 18 in Tanzania (Guilanpour and Sheate 1997).

The sample size of the study was more than 100 reports and exceeded the largest size of any previous study, and it was appropriate for the analysis.

2.2 Lee- Colley review package for assessing EIA report quality

The quality of EIA reports was reviewed by following the Lee-Colley review package (Lee et al., 1999), because it is comprehensive, robust, and widely-used by report quality review researchers (Cashmore et al. 2002; Gray and Edwards-Jones 2003; Canelas et al. 2005; Pinho et al. 2007; Badr et al. 2011; Kabir and Momtaz 2012; Barker and Jones 2013; Sandham et al. 2013; Hildebrandt and Sandham 2014; Anifowose et al. 2016; Gwimbi and Nhamo 2016). A single reviewer, who is a certified professional EIA engineer and is familiar with the JICA guidelines, conducted the review. The review package advises that two persons review the EIA report independently to control for subjective differences between individuals. It requires two reviewers to make an overall judgment on the acceptability of an EIA report as a planning document at the time of the environmental appraisal. Comparison between the individual and group assessment of the same EIA reports demonstrated that the group was more critical than the individual assessment (Peterson 2010). However, the difference between the individual and group assessment was not significant (the *p*-value was 0.58 tested by Mann-Whitney's U test using the data from that study). The present study cautiously minimized the bias of a single reviewer through the selection of reports by random sampling, the review of as many reports as possible using the same reviewer, and the use of statistical tests. A statistical test provides a mechanism for making quantitative decisions about a process. The intent is to determine whether there is enough evidence to reject the null hypothesis (NIST 2012). There are four previous cases of assessing the report quality by single reviewer (Guilanpour and Sheate 1997; Gray and Edwards-Jones 2003; Anifowose et al. 2016; Kamijo and Huang 2016).

The review criteria of the Lee-Colley review package consists of 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 (Table 1). The review starts with subcategories, then moves upwards to categories and areas, and finishes with overall quality. Grades for higher levels of the hierarchy are not determined by a simple averaging of the assessments of the component, but by an overall performance grade per category and again for the review area. Alphabetic symbols (A, B, C, D, E, F, and N/A) are used to grade the quality (Table 2).

Table 1 Review areas and review categories

1	Description of the development, the local environment and the baseline conditions
1.1	Description of the development
1.2	Site description
1.3	Wastes
1.4	Environment description
1.5	Baseline conditions
2	Identification and evaluation of key impacts
2.1	Definition of impacts
2.2	Identification of impacts
2.3	Scoping
2.4	Prediction of impact magnitude
2.5	Assessment of impacts significance
3	Alternatives and mitigation
3.1	Alternatives
3.2	Scope and effectiveness of mitigation measures
3.3	Commitment to mitigation
4	Communication of results
4.1	Layout
4.2	Presentation
4.3	Emphasis
4.4	Non-technical summary

Source: Lee et al. 1999.

Table 2 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.

2.3 Statistical tests for determining factors of overall report quality grades

The difference in overall report quality grades was tested to determine factors. The potential factors were selected in reference to the findings of previous studies and in consultation with researchers and practitioners. They are: (1) JICA guidelines in 2004 and 2010; (2) sectors and regions; (3) large-scale projects (EIA-level) and small-scale projects (IEE-level); (4) presence and absence of alternatives and public involvement; (5) the number of public involvement stages; and (6) the number of alternatives and evaluation criteria for alternatives analysis. Other factors that previous studies identified (experience of EIA practitioners, guidance, study time, baseline data, data access, attitudes, a number and composition of consultants, financial resources, review system, monitoring, public pressure, political will etc.) could play important roles in the EIA quality but were excluded from the analysis due to the absence of data.

First of all, the samples were divided into three periods: 2001 to 2004; 2005 to 2010; and 2011 to 2016, and the difference of report quality was tested to identify the time series changes in quality grades resulting from the introduction of JICA EIA guidelines in 2004 and 2010. Following this, the difference in the quality of reports was tested between six sectors (transportation, power, water resources, regional development, pollution control, and agriculture) and six regions (Asia, Africa, Middle East, South America, Europe, and the Pacific). In addition, the difference in the quality of reports was tested between EIA-level and IEE-level, and between the four variations of treatment in order to assess the effects of alternatives and public involvement: (1) for both alternatives and public involvement; (2) for alternatives only; (3) for public involvement only; and (4) for neither alternatives nor public involvement. At the end, in order to assess the difference in effects between the number of public involvement stages, and the number of alternatives and evaluation criteria, the difference in the quality of reports was tested between four stages of public involvement and between the four groups of number of alternatives and evaluation criteria.

