

Ex-Post Project Evaluation 2017 Package II-2 (Laos)

October 2018

JAPAN INTERNATIONAL COOPERATION AGENCY

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Lao People's Democratic Republic

FY2017 Ex-Post Evaluation of Japanese Grant Aid Project

“The Project for Improvement of National Road No.9 as East-West Economic Corridor”

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0. Summary

This project aimed at improvement of National Road No.9 (hereinafter referred to as “NR9”), which is very important connecting neighbor countries, i.e. Thailand and Vietnam, with sufficient driving speed, safety and comfort as international highway according to traffic conditions by refurbishing pavement structure and road structure of damaged sections, thereby contributing to promotion of trade and investment in Laos Central Region and economic development of the hinterland of NR9.

The project has been highly relevant to the country's development plan and development needs, as well as Japan's ODA policy. Therefore, its relevance is high. Both the project cost and project period were within the plan. Therefore, efficiency of the project is high. Regarding the effectiveness, although the simple comparison cannot be made due to the difference in the measurement method, the traveling speed is much higher than the expected traveling speed at the time of planning by the actual measurement, and through the driver interviews, positive effects for safety during fine and rainy weather, traveling time and comfort on drive were confirmed. Regarding the impact, it was confirmed that the renovation of NR9 led to the reduction of transportation time and transportation expenses, leading to the promotion of agriculture and the motivation for expansion of production, and through interviews, improvement of trade and investment environment, vitalization of agriculture and commercial activities and contribution to the development of the regional economy were confirmed. Also, no negative impact was confirmed. Therefore, effectiveness and impacts of the project are evaluated as high. Furthermore, the operation and maintenance systems have been improved in terms of human resources and organization. For technical aspect, participants of the trainings in the capacity building program (soft component) still engage to maintenance duties. The financial condition is still tight, but it is expected that budget for periodical repair will be assigned in the future. No other problems have been observed. Therefore, sustainability of the project effects is high.

In light of the above, this project is evaluated to be very highly satisfactory.

¹ In this Ex-Post Evaluation, Mr. Souknilanh Keola, a researcher of Bangkok Research Center, Institute of Developing Economies, Japan External Trade Organization (JETRO), conducted an expert analysis in addition to the evaluation by external evaluators for more professional and technical analysis. His specialties are international division of labor, state-owned enterprise, econometrics, Lao economy. He also plays an active part in remote sensing and its analysis by using satellite information. He participated in 1st Field Study and wrote a specialist analysis paper. In this report, the summary of his specialist analysis paper is posted as a Column.

1. Project Description



Figure 1: Project Location



Photo 1: Start Point of Section 1



Photo 2: End Point of Section 2

1.1 Background

The Lao government focused on development of the road network, since the road transport has been playing an important role in the country. However, even the pavement rate of the national roads was as low as 55% due to tight budget environment. Under such circumstances, improvements of NR9 had been implemented with supports of Japan's grant aid and Asian Development Bank's (ADB) loan from 1999 to 2004.

NR9 is about 240km long arterial road extending from Savannakhet to the national border with Vietnam at Densavan, and constitutes a key part of the East-West Economic Corridor traversing the Indochina Peninsula and ensuring access to the East China Sea. At the time, it also had an important meaning from the viewpoint of correcting regional economic disparity toward ASEAN integration.

However, development of the mine, etc. had changed traffic conditions after the improvements of NR9, and the road had suffered large-scale and extensive damage due to heavy use by large vehicles. The damage had reached to the extent that smooth traffic on the road had been hindered.

In view of the role of NR9 as the East-West Economic Corridor, Lao PDR was making its best efforts, allocating a quarter of its national road operation and maintenance budget for this

purpose. However, large scale rehabilitation of the damaged road had become difficult to handle within its own securable and implementable budget.

Aid for structural reinforcement, which meant to strengthen heavily damaged pavement sections and to complete drainage facilities of the road, was indispensable to recovering smooth traffic on NR9, as an international arterial highway. In addition, more optimization of the road maintenance and management work of the Laotian side was needed, because appropriate and timely maintenance activities for avoiding enlargement of the damages had not been done.

1.2 Project Outline

The objective of the project is to improve NR9 in order to achieve sufficient driving speed, safety and comfort as international highway according to traffic conditions by refurbishing the pavement structure and road structure of the damaged sections (Fig. 2) between Seno and Muang Phin, thereby contributing to promotion of trade and investment in the Central Region of Laos and economic development of the hinterland of NR9².

Table 1: Project Outline

Grant Limit / Actual Grant Amount	3,273 million Yen / 2,969 million Yen
Exchange of Notes Date / Grant Agreement Date	August 2011 / August 2011
Implementing Agency	Ministry of Public Works and Transport
Project Completion	March 2015
Main Contractor	Obayashi - Obayashi Road Joint Venture
Main Consultants	Consortium of Oriental Consultants Co., Ltd. and International Development Center of Japan Inc.
Basic Design	October 2010 ~August 2011
Related Projects	-Technical Cooperation “Project for Improvement of Road Maintenance Capability in Lao PDR” (JICA, September 2011~May 2018) -ODA Loans “Second Menkong International Bridge Construction Project” (JICA, December 2001) -Grant Aid “The Project for Improvement of National Road Route 9” (JICA, July 1999) “The Project for Improvement of National Road Route 9 (Phase 2)” (JICA, May 2001) “The Project for Reconstruction of the Bridges on the National Road No.9” (JICA, December 2016) -Other international organizations, aid agencies, etc.

² According to the Ex-Ante Evaluation, the objective of the project was “realization of smooth traffic of the East-West Economic Corridor by improving the pavement structure and road structure of the damaged sections of NR9”. However, the evaluators rearrange the objective as mentioned above based on descriptions of the preparatory survey and the Ex-Ante Evaluation because outcomes and impacts are not clear.

	“Project for Improvement of National Road No. 9 (Between Muang Phin and Lao Bao)” (ADB, March 2000)
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Source: Provided by JICA

2. Outline of the Evaluation Study

2.1 External Evaluator

Toru Shimada, ADAMIS Ltd.

Takahiro Yasukawa, Aviation Systems Consultants Co., Ltd.

2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule.

Duration of the Study: September, 2017 – October, 2018

Duration of the Field Study: January 7 – January 31 and April 2 – April 11, 2018

3. Results of the Evaluation (Overall Rating: A3)

3.1 Relevance (Rating: ③⁴)

3.1.1 Consistency with the Development Plan of Lao PDR

The national development plan in place at the time of planning the project in 2010, *the National Socio-Economic Development Plan (2006-2010)* stated, as one of the guidelines, “Ensure the maintenance of existing infrastructure; establish additional infrastructure specifically to support the socio-economic development activities aiming to promote trade, investment and tourism; increase the investment in the infrastructure for socio-economic development; explore national resources including human resources to be used as potentials for development in an effective manner; establish and prioritize investment projects to establish effective economic structures and to be in a good position and ready for competition.”, and stated as one of the strategy of inland transportation “The national roads connecting the Lao PDR to neighboring countries will be upgraded to standard roads. Priority will be given to highways and roads stretching to borders such as some sections of the North-South road to Bokeo, Luang Namtha; some sections of the East-West road to Savannakhet; roads to provinces within the Lao-Vietnam-Cambodia economic triangle (Attapeu, Sekong and Saravane); and the provinces within Lao-Thailand-Cambodia Economic Triangle (Saravane and Champasak).”

The current national development plan, *the 8th Five-year National Socioeconomic Development Plan (2016–2020)* sets “Sustained, inclusive economic growth with economic vulnerability reduced to levels required for growth support” as one of the three outcome, and sets

³ A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

⁴ ③: High, ②: Fair, ①: Low

priority activities of construction (Infrastructure) for ensuring sustained and inclusive economic growth as follows:

“Upgrade roads that connect to the neighboring countries, such as the Greater Mekong Subregion Corridor, Asian Highway, East-West Corridor and North-South Economic Corridor.”

Therefore, the improvement of NR9 as East-West Economic Corridor has been consistent with the national development plans.

3.1.2 Consistency with the Development Needs of Lao PDR

At the time of planning the project, as there was no detour of NR9, improvement of the pavement structure and road structure of the damaged sections were urgent. Also, the NR9 was very important for economic development of Central Region using East-West Corridor in Lao PDR.

At this Ex-Post Evaluation, according to the Ministry of Public Works and Transport (hereinafter referred to as “MPWT”) and Department of Public Works and Transport (hereinafter referred to as “DPWT”), NR9 is a part of the East-West Economic Corridor of 1,450km in length to Da Nang Port in Vietnam on the East, and through Thailand to Mawlamyaing Port in Myanmar on the West. It has been playing an important role in economic development of the inland country, Lao PDR. National Road No.12 became the shortest route connecting Thailand and northern Vietnam by the opening of the Third Thai-Lao Friendship Bridge in November 2011, but the role of NR9 in the economic development of Lao PDR is still large.

Therefore, at the both times of planning and ex-post evaluation, the development need of the project has been high.

3.1.3 Consistency with Japan’s ODA Policy

Japan’s Country Assistance Program for Lao PDR (September 2006) included “Developing socioeconomic infrastructure and effectively utilizing existing infrastructure”. This Project for improvement of existing NR9 was highly consistent with Japan’s ODA policy.

Also, in *JICA Country Analytical Work for Development (April 2011 version 1.1)* provided by JICA Laos Office, advocated infrastructure development as one of the important area which promoted economic growth considering environment and economic disparity, and stated that those were to be obtained by development of road networks. Therefore, the project was consistent with JICA Policy at that time.

3.1.4 Appropriateness of the Project Plan and Approach

Major differences between plan and actual were replacement of the existing sub-base course material, addition of access roads and associated crossing drainage pipes during construction period. The original

design of pavement assumed the existing sub-base course as a new subgrade of pavement structure based on the result of material physical tests including modified California Bearing Ratio (hereinafter referred to as “CBR”) conducted in 1 to 1.5 km intervals, and estimated the strength of existing sub-base course as CBR 6%. However, in-situ CBR tests conducted in the construction phase at the places, where the pavement surface conditions were bad, indicated the average of CBR of 3% that is much less than the assumed CBR in the original design. Therefore, the replacement of the existing sub-base course material was needed to achieve adequate strength of pavements for the sections, where healthiness of the existing sub-base course had been deteriorated. As those places that require substitutions were scattered all over the project site, it was appropriate measures to establish amount based on the construction results, and to have paid the difference. Also, it was necessary measures to add the access roads and associated crossing drainage pipes for smoothly access from neighbors to NR9.

These design changes are considered appropriate, but it must be noted that the contract cost was increased from the original cost about 2,188 million Yen to about 2,678 million Yen.

As described above, this project has been highly relevant to the country’s development plan and development needs, as well as Japan’s ODA policy. Therefore, its relevance is high

3.2 Efficiency (Rating: ③)

3.2.1 Project Outputs

Table 2 summarizes planned and actual outputs of the project.

Table 2: Project Outputs (Comparison of Plan and Actual)

Item		Planned	Actual
Road pavement	Asphalt pavement	Section 1 (Replacing with new material of 47.6 km sub-base/ base course): 10.2 km Section 2 (Replacing with in-situ recycled material): 57.8km Total:	47.0km 11.1km 58.1km
	Concrete pavement	Entrance road of vehicle weigh station : 215m	225m
Road earth works	Cut Fill	13,100m ³ 48,100m ³	5,100m ³ 19,900m ³
Box culvert		1 unit	Ditto
Drainage	Road gutter	53.4km (V type, U type w/cover, three-face armored ditch)	105.64km
	Crossing drainage	11 culverts (ø800mm、ø1000mm)	66 culverts
Road accessory works		1 lot (guard rail, lighting, etc.)	Ditto
Soft component (technical assistance)		Acquire the knowledge of appropriate construction management of large scaled road rehabilitation project by asphalt concrete	Ditto

Source: Preparatory survey report, documents provided by JICA and Consultants

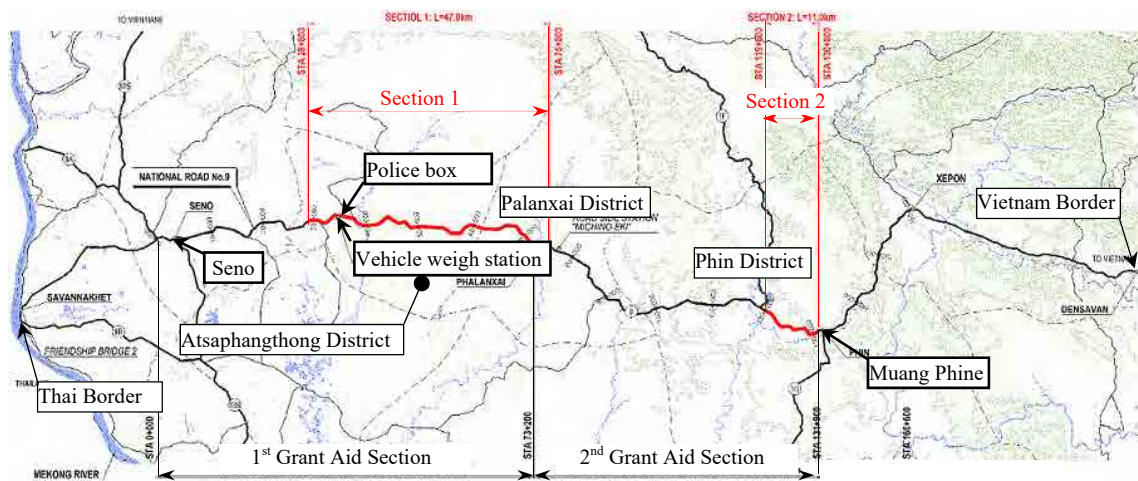


Figure 2: Sections of this Project and Sections of Past Grant Aids

As a result of the design review in the detailed design, the length of each section, the length of concrete pavement, volume of the earthworks, etc. were properly changed. Also, the design changes were made to replace the existing sub-base course material and to add the new access road and associated crossing drainage pipes during the construction period.

