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ASEAN's 10 member states[1]

FY 2020 Ex-Post Evaluation Report for Technical Cooperation Project

"ASEAN University Network/Southeast Asia Engineering Education Development Network (AUN/SEED-Net) project Phase 3"

External Evaluator: Kaneyasu Ida, Tekizaitekisho LLC

0. Summary

This project aims to form higher education networks specializing in engineering in the 10 countries making up the Association of South East Asian Nations (ASEAN) and reinforce the educational and research capacities of engineering universities in the region. Phase 3 was implemented following a preparatory phase and phases 1 and 2. Strengthening the networks in higher education is a shared need for ASEAN and the member institutions (MIs), making this project highly relevant. In Phase 3, universities and companies carried out collaborative research, and researchers at MIs engaged in collaborative research on a broad range of themes, such as natural disaster and the environment. As such, researchers at MIs gained a wealth of experience with industry-university linkage and collaborative research on common regional issues. In the scholarship program, the percentage of students earning PhD, which gives them a high likelihood of becoming teaching staff and researchers, was high compared to Phases 1 and 2, demonstrating the program's effectiveness in raising university teaching staff and researchers. In addition, the ASEAN Engineering Journal (AEJ), a publication started by AUN/SEED-Net, was indexed by the Thai Citation Index and ASEAN Citation Index, which increased contributions from researchers other than alumni members of the project's scholarship program and raised its status as an academic journal. In addition, regional conferences in ten engineering fields supported by the project were effective forums not only for the presentation of research results, but also for considering collaborative research and joint education programs. As a result, this program's returning students and researchers at the MIs engaged in collaborative research took the central role in starting courses for international graduate school programs during Phase 3, and the number of joint education programs between MIs, such as double degree programs, exchange student programs, exchange programs for instructors, short-term study abroad and research programs, increased and were highly effective.

In this ex-post evaluation, 114 collaborative research programs supported by the project were examined to what extent they had social impacts, and it was confirmed 29 concrete social impacts to the private sector and government such as joint patents and technology transfer and other. In regards to industrial human resource development, in 2018 at least 1,275 students earned PhDs from MIs, and 174 PhD recipients found employment with companies, showing that the project

[1] The 10 member states making up ASEAN are Thailand, Malaysia, Indonesia, the Philippines, Laos, Cambodia, Myanmar, Vietnam, Singapore and Brunei.

also had an impact in turning out advanced human capital for industry. These points indicate that the project had satisfactory effectiveness and impact.

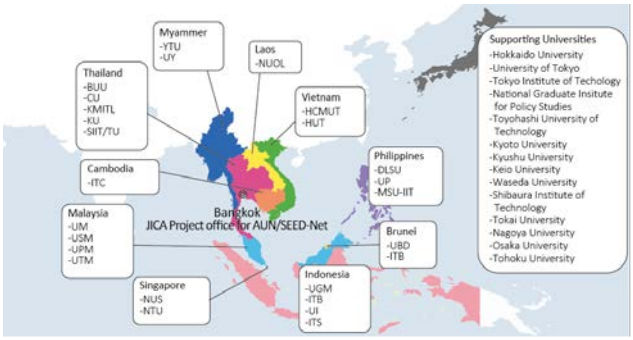
The dispatch of experts, project duration and cooperation amount were in line with the plan. Thailand, where the project's secretariat office is located, took on responsibility for appointing a deputy executive director and secretaries and the running costs for the office. MIs also took steps such as giving exemptions or reducing tuition for the scholarship recipients, as initially planned. Given these points, efficiency was high.

The member countries' government institutions and MIs have strong expectations that collaborative research and scholarship programs within the region will raise the quality of education and research and strengthen networks with Japanese companies and universities. Continuity in the policy aspect is high. In the institutional aspect, almost all MIs have established cooperation agreements with other member universities. Of the six universities in CLMV[2], alumni organizations have been formally established at four universities. As such, the foundation for networks between MIs has been built. In the technical aspect, the publication of AEJ and regional conferences are particularly important. AEJ has extremely high sustainability since its inclusion in the Scopus index[3] in 2019 means that stable contributions can be expected. MIs have built up experience in holding field-specific regional conferences and are already able to run them on their own. They have also gained good experience in conducting Collaborative Research with Industry (CRI). In the institutional aspect, collaborative research continues as a consortium, including the private sector. Alumni associations has been well instituted, and regional conferences and AEJ also continue. On the budget side, the scholarship program, which account for a high percentage of the budget, are almost over, and activities with a narrower input scale are now possible. In addition, MIs are very motivated to continue regional conferences and AEJ, including the budget input, so it will be possible to continue these programs – on a smaller scale for the conferences. There is also a possibility that MIs would continuously support some functions of the secretariat office after the end of Phase 4. Given these points, it is judged that sustainability is high.

