Ex-Post Project Evaluation 2017: Package Ⅲ- 4

(Egypt, Sudan)

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JAPAN INTERNATIONAL COOPERATION AGENCY

Mitsubishi UFJ Research & Consulting Co., Ltd.

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Arab Republic of Egypt

FY2017 Ex-Post Evaluation of Japanese ODA Loan

“ Kuraymat Integrated Solar Combined Cycle Power Plant Project (I) (II)”

External Evaluator: Kenichi Inazawa, Octavia Japan Co., Ltd.

0. Summary

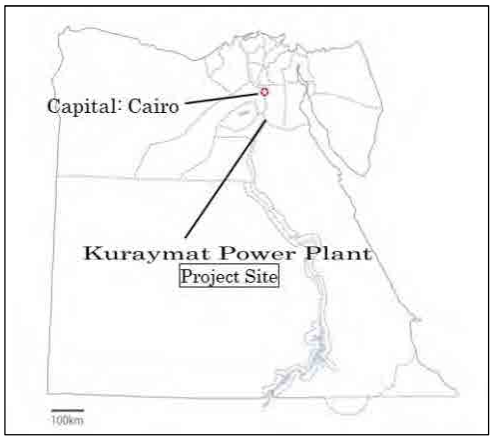
This project involved the construction of a solar thermal and gas integrated power plant in Kuraymat[1], located approximately 100km south of Cairo, in order to produce electricity to be supplied to Egypt’s existing power grid and to contribute to the economic development and environmental improvements of Egypt by mitigating environmental impacts through the introduction of the auxiliary energy of solar thermal power generation. The Government of Egypt indicated in the *National Five-Year Development Plan* (2002/2003-2006/2007) and the *Egypt Strategic Framework for Economic and Social Development plan Until year 2022* that it will promote renewable energy such as combined cycle power generation as well as solar thermal and wind power generation. Therefore, the project’s relevance is high given the development needs from growing electricity demand and consistency with Japan’s ODA policy. In terms of efficiency, project outputs were implemented almost as planned, but project costs significantly exceeded the initial plan due to the impacts of worldwide steel price rise and the rising cost of plant facilities, including gas turbines. The project period required more time than initially anticipated for selection procedures and negotiations for the contractor of the main construction component of the project. Therefore, the efficiency of the project is low. The project faced malfunctions/breakdowns of the gas turbine, etc., two years after the start of commercial operations and the shutdown period before and after this incident was prolonged. Additionally, partial malfunctions also occurred in the gas turbine and steam turbine even after the repair work completed in July 2016, resulting in several instances of shutdowns due to mechanical failures. Therefore, the quantitative effect indicators of this project did not achieve the target values. In terms of impacts realized from this project, the actual figures of the relevant indicators are considered to be limited. Thus, the effectiveness and impacts are determined to be fair. There are no major problems in the institutional, technical and financial aspects of Kuraymat Power Plant, which is responsible for the operation and maintenance of this project. No major problems in particular have occurred in the operation and maintenance of other

[1] Kuraymat is located approximately 100km south of Egypt’s capital of Cairo. Kuraymat was selected because of the following reasons: (1) the area is a desert with few residences and no obstacles in terms of facility construction (the project site is on government-owned land); (2) cooling water is required for use in the power plant and the Nile River is located in close proximity, making it easy to source water, (3) the transmission grid is located close by; and (4) a natural gas pipeline for supplying the gas combined cycle facility is located nearby.

facilities and equipment. Consequently, the sustainability of the project's effect is high.

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

2. Project Description



Project Location

Power Plants Developed by this Project

1.1 Background

Prior to the start of this project, Egypt faced the urgent task of developing planned power generation facilities in line with demand in order to achieve a stable supply of electricity. Egypt relies almost entirely on natural gas and heavy oil for the fuel needed for power generation, and oil field development for natural gas made progress. Meanwhile, the Government of Egypt has explored the use of new and renewable energy, such as wind and solar thermal power, with an emphasis on effects of load reduction in the future. As a result, the country moved ahead with promoting energy conservation and the use of new and renewable energy in order to secure electricity supply. In such circumstances, the development of integrated facilities that include high efficiency gas combined cycle power generation and solar thermal facilities for mitigating environmental impacts aimed to secure the electricity supply needed for economic growth and achieve environmental conservation. This matched the needs of the Government of Egypt.

1.2 Project Outline

The objective of this project is to construct an integrated solar combined cycle power plant in Kuraymat, about 100km south of Cairo City, to produce electricity to be supplied to domestic existing transmission grid, by using solar heat as an supplemental energy for power generation, and reduce the environmental burden, thereby contributing to economic development and environmental improvement of Egypt.

Loan Approved Amount/ Disbursed Amount	Phase I: 10,665 million yen / 10,664 million yen Phase II: 9,440 million yen / 9,421 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	Phase I: December, 2005 / January 2006 Phase II: December, 2008 / December 2008
Terms and Conditions	Phase I: Condition for procurement & installation of facilities: Interest Rate: 0.75% Repayment Period: 40 years (Grace Period: 10years) Conditions for Procurement: General Untied Consulting Service: Interest Rate: 0.75% Repayment Period: 40 years (Grace Period: 10 years) Conditions for Procurement: General Untied Phase II: Condition for procurement & installation of facilities: Interest Rate: 0.65% Repayment Period: 40 years (Grace Period: 10years) Conditions for Procurement: General Untied Consulting Service: Interest Rate: 0.01% Repayment Period: 40 years (Grace Period: 10 years) Conditions for Procurement: General Untied
Borrower /Executing Agency	New and Renewable Energy Authority (hereafter referred to as "NREA") / NREA (Guaranteed by The Government of Arab Republic of Egypt)
Project Completion	June, 2011
Main Contractors (Over 1 billion yen)	Mitsui & Co., Ltd. (Japan) / Iberdrola Ingeniería y Construcción (Spain) (JV), Arab Engineering and Distribution Company (Egypt)
Main Consultants (Over 100 million yen)	Fichtner Solar GMBH (Germany)
Related Studies (Feasibility Studies, etc.)	F/S (Own fund by Egyptian government (Ministry of Electricity and Energy), June 2000)
Related Projects	【Cooperation by other aid organizations】 ・Grant aid grant by Global Environment Facility[2] (hereafter referred to as "GEF") (support for parts of solar thermal power generation such as solar collectors) (May 2004)

[2] At the joint World Bank-IMF development committee meeting held in September 1989, France and Germany proposed a fund for preserving and improving the environment. The first meeting involving participating countries was held in May 1991 based on the resolution passed by the World Bank's Board of Governors. The GEF officially started thereafter in 1994. Meetings and ordinary meetings have been held regularly.

2. Outline of the Evaluation Study

2.1 External Evaluator

Kenichi Inazawa, Octavia Japan Co., Ltd.

2.2 Duration of Evaluation Study

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

Duration of the Study: November 2017 - December 2018

Duration of the Field Study: March 11-27, 2018 and July 20-28, 2018

3. Results of the Evaluation (Overall Rating: C[3]).

3.1 Relevance (Rating:③[4])

3.1.1 Consistency with the Development Plan of Egypt

At the time of appraisal, the Government of Egypt had established the *National Five-Year Development Plan* (2002/2003-2006/2007[5]), which cites the need to maximize the use of resources, transition thermal power plants to combined cycle versions from the standpoint of generation efficiency, and promotion of solar thermal and wind power projects to increase the use of new and renewable energy. In other words, this project, which develops a power plant with energy derived from gas combined cycle power generation and solar thermal power, was consistent with Egypt's development policy.

At the time of ex-post evaluation, the Government of Egypt (Egypt Economic Development Conference) established the *Five-Year Macroeconomic Framework/Strategy* (2014/2015-2018/2019). It cites the need to eliminate electricity shortages by increasing installed capacity, improving electricity services, including revising electricity tariff, and promoting the deregulation of the electricity market and encouraging new entry of private companies. In addition, in June 2012 the Government established the *Egypt Strategic Framework for Economic and Social Development plan Until year 2022,* which provides aspirations and strategy for national development following the Egyptian Revolution (2011). As part of the country's natural resource management strategy, the plan cites the diversification of energy resources and expansion of renewable energy use. Specifically, the plan considers the following approach as one of its electricity policy measures over the next several decades; shifting to electricity supply

[3] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[4] ③: High, ②: Fair, ①: Low
[5] Since the fiscal year of Egypt begins every year from July, it will be such description.

sources mainly from renewable energy such as solar thermal and wind power and combined cycle power generation that uses natural gas producible in Egypt as an alternative to oil for which it relies on imports.

Based on the above, throughout the time of the appraisal and the time of ex-post evaluation, the Government of Egypt is focusing on the promotion of combined cycle power generation that uses natural gas and renewable energy such as solar thermal power and wind power. Consequently, at the time of both the appraisal and ex-post evaluation, the consistency of this project is acknowledged through the national development plan and sector plan.

3.1.2 Consistency with the Development Needs of Egypt

Prior to the start of this project in 2002, the power supply-demand balance was very tight, resulting in frequent power outages during peak summer demand. Table 1 indicates electricity supply-demand conditions at the time. Securing power generation facilities was an urgent task in order to secure the stable power supply. With the Government of Egypt promoting the energy conservation and use of new and renewable energy while maintaining electricity supply, the development of integrated facilities that include high efficiency gas combined cycle power generation and solar thermal facilities for mitigating environmental impacts aimed to secure the electricity supply needed for economic growth and achieve environmental conservation. In other words, strong development needs were confirmed.

At the time of ex-post evaluation, the tight conditions involving installed capacity and electricity demand during peak times are improved, but as Table 2 indicates electricity demand is on an uptick. Taking into account this situation, the Government of Egypt is working to increase the installed capacity in areas across the country. In 2012, the Government established a new plan spanning 7 years, under which it is moving ahead with increasing installed capacity (total of 13,200MW)[6]. Under this plan, NREA is working on the development of power plants powered by renewable energy throughout the country. Up to the time of the ex-post evaluation, a wind power project[7] has been implemented in Zafarana along the Red Sea and a solar thermal power project led by private-sector investment with the goal of increasing[8] installed capacity was carried out in Aswan in the south. NREA has participated/cooperated in the form of project cooperation.

[6] As one example, at the time of ex-post evaluation, projects were being implemented for the introduction or reinforcement of combined cycle power generation facilities in Damanhur, El-Seiuf, Mahmoudia, and Benha.
[7] Installed capacity is 1,500 MW in total.
[8] Installed capacity is 200 MW in total.

Table 1: Electricity Supply-Demand Balance Before Start of This Project (1999/00 - 2002/03)

	1999/00	2000/01	2001/02	2002/03
Generation facility capacity (MW)	11,988	12,376	13,485	14,789
Power demand at peak time (MW)	11,736	12,376	13,326	14,401
Supply reserve ratio (%) **Note*	2.1	0	1.2	2.7

Source: JICA documents

Note: Reserve ratio ={(generation facility capacity - power demand at peak) / generation facility capacity} × 100

Table 2: Electricity Supply-Demand Balance in the Last Few Years (2011/12 - 2014/15)

	2011/12	2012/13	2013/14	2014/15
Generation facility capacity [9] (MW)	29,075	30,800	32,015	35,220
Power demand at peak time (MW)	25,705	27,000	26,140	28,015
Supply reserve ratio (%) **Note*	10.9	12.3	18.4	20.4

Source: Egyptian Electricity Holding Company (EEHC)

Note: Reserve ratio ={(generation facility capacity - power demand at peak) / generation facility capacity} × 100

Based on the above, at the time of ex-post evaluation securing electricity through increased generating capacity is an important task for Egypt, and power generation facilities are being developed throughout the country. Consequently, the consistency of this project with development needs is acknowledged both at the time of appraisal and at the time of ex-post evaluation.

3.1.3 Consistency with Japan's ODA Policy

The *Country Assistance Program for Egypt* established by Japan's Ministry of Foreign Affairs in June 2000 cited (1) development of economic and social infrastructure, and industrial promotion; (2) poverty reduction measures; (3) enhanced human resource development and education; (4) environmental conservation and improvement in living environment; and (5) promotion of trilateral cooperation (South-South cooperation). Additionally, the *Medium-Term Strategy for Overseas Economic Cooperation Operations* prepared by JICA in 2005 positioned "a foundation for sustained growth" as a key field and advocated for assistance in order to promote sustainable growth through economic and social infrastructure development, including electricity essential to private-sector activities. Moreover, the policy called for proactive support of the limitation or reduction of greenhouse gases through renewable energy and energy conservation to combat environmental issues as part of another key field cited as "support for global issues and

[9] At the time of ex-post evaluation, Egypt's power generation mix consists of 90% for thermal power generation, 8% for hydroelectric power generation, 2% for wind power and solar power generation. (Source: 2014/2015 annual report of The Ministry of Electricity and Renewable Energy of Egypt). Renewable energy accounts for about 700MW (35,220MW x 2%) of Egypt's total installed capacity in 2014/2015 per Table 2. As discussed in 3.2.1 Efficiency and Outputs, the maximum output of the gas turbine and steam turbine of this project (Kuraymat Power Plant) is 130MW (combined total). In other words, this represents about 0.37% of the 35,220MW (2014/2015) per Table 2.

peace building." Furthermore, the *Country Assistance Strategy for Egypt* prepared by JICA in 2005 considered socioeconomic infrastructure development and efforts to combat environmental issues as key fields, taking into account Egypt was facing issues related to sustainable economic growth and environmental conservation.

This project supports the development of Egypt's economic and social infrastructure and contributes to environmental conservation through development of economic infrastructure, and it is acknowledged as consistent with Japan's ODA policy.

This project has been highly relevant to the Egypt's development plan and development needs, as well as Japan's ODA policy. Therefore its relevance is high.

3.2 Efficiency (Rating: ①)

3.2.1 Project Outputs

This project involved the construction of a solar thermal and gas integrated power plant in Kuraymat, located approximately 100km south of Cairo. Table 3 presents the project's output plan and actual results. In addition, Figure 1 presents the correlation between combined cycle and solar thermal power generation systems.

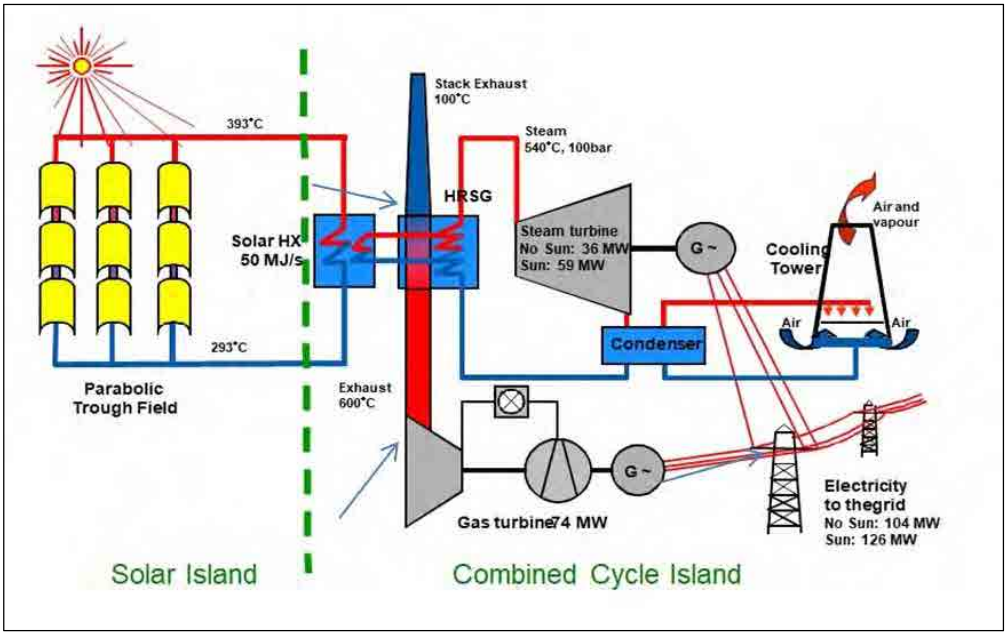
Table 3: Planned and Actual Outputs of this Project

Planned at the time of appraisal (Phase I: 2006, Phase II: 2008)	Actual at the time of ex-post evaluation (2018)
1) Civil works and procurement of equipment, etc.	
(1) Solar thermal and gas integrated power plant - Gas turbine (80MW x 1) - Steam turbine (70MW x 1) (of this, 40MW by gas turbine heat recovery and 30MW by solar thermal recovery) - Generator (Gas turbine: 80MW, Steam turbine: 70MW - Heat recovery steam generator（HRSG）(1 unit) - Main transformer - Control & instrumentation equipment	(1) Solar thermal and gas integrated power plant - Gas turbine (74MW x 1) - Steam turbine (56MW x 1) (of this, 36MW by gas turbine heat recovery and 20MW by solar thermal recovery) - Generator (Gas turbine: 74MW, Steam turbine: 56MW - Heat recovery steam generator（HRSG）(1 unit) - Main transformer - Control & instrumentation equipment

- 22kV/66kV outdoor switchgear - Cooling water equipment - Solar thermal power generation facilities (not covered by ODA loan; assistance by Global Environment Facility (GEF))	- 22kV/66kV outdoor switchgear - Cooling water equipment - Solar thermal power generation facilities (assistance by GEF; output of 20MW)
2) Consulting services	
(1) Construction supervision (2) Assistance for operation and maintenance	As planned.

Source: Documents provided by JICA, answers on questionnaire and on-site visits (actual results at the time of ex-post evaluation)

Regarding the project's outputs, it was implemented basically as planned as confirmed by the questionnaire, the visit and interviews with NREA during the field survey. While the output of gas/steam turbines and generators is lower somewhat than the initial plan, this is because it was revealed through a detailed design after the start of the project that gas turbine performance yields output less than the initial assumption because the daytime temperature around the Kuraymat power plant is high, causing generating efficiency to decline.



Source: Drafted based on NREA's documents

Figure 1: Combined Cycle of This Project and Solar Thermal Power Generation System

3.2.2 Project Inputs

3.2.2.1 Project Cost

Table 4 shows the planned and actual project costs. The total project cost was planned to be 21,383 million yen[10] (of this 10,665 million yen was covered by ODA loan), and the actual total project cost was 34,453 million yen (of this 20,085 million yen was covered by ODA loan), which exceeded the plan significantly (approximately 161% of the plan). The main reasons for this are as follows. Since the start of this project, the price of steel worldwide had increased, followed by the cost of plant facilities including gas turbines. Trends in the price of steel pipes, wire, and bar products according to the CRU Steel Price Index[11], which shows the rise of steel prices, indicate that prices rose approximately 40% from the time of the project's appraisal (February 2005) to conclusion of the contract with the construction contractor after completing bidding procedures (September 2007). In addition, Free on Board (FOB) for the gas turbine including the cost to transport freight to the vessel in port exporting the item from the factory increased to 1.75[12] in mid-2007 after the project started, compared to the price of the gas turbine in 2005 prior to the start of the project considered as 1. Moreover, the reason why the actual project cost for the construction of the integrated power plan (solar thermal) exceeded the plan is also attributed to the soaring cost of materials and labor. These can be viewed as unavoidable circumstances. In addition, the increased amount of consulting services was mainly due to the delay of project period.