The implementing agency explained that replacement of existing sub-base course material was also necessary for achieving required strength of the pavement of the sections, where bearing capacity on top of the existing sub-base course was lower than that expected in the pavement design, and that the additional access roads connecting and crossing drainages were necessary for smooth access from/to surroundings to/from NR9. Therefore, it can be judged that replacement of the sub-base course material is effective for sustainability and new access roads are effective for improving ease of use of NR9.

As described above, with the appropriate design changes such as the pavement structure, the outputs necessary for achieving the project purpose were generally achieved as planned. According to the consultant, "relocation of utility poles and distribution lines" and "securing temporary yards", i.e. obligations of the recipient country, were properly implemented.

3.2.2 Project Inputs

3.2.2.1 Project Cost

As shown in Table 3, the cost borne by the Japanese side was reduced to 91% of the plan by competitive bidding, the cost born by Laotian side was drastically reduced to 9% of the plan because tax exemption was taken outside the scope of DPWT's coverage. As a result, it fell within 85% of the plan.

Table 3: Project Cost (Comparison of Plan and Actual)

Item	Planned (Yen)	Actual (Yen)	Difference
Total Project Cost	3,523 million	approx. 2,991million	85% of planned amount
Cost borne by Japanese side	3,273 million	2,968 million	91% of planned amount
Cost borne by Laotian side	250 million	About 23 million	9% of planned amount

Source: Preparatory survey report, documents provided by JICA and Implementing Agency

Note: The Japanese Government burden was 2,464 million yen at the initial contract. Laos Government burden does not include expenses outside the scope of DPWT's duties such as tax-exempt measures.

3.2.2.2 Project Period

The planned project period from the detailed design⁵ to the completion of the works was 43 months. As the project actually started in September 2011 by signing a consulting services agreement, the planned project period should be up to April 2015, for 44 months. The project was actually completed in March 2015, and the actual project period was 43 months (93% of the planned duration).

As mentioned above, both the project cost and project period were within the plan, and output was produced as planned with appropriate design changes. Therefore, efficiency of the project is high.

3.3 Effectiveness and Impacts⁶ (Rating : ③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects

At the time of planning the project, increase of the pavement load bearing capacity (maximum axle load) and increase of average travel speed were set as quantitative effects. However, the Pavement load bearing capacity (maximum axle load) cannot be used as an indicator of effect of the project, because limitation of the maximum axle load had been relaxed from 9.1 to 11 tons before this project. Incidentally, the cumulative axial weight⁷ during the design period was to be increased from the previous 1.72×10^6 to 2.88×10^6 by this project, but this cannot be adopted as the effect indicator, because it is a design target

⁵ Because the project period in the Ex-Ante Evaluation did not make clear the starting point of the project. Therefore, implementation schedule in the preparatory survey report was referred to. The implementation schedule didn't include the Exchange of Notes Date and the Grant Agreement Date in the project period and the project period was started from the detailed design, that is the date of the consulting service agreement. Therefore, in this ex-post evaluation, the starting point of the project is considered as the starting date of the detailed design in both planned period and actual period.

⁶ Sub-rating for Effectiveness is to be put with consideration of Impacts.

⁷ Cumulative axial weight is to be calculated based on the number of traffic of axial weight of 18kip = 8.16ton during subject time period, such as analysis or design period.

value.

On the other hand, with regard to the average travel speed, the baseline value was calculated by using a software package for traffic network analysis with setting parameters such as traffic volume and free flow velocity based on the road conditions and topographic conditions for each section to obtain the average of the whole NR9. As the consultant doesn't keep those particular parameter records, validation by recalculation was impossible. Therefore, actual average speed in Table 4 was measured based on one round trip with 8-seater one box car by the evaluators. As a result, the travel speed was significantly higher than the target value

Table 4: Average Travel Speed

Baseline (2011)	Target (2018)	Actual (2018)
44.8 km/h	56.3 km/h	Section 1: 69~83 km/h Section 2: 69~82 km/h

Source: Preparatory survey report

Note: Baseline and target values were calculated by the traffic network analyze software, Actual value was measured by actual one round trip by the evaluators.

It is inappropriate to simply compare the baseline and target values calculated on traffic network analysis software, and the actual value of one round trip by the rented car, but there is no doubt from the interviews of drivers and other concerned persons (described as qualitative effects below) that the average travel speed was increased considerably by the project.

In addition to the average traveling speed, the evaluators considered the adoption of traffic volume as an auxiliary indicator, but only traffic passing volumes at Vietnam and Thailand Border were available as historical data of traffic volume at the same observation point on NR9. The annual number of vehicles passing through the Vietnam border has increased dramatically from 6,633 in 2012 and 2013 average to 27,321 in 2016, and 71,443 at Thailand border to 135,420. However, the correlation between these traffic volumes and the traffic volume of this project target sections cannot be confirmed, because there are intersections with the National Road No. 1 and the National Road No.13 between this project sections and the borders with Vietnam, Thailand respectively.

3.3.1.2 Qualitative Effects

At the time of planning the project, improvement of safety and comfortability of the passing vehicle, due to maintaining smoothness of the road surface after the improvement, were set as qualitative effects. For the purpose of verifying these, interviews of the drivers⁸

⁸ Sample size: 28 drivers. Near the Vietnam border: Large vehicle 4 (Male 4), Medium to small vehicle 1 (Male 1),

were carried out in the vicinity of the Vietnamese border, the vehicle weigh station and the police box near the vehicle weigh station in the section 1. The interviews were carried out with choosing among five or free answer format on the safety during fine weather, the safety during rain, the traveling time, and the comfort.

The results of the interviews in Tables 5 to 8 indicate a tendency to improve in safety during both fine and rainy weather, time required, and comfort and no negative opinion. In addition, as the size of the vehicle became larger, the evaluation tended to be higher. This may be because the vehicle becomes more susceptible to the influence of the road surface as the vehicle becomes larger.

Table 5: Safety during fine weather

Answer	Number
Improved very much	24
Improved a little	4
No change	0
Worsened a little	0
Worsened very much	0

Table 6: Safety during rainy weather

Answer	Number
Improved very much	23
Improved a little	5
No change	0
Worsened a little	0
Worsened very much	0

Table 7: Traveling time

Answer	Number
Shortened very much	22
Shortened a little	6
No change	0
Lengthened a little	0
Lengthened very much	0

Table 8: Comfort on drive

Answer	Number
Improved very much	25
Improved a little	2
No change	1
Worsened a little	0
Worsened very much	0

Major reasons for the changes are as follows.

Safety during fine weather:

"Good condition of road surface", "Pavement surface is thick", "No hole", etc.

Safety during rainy weather:

"State of road surface is good", "White line is pulled and visibility is good", etc.

Traveling time:

"Good condition on the road surface", "Wide road width is wide and high speed" etc.

Comfort on drive:

"Good condition of road surface", "Travel time has been shortened", etc.

Incidentally, although there is a possibility that some of these answers may include evaluations of the sections other than this project, since this project was aimed improvement of the sections with the worst condition, the majority of responses may be regarded as the effect of this project.

According to the response of the Savannakhet provincial police to the questionnaire,

Police station near the vehicle weigh station: Large vehicle 5 (Male 5), Medium to small vehicle 7 (Male 7), Motor bike 8 (Male 4, Female 4), Vehicle weigh station: Large vehicle 3 (Male 2, Female 1)

traffic accidents on NR9 decrease from an average of 211 cases/year in 2012 to 2014 to an average of 85 cases/year in 2015 to 2016, traffic death also decreased from 50 to 19 persons/year. Improvement of the safety on NR9 can be confirmed also by these data. However, this data is statistics for entire NR9, and it is considered that accidents occurred in sections other than the project sections are also included.

3.3.2 Impacts

3.3.2.1 Intended Impacts

It was intended in the planning stage that the project would contribute to:-

- Expedite trade and investment in the Central Region (Savannakhet, Khammouane, Bolikhamsai, Xaisomboun, Vientiane Provinces and Vientiane Capital), and
- Development of regional economy with agricultural and commercial activities.

(1) Trade and Investment Environment

The values of trade through border gates on NR9 in 2012 and 2017 are as shown in Table 9, the values of transit trade and import have been greatly increased, and the value of export has been slightly reduced. It seems that improvement of safety and comfort of NR9 by this project contributed to the increase of the value of transit trade, but the degree of contribution is unknown. Relationship between the changes in import/export and this project is unknown, because there are routes connecting to National Road No. 13 and National Road No. 1 without passing through the project target sections.

Table 9: Values of Trade through Border Gates on NR9 (Unit: USD)

		2012	2017	Rate of Increase
Thai Border	Import	1,549.63 million	3,014.34 million	1.94
	Export	873.21 million	784.5 million	0.90
Vietnam Border	Import	83.56 million	200.87 million	2.39
	Export	73.60 million	73.44 million	0.99
Transit Trade		83.19 million	700.65 million *	8.45

Source: Second Mekong Friendship Bridge Management Office, Densawan International Border Customs

Note: *Transit trade value in Year 2016

Approved Investments in Central Region from 2012 to 2017 were as shown in Table 10, and there is no particular tendency to be recognized.

Table 10: Approved Investments in Central Region (Unit: USD)

2012	2013	2014	2015	2016	2017
457 million	1,112 million	535 million	158 million	2,447 million	1,395 million

Source: raw data provided by Department of Investment, Ministry of Planning and Investment

In order to verify the promotion effect of trade and investment in Savannakhet Province by

this project, interviews⁹ were carried out with choosing among five and free answer format about changes in the situation of trade and investment environment in Savannakhet Province and effects of this project onto trade and investment environment.

The results of the interview show that both the trade environment and the investment environment improved as described below.

Table 11: Trade environment

Answer	Number
Improved very much	6
Improved a little	1
No change	0
Worsened a little	0
Worsened very much	0

Table 12: Investment environment

Answer	Number
Improved very much	4
Improved a little	3
No change	0
Worsened a little	0
Worsened very much	0

The reasons for the main change are as follows.

Trade environment:

"The state of the road surface is good and the logistics have become faster", "Easy to move between Thai and Vietnamese borders and it has become shorter" etc.

Investment environment:

"The state of the road surface is good and logistics speeded up", "The road improved and the investment from foreign countries increased," "It was inconvenient during the construction period," etc.

Still more, as for the influence of NR9 on the trade environment and the investment environment, the number of answers that said "Improved very much" and "Improved a little" are comparable. In addition, it seems that effects of improvements of other sections of NR9 by Laos side under "Project for Improvement of Road Maintenance Capacity in Lao PDR¹⁰" (hereinafter referred to as "the Related Technical Cooperation") is also included in the above-mentioned results.

(2) Agriculture and Commercial Activities

The agricultural production value of Savannakhet Province, as shown in Table 13, increased by 1.5 times in four years, confirming activation of agricultural activities. According to the Savannakhet Provincial Agriculture and Forestry Department, agricultural production increase is mainly due to agricultural promotion projects by JICA, ADB, World

⁹ Sample size: 7 persons, Provincial Department of Industry & Commerce (hereinafter referred to as "PDIC") officers 3 (Male 3: Chief of Administrative Section, Chief of Planning Section and Vice Chief of Export-Import Section), Owners of trading company 4 (Male3, Female1)

¹⁰ JICA's technical cooperation project, from September 2011 to September 2017, aimed at strengthening the capabilities for maintenance and management of roads and bridges, and assisted capacity building for preparation of maintenance management plan, development of technical manuals and guidelines, and improvement of skills of engineers of DPWT in Savannakhet and Vientiane Provinces.