The quality of public involvement was reviewed using a quantitative index in Kenya (Mwenda et al. 2012), and as one part of the Lee and Colley review package, amended to be suitable for South Africa (Sandham and Pretorius 2008) and Bangladesh (Kabir and Momtaz 2012). These methods are suitable to each country context but further research is required to propose comprehensive and widely used methods to review the quality of public involvement overall in developing countries. That is why this study used a simple index of public involvement using a number of stages. It was assumed that the effect of public involvement would increase with an increase in the number of public involvement stages. Zero time on public involvement (PI0) refers to no public involvement at any stage and one period (PI1) means public involvement only at the draft reporting stage. Two periods (PI2) refer to public involvement at the scoping stage and the draft reporting stage and three periods (PI3) mean public involvement at the scoping stage, the intermediate stage between the scoping and draft reporting, and the draft reporting stage. The effect of PI1 can be better than PI0; similarly, that of PI2 better than PI1; and PI3 better than PI2. The number of public involvement stages was counted by reading the public involvement sections of EIA reports. Statistical tests were performed using non-parametric tests (upper-sided Kruskal-Wallis test, both-sided Mann-Whitney's U test, or upper-sided Steel-Dwass test depending on types of data) for an ordinal scale such as A to F, and the number of public involvement stages, alternatives, and evaluation criteria. The difference with * $p < 0.05$ and ** $p < 0.01$ was considered significant. Statistical tests were performed using Excel 2010, the add-in software Statcel3 (Yanai 2014).

2.4 Cluster analysis and decision tree analysis for identifying determinants

Cluster analysis can be used to find out which objects in a set are similar or dissimilar and is a common technique used in many fields (Romesburg 2004). In the field of EIA study, cluster analysis was applied to the classification of EIA reports (Daini 2000), site alternatives (Kapsimalis et al. 2010), and fishing communities (Pollnac et al. 2015). Satisfactory reports are

grouped together and unsatisfactory reports belong to different groups. A set of branching conditions to reach the clusters of satisfactory reports could be the determinants for good report quality. Decision tree analysis is used to classify objects in the form of a tree structure, breaks down a dataset into smaller subsets, and is capable of finding an effective explanation variable out of a plurality of variables (Rokach and Maimon 2015). In the field of environmental study, decision tree analysis was applied to classification rules for forest fire hotspot occurrences (Nurpratami and Sitanggang 2015), the assessment of groundwater vulnerability (Stumpp et al. 2016), and to select methods for ecosystem service assessment (Harrison et al. 2018). Cluster analysis does not show branching conditions and analysts have to interpret them. On the other hand, the decision tree analysis explains branching conditions and supports decision-making. It is easy to obtain a setting combination of an optimal branching condition when applying an IF-THEN type rule.

Decision tree analysis was applied to the results of cluster analysis, and the branching conditions for classifying clusters of satisfactory reports could be the determinants. Cluster analysis and decision tree analysis were used to analyze 160 reports from the period 2001 to 2016. Key variables, which had a great impact on the overall report quality ($p < 0.001$**), were selected according to the results of statistical tests, and the grades of the four areas and the overall quality for assessing report quality were added to data for analysis. The ordinal scales from A to F were 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. A quantitative data matrix was standardized in order to remove any arbitrary affects, and to make attributes contribute more equally to the similarities among objects (Romesburg 2004). Cluster analysis and 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.

2.5 Scatter diagrams for seeing the effects of determinants on the report quality

The scatter diagrams with the grade of determinants on the X-axis and the overall report quality grade on the Y-axis were prepared for all 160 reports. The regression lines were added to see the effects of determinants on the report quality. The ordinal scale from A to F was converted to rank scores like 6, 5, 4, 3, 2, and 1. It is common to treat ordinal scales as if they were interval-ratio scales but statistical results should be assessed cautiously (Healey 2009, p. 16). The statistical results were assessed using the statistical test (Kruskal-Wallis test).

3. Results

3.1 Review results of report quality

The review results showed that no reports were well performed (A), 21 were generally satisfactory (B), 40 were just satisfactory (C), 80 were just unsatisfactory (D), 19 were poorly attempted (E), and no reports were very unsatisfactory (F) (Table 3). The percentage of reports graded as satisfactory (A to C) was 38%. The most common grade was D (50%), followed by C (25%) and then B (13%). Area 1 (description of the development and the environment) demonstrated better performance (60% with A to C), and Area 2 (identification and evaluation of key impacts), Area 3 (alternatives and mitigation), and Area 4 (communication of results) were performed less well (35%, 33%, and 44% with A to C). Portions of description were better, while analysis was weak. This result was similar to those observed in Egypt (Badr et al. 2011), Bangladesh (Kabir and Momtaz 2012), and South Africa (Sandham et al. 2013).

3.2 Introduction effects of JICA guidelines, and effects on the quality by sectors and regions

The report quality over three periods is shown in Table 4. The grade B reports were available after the first guidelines were introduced in 2004 and the two guidelines seemed to improve the quality of EIA reports. The satisfaction levels (A to C) showed that the tendency toward

improvement was 23% in 2001-2004, 37% in 2005-2010, and 50% in 2011-2016. Statistical differences were tested by the upper-sided Kruskal-Wallis test and the *p*-value was 0.03*. The JICA guidelines in 2004 and 2010 resulted in improved quality of EIA reports. The report quality by sectors and regions is shown in Table 5. The quality of transport and power, and the quality in Asia seemed better respectively than that of other sectors and regions. Statistical differences by sectors and regions were tested by Kruskal-Wallis test, and the *p*-value was 0.10 and 0.31, respectively. The difference between the quality in sectors and regions was not significant even though variability existed between sectors and regions. The effects on quality by sectors and regions could not be recognized.