Table 4: Original Plan and Actual Costs of This Project

	Original Plan (2006)			Actual Costs at Completion		
	Foreign Currency Million Yen	Local Currency LE	Total Million Yen	Foreign Currency Million Yen	Local Currency LE	Total Million Yen
1) Integrated power plant construction (Gas)	9,895	87	11,429	17,430	282	21,945
2) Integrated power plant construction (Solar heat)	3,952	80	5,369	7,369	187.329	10,368

[10] The initial plan (Project Phase I) called for the total cost of the project to be 21,383 million yen, but an additional ODA loan (Project Phase II) was provided thereafter in December 2008, making the total cost of the project 46,131 million yen (foreign currency: 28,335 million yen, domestic currency: 17,796 million yen; 20,105 million yen covered by ODA loan). The ex-post evaluation of this project compares with the planned amount in the initial plan (Project Phase I).

[11] This is a reference index created by CRU, a think tank headquartered in London, UK, that compiles overall trends into a single index, taking into account steel prices in Asia, Europe, North America and other countries.

[12] The sources for the above are documents provided by JICA and interviews with NREA.

3) Consulting services	465	6	567	1,329	8.314	1,462
4) Interest during construction	305	0	305	390	-	390
5) Administration cost	0	48	847	-	-	-
6) Land acquisition cost	-	-	-	-	-	-
7) Tax	0	162	2,864	-	18	288
Total	14,618	382	21,383	26,518	495.643	34,453

Source: JICA documents, NREA documents, Answers on questionnaire

Note: The abbreviation LE in the table stands for the Egyptian Pound. The foreign exchange rate at the time of appraisal was 1 USD to 6.22 LE and 1 LE to 17.7 yen. In contrast, the foreign exchange rate computed at the time of ex-post evaluation (average rate during the project period) is 1 USD to 5.92 LE and 1 LE to 16.01 yen.

3.2.2.2 Project Period

Table 5 shows the project's planned and actual period. At the time of appraisal, the project period was planned for the 4 year 3 month period (51 months) from April 2005 to June 2009. However, the actual project period was the 6 year 3 month period (75 months) from April 2005 to June 2011, exceeding the plan (approximately 147% of the plan)[13]. The main reason for this is because more time than anticipated was required for the selection procedures for the contractor of the construction works as well as negotiations and confirmation. The background to this is the impact of rising steel prices and plant facility costs including the gas turbine noted in 3.2.2.1 Project Cost.

Table 5: Original Plan and Actual Periods of This Project

	Original Plan (At the time of appraisal: 2006)	Actual
Whole Project	April 2005 - June 2009 (51 months)	April 2005 - June 2011 (75 months)
1) Selection of consultant	April 2005 - August 2006	April 2005 - September 2006
2) Bidding procedure for construction works	September 2005 - August 2006	December 2005 - September 2007
3) Construction works	September 2006 - June 2009	January 2008 - December 2010
4) Warranty period	July 2009 - June 2011	August 2011 - August 2013
5) Consulting services	August 2006 - September 2010	October 2006 - June 2013

Source: JICA documents, Answers on questionnaire

[13] This project was considered completed at the start of commercial operations on June 29, 2011. Consulting services continued until June 2013, but for the purpose of this evaluation actual period of the consulting services will not be counted as the actual project period. Furthermore, in December 2008 an additional ODA loan (Project Phase II) was granted, with the planned project period in Phase II spanning from May 2005 to August 2012. However, this evaluation will compare the planned period at the time of the initial plan (Project Phase I) with the actual project period.

3.2.3 Results of Calculations for Internal Rates of Return (Reference only)

Financial Internal Rate of Return (FIRR)

At the time of appraisal, a financial analysis was conducted based on the electricity sales income of the Kuraymat Power Plant as the benefit, the investment cost (project cost) and cost of operation and maintenance as the costs, and a project life of 25 years. As a result, the Financial Internal Rate of Return (FIRR) was calculated to be 1.1%. At the time of ex-post evaluation, an attempt was made to re-calculate the results using the same calculation method, but because the generator output was insufficient for the most recent three-year period, which meant the expected benefit (electricity sales income) was not satisfactory, and this coupled with the drop in the value of the Egyptian Pound[14] since 2016 caused the total benefit to fall below the total costs, resulting in a negative internal rate of return[15].

Economic Internal Rate of Return (EIRR)

At the time of appraisal, a financial analysis was conducted based on revenue from increased electricity supply, CO_2 reduction, and the gain associated with exports from the reduced use of fuel in Egypt as the benefits, the investment cost (project cost) and cost of operation and maintenance as the costs, and a project life of 25 years. As a result, the Economic Internal Rate of Return (EIRR) was calculated to be 18.3%. At the time of ex-post evaluation, CO_2 reduction was removed from benefits because Egypt has no emissions trading scheme, and an attempt was made to re-calculate the results using the same calculation method with the two benefits of revenue from increased electricity supply and the gain associated with exports from the reduced use of fuel in Egypt. For the same reasons as FIRR, the internal rate of return was calculated to be negative[16].

The project cost significantly exceeded the initial plan due to the impacts of worldwide steel price rise and the rising cost of plant facilities, including gas turbines. Additionally, the project period exceeded the initial plan because it required more time than initially anticipated for the selection procedures and negotiations for the contractor of the main construction work of the project. Based on the above, the project cost greatly exceeded the plan and the project period

[14] The Egyptian Pound depreciated approximately 60% against the yen from 2015 to 2017, and the downward trend is still evident even at the time of ex-post evaluation.
[15] Furthermore, when the signing year of the ODA loan agreement is used as the start point of the project life, the FIRR is negative both at the time of appraisal and at the time of ex-post evaluation.
[16] When the signing year of the ODA loan agreement is used as the start of project life, the EIRR at the time of appraisal is 17.8% but negative at the time of ex-post evaluation.

exceeded the plan. Therefore, efficiency of the project is low.

3.3 Effectiveness and Impacts[17] (Rating: ②)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

Table 6 shows the project's operation and effect indicators. The target value is the value established at the time of appraisal (2006), while the actual figure is the value after the start of operations of the power generation facilities.

Table 6: Operation and Effect Indicators (Target and Actual) of this Project

Indicator	Target	Actual			
	2012 Two years after the project completion	June 2011 - August 2013 (27 months)	September 2013 - June 2016 (34 months)	July 2016 - May 2017 (11 months)	June - December 2017 (7 months)
		After 1 to 2 years of completion	After 2 to 5 years of completion	After 5 to 6 years of completion	After 6 to 7 years of completion
【Operation Indicators】					
1) Maximum Output (MW)	140 MW	N / A (Although there was a time of operation, there were many suspensions, so calculation is not appropriate.)	N / A (Operation completely stopped)	118	114
2) Plant Load Factor (%)	70%			54.0 (Average for 11 months)	47.5 (Average for 7 months)
3) Plant Availability (%)	91%			82.67 (Average for 11 months)	58.4 (Average for 7 months)
4) Gross Thermal Efficiency (%)	50%			35.04 (Average for 11 months)	41.09 (Average for 7 months)
5) Outrage Hours by Human Errors (hours)	0 hour/year			0 hour (11 months)	0 hour (7 months)
6) Outrage Hours by Machines Errors (hours)	0 hour/year	8,838 hours (total for 27 months)		1,812 hours (Total for 11 months)	1,772 hours (Total for 7 months)
7) Planning Outrage Hours by Periodical Inspection (hours)	720 hours/year	N/A		660 hours (Total for 11 months)	420 hours (Total for 7 months)
【Effect Indicators】					
8) Annual Amount of Net Generated Output (GWh/year)	816 GWh/year	Same as above	Same as above	496 GWh (Total for 11 months)	268 GWh (Total for 7 months)
9) Reduction of CO_2	160,740t			115,992 t	56,865 t

[17] Sub-rating for Effectiveness is to be put with consideration of Impacts.

Emission（tCO_2/year）	CO_2/year *Note			CO_2 / year (Amount of solar heat reduction is 23,772 tCO_2 / year)	CO_2 / year (Amount of solar heat reduction is 19, 116 tCO_2 / year)

Source: JICA documents, Answers on questionnaire, Interviews with NREA
Note: This value was calculated based on the annual CO_2 emissions from the standard thermal power plant in Egypt (heavy oil and gas mixing fired) in case such a power plant generated the same amount of electricity as this project. The reduction amount from solar heat is 19,800t CO_2/year of the total.

The gas turbine developed for this project broke down, causing the shutdown of the power plant during the period from September 2013 to June 2016. The cause of this breakdown was a defect in the rotating part[18] inside the turbine called the rotor. NREA transported this turbine out of the country, where repairs were carried out until June 2016[19]. Also, the gas turbine malfunctioned continuously between the start of commercial operations from June 2011 (time of completion) to September 2013. While the plant operated at times, it was offline for most of this time. Therefore, it is determined that the project had not achieved its target value two years after completion. However, repairs completed and the power plant restarted operations from July 2016. Considering this background information, this evaluation study will take into account the situation after July 2016. The following is a review on the actual figures for each indicator:

1) Maximum Output

The actual figures from July 2016 to May 2017 (five to six years after completion) were slightly lower than the target value. The main reason cited is the breakdown of two maintenance vehicles (Photo 1) that clean the solar heat collectors caused by problems with the motor and hydraulic instrumentation and these vehicles were not in operation due to a shortage of spare parts which caused dust and soot to accumulate on the collectors, resulting in lower output. Other causes are that two vehicles were not operational due to the same reason from June to December 2017 (six to seven years after completion) as well as plant shut down due to periodic maintenance[20] for the gas turbine from October 2017.

[18] Comprised of multiple ring-shaped components on top of one another.
[19] The reason for the breakdown has not been clearly determined, and even at the time of ex-post evaluation, NREA continues to discuss compensation and the cause with the construction contractor through the project's consultant. The repair cost was borne by NREA.
[20] Performed every two years. It continued until February 2018.

2) Plant Load Factor, 3) Plant Availability

The actual figures from July 2016 to May 2017 (five to six years after completion) did not reach the target value. As a reason for this, NREA cited frequent shutdowns caused by malfunctions resulting from high lubricant oil temperature, high exhaust dispersion, and excessive heat in the LP drum in the steam turbine, in addition, rising of the exhaust heat temperature, very low air intake volume in the vent turbine compartment, and the excessive burden on the DLN compartment fan in the gas turbine. In terms of the actual value from June to December 2017 (six to seven years after project completion), the speed of the gas turbine did not pick up and the exhaust temperature was high, which resulted in limited incineration time. In addition, periodic maintenance was performed on the gas turbine starting in October 2017, leading to a shutdown of operations, which caused the actual figures to fall short of the target values[21]. Afterward, at the time of ex-post evaluation (as of July 2018) the gas turbine and steam turbine are operating normally.

4) Gross Thermal Efficiency

The actual figures for the periods from July 2016 to May 2015 (five to six years after completion) and from June to December 2017 (six to seven years after completion) did not reach the target value due to declined thermal efficiency caused by a water leak in the heat exchanger tube sheet. At the time of ex-post evaluation (as of July 2018), the heat exchanger was repaired and it is operating normally.

5) Outrage Hours by Human Errors, 6) Outrage Hours by Machines Errors, 7) Planning Outrage Hours by Periodical Inspection

Although no outages occurred due to human errors, there were outages due to mechanical problems. The reason for this is as explained in 2) Plant Load Factor and 3) Plant Availability above. According to NREA, the gas turbine and steam turbine experienced malfunctions from the start of operations, and it claims there were defects in the equipment, but at the time of ex-post evaluation the cause has yet to be determined and discussions with the construction contractor

[21] Considering the malfunctions of the gas turbine, NREA concluded a maintenance support agreement with a foreign company in order to steadily carry out maintenance and inspection, purchase spare parts, and introduce the latest technologies, etc. (NREA concluded a long-term maintenance support agreement for eight years with a foreign company. Operation is carried out following the program prepared by the company and NREA. A system is in place where an immediate response can be taken in case of malfunction or accident. Gas turbine operations are managed online by the company's management control division, and it is continuously monitored. If an incident were to occur, this company provides instructions or advice by telephone or email). As for the steam turbine, according to NREA, a foreign company will be selected after a competitive bid in 2018 and a long-term support contract following similar standards is expected to be concluded.

continue. 7) Planning Outage Hours by Periodical Inspection have gone according to initial expectations.

8) Annual Amount of Net Generated Output

The actual figures for the period from July 2016 to May 2017 (five to six years after completion) declined due to inoperability of maintenance vehicles for cleaning and a drop in maximum output, as discussed above. Furthermore, the period from June to December 2017 (six to seven years after completion) was less than one year and periodic maintenance was performed on the gas turbine starting in October the same year, resulting in a decline in the generated output.

9） Reduction of CO_2 Emission

The introduction and operation of a solar thermal and gas integrated solar combined cycle power plant by this project was also expected to contribute to a reduction in CO_2 emission. The actual figures are below the target values. This is attributed to a drop in generated output caused by a shutdown due to the malfunction of the steam turbine and gas turbine as discussed above from July 2016 to May 2017 (five to six years after completion). Additionally, the period from June to December 2017 (six to seven years after completion) was a short period of only seven months and power generation declined due to the periodic maintenance performed on the gas turbine starting in October the same year.

Photo 1: Specialized Cleaning Vehicle for Solar Heat Collectors

Photo 2: Solar Heat Collectors

3.3.1.2 Qualitative Effects (Other Effects)

This project was expected to mitigate environmental impacts by generating electricity using solar thermal energy as an auxiliary energy source for power generation. However, no particularly useful comments were obtained from NREA senior management and field staff with

regard to this project's effect on mitigation of environmental burden and Egyptian society. This can be attributed to the fact that particularly notable and detailed effects have not been realized (effects related to environmental impact mitigation) since the installed capacity of the solar thermal power generation system is small and the gas turbine was shutdown for a little less than three years between September 2013 and June 2016, meaning that electricity was not produced nor supplied to the transmission grid using solar thermal power generation.

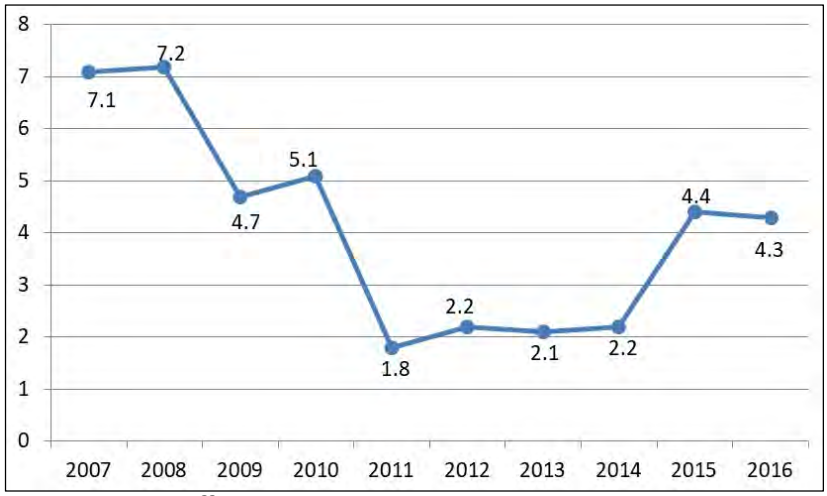
3.3.2 Impacts

3.3.2.1 Intended Impacts

1）Contribution to Economic Development of Egypt and Improvement of People's Livelihood

Figure 2 shows the trends for Egypt's GDP growth rate, Figure 3 presents the number of electrical service subscribers, and Figure 4 shows amount of electricity sales (electricity consumption).

【Unit：%】

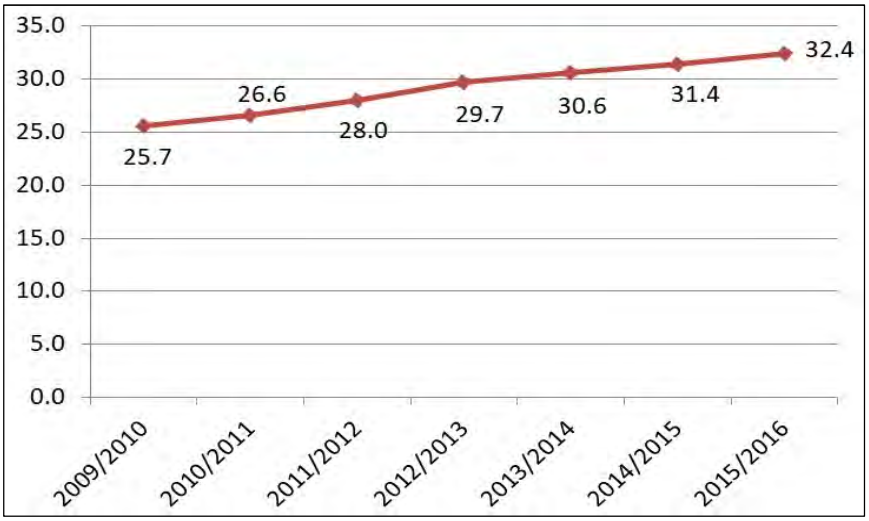


Source: World Bank[22]

Figure 2: GDP Growth Rate Nationwide

[22] Reference source: https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?end (Accessed on March 30, 2018)

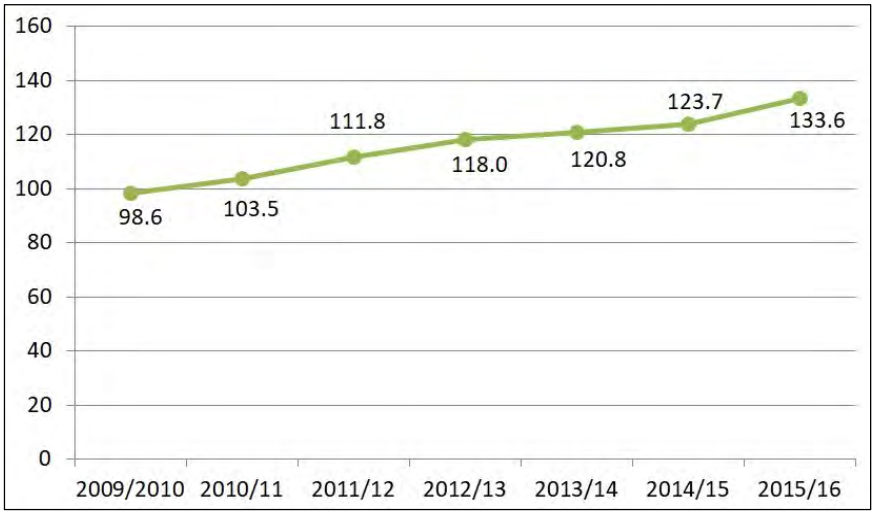
【Unit: million people】



Source: Egyptian Electricity Holding Company (EEHC)

Figure 3: Number of Electrical Service Subscribers Nationwide

【Unit: GWh】



Source: Egyptian Electricity Holding Company (EEHC)

Figure 4: Amount of Electricity Sales (electricity consumption)

As Figure 2 indicates, the country's GDP growth rate has declined and stagnated since 2011, which is believed to be attributed to the political unrest, sluggish economy, and poor public safety seen in the country following the Egyptian Revolution. Since 2015, steady economic growth has been continuing, but the current growth rate is not as high as the rate just immediately after the start of the project. Meanwhile, as Figure 3 and Figure 4 indicate, the number of electrical service subscribers and electricity sales (electricity consumption) are on an

uptick. Interviews[23] with senior management of NREA and Egyptian Electricity Holding Company (EEHC) yielded the following comments, “The Egyptian Central Government has been prioritizing investment in the electricity sector since several years ago and is focused on increasing installed capacity, in particular. Therefore, new power plants are being built or existing ones improved across the country”, “Several years ago, there were many instances of running into electricity supply shortages. There were concerns that the power will go out or could be cut off only by using air conditioning during the day in summer time. However, the situation is now improving and we no longer have to worry about this” and “There were planned outages in the past, but none at the time of ex-post evaluation. I think this shows that progress is being made with establishing a stable electricity supply. Stability of electricity supply is a top priority. It is a driving force behind people’s improved living standards, increased productivity at companies and vitality.” Considering these comments, the country’s domestic situation has stabilized gradually after the Egyptian Revolution (2011) and demand for electricity appears to be increasing. Therefore, it can be said that this project has played a role in contributing to economic activity and improvement of people’s lives through the stable supply of electricity. However, as discussed in 3.1.2 Consistency with Development Needs of Egypt, attention needs to be paid to the fact that the power generation capacity of this project is extremely small compared to Egypt’s total power generation capacity of 35,220MW, and that the gas turbine was shutdown for approximately three years after project completion.