Bank and others (expansion of planting area by irrigation etc.), increase of production of factories such as sugar, rubber etc. by foreign investment. The improvement of NR9 brings about reduction of transportation time and cost, leading to the promotion of agriculture and motivation for expansion of productions.

Table 13: Agricultural Production Value of Savannakhet Province (Unit: LAK)

2012	2013	2014	2015	2016
3,773 million	4,471 million	4,671 million	5,508 million	5,690 million

Source: data provided by Implementing Agency

For the purpose of verifying the promotion effect of agriculture and commerce in the hinterland (along the roadside) by this project, interviews¹¹ were carried out about changes in the situation of the agricultural and commercial activities of the hinterland in Atsaphangthong, Palanxai and Phin Districts, which almost overlap with the target section of this project, and effects of this project onto agricultural and commercial activities with choosing among five and free answer format.

As shown in Tables 14 to 16, the result of the interview is that transportation time is shortened, transportation costs are lowered, and the number of shops is increasing.

As for the reasons for the main changes, the following answers were obtained.

Transportation time:

Mainly "Good condition of the road surface and many things can be carried quickly", "We can carry things on the bus" etc.

Transportation cost:

"Road surface is good and we can carry quickly," "fuel saving", "vehicle damage is small", etc.

Number of shops:

"Condition of road surface is good and convenient", "Tourists increased", "Stores increased about 70% more", etc.

¹¹ Sample size: 34 people (Provincial Department of Agriculture and Forestry (hereinafter referred to as "PDAF"), Staff 4 (Male 4: Deputy Chief of Livestock Fisheries Division, Deputy Division of Agriculture Division, Deputy Chief of Planning Division, Deputy Chief of Public Relations Division), Phin District Office of Public Work and Transport (hereinafter referred to as "OPWT") Officer 2 (Male 1: Director, Female 1: Deputy Director), Commercial Personnel 3 (Male 3: Convenience store Management 2, grocery store management), farmer 6 (male 6), Palanxai District shop owner 5 (male 5: mobile dealer management, gas station staff, grocery store management, motorcycle shop management, drink store management), Farmer 4 (Male 4), at Atsaphangthong District OPWT Staff 1 (Male 1: Director), Shop owner 6 (Male 4: Food Store Management 2, grocery store management, Transportation management, Female 2: Foods Store management, grocery store management), farmer 3 (Male 3))

Table 14: Time of Transportation

Answer	Number
Shortened very much	31
Shortened a little	3
No Change	0
Lengthened a little	0
Lengthened very much	0

Table 15: Cost of Transportation

Answer	Number
Reduced very much	27
Reduced a little	7
No Change	0
Increased a little	0
Increased very much	0

Table 16: Commercial Activities

Answer	Number
Increased very much	22
Increased a little	7
No change	1
Decreased a little	3
Decreased very much	1

Four negative opinions on the number of shops were from shop owners in Atsaphangthong District, and they insisted that installation of barrier curbs made it difficult for customers and delivery companies to park their cars in front of the store, making it difficult to operate the business. According to DPWT, this is a measure necessary for traffic safety, and consultants in charge of the design said openings had been made to minimize the adverse effects.

However, at Atsaphangthong District, there was a part where there was no opening over a relatively long section, and removal of the curbs, which may be done by the residents, were also confirmed. Therefore, OPWT at Atsaphangthong District is considering additional openings.



Photo 3: Opening curbs may be made by residence

(3) Situation of Flooding in the Surrounding Area

Although not clearly stated in the preparatory survey report, this project was supposed to give a positive impact on the situation of flooding in the Palanxai embankment area (decrease of inundation), therefore interviews¹² on the change of inundation situation and the effect of this project were carried out in the area around the embankment section of Palanxai with choosing among five and free answer format.

¹² Sample size: 11 people (OPWT staff 2 (Male 2: director, general affairs section manager), Shop owner 5 (Male 5: grocery store management, mobile dealer management, motorcycle dealer management, drink store management, gas station staff), Farmer 4 (Male 4))

As shown in Tables 17 and 18, the results of the interviews show that the areas and duration of inundation were decreased except for one person. In the Palanxai embankment section, it was confirmed by surrounding residents' interview that the areas and duration of inundation of paddy fields on the north side of NR9 decreased by improving existing pipe culvert to dual box culverts with high drainage capacity.



Photo 4: Drainage on north side of NR9

Table 17: Area of Inundation

Answer	Number
Decreased very much	10
Decreased a little	1
No Change	0
Increased a little	0
Increased very much	0

Table 18: Duration of Inundation

Answer	Number
Decreased very much	10
Decreased a little	0
No Change	0
Increased a little	0
Increased very much	1

The reasons for the main change are as follows.

Area of Inundation: "Good drainage", "Good flow of water" etc.

Duration of Inundation:

"Good wastewater", "Previously it was flooded for about 3 days, now it will be drained in one day" etc.

According to one farmer who replied that "the duration of inundation increased very much", "the rice field flooded about 50 cm for 3 days". During observation of the site, he explained that the volume of water flowing under the Houay Koa Bridge (Palanxai District), which had been existing even before the project, had increased. Although it is not possible to



Photo 5: The situation on the side of Houay Koa Bridge

conclude because there are also irrigation projects supported by ADB in the vicinity, it cannot be denied that the drainage constructed on the northern side of NR9 by this project can be one of the causes of increase flooding of his land. The Implementing Agency also agreed to these opinions of the evaluator. In any case, if looking over the area surrounding the Palanxai embankment section, there is no doubt that the inundation situation was improved by this project. The root cause of inundation in the area is the overflow in the bent

section of the Xe Xamxoy River (Palanxai District) of about 1.4 km north of NR9, and secondarily cause is the lack of flow capacity of the river downstream of the Houay Koa Bridge.

3.3.2.2 Other Positive and Negative Impacts

The initial environmental evaluation of the project was conducted based on *JICA Guideline for Environmental and Social Considerations (April 2004)* was applied.

(1) Impacts on the Natural Environment

Initial Environmental Evaluation Report (June 2011) (hereinafter referred to as "IEE") stated "National Road No. 9 crosses Dongkapo Forest Production Area, but it is not part of the improved section. It is located outside the northern boundary of Dong-Phu-Vieng National Park. This project is a repair without widening and there is no negative influence on surrounding natural environment." According to the implementing agency, there was no negative impact on the natural environment, and no special mitigation measures were taken for conservation of natural environment.

Although no environmental monitoring report was confirmed, according to DPWT, there was no environmental impact during the construction period. According to the IEE, there would be no works that would cause soil erosion and water pollution, and required pollution control measures would be only watering for dust control, etc. Since such pollution control measures are quite common for road projects, it is considered that proper actions were made and that there was no remarkable pollution during the construction.

From these, the undesirable effects on the natural environment were minimal as planned.

(2) Resettlement and Land Acquisition

Since this project is improvement of the existing NR9 without widening, land acquisition was not required¹³. IEE assumed that within 10m and 14m from the center line of the road in the urban and rural areas respectively would likely be affected by the works, and identified 46 households, 218 people as affected peoples. As a result of the first consultation meeting under the condition without specifying the part that needs to be removed/relocated, 43 households agreed to remove and transfer the structures (small structures such as fences, eaves, etc.) in the right of way without compensation, and one household among the remaining three households stated "will remove and relocate without compensation, if necessary", another household stated "to remove/relocate if there is compensation", the last household stated "resulted in losing the income source, so it cannot be removed or

¹³ Right of way of a national road is within 25m from the centerline. If necessary, it is allowed to use the land within the right of way under a permission of the authority.

transferred". According to the DPWT, in the subsequent consultation meetings, the progress of the design revealed that the extent/level of influence was small and income sources would not be lost, and all households agreed to remove and relocate structures (small structures such as fences, eaves, etc.) within the affected areas without compensation based on the previous agreement regarding designation of right of way on July 16 2002. The number of affected households was less than 50, so a resettlement action plan was unnecessary in accordance with Government Ordinance PM/WREA No. 12.

Still more, there was a comment "the pavement of the connecting part with the NR9 connecting to the store was broken by construction and it was not restored" in the interviews on agricultural and commercial activities¹⁴, and that this person was not included in the above-mentioned 46 households.

From these, it was necessary to remove small structures (fences, eaves, etc.) placed within the right of way, but there were no land acquisition, resettlement of residents nor demolition of the stores or houses themselves.

As mentioned above, for the effectiveness, although simple comparison is inappropriate because there is a difference in measurement method, actual travel speed considerably exceeded the planned target speed, and certain effects could be confirmed in the interview. In addition, the improvements of safety and comfort of travelling, they were qualitatively confirmed.

With regard to the impact, activation of agricultural activities was quantitatively confirmed, improvement of trade and investment environments, vitalization of agriculture/commercial activities and development of regional economy were qualitatively confirmed, and other negative impacts was not confirmed.

As described above, this project has achieved its objectives. Therefore, effectiveness and impacts of the project are high.

3.4 Sustainability (Rating: ③)

3.4.1 Institutional/Organizational Aspect of Operation and Maintenance

The institution/organization for operation and maintenance of NR9 has been changed from the time of planning to the ex-post evaluation as shown in Table 19, and the transfer of authorities to the region is being promoted in order to respond more quickly in line with the actual situations. For example, at the time of planning the project, MPWT was responsible for inspection and maintenance plans for daily maintenance, and DPWT did all the implementation, but at the time of ex-post evaluation, OPWT is responsible for everything other than the maintenance plan and project evaluation, for which DPWT and OPWT are

¹⁴ The person made this comment stated "This is not for claiming compensation".

jointly responsible.

Table 19: Institution/Organization for Operation and Maintenance of NR9

Operation and Maintenance Item ¹⁵	Daily Maintenance		Periodical Maintenance		Repair/Emergency Repair	
	At Planned	At ex-post evaluation	At Planned	At ex-post evaluation	At Planned	At ex-post evaluation
Inspection Plan	MPWT	OPWT	MPWT	DPWT	MPWT	DPWT
Inspection	DPWT	OPWT	MPWT	DPWT	DPWT	DPWT
Update and Management of Data Base	DPWT	OPWT	MPWT	DPWT	MPWT	MPWT/DPWT
Maintenance Plan	MPWT	DPWT/OPWT	MPWT	MPWT/DPWT	MPWT • Local government	MPWT/DPWT
Budget Planning/Allocation	MPWT	MPWT/OPWT	MPWT	MPWT/DPWT	MPWT • Local government	MPWT/DPWT
Maintenance Management Implementation	Contractor		Contractor		Contractor	
Business Evaluation	DPWT	DPWT/OPWT	MPWT	MPWT/DPWT	MPWT • Local government	MPWT/DPWT
Audit	Road fund	OPWT	Road fund	DPWT	Road fund	DPWT

At the ex-post evaluation, Department of Road (hereinafter referred to as “DOR”) is responsible for maintenance of the national roads, and DPWT and OPWT in each district cooperate with DOR for implementation of the maintenance. The number of staff involved in the road maintenance is 98 in DOR, 142 in DPWT Savannakhet Province and 125 in OPWT of 15 districts in the province (staff in the six districts concerning the operation and maintenance of NR9, i.e. Kaysone, Outhoomphone, Atsaphangthong, Phalanxay, Phin and Xepon, is 55). As the number of staff increased from 279 at the time of planning to 365 (OPWT staff of 6 districts involved in the operation and maintenance of NR9 was augmented from 28 to 55 people), and many staffs were transferred to local authorities with the transfer of authority to local organizations.

Also, DPWT/OPWT plans to establish a maintenance unit for conducting periodic inspections and minor repairs by themselves.

Taken together, it is considered that the institution/organization for operation and maintenance has been improved compared with the planning time.

3.4.2 Technical Aspect of Operation and Maintenance

Regarding technology for operation and maintenance, development and strengthening of

¹⁵ "Daily maintenance" is a maintenance that is carried out on a daily basis, such as cutting grass and cleaning drainage facilities. In future, it is a direction to enable patrols and simple repairs as well. "Periodical maintenance" is a maintenance performed at regular intervals, such as repainting of road signs.

technical capacity of project members selected from DOR, DPWT, Public Transportation Training Center, and Public Transportation Research Institute were carried out through the Related Technical Cooperation. According to the termination evaluation of the Related Technical Cooperation implemented in March 2017, the DPWT in Savannakhet Province has improved its capability towards the goal in all aspects of maintenance activities.