Table 3 An overview of the quality review results of 160 reports

Summary of category grades	A	B	C	D	E	F	N/A	A-C (%)	D-F (%)
1.1 Description of the development	0	28	118	14	0	0	0	91%	9%
1.2 Site description	1	25	115	18	1	0	0	88%	12%
1.3 Wastes	0	7	61	47	24	21	0	43%	58%
1.4 Environmental description	2	27	74	50	7	0	0	64%	36%
1.5 Baseline conditions	3	22	47	37	46	5	0	45%	55%
2.1 Definition of impacts	0	15	54	63	25	3	0	43%	57%
2.2 Identification of impacts	0	13	52	75	17	3	0	41%	59%
2.3 Scoping	3	19	38	69	26	5	0	38%	63%
2.4 Prediction of impact magnitude	2	18	34	45	43	18	0	34%	66%
2.5 Assessment of impacts significance	1	15	35	44	46	19	0	32%	68%
3.1 Alternatives	4	20	35	43	7	51	0	37%	63%
3.2 Scope and effectiveness of mitigation measures	1	19	29	63	40	8	0	31%	69%
3.3 Commitment to mitigation	0	15	45	47	43	10	0	38%	63%
4.1 Layout	2	21	55	67	15	0	0	49%	51%
4.2 Presentation	2	21	49	70	18	0	0	45%	55%
4.3 Emphasis	1	18	46	67	26	2	0	41%	59%
4.4 Non-technical summary	2	17	51	67	21	2	0	44%	56%
Summary of review area grades									
1. Description of the development and the environment	2	25	69	62	2	0	0	60%	40%
2. Identification and evaluation of key impacts	0	14	42	68	33	3	0	35%	65%
3. Alternatives and mitigation	2	20	31	51	51	5	0	33%	67%
4. Communication of results	2	20	48	74	16	0	0	44%	56%
Overall quality	0	21	40	80	19	0	0	38%	62%

Source: Author.

Table 4 Report quality and three periods (n=160)

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%

Source: Author.

Table 5 Report quality, sectors, and regions (n=160)

Sector	A	B	C	D	E	F	Total	A-C (%)	D-F (%)
Transportation	0	11	13	29	7	0	60	40%	60%
Power	0	6	9	12	0	0	27	56%	44%
Water resource	0	1	6	17	3	0	27	26%	74%
Regional development	0	2	4	14	5	0	25	24%	76%
Pollution control	0	1	2	6	2	0	11	27%	73%
Agriculture	0	0	6	2	2	0	10	60%	40%
Total	0	21	40	80	19	0	160	38%	62%

Region	A	B	C	D	E	F	Total	A-C (%)	D-F (%)
Asia	0	13	28	47	8	0	96	43%	57%
Africa	0	3	3	17	4	0	27	22%	78%
Middle East	0	2	3	8	3	0	16	31%	69%
South America	0	1	3	5	3	0	12	33%	67%
Europe	0	0	2	3	0	0	5	40%	60%
Pacific	0	2	1	0	1	0	4	75%	25%
Total	0	21	40	80	19	0	160	38%	62%

Source: Author.

3.3 Effects on the quality by project size, alternatives, and public involvement

The satisfactory rate of EIA-level reports (74%) was very large compared to that of IEE-level reports (25%) (Table 6). The statistical difference was tested by the both-sided Mann-Whitney's U test and the *p*-value was < 0.001**. The effect on quality by the size of the projects could be recognized. Table 7 shows the quality of reports depending on presence or absence of alternatives and public involvement. The satisfactory rate of both processes of alternatives and public involvement was 67%. The statistical differences were tested by the Kruskal-Wallis test and the *p*-value was < 0.001**. The effects on quality by the presence of alternatives and public involvement could be recognized.

Table 6 Report quality and the size of projects

Report level	A	B	C	D	E	F	Total	A-C (%)	D-F (%)
EIA level	0	15	17	10	1	0	43	74%	26%
IEE level	0	6	23	70	18	0	117	25%	75%
Total	0	21	40	80	19	0	160	38%	62%

Source: Author.

Table 7 Report quality, presence or absence of alternatives and public involvement

Groups	A	B	C	D	E	F	Total	A-C (%)	D-F (%)
Both processes	0	21	29	23	2	0	75	67%	33%
Only alternatives analysis	0	0	5	25	5	0	35	14%	86%
Only public involvement	0	0	3	15	4	0	22	14%	86%
Neither process	0	0	3	17	8	0	28	11%	89%
Total	0	21	40	80	19	0	160	38%	62%

Source: Author.

3.4 Effects on the quality by public involvement stages, alternatives, and evaluation criteria

The satisfaction levels (A to C) showed that the tendency toward improvement was 13% at PI0, 29% at PI1, 74% at PI2, and 76% at PI3 (Table 8). The satisfactory rate at PI2 and PI3 was very large. The statistical difference was tested by the upper-sided Kruskal-Wallis test and the *p*-value was < 0.001**. The report quality could therefore be improved significantly with an increase in the number of stages of public involvement.