2) Contribution to Promoting Development and Utilization of New and Renewable Energy Technologies

In this survey, the following comments were obtained from the same interviews with NREA and EEHC senior management with regard to the development and promotion of the use of new and renewable energy technologies. “Prudent consideration is needed for the introduction of renewable energy power generation facilities because the upfront investment cost (construction cost) piles up. However, operation and maintenance costs are relatively inexpensive, so there is a high possibility that introduction of this technology will pick up speed given the cost effectiveness”, and “The determining factor of which renewable energy to use, wind or solar thermal energy, depends on the specific point in time and market needs. For example, wind power received less attention about ten years ago, but the power generation cost of the power generation facility has declined and now it is considered a promising option. We are following

[23] In this survey, key informant interviews with NREA executives (4) and EEHC executives (2) were conducted.

these trends. Additionally, we will continue to implement solar thermal power projects, too, mainly in southern regions." In addition, according to NREA, there have been many visits from people both inside and outside of Egypt during project implementation and after completion. These visits have involved students, academics and diet members, etc., who have deepened their understanding of the project. In other words, visits have deepened understanding about renewable energy, including solar thermal energy, which could serve as a launching pad for advancing the development of power generation facilities throughout Egypt for the future. As mentioned previously, although the impact of this project is surmised to be limited, the technical knowledge and experience concerning this project's solar thermal power generation and gas combined cycle power generation systems could be a leading example that can be utilized for other solar thermal power generation projects in the future.

Photo 3: Steam Turbine Room

Photo 4: Cooling Tower

3.3.2.2 Other Positive and Negative Impacts

1) Impact on the Natural Environment

This project is categorized as B according to environmental guidelines following an environmental appraisal carried out in accordance with the *JBIC Guidelines for Confirmation of Environmental and Social Considerations* (April 2002). The environmental impact assessment (EIA) for this project was approved by the Ministry of Environment of Egypt in November 2004.

The NREA headquarters has a department in charge of environmental and social considerations in relation mainly to environmental appraisals for new projects and waste disposal planning and implementation. With regard to Kuraymat Power Plant, there is no requirement for monitoring in accordance with environmental standards and environment related data is not measured. Nevertheless, power plant staff patrol the project site and strive to address any problem they may

detect in a quick manner. If a negative impact on the natural environment is confirmed, there is a system in place whereby the power plant will notify the NREA headquarters, which will immediately report to the Ministry of Electricity and Renewable Energy of Egypt and receive instructions. Based on interviews with the NREA headquarters and power plant staff along with a field visit, it was confirmed that no negative impact on the environment (air pollution, water quality, noise and vibrations, or negative impact on the ecosystem) has occurred during the project implementation and after project completion. The area around the power plant is a desert region, with no homes or commercial facilities. Therefore, there have been no impacts, noise and vibrations, or adverse health effects, etc., caused by air pollutants.

2) Resettlement and Land Acquisition

This project did not involve any land acquisitions or resettlement. The project site is located on state-owned land (land owned by the Government of Egypt) and was acquired prior to the start of the project. There were no people living in the area near the project site. As a result the project did not involve resettlement.

As for the project's operation and effect indicators (maximum output, plant load factor, plant availability, gross thermal efficiency, annual amount of net generated output, and amount of reduction of CO_2 emission), the gas turbine experienced a malfunction and breakdown two years after the start of commercial operations and there was a prolonged shutdown around this time, causing the project to fall short of the target values. Additionally, from July 2016 to December 2017, after repairs on the gas turbine were completed, the same turbine was shutdown due to a malfunction, which caused the actual figures of these indicators to be somewhat below the target values. However, there is no major problem with the operation status of the power generation facilities at the time of ex-post evaluation. In terms of the impacts from this project, the effectiveness is presumed to be limited considering the actual figures of these indicators. Therefore, effectiveness and impact of the project is fair.

3.4 Sustainability (Rating: ③)

3.4.1 Institutional Aspect of Operation and Maintenance

The executing agency of this project is NREA. NREA is an agency of the Ministry of Electricity and Renewable Energy that is responsible for power generation projects that use new

or renewable energies or promote the R&D and spread of new and renewable energies such as wind power, solar thermal energy, and biomass, etc. Kuraymat Power Plant, a division of NREA, is placed in charge of the operation and maintenance of this project. The main operation and maintenance work of this power plant involves cleaning of the solar heat collectors, cleaning of the lubricated equipment, operation and maintenance of the gas turbine and steam turbine, and overhaul work, etc. Table 7 shows the power plant's workforce at the time of ex-post evaluation.

Table 7: Breakdown of Operation and Maintenance Staff at Kuraymat Power Plant
(As of March 2018)

Type of occupation	Assumption after completion at the time of project appraisal (2006)	Number of staff at the time of ex-post evaluation
Number of engineers	Total of number of engineers, technicians and chemists: 122	29
Number of technicians		78
Number of chemists		17
Number of chauffeur		19
Number of security		27
Number of workers		10
Number of administrative affairs and public relations		3
	Total	183

Source: JICA documents, Answers from NREA

The number of Kuraymat Power Plant staff engaged in operation and maintenance work satisfies the initial assumption at the time of appraisal. As Table 7 indicates, at the time of appraisal, the required workforce (engineers, technicians, chemists only) for operation and maintenance of the project's facilities was estimated to be 122 persons. At the time of ex-post evaluation, this workforce stands at 124 persons (as of March 2018). According to the power plant's senior management, "We have secured the minimum necessary workforce, but it is desirable for us to increase our employees so that we can securely prevent unforeseen accidents or breakdowns involving facilities and/or equipment[24]. So far there are no major issues in terms of the institutional aspects of operation and maintenance because we are able to carry out this

[24] According to the power plant and NREA headquarters, "During the six month period prior to the time of the ex-post evaluation (March 2018), six engineers quit over wage and benefits issues, but replacements have not been hired. However, NREA plans to assign 8 to 12 engineers or specialists to Kuraymat Power Plant before the end of 2018. This action is intended to maintain the power plant's operation and maintenance's system." In addition, in June 2018, NREA made changes to the staff wage system with all staff receiving a uniform 7% raise in base pay. According to the power plant's senior management, "The revision to base pay was ground-breaking, and employee dissatisfaction will be eliminated as a result."

work with our present workforce and shift system." EEHC has dispatched 12 engineers[25] to the power plant in order to assist with operation and maintenance work, and their knowledge and experience with regard to operation and maintenance is being shared with the power plant's staffs.

Additionally, as noted in 3.3.1.1. Effectiveness and Quantitative Effects (Operation and Effect Indicators), due to the malfunctions of the gas turbine NREA concluded a long-term maintenance support agreement (eight years) with a foreign company in order to carry out maintenance inspections, purchase spare parts, and introduce the latest technologies, etc. Operation on this turbine is carried out following the program prepared by the company and NREA. A system is in place where an immediate response can be taken in case of malfunction or accident. Turbine operations are managed online by the company's management control division, and continuous monitoring is carried out. As for the steam turbine, according to NREA a foreign company will be selected after a competitive bid in 2018 and a long-term support contract following similar standards is expected to be concluded.

Based on the above, no major problems with the operation and maintenance system at the time of ex-post evaluation are observed.

3.4.2 Technical Aspects of Operation and Maintenance

Most of the workers (mainly specialists/engineers) centered in Kuraymat Power Plant's control room have an engineering background and graduated with a degree in electrical or mechanical engineering from a four-year university. There are quite a few young workers. At the time of the field survey, it was confirmed that there are many employees with a specialist background related to frontline operation and maintenance work (mainly technicians, engineers, chemists). In addition, according to the power plant, on-the-job training is provided as needed to new and current employees. In addition, as noted above, the power plant receives assistance from EEHC in the form of staff dispatch, which means knowledge and experience about operation and maintenance is being shared with the power plant's workers.

There is a manual on the equipment and components of the power generation facilities and it is referred to during work as needed. In addition, records of operation and maintenance are prepared and kept.

[25] At the time of appraisal, it was assumed that engineers from EEHC would be dispatched as needed to the power plant in order to reinforce Kuraymat Power Plant's operation and maintenance work. In 2010, after the start of the project, NREA and EEHC concluded an agreement and contract for the dispatch of staff (renewed every six months). The breakdown of these 12 engineers includes engineers/specialists (9) and chemical specialists (3) for the operation and maintenance of the gas turbine and steam turbine. These engineers are included in the workforce per Table 7.

Based on the above, there is no problem in the technical level of the Kuraymat Power Plant's operation and maintenance.

3.4.3 Financial Aspects of Operation and Maintenance

Table 8 shows the operation and maintenance budget (most recent three years) for facilities developed by this project. Every year, NREA prepares the budget, which is submitted to the Ministry of Finance through the Ministry of Electricity and Energy, the senior authority of the power plant. Funds are allocated after approval procedures are completed. The composition of the budget includes costs related to operation of major facilities such as the gas turbine (including periodic maintenance work performed once every two years), operating costs required for employee salary, etc., costs to purchase lubricant oil, costs to purchase supplies such as parts, and maintenance costs to maintain various equipment. The maintenance budget for 2015/2016 was low compared to other years. This was because the gas turbine was shutdown during this time. The maintenance budget for 2016/2017 and subsequent years increased as the gas turbine was returned to operation. For 2017/2018, the operating budget was higher than that of the previous year due to periodic maintenance work on the gas turbine (the maintenance budget was lower than the previous year because periodic maintenance work would be performed). NREA senior management mentioned "The operation and maintenance budget is allocated as needed. The budget is not short and there is no influence on the operation of the facilities. There are also funds available to purchase spare parts." Based on the above, it is determined that there is no financial problem in terms of operation and maintenance.

Table 8: Operation and Maintenance Budget for Facilities Developed by This Project

(Unit: Egyptian Pound)

	2015/2016	2016/2017	2017/2018
Operation Budget	93,920,780	86,647,107	236,885,357
Maintenance Budget	21,302	29,074,834	5,189,221

Source: NREA

3.4.4 Status of Operation and Maintenance

As stated in 3.4.1 Operation and Maintenance System, the main daily operation and maintenance work for the Kuraymat Power Plant consists of cleaning of the solar heat collectors and cleaning of lubricated equipment. Additionally, the gas turbine undergoes periodic maintenance including an overhaul once every two years and the steam turbine does the same every 12,000 hours of operation. This periodic maintenance was carried out on the gas turbine

between October 2017 and February 2018, and it was shutdown during this period[26].

The solar heat collectors are cleaned every two days by two maintenance vehicles designed specifically for cleaning. At the time of ex-post evaluation, both were operating normally, but up to early 2018 one was undergoing repairs[27]. It is hard to procure vehicle parts locally in Egypt and repair work is difficult; therefore, normally vehicles are sent overseas (Europe) for repair work, which takes time. According to NREA, the project has experienced delays in the procurement and delivery of general parts for facilities and equipment[28]. However, at the time of ex-post evaluation, NREA indicated that the delivery and procurement situation are improving.

Based on the above, although conditions require time to procure, repair and secure parts for the project's facilities and equipment, it is determined there is no major problem with the operation and maintenance situation at the time of ex-post evaluation.

As a result, no major problems have been observed in the institutional, technical, financial aspects and current status of the operation and maintenance system. Therefore sustainability of the project effects is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project involved the construction of a solar thermal and gas integrated power plant in Kuraymat, located approximately 100km south of Cairo, in order to produce electricity to be supplied to Egypt's existing power grid and to contribute to the economic development and environmental improvements of Egypt by mitigating environmental impacts through the introduction of the auxiliary energy of solar thermal power generation. The Government of Egypt indicated in the *National Five-Year Development Plan* (2002/2003-2006/2007) and the *Egypt Strategic Framework for Economic and Social Development plan Until year 2022* that it will promote renewable energy such as combined cycle power generation as well as solar thermal and wind power generation. Therefore, the project's relevance is high given the development needs from growing electricity demand and consistency with Japan's ODA policy.

[26] Plans call for this periodic maintenance to be performed on the steam turbine in 2019 (Similarly, it will be scheduled to stop operation for several months).
[27] NREA indicated its view that there were malfunctions in mechanical parts used on these vehicles from the beginning (hydraulic instrumentations for the motor). During the time these vehicles were not in operation, the solar heat collectors were cleaned using a fire fighting/water truck owned by NREA. In the near future, NREA plans to purchase additional vehicles to avoid any impediment to cleaning and maintenance work.
[28] However, according to Kuraymat Power Plant, it has already procured or sourced about 20 years worth of spare parts for the solar heat collectors.

In terms of efficiency, project outputs were implemented almost as planned, but project costs significantly exceeded the initial plan due to the impacts of worldwide steel price rise and the rising cost of plant facilities, including gas turbines. The project period required more time than initially anticipated for the selection procedures and negotiations for the contractor of the main construction component of the project. Therefore, the efficiency of the project is low. The project faced malfunctions/breakdowns of the gas turbine, etc., two years after the start of commercial operations and the shutdown period before and after this incident was prolonged. Additionally, partial malfunctions also occurred in the gas turbine and steam turbine even after the repair work was completed in July 2016, resulting in several instances of shutdowns due to mechanical failures. Therefore, the quantitative effect indicators of this project did not achieve the target values. In terms of impacts realized from this project, the actual figures of the relevant indicators are considered to be limited. Thus, the effectiveness and impacts are determined to be fair. There are no major problems in the institutional, technical and financial aspects of Kuraymat Power Plant, which is responsible for the operation and maintenance of this project. No major problems in particular have occurred in the operation and maintenance of other facilities and equipment. Consequently, the sustainability of the project's effect is high.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

It is preferable that NREA examine measures so that spare parts procurement and repair work at the Kuraymat Power Plant can be addressed in a timely manner.

4.2.2 Recommendations to JICA

To enable steady procurement and sourcing of spare parts, it is desirable that JICA monitor Kuraymat Power Plant for the time being and make requests regarding areas of improvement as needed.

4.3 Lessons Learned

Necessity of careful designing and supervision of construction work of power generation facilities

The gas turbine procured for this project was shutdown for a prolonged period of time due to malfunction soon after the start of service and it was forced to shutdown later after the repairs

due to a mechanical problem. Therefore, the executing agency must check to make sure that climate and environmental conditions at the project site are suitable for the gas turbine, which uses extremely fine mechanical parts, while thoroughly checking the technical and quality management capabilities of the construction contractor. If not suitable, it is important for the executing agency to take the appropriate actions or take steps to prevent malfunctions or accidents wherever possible through various considerations.

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs	1) Civil work ① Solar thermal and gas integrated power plant - Gas turbine (80MW x 1) - Steam turbine (70MW x 1) (of this, 40MW by gas turbine heat recovery and 30MW by solar thermal recovery) - Generator (Gas turbine: 80MW, Steam turbine: 70MW - Heat recovery steam generator (HRSG) (1 unit) - Main transformer - Control & instrumentation equipment - 22kV/66kV outdoor switchgear - Cooling water equipment - Solar thermal power generation facilities (not covered by ODA loan; assistance by Global Environment Facility (GEF)) 2) Consulting services ① Construction supervision ② Assistance for operation and maintenance	1) Civil work ①Solar thermal and gas integrated power plant - Gas turbine (74MW x 1) - Steam turbine (56MW x 1) (of this, 36MW by gas turbine heat recovery and 20MW by solar thermal recovery) - Generator (Gas turbine: 74MW, Steam turbine: 56MW - Heat recovery steam generator (HRSG) (1 unit) - Main transformer - Control & instrumentation equipment - 22kV/66kV outdoor switchgear - Cooling water equipment - Solar thermal power generation facilities (assistance by GEF; output of 20MW) 2) Consulting services As planned.
2. Project Period	April 2005 to June 2009 (51 months)	April 2005 to June 2011 (75 months)
3. Project Cost Amount Paid in Foreign Currency Amount Paid in Local Currency Total ODA Loan Portion Exchange Rate	 14,618million yen 6,765million yen 21,383million yen 10,665million yen 1 Egyptian pound =17.7yen 1 USD=6.22Egyptian pound (As of February 2005)	 26,518million yen 7,935million yen (495.643million Egyptian pound) 34,453million yen 20,085million yen 1 Egyptian pound =16.01yen 1 USD=5.92 Egyptian pound (Average between 2006 and 2013, based on rates issued by the IMF's International Financial Statistics Data)
4. Final Disbursement	Phase 1: August 2015 Phase 2: January 2016	

The Republic of Sudan

FY 2017 Ex-Post Evaluation of Technical Cooperation Project

"Frontline Maternal and Child Health Empowerment Project" and "Frontline Maternal and Child Health Empowerment Project Phase 2"

External Evaluator: Keiko Watanabe, Mitsubishi UFJ Research & Consulting Co., Ltd.