Currently 28 staffs, who participated in the trainings by the soft component of this project and/or the Related Technical Cooperation, are involved in operation and maintenance of NR9 in DOR, DPWT and OPWT of the six districts¹⁶. Also in OPWT, the Road Manual (Technical Manual for Road Maintenance and Management) produced by the Related Technical Cooperation is used for their activities. Also, the construction company engaged in the project as a subcontractor is implementing repair work on other sections of NR9, and the technology of asphalt pavement works has been accumulated.

It should be noted that DOR, DPWT, and OPWT do not have their own staff training system, they train staff by taking opportunities of aid projects of foreign countries, and according to the termination evaluation of the Related Technical Cooperation, it is expected that JICA's strategic cooperation plans including training and long-term training will be fully utilized to continuously provide opportunities for higher education to potential talents.

Taken together, there is no problem with the technology of operation and maintenance, because most of the training participants in the soft component and the Related Technical Cooperation are still engaged in the road maintenance work, the operation and maintenance technology transferred by the training is utilized in the road maintenance work, and the technology of asphalt pavement works is also accumulated in the private companies.

3.4.3 Financial Aspect of Operation and Maintenance

Maintenance and repair expenses of NR9 are as shown in Table 20. When comparing 2012 and 2017, the maintenance cost increased to 1.6 times, and the repair cost increased to 9.2 times.

Table 20: Expenses of Routine Maintenance and Major Repair (Actual, Unit: LAK)

	Maintenance	Major Repair
2012	242 million	22,195,000 million
2013	242 million	-
2014	242 million	-
2015	387 million	202,376,000 million
2016	562 million	202,376,000 million
2017	387 million	202,376,000 million

Source: data provided by Implementing Agency

Note: In 2013, 2014 repair was done by this project.

¹⁶ A few participants in the training have left the road maintenance and management work by moving within the organization.

However, according to the implementing agency, the maintenance cost is allocated for regular mowing and cleaning of the drainage, and it is necessary to increase the budget for periodic repair. Incidentally, the maintenance cost of NR9 (total 244km) in 2017 was 1.59 million LAK/km, and only about 27% of 747USD/km, the average annual maintenance cost of the project section (58km) in the initial four years estimated in the preparatory survey.

The Road Fund was established as a source of funds for the operation and maintenance of the national roads, and their revenues and expenditure of the recent years are as shown in Table 21.

Table 21: Revenue and Expenditure of the Road Fund (Unit: LAK)

	Revenue	Expenditure	Balance Carried Forward
2012	370,600 million	416,400 million	25,400 million
2013 (Oct.-Sep.)	392,400 million	360,300 million	57,600 million
2014 (Oct.-Sep.)	549,300 million	437,700 million	169,100 million
2015 (Oct.-Sep.)	625,600 million	392,100 million	402,700 million
2016 (Oct.-Dec.)	148,100 million	142,100 million	408,600 million
2017 (Jan.-Dec)	664,300 million	948,700 million	124,200 million

Source: data provided by Implementing Agency

Note: For the transition period in 2016 from October to September of the previous fiscal year, changed from January to December, 2016 figure is three months from October to December

The revenue in 2017 was increased to 3.8 times of that in FY 2008, which was referred to at the time of planning, mainly due to increase in the fuel levy (1.4 times). However, further increase of the fuel levy will not be easy, and revenue of the Road Fund may remain to an increase in natural.

For example, in 2017, DOR carried out major repair works of other sections of NR9 by investing about 300 times the revenue from the Road Fund and reduced the balance carried forward significantly. Therefore, it is difficult to secure sufficient budget for routine maintenance, which is almost same situation as that at the time of planning. However, as the repair works of other sections of NR9 will be completed from now on, it can be expected to implement the recommendation to be mentioned later, i.e. "to secure the budget necessary for periodic repair of NR9".

3.4.4 Status of Operation and Maintenance

As a result of the site observations, there was no remarkable problem in the present conditions of the sections of NR9 improved by this project. Major repair works on other

sections of NR9 are being continued by the Laotian Government with assistance of the Related Technical Cooperation. Number of overloaded vehicles at the vehicle weigh station within this project section is as shown in Table 22 and strengthening overloaded vehicle management by the Related Technical Cooperation is underway.

Table 22: Number of Overloaded Vehicles at Vehicle Weigh Station

Year	2014	2015	2016	2017
Number	96	5	0	6

Source: data provided by Implementing Agency

As mentioned above, there are no notable problems in the status of operation and maintenance.

Although overloaded vehicles became fewer than in 2014, it is hoped that the vehicle weigh station will be officially operated to further strengthen overload management.

Taken together, no major problems have been observed in the institutional, technical, financial aspects and current status of the operation and maintenance system. Therefore the sustainability of the project effect is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project aimed at improvement of NR9, which is very important connecting neighbor countries, i.e. Thailand and Vietnam, with sufficient driving speed, safety and comfort as international highway according to traffic conditions by refurbishing pavement structure and road structure of damaged sections, thereby contributing to promotion of trade and investment in Laos Central Region and economic development of the hinterland of NR9.

The project has been highly relevant to the country's development plan and development needs, as well as Japan's ODA policy. Therefore, its relevance is high. Both the project cost and project period were within the plan. Therefore, efficiency of the project is high. Regarding the effectiveness, although the simple comparison cannot be made due to the difference in the measurement method, the traveling speed is much higher than the expected traveling speed at the time of planning in the actual measurement, and through the driver interviews, positive effects for safety during fine and rainy weather, travel time, and comfort on drive were confirmed. Regarding the impact, it was confirmed that the renovation of NR9 led to the reduction of transportation time and transportation expenses, leading to the promotion of agriculture and the motivation for expansion of production, and through interviews, improvement of trade and investment environment, vitalization of agriculture and commercial activities, and contribution to the development of the regional economy were confirmed. Also,

no negative impact was confirmed. Therefore, effectiveness and impacts of the project are evaluated as high. Furthermore, the operation and maintenance systems have been improved in terms of human resources and organization. About technical heritage, participants of the training in the soft component still engage to maintenance duties. The financial condition is still tight, but it is expected that budget for periodical repair will be assigned in the future. No other problems have been observed. Therefore, sustainability of the project effects is high.

In light of the above, this project is evaluated to be very highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Implementing Agency

Recommendations to the Laotian implementing agency are as follows.

- In order to sustain the effect of the project for a long time, MPWT/Department of Transport shall reinforce management of overloaded vehicles by operating officially the vehicle weigh station, which has been assisted by the Related Technical Cooperation.
- In order to increase effect of the project, MPWT/DOR shall complete improvement of other sections of NR9, which has been assisted by the Related Technical Cooperation. Also, MPWT/DOR shall support establishment of Maintenance Unit on the institutional and budgetary side so that DPWT/OPWT can perform periodic inspection and minor repair of NR9.
- DOR/DPWT shall secure budget necessary for periodic maintenance of NR9.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

(1) Improve Design Accuracy

It was fortunate in this project that the design change to deal with insufficient strength on the upper surface of the existing subbase course confirmed during the construction period was possible by using grant for contingencies. In the road improvement projects, it may not be easy to accurately grasp the status of all the lines at the time of designing, but it is necessary to secure accuracy of design by conducting sufficient soil investigations, etc. in the outline and/or detailed designs, because contingency budget has some limitation.

(2) Clarify Method of Measurement of Quantitative Effects

In this project, one of the two indicators for quantitative effects, which was set in the preparatory survey, was inappropriate, and the other indicator was not available for ex-post

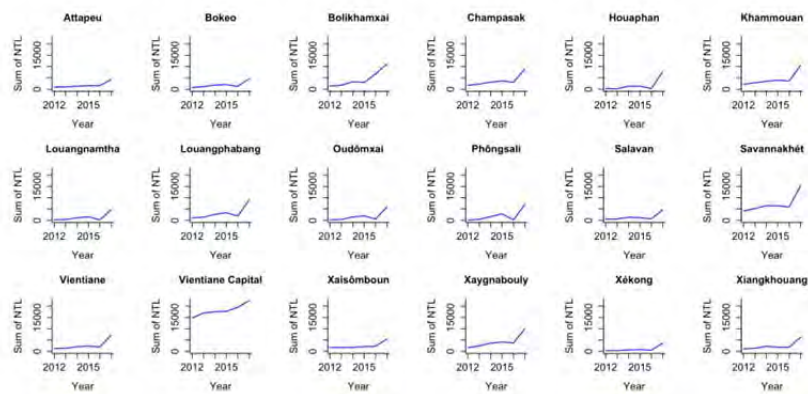
evaluation because the measurement method became unknown. In order to avoid such a situation, it is necessary to specify the definitions and measurement methods of the indicators in the preparatory survey report, and to conduct these measurements at the time of completion of the project jointly by the consultant and the implementing agency, so that the implementing agency can measure the indicators independently at the time of ex-post evaluation.

Column: Summary of Impacts of Improvement of National Road Number 9 on Regional Economy in Lao People's Democratic Republic

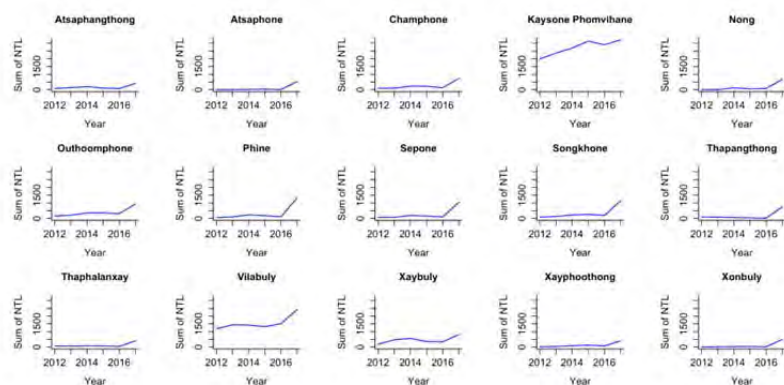
Souknilanh Keola
Research Fellow

Bangkok Research Center/Japan External Trade Organization (JETRO) Bangkok

This paper examines the impacts of improvements of National Road No. 9 (hereinafter referred to as “NR9”) under “The Project for Improvement of National Road No. 9 as East-West Economic Corridor of the Mekong Region”, grant aid project conducted by Japan International Cooperation Agency (JICA) between 2012 and 2015, on regional economies in Laos with explicit consideration of location or geography. It addresses lack of spatial information in administrative data with spatio-temporally high resolution remote sensing data.



a. By Provinces



b. By Districts in Savannakhet

Figure 1. Change of Sum of NTL (2012 and 2017)

Source: By author based on GADM (Global Administrative Areas). NTL is based on Suomi NPP-VIIRS.

Following Henderson et al. (2012) and Keola et al. (2015)¹⁷, it uses Nighttime Light (hereinafter referred to as “NTL”) data, observed with satellites from outer space, as a proxy of the level of economic activity on the ground. Nevertheless, it uses NTL data collected through Visible Infrared Imaging Radiometer Suite (VIIRS) mounted on Suomi National Polar-orbiting Partnership (Suomi NPP), instead of Operation Line Scan (OLS) on Defense Meteorological Satellite Program (DMSP) used in aforementioned studies, because latest version of the latter is currently available up to 2013, so does not cover major part of the study period. On the one hand, aggregation of NTL (for the month of December) by provinces in Laos between 2012 and 2017 reasonably reflect relative scale of Gross Regional Products (Figure 1a). On the other, aggregation by districts in Savannakhet shows sharp increase of amount of NTL in 2017 for all but its capital district of Kaysone Phomvihane. Figure 2 depicts relative position of NR9, and improved sections in Laos and Savannakhet. This study main aim is to examine the impact of these improved sections.

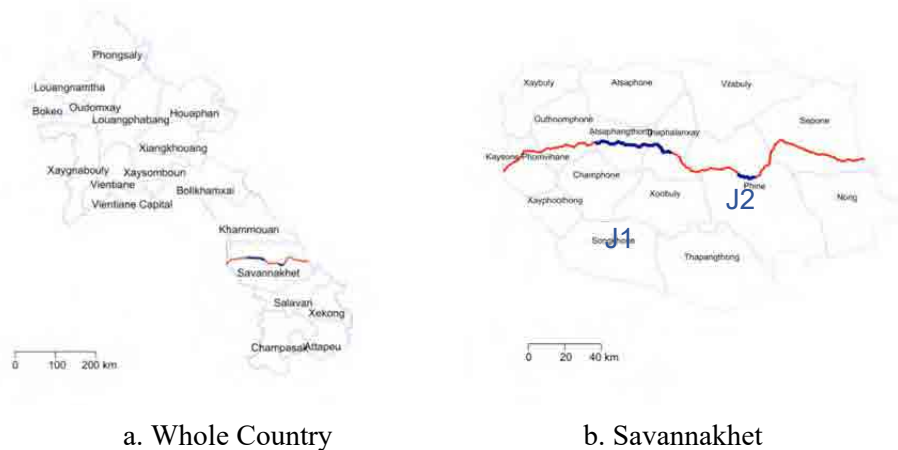


Figure 2. National Road Number 9 in Lao PDR

Source: Provincial and district maps are based on GADM. Red line represents NR9, whereas blue line represents section improved by JICA.