Next, reports were divided into four groups such as no alternative (Alt0), two and three alternatives (Alt2-3), four and five (Alt4-5), and more than six (Alt6<) as well as no criteria (Crt0), one to three criteria (Crt1-3), four to six (Crt4-6), and more than seven (Crt7<) (Table 9). The satisfaction level (A to C) increased with an increase in the number. The statistical difference was tested by the upper-sided Kruskal-Wallis test, and the *p*-value was < 0.001** and < 0.001**, respectively. The report quality could be improved significantly with an increase in the number of alternatives and evaluation criteria.

Table 10 demonstrates the Steel-Dwass test results of the stages of public involvement, and the number of alternatives and evaluation criteria. The number of alternatives and evaluation criteria increased with the increase in the number of stages of public involvement. A significant difference in the number of alternatives and evaluation criteria was recognized between PI0 and PI2 ($p < 0.01$**). The satisfaction levels (A to C) of alternatives showed that the tendency toward improvement was 17% at PI0, 26% at PI1, 66% at PI2, and 71% at PI3 (Table 11). The statistical difference was tested by the upper-sided Kruskal-Wallis test and the *p*-value was < 0.001**. An increase of the number of stages of public involvement could significantly improve the grade of alternatives.

Table 8 Report quality by the number of stages of public involvement

Groups	A	B	C	D	E	F	Total	A-C (%)	D-F (%)
PI0	0	0	8	42	13	0	63	13%	87%
PI1	0	2	10	25	5	0	42	29%	71%
PI2	0	12	16	10	0	0	38	74%	26%
PI3	0	7	6	3	1	0	17	76%	24%
Total	0	21	40	80	19	0	160	38%	62%

Source: Author.

Table 9 Report quality by the number of alternatives and evaluation criteria

Groups	A	B	C	D	E	F	Total	A-C (%)	D-F (%)
Alt0	0	0	6	33	12	0	51	12%	88%
Alt2-3	0	7	18	27	6	0	58	43%	57%
Alt4-5	0	9	13	15	1	0	38	58%	42%
Alt6<	0	5	3	5	0	0	13	62%	38%
Total	0	21	40	80	19	0	160	38%	62%
Crt0	0	1	12	47	14	0	74	18%	82%
Crt1-3	0	1	5	8	3	0	17	35%	65%
Crt4-6	0	7	16	17	2	0	42	55%	45%
Crt7<	0	12	7	8	0	0	27	70%	30%
Total	0	21	40	80	19	0	160	38%	62%

Source: Author.

Table 10 Steel-Dwass test results of stages of public involvement and number of alternatives and evaluation criteria

Groups	mean	median	n	PI1	PI2	PI3
Public involvement stages and number of alternatives						
PI0	2.0	2	63	1.4065	4.6341**	3.4396
PI1	2.6	2	42		2.9185	2.3840
PI2	3.6	4	38			0.0783
PI3	4.3	3	17			
Public involvement stages and number of evaluation criteria						
PI0	2.0	0	63	2.6986	4.8373**	4.1887*
PI1	2.8	3	42		2.8143	2.7172
PI2	4.8	4	38			0.8018
PI3	6.6	5	17			

Source: Author.

Table 11 Grade of alternatives by the number of stages of public involvement

Groups	A	B	C	D	E	F	Total	A-C(%)	D-F(%)
PI0	0	1	10	18	6	28	63	17%	83%
PI1	0	2	9	16	0	15	42	26%	74%
PI2	1	12	12	6	1	6	38	66%	34%
PI3	3	5	4	3	0	2	17	71%	29%
Total	4	20	35	43	7	51	160	37%	63%

Source: Author.

3.5 Results of cluster analysis

The data matrix was prepared based on the results of statistical tests including project size (EIA-level or IEE-level), the presence or absence of alternatives and public involvement, the number of stages of public involvement, and the number of alternatives and evaluation criteria (Table 12). These six variables were particularly impactful to the overall report quality ($p <$ 0.001**). The Ward method of cluster analysis was applied to the standardized data matrix. A dendrogram was divided into two, and then divided into small clusters (Figure 1). The number of clusters was regarded as four based on the interpretation of the dendrogram. The summary and report quality of four clusters were shown in Table 13 and Table 14.

Cluster 1 mainly consisted of IEE-level reports that included alternatives and public involvement. The medians of public involvement stages, alternatives, evaluation criteria, and

overall quality were 1, 3, 4, and C, respectively. Cluster 2 mainly comprised reports that included the presence of alternatives but the absence of public involvement. The medians of alternatives, evaluation criteria, and overall quality were 3, 4, and D, respectively. Cluster 3 mainly consisted of reports without alternatives. The median of overall quality was D. Cluster 4 mainly comprised EIA-level reports that included alternatives and public involvement. The medians of stages of public involvement, alternatives, evaluation criteria, and overall quality were 2, 5, 7, and B, respectively. The median of stages of public involvement, alternatives, and evaluation criteria of Cluster 4 was larger than those of the other three clusters, and the overall quality was the highest out of the four clusters. The median of the overall quality of Clusters 1 and 4 was satisfactory, but that of Clusters 2 and 3 was unsatisfactory.

Table 12 Data matrix for cluster analysis and decision tree analysis

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

Source: Author.