0. Summary

The project[1] was implemented aiming at promoting safe delivery throughout Sudan by enhancing the quality of maternal and child health services provided by Village Midwife (hereinafter referred to as "VMW" [2]). "Frontline Maternal and Child Health Empowerment Project" (commonly known as "Mother Nile Project", hereinafter referred to as "MNP") developed an empowerment model which strengthened the capacity of VMW and the support system for VMW's activities in the pilot state, Sinnar state. In the subsequent "Frontline Maternal and Child Health Empowerment Project Phase 2" (hereinafter referred to as "MNP2"), the empowerment model developed by MNP was scaled up in other eight states. In addition, in Sinnar state a comprehensive approach for mother and child health centered on VMW was established including the strengthening of medical facilities and equipment and capacity of medical personnel that MNP could not cover.

The objective of the project is consistent with health policy and development needs of the country and "support for improvement of basic human needs" which is the priority issue of Japan's assistance to Sudan. Therefore, the relevance is high. Although the achievement of the project purposes could not be quantitatively verified in part, considering the achievement of each output and the interview results from the stakeholders, it can be thought that the projects largely achieved their project purposes at the time of completion. Since MNP2 was implemented based on the achievement of MNP, overall goal of MNP and MNP2 were both considered as "implementation of high quality of continuum of care by VMW in whole country". In-service training (hereinafter referred to as "INSET") for VMW introduced by the project has continued even at the time of ex-post evaluation and about half of VMW in the country has been covered by the training. Although the reliable quantitative data on continuum of care[3] and referral[4] by the strengthened VMW was not obtained, it was confirmed from the results of qualitative interview as well as quantitative survey in the visited states conducted at the time of

[1] The "project" indicates the target two projects.

[2] The condition for becoming a VMW must be woman who has completed primary education and has graduated from midwifery school (18 months). VMW is called community midwife (CMW) at the time of ex-post evaluation. They are currently positioned as a part of community health workers in health administration from the volunteer position in the past. During the project period, they were called VMW. Thus, VMW is used throughout this ex-post evaluation report.

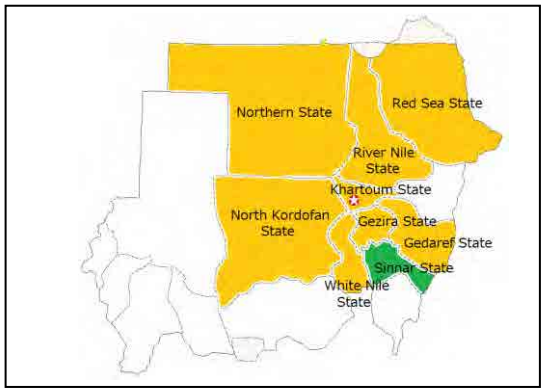
[3] Continuum of care refers to an integrated maternal and child care such as antenatal care, delivery care, newborn care, postnatal care taking each period of pregnancy, delivery and child rearing as a series. In this project, emphasis is put on antenatal care, delivery care and postnatal care for expectant and nursing mothers.

[4] Referral means to introduce/transfer patients who cannot cope with lower medical facilities like primary medical facilities to upper medical institutions such as secondary and tertiary levels.

ex-post evaluation that VMW were providing more appropriate maternal and child services than before the project to a certain extent. Therefore, overall goal was judged as almost achieved. The other positive impacts were also observed. Therefore, the effectiveness and impact of the project are high. The project period was as planned, on the other hand, the project cost exceeded the plan. Thus, the efficiency is fair. The sustainability of the project effect is fair since some problems have been observed in terms of organizational aspect and maintenance status.

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

1. Project Description



Project Locations
(Green: Pilot state, Yellow: Eight target states in MNP2)

Women and Families Waiting for Treatment
(Wad Nile Rural Hospital, Sinnar State)

1.1 Background

After the civil war that continued since 1983 in Sudan, the Comprehensive Peace Agreement was signed in 2005. However, due to the severe economic situation under the civil war of more than 20 years, the level of health status was low. In particular, indicators relating to maternal and child health were in a severe situation and those were even lower than the average level of developing countries. In response to the request from the Sudanese government, JICA implemented a technical cooperation project "Frontline Maternal and Child Health Empowerment Project (MNP)" for three years from June 2008, which contributed to the improvement of maternal and child health. The project aimed to establish the system to provide qualitative maternal and child health services to the local communities by improving the capacity of VMW, a key player of reproductive health[5] (hereinafter referred to as "RH") at the community level, strengthening the systems surrounding VMW, and enhancing the capacity of the Federal Ministry of Health (FMOH) and State Ministry of Health (SMOH).

It was confirmed that MNP has largely achieved its objective at the time of terminal

[5] RH means health and rights related to reproductive process. In concrete, it includes the rights for safe delivery, rights to decide if, when and how often to give births and right to receive appropriate reproductive and sexual information and services.

evaluation. However, some issues have been remained in medical facilities to which VMW refers high risk pregnant women. Those facilities were obsolete, their equipment was short and medical personnel at the referral hospitals lacked knowledge and skills of emergency obstetric care. In addition, it was necessary to further strengthen the support system for VMW in Sudan. Under such background, "Frontline Maternal and Child Health Empowerment Project Phase 2" (MNP2) was implemented for three years from August 2011.

1.2 Project Outline

		MNP	MNP2
Overall Goal		VMWs are empowered and organized in the Primary Health Care (PHC)[6] context to perform ideal continuum of care for maternal and child health (MCH) in Sudan.	Maternal and infant mortality is reduced in Sudan.
Project Purpose		VMWs are empowered and organized in the PHC context to perform ideal continuum of care for MCH in Pilot State.	More women receive quality cares related to pregnancy and childbirth in Sudan.
Output	Output 1	Organizational capacity of FMOH and SMOH, and rules and regulations of VMW are strengthened to perform appropriate MCH services.	Institutional capacity of FMOH and SMOH in maternal and newborn health is strengthened.
	Output 2	MCH services are provided through empowered and organized VMWs in Pilot State.	Capacity of VMWs is strengthened in order to provide quality maternal and newborn care in the 8 states[7].
	Output 3	Horizontal communication network among northern states[8] and relevant stakeholders is strengthened to address the issue on MCH.	A model of comprehensive approach to improve maternal and newborn health is established in Sinnar state.
Total Cost (Japanese Side)		317 million yen	716 million yen
Period of Cooperation		June, 2008 – June, 2011	August, 2011 – August, 2014
Implementing Agency		FMOH Sinnar SMOH	FMOH SMOHs in the target 9 states
Other Relevant Agencies / Organizations		None	None

[6] PHC is an approach that provides comprehensive, accessible, community-based care that meets health needs of individuals throughout their life.

[7] 8 states: North Kordofan State, Gezira State, White Nile State, Northern State, River Nile State, Red Sea State, Gedaref State and Khartoum State. With adding Sinnar State which is the target state of Output 3, MNP2 target total of 9 states out of 15 states in Sudan.

[8] During the project period of MNP, South Sudan has not separated from Sudan (Independent in July 2011) and the current Sudan was called the northern Sudan.

Supporting Agency/Organization in Japan	None	None
Related Projects	【Technical Cooperation】 "Project for Human Resources Development for Darfur and the Three Protocol Areas" (2009-2013) "Capacity Development Project for Provision of the Services for Basic Human Needs in Kassala" (2011-2015) "Primary Health Care Expansion Project" (2016- on going) 【Grant Assistance for Grassroots and Human Security Project】 "Rehabilitation of two midwifery schools in Sinnar State" (2008)	

1.3 Outline of the Terminal Evaluation

1.3.1 Achievement Status of Project Purpose at the Terminal Evaluation

According to the terminal evaluation of MNP, it was judged that the project purpose was likely to be achieved considering the fact that one of the indicators of the project purpose "referral cases made by VMWs are increased" has been achieved and other information received from the evaluation survey. However, the other indicator "rate of continuum of care provided by trained VMWs in pilot state is increased" could not be verified its achievement. MNP2 was judged to be achieved since it was confirmed that the quality and access of maternal and child health services has been improved by the comprehensive approach in Sinnar state which included capacity development of VMW and their organization as well as strengthening of medical facilities and personnel, and capacity development of VMW in the eight target states.

1.3.2 Achievement Status of Overall Goal at the Terminal Evaluation (Including other impacts.)

In MNP, 52 facilitators for INSET for VMW were fostered in six states other than the pilot state. The initiative for scaling-up INSET for VMW nationwide has already begun. Therefore, it was judged that the overall goal is likely to be achieved as a medium to long-term perspective. In MNP2, it was considered that the basic foundation for reducing Maternal Mortality Rate (hereinafter referred to as "MMR") has been established considering the fact that the level of maternal and child health services was upgraded. This is because the number of facilitators for INSET for VMW and VMW with improved skills increased nationwide, the comprehensive approach model implemented in Sinnar state found to be effective for continuum of care for maternal and child health, and the institutional capacity of FMOH and SMOH on VMW has been strengthened. In addition, it was considered that this would contribute to the reduction of Infant Mortality Rate (hereinafter referred to as "IMR") in the long term. Therefore, it was judged that the overall goal is likely to be achieved.

1.3.3 Recommendations from the Terminal Evaluation

Following recommendations were posed from the terminal evaluation.

＜MNP＞

	Main Recommendations
Recommendations during project period	1） Completion of VMW empowerment model 2） Approval of guideline of INSET for VMW by FMOH 3） Objective assessment of comparison results before and after training on the procedure for prevention of infection by VMW 4） Monitoring of qualitative and management of INSET for VMW in the five states including Darfur 5）Completion of a grand design of scaling-up of VMW's empowerment model in cooperation with each state and other development partners. 6） Prepare for verification of project effect utilizing health indicators
Recommendations done by Sudanese side after the completion of the project (medium /long term)	1） Scaling-up of the empowerment model to nationwide 2） Further capacity development of Health Visitors (HV), supervisor of VMW and Assistant Health Visitors (AHV)[9] 3） Strengthening of cooperation network of maternal and child health personnel 4） Implementation of training on emergency obstetric care to general practitioners of rural hospitals 5） Rehabilitation of facilities and improvement of equipment of rural hospitals, especially for obstetric care units 6）Making recommendation on fostering RH related human resources in formulation of the national health human resources strategy

＜MNP2＞

	Main Recommendations
Recommendations during project period	1） Formulation of the guideline of empowerment model 2） Documentation of training of emergency obstetric and newborn care 3） Documentation of community activities by VMW 4） Dissemination of the maintenance guideline of medical equipment and user manual 5） Implementation of End-line survey at Sinnar state
Recommendations done by Sudanese side after the completion of the project (medium /long term)	1） Promotion of empowerment of VMW (Provision of salary and incentives, necessary tools and consumptions, etc.) 2） Enhancement of support for continuation of community activities 3） Continuation of monitoring activities for VMW 4） Allocation of the provided car to RH division of Sinnar SMOH for the above 3)

[9] HV is health care worker in the position to direct, supervise, and assess VMW. HV is qualified as a nurse, enrolled at midwifery schools for three years and has undergone enrollment at HV School for two years after a one-year clinical experience. HV is mainly enrolled at local health center. In this project, HV was expected to direct and supervise VMW, as well as to become facilitators of INSET for VMW. AHV is a preparatory position to become HV in the future. The position of AHV was set as emergency measure due to the lack of the number of HV.

2. Outline of the Evaluation Study

2.1 External Evaluator

Keiko Watanabe, Mitsubishi UFJ Research & Consulting Co., Ltd.

2.2 Duration of Evaluation Study

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

Duration of the Study: November, 2017 – December, 2018

Duration of the Field Study: February 18, 2018 – March 16, 2018, July 14-22, 2018

2.3 Constraints during the Evaluation Study

Quantitative data on indicators related to continuum of care (for example, number and rate of ANC) could not be obtained from relevant organizations, or even when there was data, the reliability was low[10]. Thus, it was difficult to judge the achievement of indicators by numerical values. The evaluation was done by gathering qualitative information as much as possible from various viewpoints such as interviews with relevant parties and site surveys[11].

3. Results of the Evaluation (Overall Rating: B[12])

3.1 Relevance (Rating: ③[13])

3.1.1 Consistency with the Development Plan of Sudan

5-Year Health Sector Strategy (2007-2011) which was effective at the planning period of MNP (2008) considers "improvement of mother and child health" as one of important issues. *Sudan National Strategy for Reproductive Health* (2006-2010) sets "protection of mothers focused on safe pregnancy" as a priority issue and stipulates the strengthening of capacity of VMW as a concrete strategy in order to develop skilled health personnel.

The said policies were effective at the times of completion of MNP and planning of MNP2 (2011). In particular, FMOH put emphasis on reduction of infant mortality rate (IMR) and improvement of maternal health, which are the Millennium Development Goals (MDGs). In order to achieve these goals, the improvement of quality of mother and child health services through INSET for healthcare workers including VMW, strengthening of referral system and

[10] For example, since the data was compiled for each year without considering large variation of monthly collection rate by VMW, the trends by year cannot simply be compared. In addition, the problem was seen such that the reason is unknown even if the value of one year is far from the trend so far.

[11] At the time of ex-post evaluation, the interview was conducted to the five states; Sinnar, Gezira, North Kordofan, White Nile and Khartoum (Only local consultant visited for North Kordofan state due to the security reason). The interview was conducted to the following persons in each state; Director General of SMOH (5), 3-4 persons in charge of mother and child health, 23 HV (Sinnar 7, Gezira 4 (1 AHV), North Kordofan 3 (1 AHV), White Nile 5, Khartoum 4), 30 VMWs (Sinnar 14, Gezira 6, North Kordofan 4, White Nile 3, Khartoum 3), Others: Target hospitals personnel in Sinnar (3 Doctors, 2 Nurse Midwives, 4 Biomedical Engineers), 6 teachers and principals of midwifery schools in Sinnar, Gezira and North Kordofan states. Except 3 doctors, 2 biomedical engineers and Director General of each SMOH are women.

[12] A: Highly satisfactory, B: Satisfactory, C: Partially Satisfactory, D: Unsatisfactory

[13] ③: High, ②: Fair, ①: Low

enhancement of health information system are identified as strategy. At the time of completion of MNP2, *Primary Health Care (PHC) Expansion Project* (2012-2016) promotes one village one VMW and *National Human Resources for Health Strategic Plan for Sudan* (2012-2016) also stipulates the increase in number and capacity development of VMW.

Therefore, both the projects are in line with the development policies at the time of planning and completion.

3.1.2 Consistency with the Development Needs of Sudan

According to the Sudan Household Health Survey (SHHS, 2006), which was effective at the time of planning for both MNP and MNP2, MMR was 534 (per 100,000 live births). It was higher than 339, the average of lower middle income countries to which Sudan belongs, and 288, the world average in the same year[14]. Thus, the need for safe delivery was high. Inadequate maternal and child health services and lack of medical personnel in rural areas were raised as its reasons. Furthermore, the proportion of home delivery was very high[15] in Sudan at the time of planning and completion of MNP and MNP2, accordingly, it was urgent to strengthen the capacity of VMW who implement antenatal and postnatal care and assist deliveries at home. Therefore, both MNP and MNP2 are in line with the development needs at the time of planning and completion.

3.1.3 Consistency with Japan's ODA Policy

Japan raises the importance of health and medical area in *Japan's ODA Charter* (2003). At the time of planning of MNP, efforts to strengthen health system, improve maternal and child health and reduce MMR were stipulated in Yokohama Action Plan of the fourth Tokyo International Conference on African Development (TICAD IV) (2008). At the time of planning of MNP2, in TICAD V (2013) MMR has been listed as one of the outcome goals and the expansion of health coverage as well as providing effective basic health services for maternal, newborn and child health and RH was raised for promotion. According to *Japan's ODA Data by Country* at the time of planning of MNP and MNP2 (2008 and 2010), both the projects are positioned as "assistance to basic human needs", which is a priority area of Japan's assistance to Sudan and propose the improvement of maternal and child health services in rural areas to rectify regional disparity in Sudan. Therefore, both MNP and MNP2 were in line with the Japan's assistance policy at the time of planning.

[14] Average of lower middle income countries and world average are from open data of the World Bank. (Data source is from State of the World's Children (UNICEF), Childinfo, Demographic and Health Surveys in every other year.)

[15] According to SHHS (2006), at the time of planning of MNP, delivery rate at health facility in Sudan varies by state, from 5% (Blue Nile state) to 54% (Khartoum state) but only about 20% in average. That is to say, overwhelmingly there were many home deliveries. SHHS II (2010) and Multi Indicators Cluster Survey (MICS, 2014) at the time of completion of MNP and planning of MNP2, showed that delivery rate at health facility was still low as 20.5% (2010) and 27.7% (2014) each on the national average.

This project was 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 Effectiveness and Impact[16] (Rating:③)

3.2.1 Effectiveness

3.2.1.1 Achievement of Project Purpose

(1) MNP

MNP aimed to build a system to provide continuum of care by strengthened and organized VMW. It was tried to be achieved through strengthening institutional set up of VMW and capacity of FMOH and Sinnar SMOH of the pilot state (Output 1), building capacity of VMW and their supporting system (Output 2), and sharing achievements and experiences of the project to other states (Output 3). Three outputs were judged as achieved (details of achievement of each output are in Annex Table 1). Based on the achievement of the two indicators shown in Table 1, MNP contributed to the realization of safe delivery. Thus, it can be judged that the project purpose has largely been achieved.