The results of econometric analyses of relationship between NTL, by grids of approximately 500 by 500 meters, and reciprocal distances to NR9, and improved sections conducted by JICA (J1 and J2 in Figure 2.) can be summarized as follows. First, when differences among all approximately 140 districts in Laos are controlled for, the reciprocal distances have robust, significant and positive relationship with NTL. In other words, when all else is equal, the closer a grid to NR9 the higher the NTL (Table 1 and Figure 4). However, the relative importance of

¹⁷ Refer to Henderson, J. Vernon, Adam Storeygard, and David N. Weil. "Measuring economic growth from outer space." *American economic review* 102.2 (2012): 994-1028. Keola, Souknilanh, Magnus Andersson, and Ola Hall. "Monitoring economic development from space: using nighttime light and land cover data to measure economic growth." *World Development* 66 (2015): 322-334.

NR9 decreases with distances, while districts with alternative accessibility depend less on the road. This is evidenced from negative coefficients of district dummies for many districts in Savannakhet including adjacent and nearby provinces such as Khammouan, Salavan and Attapue (Figure 4). Negative coefficients imply higher dependence of corresponding districts on NR9. On the contrary, coefficients of district dummies for the rest of provinces and some districts facing Mekong River in Savannakhet and nearby provinces are positive.

Second, effect of road improvement is detected for both sections, i.e. J1 and J2 through comparing difference of year effect of regions defined by 2km buffers from improved section of 2017 against 2015 when improvement works are basically completed. Such differences are illustrated in Figure 3. Year effects capture many factors including the impact of road improvements. The difference of year effects (2017-2015) for J1 shows an increasing trend, from a distance of 50 km, towards this improved section. If the part of year effect arising from factors other than road improvements can be considered uniform among regions, I argue that this is an evidence suggesting that the road improvement, of this ODA project, generated positive impacts to regional economies, between 2015 and 2017, but decreasing by distance. The increasing trend of difference of year effect (2017-2015) for J2 can be observed from about 45 km and 30 km, before becoming more or less stable to slightly declining. However, the distance of J2 is less than a fourth that of J1. This may contribute to less obvious impacts in area closer to J2. Dozens of local people living along the road interviewed by author in January 2018 responded quickly and with seemingly absolute confidence of the positive impacts of road improvements. Official macro statistics of movement of people and goods, and traffic along NR9, obtained from provincial divisions, obviously depict sharp increasing trend from 2016. The analysis of this paper confirms the subjective insight based on partial facts on the ground, with inclusive and comparable evaluation of the project, using information collected remotely at outer space.

Table 1. Main Result for NR9

	Estimate	Std. Error	t value	Pr(> t)
log(1/dis_r9)	0.293	0.002	125.524	0.000
factor(year)2012	(0.885)	0.015	(57.137)	0.000
factor(year)2013	(1.372)	0.015	(91.537)	0.000
factor(year)2014	(1.940)	0.015	(131.560)	0.000
factor(year)2015	(1.990)	0.015	(135.217)	0.000
factor(year)2016	(1.187)	0.015	(79.067)	0.000
factor(year)2017	(1.241)	0.015	(84.624)	0.000

Residual standard error: 0.9277 on 1885886 degrees of freedom
Multiple R-squared: 0.8978, Adjusted R-squared: 0.8978
F-statistic: 1.119e+05 on 148 and 1885886 DF, p-value: < 2.2e-16
Note: Coefficient of district dummies are shown separately in Figure 4.

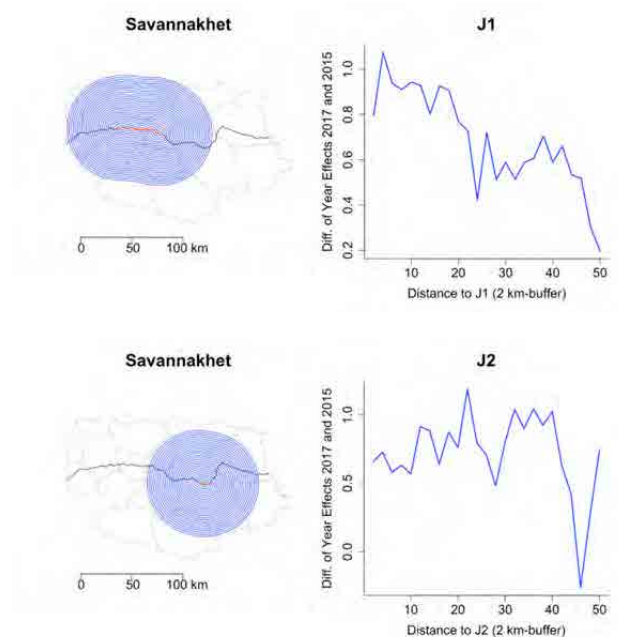


Figure 3. Difference of Year Effects 2017 and 2015

Source: By author.

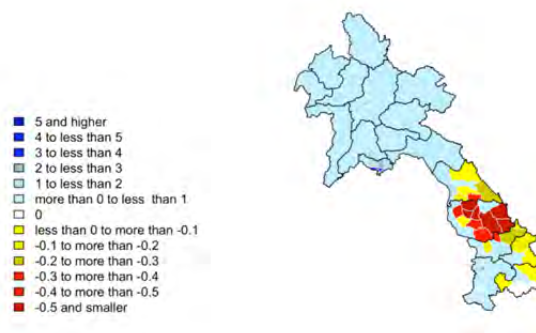


Figure 4. Coefficients of District Dummies

Source: By author.

Lao People's Democratic Republic

FY2017 Ex-Post Evaluation of Japanese Grant Aid Project

“Mini-Hydropower Development Project”

External Evaluator: Toru Shimada, ADAMIS Ltd.

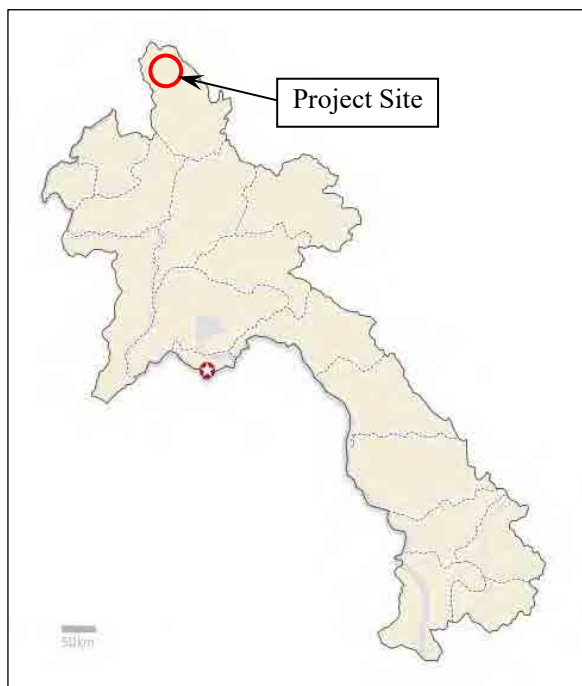
Hiromitsu Takao, Aviation Systems Consultants Co., Ltd.

0. Summary

The project aimed at promoting utilization of renewable energy, contributing to reduction of greenhouse gas emission, and promoting electrification in rural areas by constructing a mini-hydropower plant and distribution networks in Gnod Ou District, Phongsaly Province, thereby contributing to the socio-economic development of Laos. The project has been highly relevant to the country's development plan and development needs, as well as Japan's ODA policy. Therefore, its relevance is high. With regards to efficiency of the project, the project cost exceeded the plan although the project period was within the plan. Therefore, efficiency of the project is fair. Qualitative effects of the project are observed, but achievement of operational indicators, such as plant factor and generation of hydropower plant are below the targets. Therefore, effectiveness and impacts of the project are fair. With regards to operation and maintenance of facilities, some minor problems have been observed in terms of the institutional aspect, technical aspect, financial aspect and current status. Therefore, sustainability of the project effects is fair.

In light of the above, this project is evaluated to be partially satisfactory.

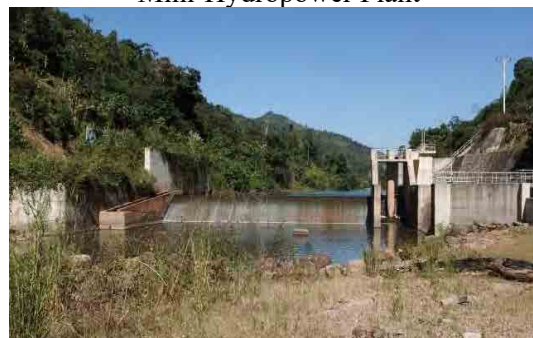
1. Project Description



Project Location



Mini-Hydropower Plant



Diversion Weir

1.1 Background

Lao People's Democratic Republic (hereinafter referred to as "Lao PDR") is an inland country affected by the tropical monsoon, and its potential of hydropower development is estimated to be more than 26,000 MW¹. The Government of Lao PDR has planned power development with the practical use of the high hydropower potential through the positive introduction of independent power plants. The national electrification ratio of Lao PDR had consequently been increasing from 36% in 2000 to 73% in 2010. By region, the electrification ratio became as high as 96% in the Central Region including the capital in 2010 but remained as low as 59% in the Northern Region. The Government of Lao PDR showed a policy to actively promote rural electrification from the viewpoint of reducing the internal disparities between urban and rural areas and poverty reduction in the remote areas, and set targets to improve the national electrification ratio to 80% by 2015 and to 90% by 2020 in *The Seventh Five-year National Socio-Economic Development Plan (2011-2015)*.

One of issues on the future rural electrification was financial issue. Most of the power in villages near the border was imported, and the import tariff was relatively expensive. The power price was more expensive than electricity tariff to consumer in Lao PDR. Therefore, reduction of volume and/or tariff of import power have been required. In addition, there was technical issues, i.e. low reliability of power supply through long distance distribution networks and insufficient technical and management capabilities of off-grid electrification.

Phongsaly Province, the target area of the project is located in the northernmost of Lao PDR, its electrification ratio was the lowest in the country, and electrification of remote areas had not been progressed. This is because there were only Nam Ngai mini-hydropower plant (1,200 kW) and Mai hybrid power plant (mini-hydropower 110 kW + solar power 40 kW) in Phongsaly Province, which could not generate sufficient power, it is difficult to maintain reliability of supply and of appropriate voltage of power generated in the country through long distance 22kV distribution networks from national power grid, and import power from China is expensive.

In order to solve such conditions, the Government of Lao PDR requested Government of Japan for Japan's Grand Aid to construct a mini-hydropower plant and to extend distribution networks to the surrounding un-electrified villages in Gnod Ou District, Phongsaly Province.

1.2 Project Outline

The objective of the project is to promote utilization of renewable energy, to contribute to reduction of greenhouse gas emission, and to promote electrification in rural areas by

¹ *Current Status and Future Trend of Laos Energy and Power* by Inoue, Asakura and Sasaki, posted on website of the Institute of Energy Economics, Japan in October 2003 <http://eneken.ieej.or.jp/data/pdf/749.pdf> (accessed 2018-6-11)

constructing a mini-hydropower plant and distribution networks in Gnod Ou District, Phongsaly Province, thereby contributing to the socio-economic development of the country.

Grant Limit / Actual Grant Amount	JPY 1,775 million / JPY 1,772 million
Exchange of Notes Date / Grant Agreement Date	March 2013 / March 2013
Executing Agency	Ministry of Energy and Mines
Project Completion	February 2015
Main Contractor	Hazama Ando Corporation
Main Consultant	Tokyo Electric Power Service Co., Ltd.
Basic Design	August 2012 - March 2013
Related Projects	Technical Cooperation: “The Master Plan Study on Small Hydropower in Northern Laos” (JICA, 2003-2005) Other international organizations, aid organizations etc.: “Greater Mekong Subregion Northern Power Transmission Project” (Asian Development Bank, 2011-2015), “Lao Rural Electrification Phase II Project”, (The World Bank, 2010-2013)

2. Outline of the Evaluation Study

2.1 External Evaluator

Toru Shimada, ADAMIS Ltd.

Hiromitsu Takao, Aviation Systems Consultants Co., Ltd.

2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule.