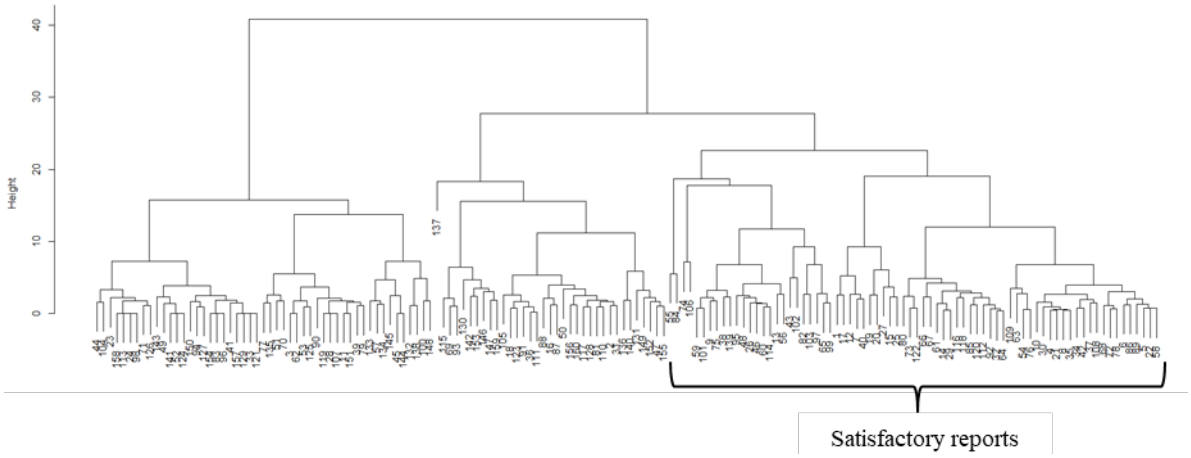

Figure 1 Cluster dendrogram for 160 reports

Source: Author.

Table 13 Summary of four clusters

Variables	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Total
Number	49	35	51	25	160
EIA level	3	8	10	22	43
IEE level	46	27	41	3	117
Alternatives yes	49	35	0	25	109
Alternatives no	0	0	51	0	51
PI yes	47	3	22	25	97
PI no	2	32	29	0	63
PI stages median	1	0	0	2	1
Alternatives median	3	3	0	5	3
Criteria median	4	4	0	7	2
Area 1 median	C	D	D	B	C
Area 2 median	D	D	D	C	D
Area 3 median	D	D	E	B	D
Area 4 median	C	D	D	C	D
Overall quality median	C	D	D	B	D

Note: PI: Public Involvement

Source: Author.

Table 14 Report quality of four clusters

Clusters	A	B	C	D	E	F	Total	A-C (%)	D-F (%)
Cluster 1	0	6	21	20	2	0	49	55%	45%
Cluster 2	0	0	4	26	5	0	35	11%	89%
Cluster 3	0	0	6	33	12	0	51	12%	88%
Cluster 4	0	15	9	1	0	0	25	96%	4%
Total	0	21	40	80	19	0	160	38%	62%

Source: Author.

3.6 Results of the decision tree analysis and branching conditions

A decision tree analysis was applied to the results of the cluster analysis (Figure 2) in order to clarify the branching conditions of cluster 1 and 4 (satisfactory reports). Each node showed the ratio of four clusters. The top node showed '.31 .22 .32 .16', which meant the ratio of each cluster. The number of reports was 49 (160×0.31) in Cluster 1; 35 (160×0.22) in Cluster 2; 51 (160×0.32) in Cluster 3; and 25 (160×0.16) in Cluster 4. The top node branched to 'yes' and 'no' from 'ALT=yes.' The reports with the presence of alternatives proceeded to the lower left and those with absence of alternatives to the lower right (Cluster 3). Next, the reports with the

absence of public involvement went down to the left (Cluster 2). The reports with the presence of public involvement went down to the right (Cluster 1 and Cluster 4). At the end, IEE-level reports went down to the left (Cluster 1) and EIA-level reports went down to the right (Cluster 4). Clusters 1, 2, and 4 included some reports of other clusters.

Cluster 1 was a group of IEE-level reports with the presence of alternatives and public involvement. Cluster 2 was a group of EIA- and IEE-level reports with the presence of alternatives and the absence of public involvement. Cluster 3 was a group of EIA- and IEE-level reports with the absence of alternatives, and Cluster 4 was a group of EIA-level reports with the presence of alternatives and public involvement. A decision tree can be transformed to a set of rules by mapping from the top node to the bottom node, one by one. The decision tree showed that the determinants of satisfactory reports (Cluster 1 and Cluster 4) were the presence of alternatives and public involvement.