Table 1 Achievement of Project Purpose (MNP)

<table>
<tr><th>Project Purpose</th><th>Indicator</th><th>Actual</th><th>Achievement</th></tr>
<tr><td>VMWs are empowered and organized in the PHC context to perform ideal continuum of care for MCH in Pilot State.</td><td>1. Rate of continuum of care (ANC, delivery, PNC) provided by trained VMW in pilot state is increased.</td><td>・According to the terminal evaluation report, the rate of ANC and delivery assistance could not be calculated since the total number of pregnant women were unknown. The number of implementation was as in the below table.
<Transition of Number of Continuum of Care and Referral Cases in Pilot State>
<table>
<tr><th colspan="2">Indicator</th><th>BL (Jan.-Dec. 2008)</th><th>At the Mid Term Review (Jan.- Dec. 2009)</th><th>EL (Jan.-Sep. 2010)</th></tr>
<tr><td rowspan="3">Continuum of Care (Indicator 1)</td><td>No. of ANC</td><td>21,330</td><td>24,330</td><td>8,282</td></tr>
<tr><td>No. of delivery</td><td>13,660</td><td>20,585</td><td>7,643</td></tr>
<tr><td>No. of PNC per delivered mother (recommended 4 times)</td><td>2.2 times</td><td>-</td><td>3.8 times</td></tr>
<tr><td colspan="2">No. of referral cases (Indicator 2)</td><td>1,168</td><td>-</td><td>2,082</td></tr>
</table>
BL：Baseline Survey, EL: End-line Survey
Source: MNP Terminal Evaluation Report

Although the Indicator 1 which is the implementation rate of continuum of care could not be obtained, through the interview with the relevant officers of FMOH and Sinnar state at the time of ex-post evaluation, it was confirmed that VMW who have built capacity and organized have been implementing</td><td>Fair</td></tr>
</table>

[16] Sub-rating for Effectiveness is to be put with consideration of Impact.

		continuum of care more appropriately than before the project. Thus, the level of achievement of the indicator was fair.	
	2. Referral cases made by VMW are increased.	・The number of referral cases by VMW was increased as in the above table. According to the data obtained at the time of ex-post evaluation, the number of delivery at facility has increased more than double from 5,913 (2008) before MNP to 12,663 (2012) after MNP. From the interview to the relevant stakeholders at the time of ex-post evaluation, it was confirmed that ANC, PNC and referral which were carried out appropriately by VMW led to delivery at facility. Thus, the indicator was judged as achieved.	Achieved

Source: MNP Terminal Evaluation Report, Interview Results from SMOH, HV, VMW in Sinnar state at the time of ex-post evaluation

(2) MNP2

MNP2 further enhanced the system for VMW which had been strengthened in MNP and contributed to facilitate the implementation of FMOH's "*PHC Expansion Project*". In addition, MNP2 improved the MNP's empowerment model for VMW and applied to the target eight states. Furthermore, in Sinnar state MNP2 built a comprehensive approach centered on VMW by improving the environment through improvement of medical facilities and equipment provision as well as strengthening the capacity of medical personnel, which contributed to the realization of safe delivery. The indicator to verify the achievement of project purpose was set as "Numbers of ANC, delivery and referral services provided by VMWs are increased in nine model localities[17] (all seven localities of Sinnar state and one each from North Kordofan and Gezira states)". The BL survey and EL survey[18] were conducted for the above nine localities in MNP2 (Table 2). However, since MNP2 was targeting the nine states, the supplementary data was tried to collect in the five states visited at the time of ex-post evaluation. Although clear quantitative data could not be obtained in these states, the interview to the relevant persons in the visited five states revealed that the number of ANC has increased, the delivery has been assisted with appropriate method and treatment, and that the referral has been implemented in timely manner by VMW who have received INSET in any of the states. Therefore, it was assumed that the behavior change of VMW has been made and that improvement of quality of continuum of care by VMW was surely realized. According to the information provided by JICA, the numbers of ANC and the facility-based delivery have been increased by 39% and by 51% respectively in comparison of 2010/2013 in the three hospitals in Sinnar state that have been improved by constructing the obstetric care units and providing equipment. It was also reported that the hospitals with improved facilities and equipment was used more often by pregnant women and that VMW became easier to refer to those hospitals. Therefore, it can be

[17] Locality is the administrative division under state.
[18] Baseline survey was conducted from November 2011 to May 2012. End-line survey was conducted from October 2013 to January 2014.

said that the improvement of medical facilities and equipment also contributed to the increase in number of continuum of care. The three outputs of MNP2 have largely been achieved (Annex Table 1). It is considered after judging comprehensively that the project purpose of MNP2 has largely been achieved.

Table 2: Achievement of Project Purpose (MNP2)

<table>
<tr><th>Project Purpose</th><th>Indicator</th><th>Actual</th><th>Achievement</th></tr>
<tr><td rowspan="2">More women receive quality cares related to pregnancy and childbirth in Sudan.</td><td rowspan="2">Numbers of ANC, delivery and referral services provided by VMWs are increased in 9 model localities.</td><td>Based on the results of BL survey and EL survey implemented in MNP2, the achievement of the indicator is as below (Annex Table 2, Annex Table 3)
<7 Localities in Sinnar state>
【No. of ANC】A statistically significant increase was observed. The increase was observed by about 39% in the three target hospitals in Sinnar state, which were from 10,333 (2010) to 14,376 (2013).
【No. of Assistance in Delivery】The monthly average number of assistance in delivery at home by VMW increased from 1.4 to 3.3 times. However, it was not statistical significance.
【No. of Referral】A significant increase was confirmed in the number of referral during delivery assistance. The annual average number of referral during high risk delivery by VMW was increased from 1.6 to 3.5 times.

Based on the above, it is considered that more pregnant women received the continuum of care in improved form in Sinnar state at the time of project completion. Therefore, it can be said that the project purpose was largely achieved.</td><td>Largely Achieved</td></tr>
<tr><td><South Gezira Locality, Gezira State>
【No. of ANC】The absolute number decreased but it was not statistically significant. According to the state record of the same period obtained at the time of ex-post evaluation, as shown in the table below, the increase rate exceeded 40% both for the ANC 1 and ANC 4 (comparison 2012/2014). However, since these figures shows the whole state of Gezira, the contribution degree of MNP2 is not clear.

<Transition of Number of ANC in Whole Gezira State>
<table>
<tr><th>No. of ANC</th><th>2012</th><th>2014</th><th>Rate of Increase</th></tr>
<tr><td>ANC 1</td><td>14,009</td><td>25,685</td><td>45.5%</td></tr>
<tr><td>ANC 4</td><td>6,417</td><td>10,929</td><td>41.3%</td></tr>
</table>
Source: Gezira SMOH

【No. of Assistance in Delivery】A statistically significant increase was confirmed.
【No. of Referral】There was a significant increase in the</td><td>Largely Achieved</td></tr>
</table>

<table>
<tr><td></td><td></td><td>number of referral during delivery.

Based on the above, statistically significant increase in the numbers of assistance in delivery and referral were confirmed except the number of ANC in the target locality in Gezira state. It was also confirmed by the interview with the relevant persons at the time of ex-post evaluation that the pregnant women were able to receive continuum of care in quality-wise improved form. Therefore, it can be said to be largely achieved.</td><td></td></tr>
<tr><td></td><td></td><td><Oum Ruwaba Locality, North Kordofan State>
【No. of ANC】A statistically significant decrease was observed. According to the information provided by JICA, there was a possibility that deterioration of security situation may have affected to the number of visit. On the other hand, the data of the target locality shown in the below table which was obtained at the time of ex-post evaluation, although the number of ANC 4 decreased in the comparison of 2012/2014, the increase was confirmed totally by about 30%.

<Transition of Number of ANC in Oum Ruwaba Locality>
<table><tr><th>No. of ANC</th><th>2012</th><th>2014</th><th>Rate of Increase</th></tr><tr><td>ANC 1</td><td>1,330</td><td>2,087</td><td>36.3%</td></tr><tr><td>ANC 4</td><td>344</td><td>291</td><td>-18.2%</td></tr><tr><td>ANC 1 + ANC 4</td><td>1,674</td><td>2,378</td><td>29.6%</td></tr></table>Source: North Kordofan SMOH

【No. of Assistance in Delivery】There was no statistically significant difference.
【No. of Referral】A statistically significant increase was confirmed for both number and rate of referral during assistance in delivery. According to the information from SMOH obtained at the time of ex-post evaluation, the number of delivery at facility was increased by 54.8% from 2,855 (2012) to 6,311 (2014). It is considered that the appropriate referral and ANC implemented by VMW was a great impact.

From the above, although the improvement by referral was confirmed in the target locality in North Kordofan state, clear improvement on the numbers of ANC and assistance in delivery could not be confirmed. Therefore, the effectiveness is fair.</td><td>Fair</td></tr>
</table>

(3) MNP and MNP2

FMOH is planning to apply the VMW empowerment model to all states, which was established in this project, aiming of implementing INSET for VMW as well as strengthening

VMW support system. At the time of completion of MNP2, about 20% of the VMW in the target nine states, that is, about 12% of the total VMW in all states of Sudan in the same period, have received INSET for VMW by the project (Table 3). Considering the fact that VMW has important role in Sudan where birth delivery at home was common while INSET for VMW has rarely been implemented before this project, it can be said that the project has greatly contributed to the realization of safe delivery of women in Sudan. The degree of achievement of indicators of project purposes of both MNP and MNP2 were not verified since clear justification based on the quantitative data could not be obtained. However, the interview with the relevant persons at the time of ex-post evaluation revealed that the quality of mother and child health services that VMW provides has been improved. It can be said that the project has contributed to the realization of safe delivery. Therefore, it can be considered that the project purpose of the project has largely been achieved.

Table 3: INSET for VMW conducted under this project (MNP＋MNP2)

State		No. of VMW (2012)	No. of VMW who received INSET				Proportion of VMW among state VMW
			MNP	MNP2		Total	
					Contract with UNICEF[19]		
1	North Kordofan	1,189	-	104	149	253	21%
2	Gezira	1,509	-	111	210	321	21%
3	River Nile	513	-	-	-	-	-
4	White Nile	1,033	-	-	189	189	18%
5	Northern	339	-	-	126	126	37%
6	Red Sea	331	-	-	126	126	38%
7	Gedaref	776	-	-	-	-	-
8	Khartoum	1,416	-	-	-	-	-
9	Sinnar	684	556	-	-	556	81%
	Total	7,789	556	215	800	1,571	20%

Note: Total number of VMW in all states of Sudan was 13,260 as of 2012.
Source: Information provided by JICA

3.2.2 Impact

3.2.2.1 The Situation Leading to Achievement of Overall Goal after the Completion of the Projects

The following impacts have been found after confirming the project effects of project outputs and project purpose during the period between project completion and ex-post evaluation.

[19] In the output 2 of MNP2, UNICEF was contracted as the implementing agency in order to implement INSET for VMW in other target states.

(1) Situation of INSET for VMW

According to FMOH, INSET for VMW has been carried out after the completion of MNP2 as in Table 4. FMOH also pointed out that the target states was decided based on the request from the states, unattended rate of INSET for VMW, situation of mother and child health and so on. INSET has been also continued at each SMOH visited at the time of ex-post evaluation. FMOH has also provided VMW kits[20] to VMW after the training. The curriculum of INSET for VMW developed in MNP has been further improved and utilized. The facilitators of INSET for VMW who have been fostered in the project are also active. Therefore, the continuity of the project effects was recognized.

Table 4 The situation of INSET for VMW after the Completion of the Project

(Sudan Total)

Year	No. of Participants/ No. of Training	Funding Source
2014	1,000 ／40	FMOH
2015	1,000 ／40	FMOH
	300 ／12	UNFPA
	200 ／ 8	WHO
2016	200 ／ 8	UNFPA
2017	1,500 ／60	FMOH
	100 ／ 4	UNFPA
2018 Plan	1,000 ／40	FMOH
	500 ／20	WHO

Source: FMOH

(Achievement of INSET in the Visited States

State/Year	2015	2016	2017	Total
Sinnar	60	45	50	155
Gezira	41	0	0	41
North Kordofan	84	212	92	388
White Nile	40	0	93	133
Khartoum			255	255

Note: Funding source for training includes UNFPA, WHO, NGO besides FMOH
Source: SMOH in each state

(2) Situation of Employment of VMW and Provision of Incentives

By the presidential decree of 2013, a policy was laid out that VMW is to be employed officially from the status of volunteer. As in Annex Table 4, the employment rate of VMW increased from 23% as of 2012 to 49% as of the end of 2017. A certain number of VMW regularly receive incentives from FMOH even if they are not employed (6% of the total). The employment rate of VMW in Sinnar state also increased from about 30% at the time of EL survey of MNP2 to 51% according to the quantitative survey conducted at the time of ex-post evaluation[21] (Annex Figure 1). The interview with VMW revealed that their lives have been stabilized since there was a fixed payment every month and it was confirmed that VMW is positioned as a profession that stable income can be obtained.

[20] Minimum necessary tools and consumables for VMW to assist delivery (stethoscope, scissors, disinfectant, absorbent cotton, soap, etc.)

[21] Quantitative survey was conducted in Sinnar state with sample of 120 VMWs at the time of ex-post evaluation. Based on the VMW list in Sinnar state (958 VMWs), the sample size was decided taking into consideration of the percentage of VMW in seven localities. Firstly, the target VMWs were extracted randomly from the VMW list of each locality. Those VMWs who could not be contacted and were at remote location were excluded. Ultimately, the VMWs who could come to the neighboring medical facilities or SMOH office were selected as target samples. The similar questions were posed in order to compare with BL and EL surveys carried out in MNP2.

(3) Obstetric Care Units Additionally Constructed in Two Hospitals in Sinnar State

Obstetric care units additionally constructed in MNP2 have been generally utilized as below.

(a) Obstetric Care Unit at Wad Nile Rural Hospital

Some troubles were found in this obstetric care unit such that the usual delivery room has not been operational due to poor drainage system since 2017. However, the theater for caesarean operation has been utilized. There was no record on number of obstetrical outpatients in the hospital. According to the hospital officials, the caesarean operation was about 13 to 15 times a month prior to the implementation of MNP2. However, it was said that it increased to 30 to 35 times a month (45 times at maximum month) due to the construction of the operation theater. Before the MNP2, many patients could not be admitted because of lack of theater and they have been transferred to the tertiary hospitals[22] of the state, where took nearly two hours. The addition of the theater also contributed to reduce the risk associated with transport. A care unit for ANC and PNC was under construction by the community fund near the obstetric care unit at the time of ex-post evaluation. It is expected that the unit would be more effectively utilized after its construction[23].

(b) Obstetric Care Unit at Suki Locality Hospital

The obstetric care unit has been daily utilized. However, structurally significant cracks occurred in the entire building from two years after the completion and the rehabilitation of the building has begun at the time of ex-post evaluation (details are described in 3.4 “Sustainability”). There was no record on obstetric outpatients in this hospital as well. However, according to the staff in charge of summarizing total outpatients in the hospital since 1993, surrounding residents who used to go to the tertiary level hospitals in the state before the establishment of facilities and provision of equipment by MNP2 turned to come to this hospital. The same staff also stated that about 10 to 15 people per day came for maternal consultation before implementation of MNP2 and the number increased to about 40 people per day after the implementation. The number of caesarean operations turned to be 5 to 7 cases per day and the number of normal deliveries turned to be 7 to 8 cases per day in the newly established obstetric care unit.

[22] In Sudan, the health services are divided into three levels. Primary level means rural clinics and health centers, secondary level is for rural hospitals and locality hospitals and tertiary level stands for specialized hospitals and education hospitals. Wad Nile Rural Hospital and Suki Locality Hospital at which the obstetric care units were constructed in MNP2 are secondary level hospitals.

[23] According to the hospital officials, although the construction has been delayed due to cash flow, it is planned to be completed by mid-2019.

(4) Provided Equipment

Although some of provided equipment to the above two hospitals have not been utilized as described later in 3.4 “Sustainability”, other equipment provided to Sinnar Teaching Hospital, midwifery schools, and health centers have been utilized with generally good conditions. It was confirmed from the interview with SMOH and hospital officials that the provision of equipment led to the improvement of quality of services.

On the other hand, according to the interview with VMW and HV, among the VMW kits granted after INSET for VMW and graduating from midwifery school, there were many cases that rubber balls of blood pressures gauge have deteriorated in two weeks to two months and become useless under the severe weather in Sudan.

VMW Kits provided after INSET for VMW

Unutilized Incubator (Obstetric Care Unit at Wad Nile Rural Hospital)

Training Equipment provided to Dindir Midwifery School (Sinnar State)

Rehabilitated Obstetric Care Unit at Suki Locality Hospital at the Time of Ex-post Evaluation

Rehabilitated Delivery Bed
(Obstetric Care Unit at Suki Locality Hospital)

Operation Theater
Obstetric Care Unit at Wad Nile Rural Hospital

3.2.2.2 Achievement of Overall Goal

The overall goal of MNP2 is "maternal and infant mortality is reduced in Sudan" and the reductions of MMR and IMR were set as its indicators. However, in order to achieve the objective of reduction of MMR and IMR in Sudan, the change of many external factors are necessary such as development of medical personnel including VMW, upgrading of medical facilities and access to those facilities, improvement in nutrition, and expansion of immunization. Therefore, the said overall goal is difficult to be achieved in three years after the completion of the project as well as it is hard to specify the contribution made by MNP2.

MNP2 expanded the capacity building and organization of VMW which MNP implemented in the improved form to other states. MNP2 also implemented the mother and child health approach centered on VMW comprehensively by tackling the issues which MNP could not deal with in Sinnar state, which were improvement of medical facilities and equipment, and upgrading capacity of medical personnel. Therefore, the evaluation was implemented considering that the overall goal of MNP2 was judged as the same as "high-quality continuum of care is expanded in whole country", which is the overall of MNP as a matter of fact. Table 5 shows the achievement of indicators of overall goal (the indicators of MNP2 are used as reference indicators).

Table 5 Achievement of Overall Goal

Overall Goal	Indicator	Actual	Achievement
VMW are empowered and organized in PHC context to perform ideal continuum	<MNP Indicator> Number of states which conduct VMWs training in accordance with state policy and	・As stated above, FMOH has been continuing INSET for VMW in all 18 states in Sudan. The number of VMWs received INSET for VMW was 10,058 VMW as of the end of 2017 including VMW in the JICA relevant projects (Details are described in 3.2.2.3 "Other Positive and Negative Impacts"), which consists of about 43% of total number of VMW in every state of Sudan in the same period (Annex Table 5).	Achieved

<table>
<tr><td rowspan="2">of care for maternal and child health in Sudan</td><td>guideline</td><td>・The guideline of INSET for VMW which MNP has developed has been utilized with some improvement.</td><td></td></tr>
<tr><td><MNP2 Indicator>

Reduction of MMR and IMR[24] (as a reference)</td><td>・Since official data on MMR is available only from SHHS (2006), trends could not be identified over the years.
・The reduction of IMR is observed, however, as mentioned above, there are many factors other than this project. It cannot be confirmed the causal relation with this project.
<Trends of MMR and IMR in Sudan>
<table><tr><th></th><th>MMR (Per 100,000 live births)</th><th>IMR (per 1,000 live births)</th><th>Source</th></tr><tr><td>2006</td><td>534</td><td>83</td><td>SHHS</td></tr><tr><td>2010</td><td>-</td><td>60</td><td>SHHS II</td></tr><tr><td>2014</td><td>-</td><td>52</td><td>MICS</td></tr></table></td><td>—</td></tr>
</table>

In order to supplementary verify the achievement of overall goal, the degree of implementation of continuum of care was attempted to be confirmed. However, as mentioned in 2.3 “Constraints during the Evaluation Study”, reliable quantitative data could not be obtained in any of the visited states. On the contrary, from the interviews with the concerned parties such as SMOH, HV, VMW in the visited states at ex-post evaluation, it was confirmed that the number of implementation of continuum of care has been increased, appropriate referral was made and the quality of records and report was improved through close supervision and guidance to VMW. In particular, the following effect was confirmed by the quantitative survey at ex-post evaluation in Sinnar state.