Duration of the Study: September, 2017 - October, 2018

Duration of the Field Study: January 7 - January 31 and April 1 - April 10, 2018

3. Results of the Evaluation (Overall Rating: C²)

3.1 Relevance (Rating: ③³)

3.1.1 Consistency with the Development Plan of Lao PDR

The Seventh Five-year National Socio-Economic Development Plan (2011-2015) in place at

² A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

³ ③: High, ②: Fair, ①: Low

the time of planning the project stated, as approaches of the energy sector, “Expansion of lines to meet the twin objectives of supplying electricity domestically for country’s development, and export.”, “become battery of ASEAN”. The same plan also set a target of expansion of rural electrification.

The Eighth Five-year National Socio-economic Development Plan (2016-2020) in place at the time of the ex-post evaluation states, as activities for energy integration, “focus on the development and utilization of clean and environmentally friendly energy”, “expand electricity coverage to rural remote and hard-to-access areas, leading to at least 90% of the total number of families in the country having access to electricity by 2020”.

Since both *the Seventh National Socio-economic Development Plan* and *the Eighth National Socio-economic Development Plan* aimed at rural electrification as mentioned above, the project has been consistent with the national development plans.

3.1.2 Consistency with the Development Needs of Lao PDR

At the time of planning, there were only two small power plants in the project target area, i.e. Phongsaly Province. Import power was supplied in Gnod Ou district from China through a substation near the border with China, and distributed to the villages through 22 kV distribution lines along the provincial road. However, other villages away from the distribution lines were not electrified. Under such circumstances electrification ratio of Phongsaly Province was only 23% in the first half of year 2012, the lowest among all provinces in Lao PDR. The Government of Lao PDR set targets to improve the household electrification ratio of Phongsaly Province to 60% by 2015 and to 70-80% by 2020. Furthermore, expensive power was imported from China at 9.2 US¢/kWh, so that reduction of import power cost and volume was one of issues of the energy sector.

At the time of ex-post evaluation, electrification ratio of Phongsaly Province was 59.04% (in November 2017), and that of Lao PDR was 93.82%, still the lowest among all provinces in Lao PDR.

Table 1 shows volume of power import from China (MWh) and average price (US¢/kWh). Volume of import power from China increased as demand increased in Phongsaly Province. The average price of the import power is on a downward trend with increase of import volume, but it is approximately twice as high as the lowest unit price of household electricity (up to 25 kWh, LAK 355 per kWh).

Table 1: Volume and Average Price of Power Imported from China

Year	2014	2015	2016	2017
Import volume (MWh)	8,261	10,119	11,385	11,129
Average price (US¢/kWh)	9.41	9.25	8.73	8.59

Source: Documents provided by Electricite du Laos (hereinafter referred to as “EdL”)

Therefore, the project has been consistent with the development needs of the target area, in terms of increasing electrification ratio of Phongsaly Province.

3.1.3 Consistency with Japan's ODA Policy

Japan's Country Assistance Policy for Lao PDR (April 2012) in place at the time of planning the project stated to extend Japan's assistance to "rectifying disparities in access to electric power within Lao PDR and enhancing power export through expanding electric power in safe and stable manner" in Development of Economic and Social Infrastructure that was one of the priority areas, and *Rolling Plan for Lao People's Democratic Republic* annexed to the Country Assistance Policy placed energy sector in "Power Development Program" and stated to provide assistance for improvement of the capacity of administering electricity enterprises, development of government-owned power generation facilities and main transmission networks, and development of facilities for rural electrification in order to expand stable, sustainable and efficient power supply. Also, the Government of Japan declared a policy to support realization of the green growth of developing countries by utilizing Japan's superior techniques in the field of renewable energy (micro hydropower, solar power and so on) in the JFY2012 budget. Therefore, the project was consistent with Japan's assistance policy for Lao PDR and policy to support realization of the green growth at the time of planning the project.

As described above, the country's socio-economic development plans at the times of planning the project and ex-post evaluation aim at increase of electrification ratio, development needs is high in Phongsaly Province because of the lowest electrification ratio in the country, and Japan's ODA policy aimed at rectifying disparities in access to electric power within Lao PDR. Therefore, this project has been highly relevant to the country's development plan and development needs, as well as Japan's ODA policy. Therefore its relevance is high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

This project is to construct a mini-hydropower plant and distribution networks in Gnod Ou District, Phongsaly Province, and planned and actual outputs of the project are summarized in Tables 2 and 3. Major changes were exclusion of the distribution networks in the Northeast area and an increase of the effective head in order to resolve shortage of power output.

Table 2: Comparison of Project Outputs

Item	Planned	Actual
Generation Type	Run-Off-River Type	Run-Off-River Type
Maximum Discharge	7.02 m ³ /s	7.02 m ³ /s
Effective Head	8.8 m	8.92 m

Installed Capacity	450 kW	450 kW
Diversion Weir	H4.5 m, L41.1 m	H4.5 m, L37.6 m
Intake	W4.2 m, H3.3 m, L16.8 m	W5.2 m, H3.0 m, L18.0 m
Setting Basin	W10.7 m, H3.5 m, L31.2 m	W13.2 m, H3.5 m, L31.8 m
Headrace	W2.0 m, H2.5 m, L680.5 m	W2.0 m, H2.5 m, L695.0 m
Head Tank	W5.0 m, H6.2 m, L32.7 m	W10.4 m, H7.0 m, L33.5 m
Penstock	D1.2 m, L5.2 m, 3 units	D1.2 m, L5.1 m, 3 units
Powerhouse	W8.9 m, L14.0 m, H6.7 m	W8.9 m, L14.0 m, H8.4 m
Water Turbine and Generator	Submersible Pump Turbine: 3 units 173.5 kW, 600 rpm	Submersible Pump Turbine: 3 units 173.5 kW, 600 rpm
Generator	Vertical Shaft Three Phase Synchronous Generator: 3 units 166.7 kVA, 600 rpm	Vertical Shaft Three Phase Synchronous Generator: 3 units 166.7 kVA, 600 rpm
Controller	Start & stop Operation of the Plant; Protection Stop Control; Voltage, Current, Output Observation; Automatic Synchronizer; Protection Relay; Isolated Operation Detecting Device	Start & stop Operation of the Plant; Protection Stop Control; Voltage, Current, Output Observation; Automatic Synchronizer; Protection Relay; Isolated Operation Detecting Device
Main Transformer	Oil Self Cooling Three Phase Transformer; Rated Capacity: 500 kVA; Voltage: 22 kV/440 V	Oil Self Cooling Three Phase Transformer; Rated Capacity: 500 kVA; Voltage: 22 kV/440 V
Switch Gear	Three Phase Switchgear with Fuse; Transformer for Instrument; Current Transformer for Instrument; Arrester	Three Phase Switchgear with Fuse; Transformer for Instrument; Current Transformer for Instrument; Arrester
22kV Distribution Lines	Three Phase Bare ACSR; 12 m Reinforced Concrete Pole; Northeast Area: 76.3 km, West Area: 47.5 km	Three Phase Bare ACSR; 12 m Reinforced Concrete Pole; West Area: 51.9 km
400V Distribution Lines	Three Phase 4 lines Insulated ACSR; 8 m Reinforced Concrete Pole; Northeast Area: 10.0 km West Area: 6.1 km	Three Phase 4 lines Insulated ACSR; 8 m Reinforced Concrete Pole; West Area: 6.0 km
Transformers (22 kV/400 V)	Northeast Area: 13 units West Area: 10 units	West Area: 10 units

Table 3: Comparison of Project Outputs (Soft Component)

Planned	Actual
Establishment of Provincial-Rural Electrification Fund in Phongsaly Province (hereinafter referred to as “P-REF”). (P-REF management manual is prepared. P-REF is established. P-REF officers properly have capability for financial management.)	<ul style="list-style-type: none"> • Final draft of P-REF management manual was proposed. • P-REF was established about 17 months after the end of the soft component (August 1, 2016). • PDEM could understand incompletely the details of P-REF balance of payment.
Selection/Procurement of Special Purpose Organization (hereinafter referred to as “SPO”) for Operation and Maintenance	<ul style="list-style-type: none"> • A draft of criteria for SPO selection were prepared. • Licensing of the SPO was given about two months

(hereinafter referred to as “O&M”). (Criteria for SPO selection are prepared. License is issued to a selected SPO.	after the end of the soft component (May 22, 2015).
Establishment of O&M Monitoring System. (Provincial Department of Energy and Mines of Phongsaly Province (hereinafter referred to as “PDEM”) staff acquires sufficient knowledge and skills of designing and plant structures for monitoring/supervising “O&M” activities. O&M manual is prepared. PDEM staff is capable in monitoring/supervising activities for the plant.)	<ul style="list-style-type: none"> • Basic training for mini-hydro power plant and On the Job Training (hereinafter referred to as “OJT”) were conducted. • O&M manual (for civil structure) was produced in English Language. No O&M manuals for the plant and Lao Language version were not produced.

It was agreed, as a design change during the detailed design, to exclude the distribution networks in the Northeast area from the project scope so as to deal with increase of the project cost due to the depreciation of Japanese Yen (from JPY 80.41 per US\$ to JPY 99.80 per US\$ at the times of outline design and detailed design respectively) and to construct them by the Laotian side.

Background and reason of the increase of the effective head in order to resolve shortage of power output are described below.

The designed output of the mini-hydropower plant is 450kW (150kW x 3 units). During the commissioning tests in February 2015, 152kW of one unit operation was confirmed. However, it was not possible to confirm output of simultaneous 3 units operation due to shortage of water volume. After that, as a result of more than one year operations, it was confirmed that the maximum output at simultaneous 3 units operations was only 400-407kW even in water rich period during the rainy season, and countermeasures to increase the output was required. As a countermeasure, removal of the submersible weir and increasing crest elevation of the spillway of the head tank were proposed by using calculation and observation. The countermeasure was executed in April 2016, followed by output confirmation tests. It was not possible to confirm the output for simultaneous 3 units operations, because it was the dry season, but the output of one unit was 165kW, which was 13kW more than the output before the countermeasure. This result is almost same as expected in the calculation, and it was considered that 450kW would be almost achieved by simultaneous 3 units operation.

There is little difference between the planned and actual outputs of the mini-hydropower plant, but achievement rate for 22kV distribution lines, 400V distribution lines and transformers were 41.9%, 56.6% and 43.5%, respectively due to the exclusion of the distribution network in the Northeast area.

With regard to the soft component, final draft of P-REF management manual was proposed for establishment of P-REF, but P-REF had not been established; a draft of criteria for SPO selection were prepared and advices were made for selection/procurement of SPO, but selection/

procurement has not been completed; and basic training for mini-hydro power plant and OJT were conducted, and O&M manual for civil structure in English was produced for establishment of O&M monitoring system, but O&M manuals for the plant and Lao Language version had not been produced; by the end of the soft component.⁴

3.2.2 Project Inputs

3.2.2.1 Project Cost

Table 4 summarizes planned and actual cost of the project. The cost borne by Japanese side was within the planned amount, but it was exceeded essentially considering the reduction of the output. By the way, the project cost excluding the distribution networks in the Northeast area was estimated to be JPY 1,560 million at the time of planning, and the actual cost exceeded it by 13%. The cost borne by Laotian side was estimated to be JPY 3 million at the time of planning, and the actual cost was not available from Institute of Renewable Energy Promotion, Ministry of Energy and Mines (hereinafter referred to as “IREP”). Therefore, the total project cost was not available, and comparison was made on the cost borne by Japanese side.

Table 4: Comparison of the Project Cost

Item	Planned	Actual
Cost borne by Japanese Government	JPY 1,775 million	JPY 1,772 million
Cost borne by Laotian Government	JPY 3 million	(Not available)
Total	JPY 1,778 million	(Not available)

Source: Documents provided by JICA

3.2.2.2 Project Period

The planned project period was 23 months (April 2013 - February 2015). The actual project period was 23 months, from April 2013 to February 2015, as planned (100%)⁵.

Although the project period was within the plan, the project cost essentially exceeded the plan. Therefore, efficiency of the project is fair.

3.3 Effectiveness and Impacts⁶ (Rating: ②)

3.3.1 Effectiveness

⁴ According to the consultant, “With regard to that the Lao version was not produced, there were no concepts equivalent to the technical terms on the manual in the Lao language. Therefore, there would be risks of erroneous operation, which might cause serious safety issue, due to mistranslation.” and “With regard to the manual for plant, there was a judgment that substitution by training etc. using the manufacturer's manual was appropriate from a safety standpoint.”

⁵ The distribution network in the Northeast area was agreed to be constructed by Laotian side. However, it was completed, by the time of the field study, only 3 out of 13 villages due to delay of development of access road to the villages.

⁶ Sub-rating for Effectiveness is to be put with consideration of Impacts.

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

Table 5 summarizes achievements of quantitative effects (operation and effect indicators). The actual value for 2017 is 2.8 years after the project completion, and can be regarded as equivalent to the target value (3 years after completion).