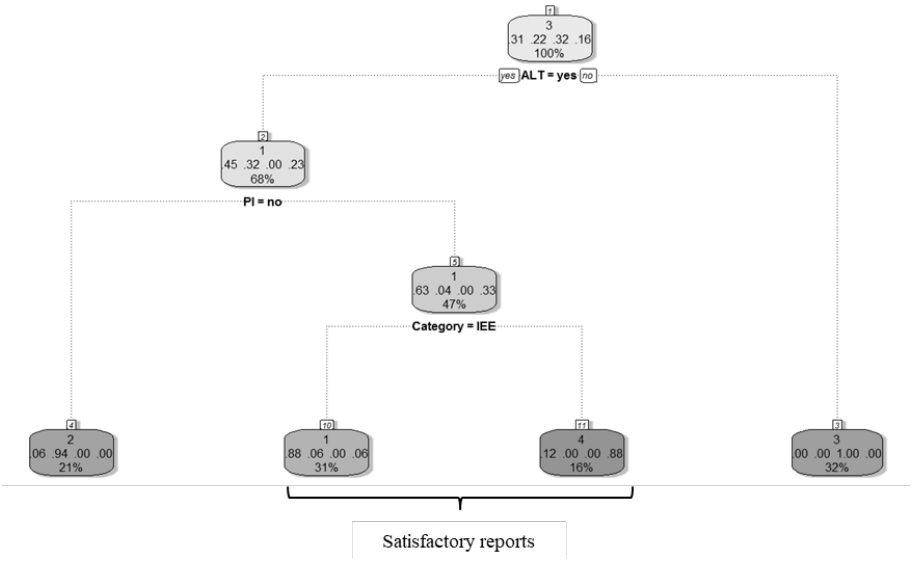

Figure 2 Decision tree for 160 reports and branching conditions of satisfactory reports

Source: Author.

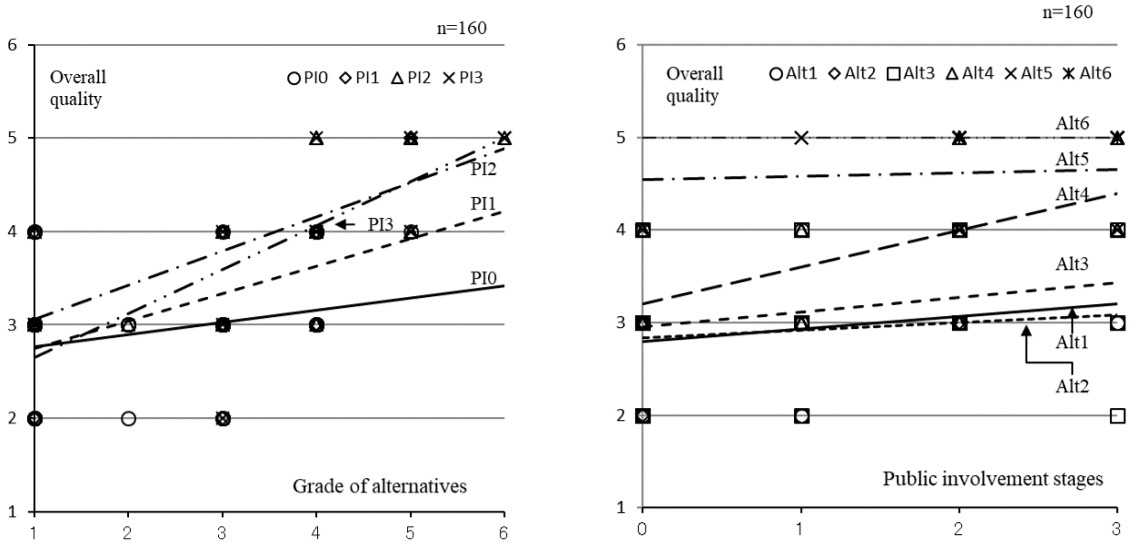

Figure 3 Correlation between grade of alternatives, stages of public involvement, and the overall report quality (n=160)

Source: Author.

3.7 Correlation between alternatives and public involvement, and the overall report quality

Two scatter diagrams with the grade of alternatives and the number of stages of public involvement on the X-axis and the overall report quality grade on the Y-axis were prepared for all 160 reports (Figure 3). The grade of alternatives and the overall report quality were positively correlated with a correlation coefficient of 0.66. The correlation between the number of stages of public involvement and the overall quality was also positive with a correlation coefficient of 0.56. The report quality improved as the grade of alternatives improved, and the number of stages of public involvement increased.

The inclinations of regression lines of PI0, PI1, PI2, and PI3 as well as of Alt1 (grade F of alternatives), Alt2 (grade E), Alt3 (grade D), Alt4 (grade C), Alt5 (grade B), and Alt6 (grade A) showed their effects. The inclination of PI0 (only alternatives) was small, the inclinations of PI1 and PI2 became large, and the inclinations of PI2 and PI3 were not very different. The inclinations of PI2 and PI3 were larger compared to those of PI0 and PI1. Similarly, the inclinations of Alt1, Alt2, and Alt 3 were small, the inclination of Alt4 became large, and the

inclinations of Alt5 and Alt6 were small even when the overall report quality was more than C (quality score 4). The inclination of Alt4 was larger than those of other grades. The difference in the quality of reports in the case of PI2 and Alt4 was tested using the Kruskal-Wallis test and the *p*-values were < 0.01** and < 0.01**, respectively. The larger effects of PI2 and Alt4 calculated by regression analysis were assessed by the statistical test.