(1) Implementation Status of Continuum of Care (ANC, PNC, and Birth Assistance)

There is no major change in the number of ANC implemented at home, however, the number of ANC at medical facility has been increased (Annex Figure 2). Similarly to the result of EL survey, more than 90% of VMW answered in self-evaluation that ANC has been improved after INSET for VMW (Annex Figure 3). The main reasons for this include that “they could give advice and guidance to pregnant women on nutrition, medicine and vaccination (about 50%)”, “they could sterilize tools appropriately (about 20%)”, and that “the awareness of mother towards ANC has been improved (about 15%)”. From these reasons, it is assumed that VMW have been utilizing knowledge improved by INSET. In addition, it can be thought that improvement of ANC was realized by appreciation of VMW by mothers and community as described later.

[24] International organizations such as WHO publish the estimated value of MMR and IMR, however, those figures are far from the figures certified by FMOH. Therefore, those figures are not adopted as information in this ex-post evaluation.

ANC has been implemented by all VMW. Almost half of the VMW has implemented ANC for four times recommended frequency by FMOH. The result was the same at the time of EL survey.

There is no major change in the number of assistance in delivery at medical facility. However, it was found that 60% of VMW assisted delivery at home more than seven times a month. The number of assistance in delivery at home has been surely increased (Annex Figure 6 and Figure 7).

(2) Implementation Status of Referral

There was no major change in the number of referral between at the times of EL survey and ex-post evaluation (Annex Figure 4). However, the number of VMW who answered that it became easier to refer to hospitals increased largely (Annex Figure 5). Many answered for its reason that "awareness of pregnant women was raised (40%)" and "pregnant women recognized referral in advance due to making a delivery plan with VMW (32%)". From the above, it was apparent that mother's consciousness for delivery at facility was raised. It can be though that there was improvement of VMW's ability and strengthening relationship with mothers behind this. Furthermore, by strengthening relationship between VMW and medical facilities as well as medical personnel, the interview results showed that the referral became easier[25]. In addition, the interview with SMOH in Sinnar and other states confirmed that pregnant women have rarely died during delivery assisted by VMW at home because VMW referred them in timely manner. According to the interview with VMW, it was pointed out that external factors such as improving traffic access and prevailing mobile phones had an influence on ease of referral, however, it is sure that the project also contributed to some extent from the above.

(3) Supervision and Guidance to VMW

It can be seen that the frequency of VMW's recieving supervision and guidance from HV was increased (Annex Figure 8). In addition, the location where the supervision and guidance was received was a medical facilities such as health centers and hospitals which was the same as at the time of the EL survey (Annex Figure 9). The supervision and guidnance in Sinnar state have been carried out more frequently after the project and it was confirmed that regular meetings at medical facilities recommended by the project have been established[26].

[25] In the interview with VMW, there were many comments that "previously doctors and nurses were distant persons for VMW and VMW felt that they did not trust them".

[26] Before implementing this project, HV used to visit VMW at home, however, there were many cases that HV visited once a year to VMW who lives remote areas without transport means. In this project, instead of HV's visiting VMW, VMW went to nearby medical facilities and received supervision and guidance through a regular meeting with HV. FMOH also recommends this format to all states.

(4) Records and Reports by VMW

The practice of monthly reporting from VMW to HV has been established (Annex Figure 10). According to the interview with SMOH and HV, the percentatge of submission of the activity report obligated every month has much increased and it helped the information management on continuum of care and referral.

(5) Strengthening Relationship with Community

Even at the time of ex-post evaluation, 66% of the VMW has been continuing awareness raising activities to the community, although the implementation ratio decreased compared with that at BL and EL surveys (Annex Figure 11). Despite the absence of provision of incentives such as transport expenses, about 70% are continuing for awareness activities. Therefore, it can be said that awareness activities have been almost established as activities of VMW. The principal of midwifery school in Sinnar state pointed out that the project triggered the awareness raising activities to community into the curriculum of the class. The understanding of community on the role of VMW became deepened through awareness raising activities to the families of pregnant women such as explaining how to treat pregnant women and how to respond in case of emergency. In addition, as part of awareness raising activities, the emergency funds established in seven model villages during MNP2, and meant to be used for emergency referral during pregnant and delivery period, have been mostly continued. Total number could not be identified, however, disseminated cases to other villages were confirmed. According to the quantitative survey at the time of ex-post evaluation, the result came out that all VMW who have answered have established trustful relationship with community and they felt they were appreciated by the community.

Accordingly, the improvement of continuum of care and establishment and strengthening of relations between VMW and their supervisor as well as community were confirmed to a certain extent in the five states visited at the time of ex-post evaluation. As stated above, the curriculum of INSET for VMW developed by MNP was further improved by FMOH and was utilized in training in the whole country. In addition, it was confirmed that FMOH has been disseminating the approach established by the project throughout the country. Therefore, it can be inferred that implementation of continuum of care has been improved nationwide. Furthermore, FMOH has strengthened the institutional set up for VMW and the system has established that allows FMOH to consolidate basic information such as the numbers of VMW and employment in each state through INSET. Thus, it is judged that overall goal of the project was largely achieved.

3.2.2.3 Other Positive and Negative Impacts

(1) Collaboration Effect with JICA Related projects and Improving Recognition of JICA in the Area of Maternal and Child Health

MNP is the first full-scale maternal and child health project from Japanese aid which has resumed after Comprehensive Peace Agreement in Sudan. Triggered by MNP, mother and child health activities were implemented in "Project for Human Resources Development for Darfur and the Three Protocol Area" (2009-2013) (hereinafter referred to as "SMAP" [27]), and "Capacity Development Project for Provision of the Services for Basic Human Needs in Kassala" (2011-2015) (hereinafter referred to as "K-TOP" [28]), in collaboration with the project. For example, the facilitators of INSET for VMW who were fostered in MNP have implemented INSET for VMW in SMAP and K-TOP (Annex Table 5). Total of 5,758 VMW (43% of total number of VMW in Sudan at that time) have been received INSET by November 2013 through the project and the above JICA related projects. Considering the fact that INSET for VMW was hardly implemented before the project, it can be said that impact made to VMW was large. In addition, due to synergistic effect with the related projects, it was found by the ex-post evaluation that the word "Om Nile" ("Mother Nile" in Arabic which is the nickname of the project) has become widespread to village people and even to the students of midwifery school. It was also confirmed that the recognition of JICA in the area of mother and child health has been improved.

(2) Increase in Number of VMW

The number of VMW has been increasing by about 44% from 2012 to 2017. Through the interview with FMOH, it was confirmed that the Sudanese government recognized the importance of VMW triggered by the project and has been promoting increase in number of VMW. In addition, it was also confirmed the case from the interview with the midwifery school that influenced by the project and JICA related projects even the traditional village that had not fostered VMW became to send villagers to midwifery schools. Some states have increased midwifery schools such as Sinnar and White Nile states. It can be said that the project made a certain contribution to the increase in number of VMW.

(3) Establish Networks among VMW

As a result of the projects, VMW received INSET for VMW and participated in regular meetings at medical facility. This led to strengthen the relationship with HV, supervisor as well as enhance the networks with VMW in other villages. According to the interview with VMW, they made friends who can easily consult the problems. Meeting with friends also motivated to further participation in regular meetings.

[27] Nickname of the project, which covered North Darfur, South Darfur, West Darfur, South Kordofan and Blue Nile.
[28] Nickname of the project. The target state is Kassala.

(4) Impact on Policy and Organization

The project focusing on enhancing capacity of VMW targeting improvement of MMR and IMR was the first attempt in Sudan. It can be considered that the project has contributed to a certain degree to the formulation and implementation of strategies and plans[29] that emphasize the roles of VMW which were issued during and after the completion of the project. According to the JICA officials, based on the action plan, which was developed by one of the FMOH participants during the training in Japan under the project, the idea of VMW kits and salary payment was incorporated into *PHC Expansion Project*.

In addition, the establishment of a new department of biomedical engineer by Sinnar SMOH to control maintenance and management of provided equipment contributed to strengthening of the system. Two staff members were assigned in the department during implementation of MNP2 and five staff members have been assigned at the time of ex-post evaluation.

MNP established a capacity strengthening and organizing model of VMW, while MNP2 expanded the achievement of MNP to other states and implemented a comprehensive approach in Sinnar. This led to upgrading of the quality of services which VMW provides to pregnant women. Thus, it can be said that the projects have largely achieved the project purpose. Regarding to the overall goal, it was not possible to be quantitatively confirmed. However, INSET for VMW has been sustained nationwide, about 40% of VMW nationwide has received INSET, and "implementation of qualitative continuum of care" has been confirmed to a certain extent from the results of interviews with the relevant persons and quantitative survey in Sinnar state at the time of ex-post evaluation. Therefore, effectiveness and impact of the project are high.

3.3 Efficiency (Rating: ②)

3.3.1 Inputs

Table 7 and Table 8 show the plan and actual inputs of the project.

[29] For example, *National Strategy on VMW* (2010) pointing out the importance of improvement of working condition of VMW, *PHC Expansion Project* (2012-2020) focusing role of VMW and aiming of increase in number and employment of VMW, and *Ten in Five Strategy* (2016-2020) likewise advocating one village one VMW.

Table 7　Plan and Actual of Inputs of MNP

Inputs	Plan	Actual (Project Completion)
(1) Experts	Number and MM not stated ・Expertise (Team Leader, Vice Team Leader/Mother and Child Health (MCH) , Training Plan, Information/Education/Communication (IEC)/Behavior Change Communication (BCC), Community Involvement, etc.	Short-term experts: total of 13 experts in 9 areas (85.86 MM) ・Expertise: Team Leader, Vice Team Leader, MCH, Training Plan, IEC/BCC, Community Involvement, Scaling up of Sinnar Model, Nutritional Education Coordination
(2) Trainees received	Number not stated	Training in Japan: 3 persons Training in Third Country: 3 persons in Jordan “Regional Workshop of Sharing Experiences and Learning from Good/Successful Practices in the Islamic Communities”
(3) Equipment	Vehicle necessary for project activities	2 Vehicles, OA equipment, Training equipment
(4) Local Expenses	Amount not stated (A part of cost necessary for project implementation)	Amount not stated
Japanese Side Total Project Cost	280 million yen	317 million yen
Sudanese Side Total Project Cost	Amount not stated ・Project offices both in FMOH and SMOH ・Basic training and re-education for relevant stakeholder, rehabilitation for training facilities, training equipment, and equipment necessary for VMW activities	Amount not stated ・Project offices both in FMOH and SMOH in Sinnar state ・Incentive for two months for existing VMW in Sinnar state, equipment necessary for VMW activities, etc.

*MM stands for man month.
Source: Information provided by JICA, MNP Terminal evaluation report

Table 8　Plan and Actual of Inputs of MNP2

Inputs	Plan	Actual (Project Completion)
(1) Experts	Number and MM not stated ・Expertise (Chief Advisor, MCH, Health Information System Management, Institutional Capacity Development, Training Management, Medical Facility, Medical Equipment, Dispatch other expertise as necessary)	Short-term Expert: total of 20 experts in 11 areas (119.97 MM) ・Expertise (Chief Advisor/Capacity Development, Deputy Advisor, Training Management, MCH, Medical Facility, Medical Equipment, Medical Equipment for PHC, Health Information System Management, Community and Health Facility Relations, Monitoring and Evaluation, Project

		Coordinator/assisting MCH)
(2) Trainees received	Number not stated	・Training in Japan: 16 people for 12 courses ・Training in Third Country: 10 people in 3 courses (2 courses in Jordan and 1 course in Egypt)
(3) Equipment	Construction and Equipment necessary to improve medical facilities and equipment in Sinnar state	・Provision of equipment to medical facilities in Sinnar state (27 HC, target 3 hospitals) ・Training equipment for INSET for VMW ・VMW Kits, etc.
(4) Local Expenses	・Construction cost to improve the target medical facilities in Sinnar state ・Additional operation expenses necessary for training for facilitators and INSET, part of cost necessary for project implementation	182 million yen Including construction cost of obstetric care units in two hospitals in Sinnar state (51 million yen)
Japanese Side Total Project Cost	470 million yen	716 million yen
Sudanese Side Total Project Cost	Amount not stated ・Project offices both in FMOH and SMOH ・Necessary activity costs for project implementation ・Running cost necessary for midwifery school and INSET ・Tools and consumable necessary for VMW Kits, Provision of incentive	Amount not stated ・Project offices (in FMOH and SMOH in eight target states and Sinnar state) ・INSET expenses for additional 5 days in two target localities in North Kordofan and Gezira state, Provision of accommodation and training facilities for INSET in eight target states, etc.

*MM stands for man month
Source: Information provided by JICA, MNP2 Terminal evaluation report

3.3.1.1 Elements of Inputs

The plan and actual could not be compared both in MNP and MNP2 since number and amount of experts, trainees received, and equipment at the time of planning were not stated. However, in MNP2, according to the terminal evaluation report and the information provided by JICA, it pointed out that there were areas where Japanese experts were fragmentally inputted and replaced frequently, which have affected the productivity of the project and establishment of mutual trust relationship. The common understanding with the implementing agency was promoted such as on how to proceed and direction of the project through changing a dispatch plan of Japanese experts and inputting the JICA senior expert regularly and so on. However, it can be thought that there was a problem in terms of inputting Japanese experts.

3.3.1.2 Project Cost

The project cost of MNP was 317 million yen in actual figure against 280 million yen in planning figure, which exceeded the plan (113% of the planned amount). According to the implementing consultant, the reason of increase was due to the additional activities including subsidy for running cost and training equipment for two midwifery schools, purchasing of VMW kits provided after graduation, 5S seminars[30] for hospitals and health centers. Those additional activities for midwifery schools are considered as necessary for strengthening of VMW who are the target of the project and as supplementary activities to achieve the project purpose. Thus, it is considered as reasonable.

The project cost of MNP2 was 716 million yen in actual figure against 470 million yen in planning figure, which was significantly higher than plan (152%). According to the information provided by JICA, the reasons were additional activities including; 1) provision of equipment to 27 health centers in Sinnar state, 2) implementation of INSET for VMW directly contracted with UNICEF (for five states) [31], 3) implementation of the training in third country, 4) additional implementation of the training in Japan. These activities were considered as necessary to produce effectiveness of the project. It was confirmed that the additional activities contributed to produce the outputs as seen in the above that the additional training in Japan triggered the formulation of *PHC Expansion Project* of FMOH.

Therefore, the project cost for both MNP and MNP2 exceeded the plan.

3.3.1.3 Project Period

The project period of MNP was for three years (36 months) from 10 June, 2008 to 9 June, 2011. That of MNP2 was for three years (36 months) from 10 August, 2011 to 9 August, 2014. Both projects were as planned (100% of the planned period).

Although the project period was as planned, the project cost exceeded the plan. Therefore, efficiency of the project is fair.

3.4 Sustainability (Rating: ②)

3.4.1 Policy and Political Commitment for the Sustainability of Project Effects

The following policies and strategies have been developed after August 2014 when MNP2 was completed. The long-term policy of *National Health Policy* (2016-2025) emphasizes development of health human resources as one of priority issues and stipulates that efforts to

[30] 5S (Sort, Set in order, Shine, Standardize, Sustain) is methodology to improve the work environment.

[31] According to JICA officials, initially the plan was to implement INSET for VMW by each target SMOH. However, it was actually difficult for SMOH alone to manage implementation of INSET for VMW including financial management. Considering the situation, JICA contracted with UNICEF.

achieve Universal Health Coverage (UHC) [32] will contribute to the reduction of MMR and IMR. *Ten in Five Strategy* (2016-2020), which the Sudanese government developed to implement ten strategies in five years under the vision of *Global Strategy for Women's Children's and Adolescents' Health* (2016-2030), puts the reduction of MMR and IMR as a priority issue and emphasizes VMW's capacity development, increase in number and employment as its strategy. In addition, *PHC Expansion Project* (2012-2016) which focuses on the role of VMW in order to achieve UHC has been extended to 2020 and continues to emphasize the strengthening of the capacity of VMW and their institutional aspects. *National Health Sector Strategic Plan* (2016-2020) also advocates the continuity of INSET for VMW (requiring retraining every three years).

Therefore, the necessary policies and institutional aspects for sustaining the project effects are installed.

3.4.2 Institutional/Organizational Aspect for the Sustainability of Project Effects

The function and roles of the relevant departments of FMOH, the implementing agency, are the same as during the project implementation period. Mother and Child Health Division under PHC department was in charge of the project, among which RH section is in charge of training and strengthening VMW. RH section is divided into three units. Safe Motherhood unit is responsible for strengthening the capacity of VMW. Information unit of the RH section has database information on VMW. There are about 30 staff members in total in RH section. Five are allocated in Safe Motherhood unit (including three doctors). In addition to VMW issues RH section is responsible for wide range of areas including family planning, prevention of mother to child transmission, and cervical cancer. Therefore, it cannot be said that the number of staff members is sufficient. However, the situation has been the same as during the project implementation period. Considering the fact that they have been continuously implementing INSET for VMW and improving supporting system, it can be considered that a certain level of organizational arrangement is ensured. In addition, the facilitators for INSET for VMW have been developed in each state of Sudan through the project. Accordingly, there is a system that can continue INSET in each state.

In Sinnar state, with the provision of facilities and equipment in MNP2, the Biomedical Engineering section, which is in charge of maintenance and management of the medical equipment, was newly established at SMOH and 22 biomedical engineers were deployed at the time of ex-post evaluation (5 in SMOH, 17 in 34 primary and secondary hospitals). Five engineers allocated in SMOH visit hospitals in the state quarterly where biomedical engineers are not allocated. Regarding the equipment in health centers, the system is that they respond on

[32] "All people receive the appropriate services on health promotion, prevention, treatment, restoration of function at payable expenses" (https://www.jica.go.jp/aboutoda/sdgs/UHC.html Accessed in Japanese on 14 September, 2018)

call basis. Although it is not enough staff members to cover whole Sinnar state, it can be said that a certain degree of system is in place. However, it should be noted that some cases that the system has not been functioned fully. For example, a biomedical engineer appointed in Suki Locality Hospital has been on long sabbatical leave since 2017, however, the support has not been made by the biomedical engineer department of SMOH. Other case as stated later in 3.4.5 "Status of Operation and Maintenance" was that some problems were observed in maintenance situation of provided equipment in the said hospital and Wad Nile Rural Hospital. Furthermore, among 24 general practitioners in Sinnar state who have received training on Emergency Obstetric and Neonatal Care (EmONC), none of them remained in Sinnar state[33]. However, Nurse Midwife who received EmONC training have continuously worked at health facility in Sinnar state. Therefore, the system to ensure the project effects to a certain degree is installed.

Thus, some minor problems have been observed in terms of organizational aspects to sustain the project effect.

3.4.3 Technical Aspect for the Sustainability of Project Effects

FMOH officials have updated the training curriculum and teaching materials developed by the project and conducted training by themselves. There is no major technical problem for FMOH officials concerning INSET for VMW. FMOH is also carrying out technical training for facilitators on newly required issues in order.

Biomedical engineers in SMOH who implements maintenance and management of provided equipment in hospitals and health centers in Sinnar state have opportunities to receive technical training from FMOH. They have been conducting maintenance activities in accordance with the maintenance guideline of FMOH.