Table 5: Achievement of Quantitative Effects

	Baseline	Target	Actual		
	2012	2018	2015	2016	2017
		3 Years After Completion	Completion Year	1 Year After Completion	2 Years After Completion
Maximum output of Mini-hydropower Plant (kW)	0	450	407	NA	About 430
Plant factor* ¹ (%)	0	79.6	NA	NA	43.4
Generation of Mini-hydropower Plant and reduction of power import (MWh/year)	0	3,141	1,631	2,089	1,714
Household Electrification ratio in Gnod Ou district (%)	32	60	51.27	58.26	58.86

Source: Installed capacity provided by SPO, other data provided by EdL

Notes: *¹ Plant factor = (Generation of mini-hydropower plant per year)/(Installed capacity x 24 x 365)

The achievement rate for plant factor and generation of mini-hydropower plant per year was only 54.6%. According to the executing agency, main reasons for less achievement are as follows. The effective head is reduced due to raising downstream water level in rainy season because of sedimentation of soil in downstream of the power station. Frequent stop of power generation due to faulty alarm of the main transformer could not be repaired until October 2017. Operations of the generator(s) should be stopped due to troubles of the EdL's power distribution network.

Figure 1 shows monthly generation of the mini-hydropower plant. It indicates that generation in October to December was greater than that in the rainy season when water is rich (from May to October) in any year. This confirms that the effective head was reduced in rainy season. Generation in June to September 2017 is lower than the same period of other years. It is considered to be because of faulty alarm of the main transformer. According to the contractor's *Monthly Progress Report*, the monthly average water level at the powerhouse in 2014 was high in July at 739.71m and low in December at 738.47m, and they are 1.81-0.57 m higher than 737.90 m of outlet level described in *The Preparatory Survey for Mini-Hydropower Development Project in Lao PDR Final Report*. It is assumed that a landslide of the downstream right bank, after the detailed design and before commencement of works, caused

raise of water level. Therefore, it is considered to be necessary to decrease the water level of downstream in rainy season in order to achieve target values of the plant factor and generation of the plant.

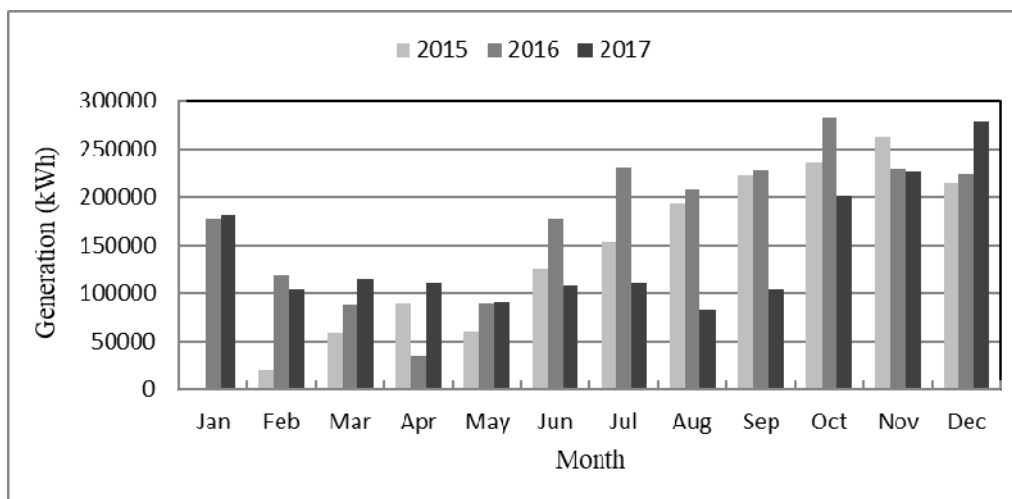


Figure 1: Monthly Generation of Mini-hydropower Plant

The power generated by the plant has been effectively used in Gnod Ou District, and saved approximately US\$ 2.89 million on import cost from China for about 3 years.

Achievement of household electrification ratio in Gnod Ou District is 98.1% of the target, although only 3 out of 13 villages in the Northeast area have been electrified by the Laotian side. It is considered to be because the target was set as same as that for Phongsaly Province in 2015 and electrification has been progressed in other areas in Gnod Ou District.

As a reference indicator, number of electrified households in the West area, the target area of Japanese assistance, at the end of 2017 was 627, and exceeded the expected number of households in the preparatory survey (581) by 8%. Number of electrified households in the Northeast area, which was excluded from the Japanese assistance, was 185, and remained at only 29% of the expected number of households in the planning stage (641).

3.3.1.2 Qualitative Effects (Other Effects)

(1) Strengthening of Stable Power Supply

At the time of planning, it was understood that installation of a power plant at the ending point of system grid would contribute to transmission and distribution loss reductions as well as strengthen stable power supply to the adjacent areas, because Gnod Ou District would continue to be located at an end of Lao national power grid.

Interviews of 13 persons⁷ including staff of PDEM, District Department of Energy and Mines

⁷ PDEM: 1 (male), DDEM: 4 (3 (male), 1 (female)), EdL (Phongsaly): 2 (male), EdL (Gnod Ou): 2 (male), residents:

(hereinafter referred to as “DDEM”), provincial and district offices of EdL, and residents of Ou Tai, where electricity had been supplied even before the project, were conducted during the field study. As results of the interviews, 12 out of 13 persons answered positive opinions, such as easier to live due to reduction of power outages, keeping food safely and effective utilization of night time, and all of staff of PDEM, DDEM and EdL answered that voltage stability has been enhanced.

Therefore, it is considered that number of power outages was reduced and voltage stability was enhanced in the adjacent areas by the project.

(2) Promotion of Renewable Energy Development

At the time of planning, it was considered that the project would contribute to promotion of renewable energy development in Phongsaly Province, because the minihydropower plant was one of renewable energy utilizing domestic resources. In addition, it was expected that renewable energy development would be accelerated by utilizing fund of P-REF.

In addition to the project, Nam Ou 5 and Nam Ou 6 hydropower plants (total 420 MW) are in operation in Phongsaly Province, but power generated by these plants has been sent to a substation in OudomXay Province and has almost no effect on power supplied in Gnod Ou District. Nam Ngay hydropower plant (1.2 MW) and Mai hybrid plant (0.15 MW) operated at the time of planning the project have been stopped operations.

Therefore the project itself has promoted renewable energy development in Phongsaly Province. Apart from the project, there is no prominent promotion of renewable energy development in Phongsaly Province.

P-REF fund has been mainly used for operating cost (such as travel and meeting) of P-REF, and cost for construction of a small roof structure for operator’s quarters, but not used for promotion of renewable energy development. It is considered to be premature to expect promotion of renewable energy development in Phongsaly Province by utilizing P-REF.

3.3.2 Impacts

3.3.2.1 Intended Impacts

(1) Reduction of Emission of Greenhouse Gas in China

At the time of planning, it was predicted that 3,141 MWh/year of power import would be reduced after completion of the project⁸, since the project was planned to provide electricity to the areas where electricity from China was supplied through 35 kV/22 kV distribution lines. Therefore, it was expected that emission of greenhouse gas would be reduced by 3,367 tCO₂ per year in China.

4(2 (male), 2 (female)) (With regard to interviewees, each organization selected appropriate staff after recognizing main purpose of the survey. Residents were selected in the area out of the project considering gender balance.

⁸ Source: Documents provided by JICA

An average reduction of emission of greenhouse gas by the project per year can be re-calculated at the time of the ex-post evaluation by using the same equation used in the planning stage as follows:

$$0.9873 \text{ tCO}_2/\text{MWh} \times 1,916.5 \text{ MWh} \times 1.1 \text{ (distribution loss rate)} = 2,081 \text{ tCO}_2$$

(1,916.5 MWh is average generation of the mini-hydropower plant (reduction of power import from China) for three years.)

This is 62% of the amount expected in the planning stage due to the less generation per year than the plan.

(2) Improvement of Rural Economy

At the time of planning, it was expected that the promotion of rural electrification and stable power supplies by the project would activate local industries and change lifestyle of residents that would lead to better living.

With regards to change of local economy, livelihoods, social services and living conditions of residents, interviews of 26 persons⁹ including a staff of Department of Planning and Investment of Phongsaly Province, a staff of Office of Planning and Investment of Gnod Ou District, and residents, including shop owners, of the villages, where distribution networks were constructed, were conducted during the field study. As results of interviews, all persons answered that there were positive changes in local economy and livelihoods, such as reduction of using fire, comfort of living and increase in income. In social services and living conditions of residents, all persons also answered that there were positive changes, such as utilization of television and refrigerator, reduction of cooking time and labor and possibility of night work and/or study.

Since everybody gave positive answers on change of livelihood and living conditions, it is considered that livelihood of the residents were improved by the project as planned. In addition, some residents have a buying motivation for a rice mill machine and/or a weaving machine. The project contributes to activation of local industries.

3.3.2.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

According to the environmental management plan in *Gnod Ou Mini-Hydro Power Project Initial Environment Examination 28 December, 2012 Chareun and Associates Co.Ltd* (hereinafter referred to as “IEE”), it was planned to minimize impacts on natural conditions by watering for mitigating air pollution, construction of a temporary sedimentation pond for

⁹ Department of Planning and Investment of Phongsaly Province: 1 (male), Office of Planning and Investment Gnod Ou District: 2 (male), shop owners: 2 (female), residents: 21 (12 (male), 9 (female)) (With regard to interviewees, each organization selected appropriate staff after recognizing main purpose of the survey. Shop owners and residents were significantly selected from rural communities closest to Ou Tai, where distribution networks were laid, considering gender balance.)

mitigating water pollution, etc.

It was not possible to confirm whether various mitigation measures described in the IEE were actually implemented and/or whether the natural environment was kept within environmental standards. According to DDEM, there were no adverse impacts on environmental and no complaints from the residents. According to the contractor's monthly progress report of December 2014 (earthworks were almost finished by that time), water quality of that month conformed to environmental standards as shown in Table 6.

Table 6 Results of Water Testing in December 2014

Item	Location	Dec. 15	Dec. 31	Standard	Judgement
Power of Hydrogen	Upstream	7.5	7.5	6.6-9.5 (EU)	○
	Downstream	7.5	7.5		○
Dissolved Oxygen (mg/l)	Upstream	6.0	7.0	>5 (Japan)	○
	Downstream	6.0	7.0		○

Source: Monthly Progress Report No.14 (December 2014)

Therefore, although it was not possible to obtain an evidence, such as environmental monitoring reports, it is thought to minimize the environmental pollution by construction of the plant, according to response from DDEM and the result of water testing at the time of near completion of earthworks by contractor.

(2) Resettlement and Land Acquisition

There was a need of compensation of crops on the Government land (0.8 ha), and it was planned to compensate in accordance to *JICA Guidelines for Environmental and Social Considerations* and Laws of Lao.

According to the IEE, stake holders meetings were held in September and December 2012. Acquisition of land was not necessary, however the IEE estimated amount of compensation for loss of livelihood (loss of crop production/income for three years) of the rice fields of 2.66 ha (13 families) that would be subject to occasional flooding, and a corn garden of 0.8 ha that would be affected by construction of penstock in accordance with *Technical Guidance on Compensation and Resettlement of People Affected by Development Projects (Decree 192/MONRE)*. According to hearing from IREP, compensation was made by provision of alternative land instead of monetary form. According to hearing from DDEM, the compensation was adequate and there was no complaint from people affected by the project.

It was not able to confirm details of the compensation of crops, etc., but it is thought to be properly implemented.

There are some positive qualitative effects, such as reduction of number of power outages, improvement of voltage stability and promotion of introducing renewable energy in area around

the project, but for the achievement rates of quantitative effects, installed capacity and plant factor in 2017 was 54.6%. Therefore, effectiveness of the project is fair. Improvement of livelihood of residents and activation of local industries were found in qualitative effects, but reduction of greenhouse gas was 62% of the amount expected in the planning stage. Therefore, impacts of the project is fair. There were no notable unintended positive/negative impacts.

In light of the above, this project has achieved its objectives to some extent. Therefore effectiveness and impacts of the project are fair.

3.4 Sustainability (Rating: ②)

3.4.1 Institutional / Organizational Aspect of Operation and Maintenance

It was considered in the planning stage that the mini-hydropower plant would be owned by PDEM and operated and maintained (plant operation, inspection and maintenance, replacement of spare parts and business management) by SPO. However, the contract between PDEM and SPO requires SPO to conduct operation, maintenance and management of the dam and monitoring, record and report of generation, but does not require to conduct periodic inspection and replacement of spare parts. It specifies that SPO shall solve any problems of the plant jointly with PDEM, however SPO has not conducted periodic inspection and replacement of parts. There were changes in organization that is introduction of inspection by DDEM and no involvement of IREP in P-REF management.