4. Discussion

4.1 Determinants of satisfactory reports

According to the results of the decision tree analysis, the first, second, and third factors influencing satisfactory reports are the presence of alternatives, the presence of public involvement, and the project scale. The presence of alternatives and public involvement could be determinants of satisfactory JICA reports at the EIA- and IEE-levels. The project scale has been identified as the key factor in developed and developing countries such as in the United Kingdom (Lee and Brown 1992; Lee and Dancey 1993; Glasson et al. 1997), in European countries (Barker and Wood 1999), in Portugal (Pinho et al. 2007), in South Africa (Sandham and Pretorius 2008), and in Zambia (Gwimbi and Nhamo 2016). The quality of reports on large-scale projects is notably better than that of reports on small-scale projects. This may be a reflection of funding allocated to EIA by large- and small-scale projects (Gwimbi and Nhamo 2016). This study found the presence of alternatives and public involvement were more important to improving the quality of reports than the project scale (funding).

The quality of Cluster 2 (presence of alternatives and absence of public involvement) was unsatisfactory and the quality of Cluster 1 (presence of alternatives and public involvement at IEE-level) was satisfactory even though the portion of EIA-level of Cluster 2 (23%) was higher than Cluster 1 (6%). The difference between satisfactory (Cluster 1) and unsatisfactory (Cluster 2) reports was the presence or absence of public involvement, and the quality of Area 1

and Area 4 (description parts) of Cluster 1 and Cluster 2 was C and D, respectively (Table 13). One probable effect of public involvement is that project proponents collect information about environmental and social impacts through preparation and selection of alternatives that reflect public opinion. The information in reports that lack public involvement may be limited even at the EIA-level.

4.2 Linkage between alternatives and public involvement improving the quality of reports

Increasing the number of stages of public involvement (from PI0 and PI1 to PI2 and PI3) improved the quality of reports over the grade of alternatives (the left part of Figure 3). The regression line of PI0 (no public involvement) indicated the effect of alternatives themselves: the overall quality of reports was very low. The regression line of PI1 showed a slight improvement, but the quality of reports was still unsatisfactory. However, the regression lines of PI2 and PI3 showed the improvement in the quality of reports, with the majority of reports at the satisfactory level (Table 8). Public involvement at the draft reporting stage only (PI1) was insufficient. The effect of more than two stages of public involvement (PI2 and PI3) may positively influence the effect of alternatives at the scoping stage and the effect of mitigations at the draft reporting stage, and have a stronger influence on the overall quality of reports.

Public involvement at the scoping stage (PI2 and PI3) could positively affect the will and environmental and social awareness of project proponents because of public pressure, and it could increase the number of alternatives and evaluation criteria (Table 10). Widening the range of alternatives and evaluation criteria increased the amount of environmental and social information to account for a justification of projects and to provide a reason for selecting the best option at the scoping and draft reporting stages. Alternatives could be also options for mitigations, for example, while a no action alternative could be an avoidance option. Each alternative could mix various mitigation measures including avoidance, minimization,

restoration, and compensation. Public involvement could increase the effects of alternatives and mitigation.

On the other hand, public involvement was effective only at the time of Alt4 (the right part of Figure 3). The regression line of Alt1 (grade F of alternatives) showed the effect of public involvement only and the quality of reports was very low. The grades of Alt2 and Alt3 (grade E and D) were not different from the grade of Alt1 and did not improve the quality of reports even if the number of stages of public involvement increased. Nevertheless, the regression line of Alt4 (grade C) improved overall quality. Public involvement had a positive effect at the time of Alt4. The majority of satisfactory alternatives (grade A and B) already had two or three stages of public involvement and the quality of reports was satisfactory. The increase in the number of stages of public involvement may be effective in improving the quality of reports with satisfactory alternatives (grade A, B, and C), but not in the case of unsatisfactory alternatives (grade D, E, and F). Reports with unsatisfactory alternatives (grade D, E, and F) have no potential to improve in quality even with public involvement at the scoping and draft reporting stages (PI2 and PI3). Likely unsatisfactory alternatives could reflect the negative will of project proponents and thus public involvement would have a limited effect on improving the quality of reports. The grade C of alternatives (Alt4) improved the quality of reports when increasing the number of stages of public involvement. Public involvement could increase the grade C of alternatives to improve the quality of reports through the development and selection of alternatives, and the collection of related information. The good will of the project proponents, when combined with public pressure can positively influence the quality of reports.

4.3 Benchmarks for satisfactory reports

PI0, PI1, and PI2 improved the overall quality of reports when raising the grade of alternatives, but in comparison with PI0 and PI1, the increase of PI2 was larger (the left part of Figure 3). The effect of public involvement on the overall quality differed depending on the grade of

alternatives and the increase of Alt4 was larger (the right part of Figure 3). The effect of two processes can become larger in the case of public involvement at the scoping and draft reporting stages (PI2) and the grade C (just satisfactory) of alternatives (Alt4).