Thus, no major problems have been observed in technical aspects on VMW capacity development and maintenance of facilities and equipment.

3.4.4 Financial Aspect for the Sustainability of Project Effects

The detailed budget on mother and child health in FMOH could not be obtained since it was not disclosed. However, as stated above FMOH has continued INSET for VMW and training of facilitators which are necessary to continue the effect of the project. Although the number of the training which they have done is not enough compared to the needs, it can be appreciated that budget has been allocated continuously even in the tight fiscal circumstances of Sudan[34]. In addition, according to FMOH, WHO has decided to support two training courses of

[33] According to FMOH and SMOH, doctors in rural areas in Sudan move on a rotation of two to three years and it is a problem that the retention rate is very low.

[34] According to *African Economic Outlook 2018* by the African Development Bank, the real GDP growth rate was 3.3% on average from 2011 to 2016, compared to an average of 7.1% from 2000 to 2010. It is forecasted to be 4% in 2018 as domestic demand decreases. In addition, according to IMF, the inflation rate is rapidly rising from 17.8% in 2016 to 32.4% in 2017 and to 43.5% in 2018.

facilitators (20 people) and INSET for VMW for 500 VMW in five states[35] in FY 2018. Continued support can be expected from FY 2019 onwards, therefore, it is anticipated that a certain degree of effect will sustain in capacity development of VMW.

At the time of ex-post evaluation, the proportion of VMW who is hired by SMOH or receives incentives has steadily increased from about 20% at the time of completion of MNP2 to 55% of the total VMW. Therefore, financial allowance for VMW has been secured to a certain extent.

At the time of ex-post evaluation, FMOH introduced delivery kits consisting of necessary consumables for assisting delivery such as cotton, gloves, and vinyl sheets to reduce the burden on VMW. They were delivered to SMOH of each state although sufficient quantities cannot be secured due to budget constraints. The delivery kits are meant to be distributed to pregnant women, however, it was observed in the visited states[36] that many delivery kits were remained in warehouse of SMOH since there was no budget to distribute them around the state. As VMW have purchased necessary consumables from their pockets or rewards from pregnant women as usual, there was no particular indication that they could not perform due to lack of provided consumables. However, it is necessary for FMOH to conduct monitoring and provide guidance to SMOH as for distribution of delivery kits.

Therefore, it can be said that a certain level of finance has been secured to sustain the project effect for safe delivery by VMW and no major problems have been observed in financial aspect.

3.4.5 Status of Operation and Maintenance

There have been serious cracks in the whole building of the obstetric care unit at Suki Locality hospital constructed by MNP2 since the second year of completion. The facility has been utilized as it was, however, large-scale rehabilitation and reinforcement began at the time of ex-post evaluation. It was judged by the hearing from Sinnar SMOH, officials from the hospital and JICA Sudan office as well as the report from JICA Project Formulation Advisor (Finance Cooperation) who has expertise on building maintenance that the cracks occurred primarily due to uneven settlement caused by soft ground (inclination of the building due to distortion of the ground, etc.) and it was not the matter of maintenance[37]. During the site survey at the time of ex-post evaluation, even after the rehabilitation some troubles were observed such that water was not available due to water tank problem and that air conditioners could not be used in some rooms. As for the obstetric care unit at Wad Nile Rural Hospital, it was confirmed

[35] North Kordofan state, Gezira state, Gedaref state, Northern state, South Darfur state
[36] Sinnar state, White Nile state and Gezira state
[37] According to JICA Sudan office, it has been understood that the ground was soft from the design period and countermeasures to the extent possible have been undertaken. According to the JICA Project Formulation Advisor, the fact that construction site was weaker than the surrounding land, seemed to be the cause of the uneven settlement.

that the operation theatre was utilized every two days a week for caesarean operation[38]. However, the delivery room has not been used due to the hygienic problem. This is because the drainage system has not functioned well from the beginning of 2017 and the wastewater has returned into the room. Therefore, the delivery room which was existed before the project was utilized instead.

Some problems were observed in equipment. Regarding the incubators provided for the two obstetric care units, there was no problem in the condition, however, they have not been utilized for more than three years. According to Sinnar SMOH, a nurse with the qualification necessary for handling an incubator (senior nurse or specialized nurse) had not been in place for three years in Suki Locality Hospital and for more than two years in Wad Nile Rural Hospital. In addition, Suki Locality Hospital has reported the problem of suction machine to the biomedical engineering department of SMOH, it has not been repaired for more than two years.

The Minister of Health in Sinnar state who were interviewed at the time of ex-post evaluation expressed that he would clarify the roots of the problems and cope with them at an early stage with respect to the above two facilities and broken equipment. In addition, regarding the incubators, the Minister promised that the training for nurses would be conducted in order to be utilized them. Therefore, improvement of status of operation and maintenance is expected to be made.

Thus, it can be said that there are some problems in the status of operation and maintenance.

Some minor problems have been observed in terms of the organizational and operation and maintenance aspects. Therefore, sustainability of the project effects is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The project was implemented aiming at promoting safe delivery throughout Sudan by enhancing the quality of maternal and child health services provided by VMW. MNP developed an empowerment model which strengthened the capacity of VMW and the support system for VMW's activities in the pilot state, Sinnar state. In the subsequent MNP2, the empowerment model developed by MNP was scaled up in other eight states. In addition, in Sinnar state a comprehensive approach for mother and child health centered on VMW was established including the strengthening of medical facilities and equipment and capacity of medical personnel that MNP could not cover.

The objective of the project is consistent with health policy and development needs of the

[38] According to the officials of Wad Nile Rural Hospital, about eight caesarean operations a week have been implemented both in the operation theater which is existed before the project and in the operation theater built by the project. The days when operation is not done are devoted to disinfection.

country and "support for improvement of basic human needs" which is the priority issue of Japan's assistance to Sudan. Therefore, the relevance is high. Although the achievement of the project purposes could not be quantitatively verified in part, considering the achievement of each output and the interview results from the stakeholders, it can be thought that the projects largely achieved their project purposes at the time of completion. Since MNP2 was implemented based on the achievement of MNP, overall goal of MNP and MNP2 were both considered as "implementation of high quality of continuum of care by VMW in whole country". INSET for VMW introduced by the project has continued even at the time of ex-post evaluation and about half of VMW in the country has been covered by the training. Although the reliable quantitative data on continuum of care and referral[39] by the strengthened VMW was not obtained, it was confirmed from the results of qualitative interview as well as quantitative survey in the visited states conducted at the time of ex-post evaluation that VMW were providing more appropriate maternal and child services than before the project to a certain extent. Therefore, overall goal was judged as almost achieved. The other positive impacts were also observed. Therefore, the effectiveness and impact of the project are high. The project period was as planned, on the other hand, the project cost exceeded the plan. Thus, the efficiency is fair. The sustainability of the project effect is fair since some problems have been observed in terms of organizational aspect and maintenance status.

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

4.2 Recommendations

4.2.1 Recommendations to the Implementing Agency

FMOH has system to consolidate data in regards for VMW by each state. However, there is a problem with accuracy of collected data by VMW on maternal and child health (for example, numbers of ANC, PNC and referral) which is submitted to FMOH by SMOH. Accordingly, it is difficult to maintain the reliability of basic data necessary for capacity building training and assessment of effect of VMW. Instead of inputting data submitted by SMOH as it is, FMOH (Mother and Child Health Division) should foster critical eyes when the data differs greatly from the usual year after comparing the past years. It is important to upgrade the quality of data by firstly providing feedback to the staff members of SMOH.

Sinnar SMOH should immediately respond to the following problems; drainage problems in the obstetric care units in the two hospitals constructed in MNP2, repair of broken equipment including sucking machine in Suki Locality Hospital, and training of nurses in order for the incubators of both the hospitals to be utilized. In addition, in regard to the obstetric care unit at Suki Locality Hospital where the cracks were repaired, SMOH needs to undertake initiatives to

[39] Referral means to introduce/transfer patients who cannot cope with lower medical facilities like primary medical facilities to upper medical institutions such as secondary and tertiary levels.

conduct periodical monitoring on the condition of building. Furthermore, since the biomedical engineer allocated in Suki Locality Hospital has been absent for a long time, it is desirable that SMOH build a system that can appropriately cope with such as through allocating substitute personnel or assigning a staff from the biomedical engineer department of SMOH to take in charge of the said hospital.

4.2.2 Recommendations to JICA

JICA should confirm the reaction by SMOH on the above two hospitals in Sinnar state during FY 2018. Based on the assessment of JICA project formulation advisor in Kenya who has expertise in maintenance management, it is also necessary for JICA to monitor the obstetric care unit of Suki Locality Hospital for one year after rehabilitation in cooperation with Sinnar SMOH whether or not cracks do not occur in the building under the influence of the ground. In addition, based on the monitoring results, it is desirable that JICA encourage Sinnar SMOH to undertake initiative for maintenance and management.

4.3 Lessons Learned

(1) Indicators that can grasp the effect of the project should be set.

"Reduction of MMR and IMR" was set as indicator of overall goal in MNP2. It was difficult to measure the contribution of the project since this indicator has too many external factors and there was a gap between project purpose and overall goal. When such indicators were set, it cannot grasp the project effect accurately. Furthermore, there are few data by donors in Sudan and reliability of official data obtained from the end such as VMW is low. When setting the project effectiveness by quantitative indicators in such countries, it is necessary to decide indicators with consideration of when the outcome of the project are shown as well as the timing of measuring outcome, and the reliability of those data. Otherwise, such activities to strengthen obtaining and scrutinizing data from relevant personnel should be included in the project.

(2) Establishment and verification of a comprehensive approach centered on VMW effective for continuum of care for mother and child

This project tried to establish a model of "comprehensive approach" including strengthening medical facilities and medical personnel as well as strengthening and organizing VMW. As a result of introducing this approach, the relationship between VMW and HV, their supervisor, has been strengthened, the understanding of community and medical personnel towards VMW has been nourished, the appreciation to VMW has increased, and the motivation of VMW themselves has been upgraded. In addition, there was a report that with regard to the upgraded and equipped medical facilities, the usage of pregnant women was promoted and

VMW became easier to refer. It can be said that such comprehensive approach resulted in improvement of the quality and promotion of implementation of continuum of care for mother and child. Even in the case of community based mother and child health projects, not merely focusing on strengthening VMW's capacity but comprehensively developing and strengthening the surrounding environment of VMW, that will lead to improvement of mother and child health services provided by VMW. However, since it was not compared with the areas where facilities and equipment have not been improved, it is necessary to verify in the future.

END

Annex Table 1　Achievement of indicators of Outputs (At the time of completion)

Output	Indicator	Achievement
＜MNP＞		
Output 1: Organizational capacity of FMOH and SMOH, and rules and regulations of VMW are strengthened to perform appropriate MCH services. <Achieved>	1-1 VMW's policy is reviewed and strengthened.	Achieved ・After reviewing the existing policy and institutional arrangement with FMOH, agreed on INSET for VMW, reconfirmed on the training policy and clarified roles and rights of VMW. In Sinnar state, employment system was introduced since 2011.
	1-2 Curriculum of in-service training for VMW is developed.	Achieved ・Curriculum for INSET for VMW was not existed. Seven-day program was developed in February in 2009 by the project.
	1-3 Guideline of in-service training for VMW is developed.	Achieved ・A guideline was developed including the above curriculum, teaching methodologies, and procedure of training management. It was approved by FMOH.
	1-4 Assigned focal person of FMOH coordinate technical coordination meeting of VMW training with SMOH.	Achieved ・Although there was a change of assigned personnel, FMOH officer, whether or not she/he was not in charge, visited Sinnar state and coordinate issues on VMW with SMOH. ・RH coordinator meetings were held twice a year. The achievement from MNP was shared with other states.
	1-5 Numbers of facilitator who can provide in-service training for VMW is increased (from 0 to 10).	Almost Achieved ・Nine facilitators were developed.
	1-6 Administration staff in charge of VMW training is assigned in pilot state.	Not Achieved ・Administration staff was not assigned due to financial reason.
	1-7 FMOH and SMOH submit technical report on the impact of VMW's in-service training in pilot state (including the assessment of job performance).	Achieved ・HV conducted interview in EL survey and SMOH consolidated the report.
Output 2: MCH services are provided through empowered and organized VMWs in Pilot State. <Achieved>	2-1 Number of VMW's graduated in-service training and pre-service training.	Achieved ・556 out of 566 VMW in Sinnar state at the completion time received INSET (coverage is 98%). ・According to the implementing consultant, 90 VMW graduated from pre-service training from midwifery schools, against target value of 100 VMW (50 VMW each from two midwifery schools) (Achievement 90%)
	2-2 Number of VMW participated in regular meetings at health facilities is increased.	Almost Achieved ・Developed a VMW list in Sinnar state and allocated medical facilities and supervisors for each VMW to be belong to. At the time of terminal evaluation, 65% of HV turned to have regular meetings with VMW. Before the project, there were VMW who have received visits from HV only once in two to three years. The mechanism of regular meetings at medical facilities was groundbreaking.
	2-3 Number of community events which are planned and implemented by VMW and community in model villages.	Achieved ・Held community events in four model villages once each in order to raise community awareness. Community understood the importance of work conducted by VMW. That led to increase in user of ANC and family planning.
	2-4 Necessary equipment and materials for services are provided to VMWs by SMOH.	Partially Achieved ・A part of VMW Kits were provided by SMOH to VMW (consumables such as cotton and gloves)

Output	Indicator	Achievement
Output 3: Horizontal communication network among northern states and relevant stakeholders is strengthened to address the issue on MCH. <Achieved>	3-1 Number of publications by the Project	Achieved ・Developed two kinds of pamphlet ・Distributed progress reports in regular meetings and shared information.
	3-2 Number of regular meetings and exchange visits between SMOHs are increased.	Achieved ・Attended the RH coordination meeting twice a year which was the core regular meetings. ・Conducted TOT for INSET for VMW in total of six target states of SMAP and K-TOP. Total of 68 people received TOT and 52 out of them were certified as facilitators. ・Conducted two field visits to other states. In Khartoum the project conducted INSET and seminar on methodology of training operation and management inviting five states.
	3-3 Progress and achievement of the project are shared among stakeholders.	Achieved ・Project progress and achievement were shared with FMOH, SMOH in other states, and donors at the RH coordination meeting which were held twice a year. ・After the completion of project, a presentation workshop on achievement was held inviting relevant persons in all 15 states and shared information.
＜MNP2＞		
Output 1: Institutional capacity of FMOH and SMOHs in maternal and newborn health is strengthened. <Achieved>	1-1 More than 6 states (excluding Sinnar state) develop lists of VMW based on in-service training.	Achieved ・Collected VMW lists from 8 target states through INSET. The information was compiled at FMOH by collecting the lists from other states than target and a list was developed.
	1-2 Number of VMWs who receive regular incentive or salary is increased.	Achieved ・The indicator does not show the output achieved through the activities of the project. Instead of increase in the number of VMW who receive regular incentive or salary, “clarifying the VMW support system” including the development of document which was the basis of guideline on the VMW support system, is a result of strengthening the institutional capacity.
	1-3 Number of VMWs who receive supplies and consumables of VMW Kit from SMOHs is increased.	Achieved ・The indicator is also similar to 1-2. The contribution of the project was that “The VMW Kit was standardized” instead of increasing the number of VMW who receives VMW kits.
	1-4 Number of actions taken according to the action plan of Medical Engineering Working Group (ME-EG).	Achieved ・ME-EG consisted of FMOH, Sinnar SMOH, officers in charge of medical equipment. Based on the situation analysis, five action plans were developed to fill the gaps identified from the analysis of the survey results. By the completion of the project, five action plans were completed.
	1-5 FMOH has a workforce planning of VMW.	Achieved ・Similar to the indicators 1-2 and 1-3, this indicator was achieved but it was not achieved through the project activities. However, the achievement of the indicator is largely influenced by MNP and MNP2’s approach to FMOH. The contribution of the project was that workforce planning of VMW and others were incorporated into *PHC Expansion Project*.
Output 2: Capacity of VMWs is strengthened in order to provide	2-1 80 facilitators for VMW in-service training are trained.	Achieved ・As in Annex Table 6, 82 facilitators and 26 assistant facilitators were developed in MNP2.
	2-2 210 VMWs are trained in in-service training in model locality.	Achieved ・As in Annex Table 5, in each model locality of Gezira

Output	Indicator	Achievement
quality maternal and newborn care in the 8 states. <Almost Achieved>		state and North Kordofan state total of 215 VMW, 111 VMW and 104 people respectively, received INSET.
	2-3 More than 80% of VMWs receive regular training follow-up in selected model sites.	Not Achieved ・The participation rate of regular meeting was 37.1% and 56.1% in North Kordofan state and Gezira state respectively. The reasons for not achieving were that there were no transportation expenses or incentives. In North Kordofan state, security deterioration was one of factors.
	2-4 80% of VMWs increase knowledge and skills after participating in-service training in selected model sites.	Achieved ・According to the tests conducted by the project before and after the training, the score increased 93% of VMW in North Kordofan state and 90% of VMW in Gezira state
Output 3: A model of comprehensive approach to improve maternal and newborn health is established in Sinnar state. <Almost Achieved>	3-1 Number of ANC, delivery and referral provided by skilled birth attendants at hospitals* in Sinnar state increases. (* Referral data is collected from Sinnar Teaching Hospital, Suki Locality Hospital and Wad Nile Rural Hospital.)	Almost Achieved ・Number of ANC increased 39.1% from 2010 to 2013. ・Regarding assistance in delivery at facilities by skilled birth attendants increased 51% from 2010 to 2013. It can be said that the number of delivery at facility has increased due to the fact that the ratio was higher than the population increase. ・The trends of change on referral was not identified since data on referral was not recorded and collected at the hospitals.
	3-2 80% of general practitioners increase knowledge and skills of EmONC after the training.	Achieved ・95.8% of general practitioners increased the score before and after the training.
	3-3 80% of Nurse Midwives increase knowledge and skills of EmONC after the training.	Achieved ・After implementing training on obstetric session of EmONC and neonatal session for Nurse Midwife, the score increased 77.8% and 88.9% respectively.
	3-4 Improved health facility and provided medical equipment is appropriately used and maintained according to the checklist developed.	Achieved ・The obstetric care units at two hospitals in Sinnar state were constructed. ・Building and equipment checklists for the constructed obstetric care facility was formulated. ・Medical equipment was provided to three hospitals in Sinnar state and whole 27 health center in Sinnar state. A set of guideline and user manual is developed for medical equipment maintenance.
	3-5 A person in charge of medical engineering/health facility maintenance is assigned to Sinnar SMOH.	Achieved ・One official in charge of building was allocated in SMOH from February 2012. ・Biomedical Engineer section was established under the Division of Curative Medicine of SMOH. Total of three officers were assigned, one in September 2011 and the other two in January 2013.
	3-6 More than 4 communities have pregnancy registration and emergency referral system.	Achieved ・Information collection by volunteers and pregnancy registration by VMW were carried out in all eight villages where the project directly intervened. ・Community emergency referral fund was established in seven out of eight target villages.