In regard to manpower, staff in Rural Electrification Division of IREP increased from 4 persons at the time of planning to 5 persons, and staff in Energy Division of PDEM increased from 10 persons to 12 persons. Staff in Energy Division of DDEM and in SPO were 3 and 3 persons (including 2 engineers) respectively.

DDEM has been inspecting the plant twice a month and reporting to PDEM monthly. SPO is required to submit monthly reports to PDEM and IREP, but the report was not submitted sometimes. It is undesirable in management of P-REF that monitoring and audit of P-REF account by Provincial Department of Finance (hereinafter referred to as “PDOF”) have not been made and that PDEM does not fully understand details of the balance of P-REF.

Ownership of the distribution networks were transferred to EdL, and EdL operates and maintains them together with other distribution networks as planned.

Therefore, in regard to institutional aspect of operation and maintenance of the mini-hydropower plant developed by the project, it has concerns for fund management.

3.4.2 Technical Aspect of Operation and Maintenance

It was considered in the planning stage that an organization that had sufficient technical and financial capability would be selected as SPO and that PDEM, which would monitor SPO, needed strengthen its capacity through a soft component of the project although it had

foundation for monitoring SPO through experiences of management of operation and maintenance of existing Nam Ngay hydropower plant and Mai hybrid plant in the province.

At the time of the field study, all of the trainees who received trainings in the soft component, worked for PDEM and DDEM. Operators of SPO are university graduates and received trainings in the soft components. However, the company selected as SPO had no experience of O&M of a power plant, but had only experience of O&M of power distribution networks (including transformers). Their technical capability of operation, maintenance and management of the power plant is limited. The SPO have been relied on an external volunteer when a technical trouble occurred, and it took quite a while to take countermeasures including coordination with PDEM.

The O&M manual prepared by the supplier were kept in PDEM, and there was no O&M manual in the plant. DDEM has been conducting inspection of the mini-hydropower plant and dam twice a month. However, there is no checklist and/or handbook for inspection. In the planning stage, it was understood “Aside from an operation manual, which will be prepared by a supplier of the equipment, more simplified but useful O&M manual is needed for plant operators to carry out daily patrol, periodical inspection, O&M recordings, O&M activities before/during/after floods, troubleshooting in abnormal situations, and communication with the substation near the border, etc.”, and “Japanese Consultant will prepare a draft of O&M manuals in Lao language using figures, photos and illustration in order for operators to easily understand.” in the soft component. However, O&M manual for the plant, which can be understood easily by the operators, was not prepared, and only O&M Manual for Civil Structures in English was prepared. In addition, PDEM staff did not recognize existence of that manual, when the evaluation team asked PDEM in the field study, although the consultant proposed Laotian side to translate the O&M manual for civil structure into Lao language and its formal utilization, at the completion of the soft component. The absence or non-utilization of such manuals should be resolved as soon as possible in order to implement appropriate operation and maintenance continuously.

It is considered, despite conduct of the soft component, that technical capabilities of SPO and PDEM are inadequate from the facts that SPO does not have an expert who can respond to troubles, and that frequent faulty alarm of the main transformer had been left for a long time.

Therefore, there is a technical concern in operation and maintenance of the plant.

With regard to operation and maintenance of the distribution networks, it was understood in the planning stage that technical level of EdL was sufficient to manage the distribution networks because it provided power supply in the country including rural areas, and EdL branch in Phongsaly operated power transmission and distribution business including operation, maintenance and management of the existing substation (35/22kV) for power import from China, 22kv and 400V distribution lines, metering, collection of electricity fees, etc.

EdL branch in Phongsaly answered to a questionnaire “The distribution networks were constructed by the Japanese side with the same specifications as other distribution networks. Therefore, there is no particular problem in operation and maintenance of the distribution networks.” However, the road along the 22 kV distribution lines is a rough dirt road, so that it is considered that inspect work is not easy.

Taken together, there are technical concerns in operation, maintenance and management of the facilities and equipment constructed by the project.

3.4.3 Financial Aspect of Operation and Maintenance

For the mini-hydropower plant, it was planned in the planning stage to establish P-REF for management of the fund for the future overall and replacement of the plant.

Financial conditions of P-REF was reviewed in this ex-post evaluation. As a result, Table 7 shows balance of P-REF. P-REF has been receiving a half of income from sales of power to EdL in US Dollar and another half in Lao Kip. SPO deducts SPO's expenses (operation and management cost), receives 40% of the net profit as O&M charge, and transfers 60% of the net profit to P-REF account.

Table 7: Balance of P-REF

(Unit: LAK)

	2015	2016	2017
Power Sale Income	634,290,613	547,198,332	461,546,799
Cost of SPO	154,175,000	152,510,000	139,200,000
O&M Charge	191,807,020	156,988,841	128,939,533
Income to P-REF	288,308,593	239,200,124	193,407,266
P-REF Expenditure	0	22,122,090	146,142,139
Balance of P-REF	288,308,593	217,078,034	47,265,127

(Unit: US\$)

	2015	2016	2017
Power Sale Income	51,911	67,893	55,711
Cost of SPO	0	0	0
O&M Charge	20,764	27,157	22,284
Income to P-REF	31,146	40,736	33,427
P-REF Expenditure	0	0	0
Balance of P-REF	31,146	40,736	33,427

Source: Data provided by PDEM

Total income from the sales of power to EdL at the end of 2017 was approximately US\$ 350 thousand, and 60% of the net profit after deducting SPO's operation and management cost of about US\$ 60 thousand was transferred to P-REF. The fund remained in P-REF as at the end of 2017 was approximately US\$ 174 thousand. This is nearly equal to only 1.2 years of the amount estimated in the preparatory survey. This is because the total generation was only 61% of the planned volume and the total amount paid to SPO (cost of SPO + O&M charge) was approximately 30% more than the estimated amount of LAK 379 million per year in the

preparatory survey.

As described in section 3.3.1.1, the power sale income will stay less than the planned amount, if the problem of decrease of effective head in the rainy season is not solved. In addition, increase of P-REF expenditures is envisaged for procurement of new spare parts, increase of troubles by aging and periodic overhaul. Therefore, P-REF should be managed carefully.

It was recognized in the planning stage that “Most of income of EdL is from sale of power in the country, and most of expenditure is for import of power and buying power from independent power producer. Income and expenditure steadily are increased as the power demand increase. During 2008 to 2011 EdL run a loss only in 2011, main reason for the loss was the fact that power generation sector was spun off into a separate company in December 2010 and that fund was flown out for power purchase.”

Table 8 summarizes profit and loss of EdL (consolidated balance including power generation company).

Table 8: Profit and Loss of EdL (Unit: Million LAK)

	2014	2015	2016
Operating Income	3,276,662	3,695,640	4,273,879
Operating Expenditure	2,963,655	4,018,523	4,664,194
Operation Profit	313,007	-322,883	-390,315
Non-operating profit	10,788	350,747	-339,287
Net profit	323,795	27,864	-729,598

Source: Data provided by EdL

Profit had a surplus in 2014, but a deficit in 2015 and 2016. Net profit had a surplus due to make up for a loss by non-operation profit in 2015, but a deficit in 2016. Main reason for deficits were negative spread between a price of power purchase from independent power producer and sales price to customers, and import of electricity from foreign country in dry-season.

Taken together, there is financial concern in operation and maintenance of the facilities and equipment developed in the project.

3.4.4 Status of Operation and Maintenance

The following problems were observed at the time of the field study.

- Frequent shutdown due to the faulty alarm of the main transformer in simultaneous 3 units operations had been left for a long time, but according to the SPO's operators it was remedied by replacing a thermometer with its spare in September 2017.
- Data logger was broken in June 2016, and has been unusable. A quotation from the supplier was expensive as JPY 910,000 for only investigation of the cause. Therefore, the data logger has not been repaired, and operators have been recording operating status in handwriting. Possibility of purchasing similar product from third country was being

considered at the time of field study.

- Concrete blocks for river bed protection were washed out by the flood, and rearranged at the end of the defect liability period. However, the concrete blocks were washed out as shown in Figure 2 again after two months (in September 2016), and have not been repaired yet. Repair by using P-REF has been considered at the time of field study.
- With regard to the distribution networks, one pole of 22 kV distribution line constructed by Japanese side is inclined as shown in Figure 3. It may not be in a critical situation, but it is necessary to pay attention to the expansion of inclination during periodic inspections.

These situations of operation and maintenance are undesirable. Although it is noteworthy that countermeasures by using P-REF were being considered, there is a concern when and how it will be done. It is necessary for ensuring execution of the countermeasures to undertake technical improvement as soon as possible.

Taken together, there are problems in operation and maintenance of the facilities and equipment developed in the project.

The field study made clear the following facts; audit of P-REF account by PDOF have not been made; there were no expert who can respond to troubles in SPO; there was no O&M manual at the plant; and there was no checklist for periodic inspections by DDEM; it will be not possible to earn power sale income as planned, if the decrease of effective head in the rainy season is not solved; and the broken data logger and washed out concrete blocks for river bed protection have been left for a few years.

In light of the above, some minor problems have been observed in terms of the institutional aspect, technical aspect, financial aspect and current status. Therefore sustainability of the project effects is fair.



Figure 2: Washed out Concrete Blocks



Figure 3: Slanting Pole

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The project aimed at promoting utilization of renewable energy, contributing to reduction of greenhouse gas emission, and promoting electrification in rural areas by constructing a mini-hydropower plant and distribution networks in Gnod Ou District, Phongsaly Province, thereby contributing to the socio-economic development of the country. The project has been highly relevant to the country's development plan and development needs, as well as Japan's ODA policy. Therefore, its relevance is high. With regards to efficiency of the project, the project cost exceeded the plan although the project period was within the plan. Therefore, efficiency of the project is fair. Qualitative effects of the project are observed, but achievement of operational indicators, such as plant factor and generation of mini-hydropower plant are below the targets. Therefore, effectiveness and impacts of the project are fair. With regards to operation and maintenance of facilities, some minor problems have been observed in terms of the institutional aspect, technical aspect, financial aspect and current status. Therefore, sustainability of the project effects is fair.

In light of the above, this project is evaluated to be partially satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

(1) Recommendations to PDEM

PDEM should implement, without delay, repair or replacement of the data logger and restoration/improvement of the concrete blocks for river bed protection. In addition, PDEM should develop, as soon as possible, an O&M manual in Lao language for operators of mini-hydropower plant and inspection manual/checklist for DDEM staff by referring to the O&M manual for the plant prepared by the manufacture. PDEM should make SPO hire a part-time expert, prepare periodic inspection and maintenance plans urgently, and conduct periodic inspection and maintenance according to the plans.

It is preferable to confirm the rise in water level of the downstream during the rainy season, to consider possibility of lowering the water level, to confirm financial validity of countermeasures, and to take appropriate measures.

(2) Recommendations to PDOF

P-REF is important for securing funds for operation and maintenance in the future including procuring spare parts and rehabilitation of the plant after 25 years. P-REF should be managed more carefully under the present circumstances, in which income is lower than the plan. Therefore, PDOF should audit cash flow of P-REF in the past, and then conduct regular audits thereafter.

(3) Recommendations to EdL

The slanting pole in Figure 3 was found out along the way to interview of villagers, and all poles constructed by the project were not checked. Because such a condition was observed in less than three years after the end of the defect liability period of the distribution networks in June 2015, other poles should be checked. It is not desirable to increase tension of the cable due to the slanting pole. Therefore, EdL should regularly inspect the poles, follow-up slanting conditions, and take appropriate measures if inclination increases.

4.2.2 Recommendations to JICA

JICA Laos Office should monitor implementation of the above-mentioned recommendations by the executing agency, and provide advices as necessary.

4.3 Lessons Learned

Establishment of Appropriate Executing Organization

The preparatory survey of the project found that while the Ministry of Energy and Mines had a lot of experiences of power development projects, organization of IREP was insufficient. However, IREP was responsible for the implementation of the project, and it was not possible to organize sufficient participation and cooperation of other departments such as Department of Energy Business, which had the experience of selection of and contract with SPO. The weakness of the executing organization is one of the factors that caused some problems for operation and maintenance. When planning and implementing a project, it is necessary to establish a system that can effectively utilize overall capacity of the executing agency as necessary, after checking the organization and technical capacity of the department(s) that actually handle the project.

IREP told in the field study that the project was positioned as the pilot project for establishing a fund to cover the operation and maintenance costs. However, such descriptions were not in the preparatory survey reports or documents from JICA. When establishing a project organization, it is necessary to discuss and have a common understanding between JICA and executing agency during the preparatory survey, and to record the results in the minutes of discussions.