The scatter diagrams and regression lines can give a guide for the preparation of satisfactory reports. The intersection point of grade C of alternatives (Alt4) and public involvement at the stages of scoping and draft reporting (PI2), marked the point four (grade C) of the overall quality of reports (Figure 3). Thus, grade C of alternatives and public involvement at the stages of scoping and draft reporting could be the benchmarks for grade C (just satisfactory) in the overall quality of JICA reports. This group consists of 12 reports (two reports at the EIA-level on large-scale projects and ten reports at the IEE-level on small-scale projects). Three reports are generally satisfactory (B), eight are just satisfactory (C), and one is just unsatisfactory (D). These benchmarks would also be useful for preparing satisfactory reports at the IEE-level on small-scale projects.

4.4 Comparison with other findings by the Lee-Colley review package

Previous studies used the portion of grades that were satisfactory (A to C) and unsatisfactory (D to F), and then pointed out the necessity of improving the analysis parts such as alternatives, the prediction of impacts, and the effectiveness of mitigation. They identified qualitatively the factors influencing the report quality based on practitioner perspectives and interview results. The factors in developing countries were experience, the size of the project, information, guidance, and adequate funds but they did not explain the effects of factors nor provide practical solutions for improving the quality of reports.

This study verified using statistical tests the effects of six factors: (1) JICA guidelines in 2004 and 2010; (2) sectors and regions; (3) large-scale projects (EIA-level) and small-scale projects (IEE-level); (4) the presence and absence of alternatives and public involvement; (5) the number of stages of public involvement; and (6) the number of alternatives and evaluation

criteria for alternatives analysis. At the same time, the study showed that alternatives and public involvement could be the determinants of satisfactory JICA EIA reports using cluster analysis and decision tree analysis, and clarified the linkage between alternatives and public involvement affecting the overall quality of reports. In addition, the study showed that grade C of alternatives and public involvement at stages of scoping and draft reporting were the benchmarks for the grade C (just satisfactory) in the overall quality of reports. The statistical methods used here, including statistical tests, cluster analysis, and decision tree analysis were very useful tools for identifying the determinants of satisfactory reports and proposing the optimum solution to a lack of quality. The study quantitatively showed a linkage between alternatives and public involvement affecting the quality of reports.

4.5 Advantages and limitations of statistical analysis

The advantages of statistical analysis are to clarify the effects of factors influencing the quality of reports and to identify the determinants among factors with evidence data. This study verified the effects of legislation (JICA guidelines), project types (sectors and regions), the project scales (EIA-level and IEE-level), and the presence of alternatives and public involvement on the report quality for the first time. At the same time it identified alternatives and public involvement as determinants of the quality of reports, and provided a suitable solution for satisfactory EIA reports. These findings could be practically useful for improving the quality of EIA reports under the constraints in developing countries. Limitations to statistical analysis are the study's dependence on available data and its narrow target, even if the multiple component analysis is used in comparison with the qualitative studies based on practitioner perspectives and interview results. Qualitative analysis is beneficial to discuss the wide range of issues but the evidence is weak. We conducted this study based on the findings from previous qualitative studies. It is appropriate to conduct both qualitative and quantitative studies and complement the advantages and limitations of both study methods.

5. Conclusions and a way forward

This study quantitatively showed the effects of factors that improved the quality of reports and clarified that the effects of alternatives and public involvement were determinants in the improvement of the overall quality of the EIA reports for development cooperation projects. The public involvement at the scoping and draft reporting stages (PI2) can improve the effect of alternatives and the just satisfactory alternatives (grade C) can increase the effect of public involvement. The grade C level of alternatives and public involvement at the scoping and draft reporting stages (PI2) could be the benchmarks for achieving a grade C level of overall report quality. The study indicates the importance of alternatives and public involvement on the overall quality of reports.

Compared with previous findings that reviewed the quality of reports this study found more practical solutions using data analysis for improving the quality of reports under the present situation in developing countries. The study also showed the linkage between alternatives and public involvement, which has not yet been quantitatively examined, and would be beneficial for enhancing justifications and understanding of alternatives and public involvement in EIA in developing countries. The study suggests the possibility of improving the quality of not only JICA EIA reports but also EIA reports of other donors and developing countries. Further research using comparative studies and case studies needs to confirm how the two processes have an effect on the report quality.

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Abstract (in Japanese)

要約

環境影響評価報告書の質はよい意思決定を行うための基礎であるが､質の低さが途上国の問題点の一つと指摘されている。予算や人的資源および情報の不足という状況下で報告書の質を向上させることは大変困難に見える。本研究の目的は、国際協力機構が支援している開発事業に関する環境影響評価報告書の質に対する決定要因を明らかにし、さらに途上国の現況下において良い質の報告書のためのベンチマーク(基準)を提案することである。本研究では、2001 年から 2016 年に作成された 160 冊の報告書の質を評価し、統計検定、クラスタ分析、決定木分析を用いて報告書の質に対する決定要因を調査した。本研究では、代替案と住民参加が決定要因であり、そのリンケージ(連動)が報告書の質に影響を与えたことを明らかにした。良い報告書の質を確保するためのベンチマーク(基準)は、①ほぼ満足する程度の代替案、②スコーピング段階と報告書案段階での住民参加、の二つであるとの結論となった。代替案と住民参加のプロセスがどのように報告書の質に影響を与えるのか、比較研究と個別研究を通じた更なる研究が必要である。

キーワード：環境アセスメント報告書の質、代替案、住民参加、統計検定、クラスター分析、決定木分析

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