Annex Table 2　Results from Baseline and End-line Surveys (Sinnar State)
（Summary of Difference of Means of Two Populations (2-sample t-test)）

		7 Localities, Sinnar state			South Gezira Locality, Gezira state			Oum Ruwaba Locality, North Kordofan state		
		N	Average	Sig. (2-tailed)	N	Average	Sig. (2-tailed)	N	Average	Sig. (2-tailed)
No. of ANC	BL	125	7.64	**.001*** **	90	6.17	.808	82	5.39	**.012***
	EL	141	11.94		83	5.90		68	3.10	
No. of Referral from ANC	BL	125	1.10	.219	90	1.03	.372	82	.76	.125
	EL	141	1.37		83	.88		68	.43	
No. of Assisting delivery	BL	125	3.27	.499	90	2.12	**.026***	82	2.94	.646
	EL	141	3.50		83	2.87		68	2.68	

Note: Services that VMW provided during the 30 days from the interview time　*p<0.5, **p<.01, ***p<.001
N：Population
Baseline survey was conducted from November 2011 to May 2012. (Report issued in August 2012)
End-line survey was conducted from October 2013 to January 2014. (Report issued in August 2014)
Source: Information provided by JICA

Annex Table 3　Summary of Difference of Means of Two Populations (2-sample t-test)

State (Target locality	Number of ANC	Referral from ANC	ANC Referral Rate	Number of deliveries	Referral from deliveries	Delivery Referral rate
Sinnar	Significantly increased (p=0.001)	Increased	Decreased	Increased	Significantly increased (p=0.019)	Increased
Gezira	Decreased	Decreased	Decreased	Significantly increased (p=0.026)	Significantly increased (p=0.004)	Significantly increased (p=0.003)
North Kordofan	Significantly decreased (p=0.012)	Decreased	Increased	Decreased	Significantly increased (p=0.001)	Significantly increased (p=0.002)

Source: Information provided by JICA

Annex Table 4　No. of VMW, Employment, Incentive Receiver, and VMW who received INSET for VMW by State (as of December, 2017)

No	State	No. of VMW	No. of VMW who are employed by SMOH	Employment Rate	No. of VMW who receive incentive from Social Security*1	No. of VMW who receive incentive from FMOH*2	Rate of VMW received incentive from FMOH	No. of VMW received INSET*3
1	Gedaref	997	654	66%	0	105	11%	175
2	Kassala	1,137	981	86%	450	81	7%	150
3	Red Sea	634	590	93%	35	101	16%	75
4	Northern	642	419	65%	150	42	7%	200
5	River Nile	605	342	57%	310	28	5%	270
6	Khartoum	2,012	1,274	63%	325	38	2%	200
7	Gezira	2,318	1,048	45%	470	99	4%	150
8	Sinnar	1,056	295	28%	580	25	2%	150
9	Blue Nile	910	906	100%	225	108	12%	225
10	South Kordofan	1,029	937	91%	448	48	5%	175
11	West Kordofan	1,426	298	21%	482	52	4%	261
12	North Kordofan	2,500	0	0%	850	65	3%	200
13	White Nile	1,491	443	30%	735	52	3%	125
14	East Darfur	638	443	69%	170	100	16%	125
15	South Darfur	2,107	1,144	54%	582	173	8%	50
16	West Darfur	1,224	1,000	82%	400	146	12%	125
17	Central Darfur	775	350	45%	38	169	22%	0
18	North Darfur	2,084	355	17%	750	59	3%	75
	Total	**23,585**	**11,479**	**49%**	**7,000**	**1,491**	**6%**	**2,731**

Note: *1: Implemented for only one year of 2016 due to the shortage of fund from Social Security. 250 SDG per month

*2：Although it may stuck sometimes, it is retroactively paid monthly. 250 SDG per month

*3：The numbers of VMW who received INSET by the project, JICA related projects and donor funded training courses are not included since it is the number implemented by FMOH as a part of *PHC Expansion Project* after 2015 when the new curriculum was introduced.

Source: FMOH

Annex Table 5 Achievement of INSET for VMW by JICA Related Projects

No	State	MNP 1	MNP 2		JICA SMAP		JICA K-TOP	Total (as of Nov. 2013)
			Direct	UNICEF Contract	UNICEF Contract	Grant assistance through UNICEF		
1	Gedaref	-	-	-	-	-	-	0
2	Kassala	-	-	-	-	-	177	177
3	Red Sea	-	-	126	-	-	-	126
4	Northern	-	-	126	-	-	-	126
5	River Nile	-	-		-	-	-	0
6	Khartoum	-	-		-	-	-	0
7	Gezira	-	111	210	-	-	-	321
8	Sinnar	556	-	-	-	-	-	556
9	Blue Nile	-	-	-	147	368	-	515
10	South Kordofan	-	-	-	126	667	-	793
11	West Kordofan*	-	-	-			-	
12	North Kordofan	-	104	149	-	-	-	253
13	White Nile	-	-	189	-	-	-	189
14	East Darfur*	-	-	-	147	697	-	1,079
15	South Darfur	-	-	-	235		-	
16	West Darfur	-	-	-	147	261	-	554
17	Central Darfur*	-	-	-	146		-	
18	North Darfur	-	-	-	215	854	-	1,069
	Total	**556**	**215**	**800**	**1,163**	**2,847**	**177**	**5,758**

Note:
1) JICA SMAP: “Project for Human Resources Development for Darfur and the Three Protocol Area”
2) JICA K-TOP: “Capacity Development Project for Provision of the Services for Basic Human Needs in Kassala”
3) Darfur states were divided into five states from three states from May 2011. East Darfur state and Central Darfur state were newly established. In July 2013, West Kordofan state was separated from South Kordofan state.

Source: Information provided by JICA, Ex-post Evaluation Report on “Project for Human Resources Development for Darfur and the Three Protocol Area”

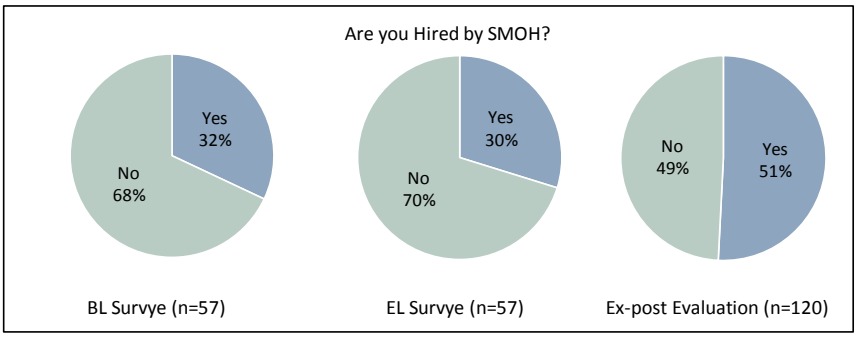
Annex Table 6 No. of HV/AHV who were approved as Facilitators and Assistant Facilitators after TOT of INSET for VMW

No	State	MNP1		MNP2		Total Facilitator
		Facilitator (HV)	Assistant Facilitator (AHV)	Facilitator (HV)	Assistant Facilitator (AHV)	
1	Gedaref	-	-	12	4	12
2	Kassala	6	3	-	-	6
3	Red Sea	-	-	6	1	6
4	Northern	-	-	7	1	7
5	River Nile	-	-	9	4	9
6	Khartoum	-	-	15	-	15
7	Gezira	-	-	9	6	9
8	Sinnar	9	-	-	-	9
9	Blue Nile	6	3	-	-	6
10	South Kordofan	7	3	-	-	7
11	West Kordofan	-	-	-	-	0
12	North Kordofan	-	-	12	6	12
13	White Nile	-	-	12	4	12
14	East Darfur	-	-	-	-	0
15	South Darfur	14	-	-	-	14
16	West Darfur	5	-	-	-	5
17	Central Darfur	-	-	-	-	0
18	North Darfur	14	-	-	-	14
	Total	**61**	**9**	**82**	**26**	**143**

Source: Results from questionnaire to MNP implementing consultants, Information provided by JICA

<Results of Quantitative Survey Conducted in Sinnar State at the Ex-post Evaluation>

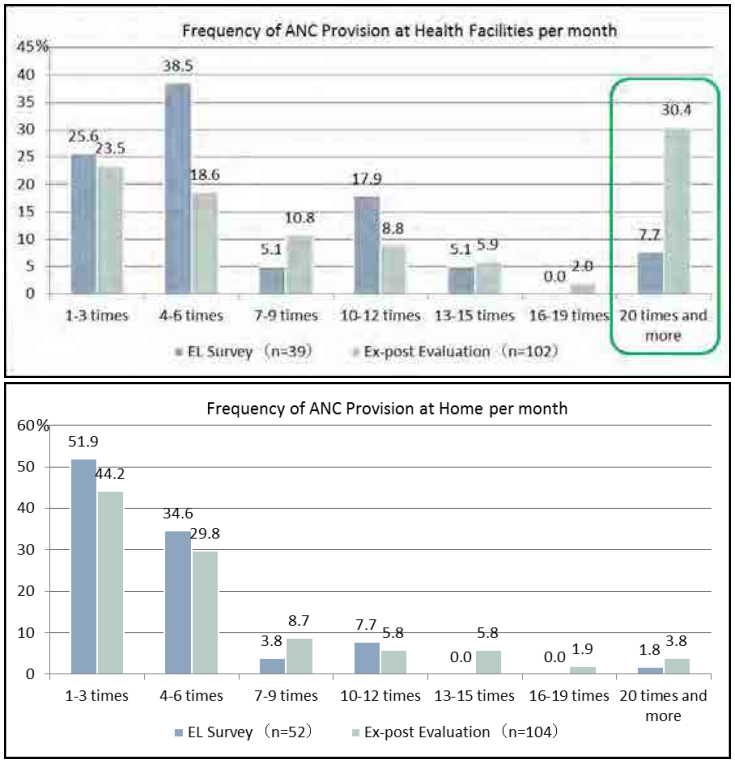
（1） Employment situation of VMW



Source: Results of the quantitative survey at the ex-post evaluation

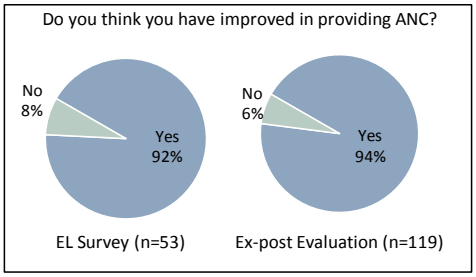
Annex Figure 1 Employment Status of VMW (Sinnar State)

（2） ANC situation



Source: Results of the quantitative survey at the ex-post evaluation

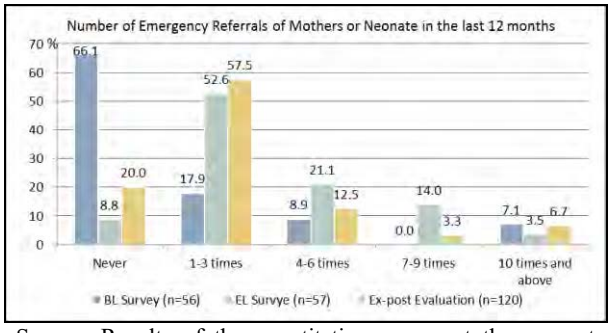
Annex Figure 2 Frequency of ANC (at Health Facility/at Home)



Source: Results of the quantitative survey at the ex-post evaluation

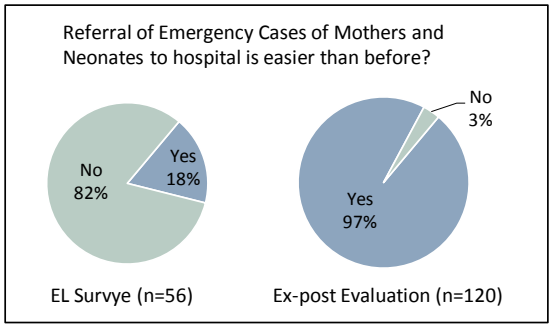
Annex Figure 3 Change in awareness on improvement of ANC

（3） Referral situation



Source: Results of the quantitative survey at the ex-post evaluation

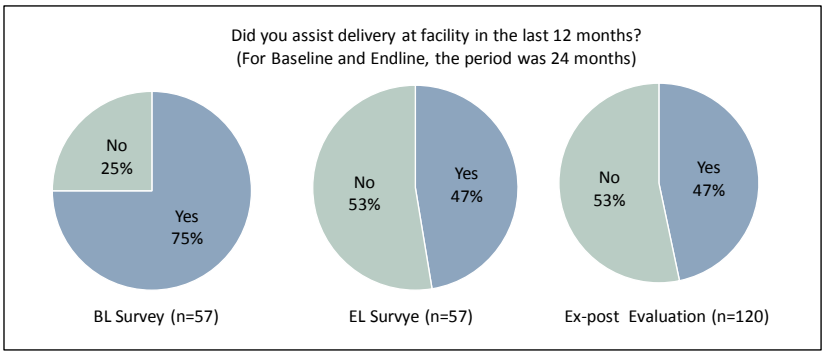
Annex Figure 4 Number of Emergency Referral



Source: Results of the quantitative survey at the ex-post evaluation

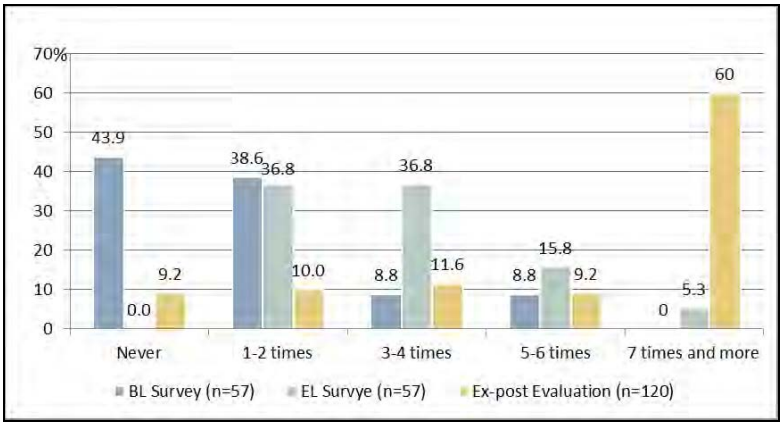
Annex Figure 5 Easiness of Referral

（4） Situation of Assisting in Delivery



Source: Results of the quantitative survey at the ex-post evaluation

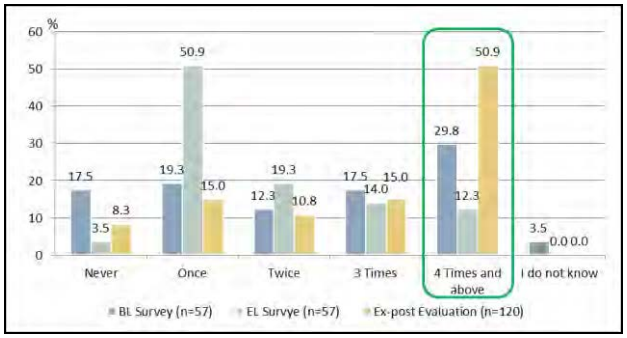
Annex Figure 6 Assist in Delivery at Health Facility in the past two years (past 12 months only for the time of ex-post evaluation)



Source: Results of the quantitative survey at the ex-post evaluation

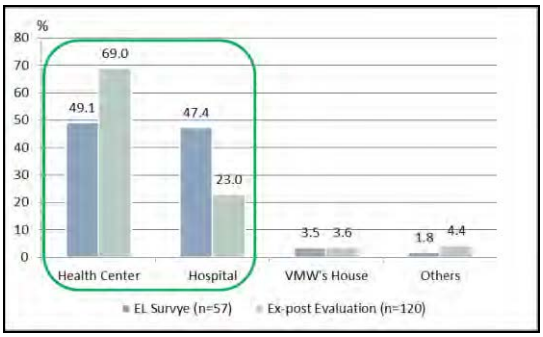
Annex Figure 7 Monthly Average Number of Assisting Delivery at Home

（5） Supervision and Guidance for VMW



Source: Results of the quantitative survey at the ex-post evaluation

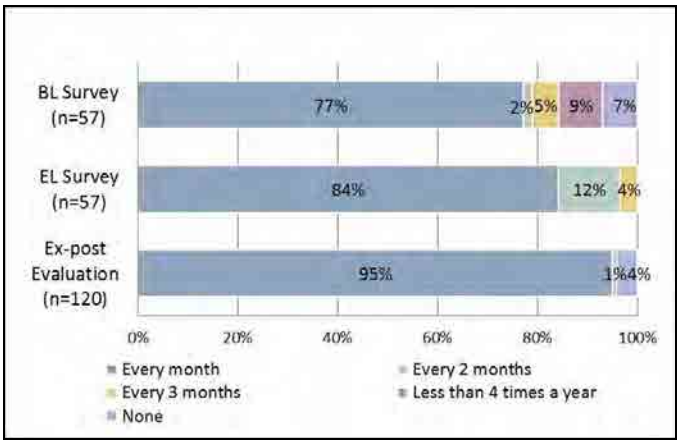
Annex Figure 8 Number of Times VMW's Recived Supervision and Guidance per Month



Source: Results of the quantitative survey at the ex-post evaluation

Annex Figure 9 Place where Supervision is Usually Received by VMW

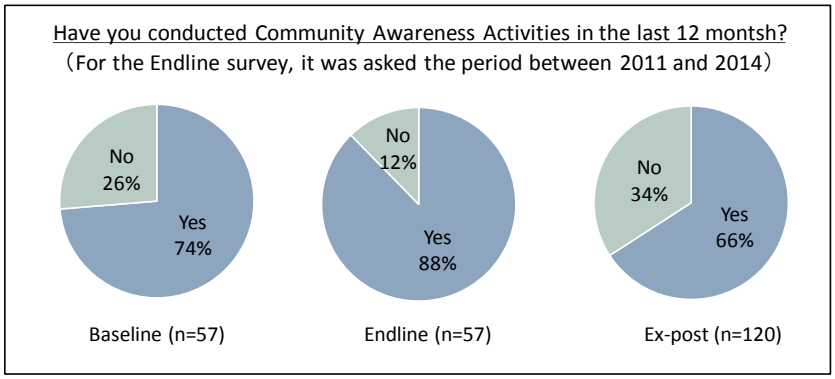
（6） Record / Report by VMW



Source: Results of the quantitative survey at the ex-post evaluation

Annex Figure 10 Frequency of Report Submitted to Supervisor

（7） Strengthening of Relations with Community



Source: Results of the quantitative survey at the ex-post evaluation

Annex Figure 11 Conducting Community Awareness Activities in the last 12 months