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

[2] The four countries are Cambodia, Laos, Myanmar and Vietnam.
[3] SCOPUS is the world's largest abstract and citation database for post-print documents.

1. Project Description



List of participating universities in ASEAN and Japan

Regional conference hosted in 2017 by the Institute of Technology of Cambodia (geological and geo-resource engineering field)
* Reposted from AUN/SEED-Net's Facebook page

1.1 Background

At the Japan-ASEAN Summit Meeting held in 1997, then-Prime Minister of Japan Ryutaro Hashimoto announced the Japanese government's plans to provide cooperation to strengthen higher education in ASEAN in order to overcome their economic crisis. In response to this announcement, it was recognized that transferring Japan's experience and know-how in higher education and research in the engineering field to engineering universities in ASEAN would be effective in developing human resources able to adapt to globalization within ASEAN. Accordingly, AUN/SEED-Net was established as a sub-network specializing in engineering of the ASEAN University Network (AUN)[4], a framework for cooperation among universities in the ASEAN region. After a two-year preparatory period from 2001, the project was formally started in March 2003 for a five-year period through March 2008. Phase 1 was intended to build the foundation for networks among MIs and improve the qualifications of academic staff. Phase 2 was started in March 2008 for a five-year period lasting through March 2013. This phase was intended to further strengthen the foundation, expand the scope of the project and continue helping academic staff acquire degrees, using as its base the improvements made to academic staff qualifications and the networks among MIs that were established in Phase 1. During both phases, there were 19 universities in ASEAN and 11 Japanese Supporting Universities (JSU). During Phases 1 and 2 of AUN/SEED-Net, the project's focus was on improving the education and research capacity of academic staff at MIs through study abroad in the region and Japan, but there were still issues in terms of reinforcing networks among MIs. As a result, Phase 3 was implemented, and efforts were made to strengthen networks by further promoting the establishment of collaboration with industry and international programs and joint programs at MIs. In Phase 3, the network expanded with the number of MIs in ASEAN increasing from 19 to 26 and the number of JSUs increasing from 11 to 14, and it was necessary to provide support to new members. In addition, based on the realization that the networks need to be strengthened

[4] AUN has its headquarters in Bangkok. AUN/SEED-Net is one of the 17 networks making up AUN.

further through international and joint programs and collaborative initiatives between industry and universities, Phase 4 is currently being implemented.

1.2 Project Outline

Overall Goal		The advancement and globalization of industry and initiatives to address common regional issues are promoted in South East Asia.
Project Purpose		A system for advanced research and education is established by MIs and JSUs.
Output(s)	Output 1	Links among MIs, industry and communities are strengthened.
	Output 2	A system to implement research activities that contribute to the resolution of common regional issues is established.
	Output 3	The research and educational capacity of academic staff at MIs is improved.
	Output 4	The academic networks between organizations and between academic staff among MIs and JSUs are strengthened.
Total cost (Japanese side)		3,860 million yen
Period of Cooperation		March 2013 – March 2018
Target Area		Sites of Member Institutions in 10 countries: Thailand (Bangkok, Chonburi) Malaysia (Kuala Lumpur, Penang, Seri Kembangan), Philippines (Manila, Iligan), Indonesia (Jakarta, Bandung, Yogyakarta, Surabaya), Vietnam (Hanoi, Ho Chi Minh), Cambodia (Phnom Penh), Myanmar (Yangon), Singapore, Brunei
Implementing Agency		26 Member Institutions in 10 ASEAN countries: Burapha University, Chulalongkom University, King Mongkut's Institute of Technology Ladkrabang, Kasetsart University, Sirindhorn International Institute of Technology, Thammasat University (Thailand); Ho Chi Minh City University of Technology, Hanoi University of Science and Technology (Vietnam); Universitas Gadjah Mada, Institut Teknologi Bandung, Universitas Indonesia, Institut Teknologi Sepuluh Nopember (Indonesia); Institute of Technology of Cambodia (Cambodia); National University of Laos (Laos); De La Salle University, University of the Philippines-Diliman, Mindanao State University-Iligan Institute of Technology (Philippines), University of Malaya, Universiti Sains Malaysia, Universiti Putra Malaysia, Universiti Teknologi Malaysia (Malaysia); University of Yangon, Yangon Technological University (Myanmar); National University of Singapore, Nanyang Technological University (Singapore); Universiti Teknologi Brunei, Universiti Brunei Darussalam (Brunei)
Other Relevant Agencies/Organizations		10 ministries in charge of higher education in 10 ASEAN countries
Organization in Japan		14 Supporting Japanese Universities (Hokkaido University, Keio University, Kyoto University, Kyushu University, Nagoya University, National Graduate Institute for Policy Studies, Osaka University, Shibaura Institute of Technology, Tohoku University, Tokai University, Tokyo Institute of Technology, Toyohashi University of Technology, The University of Tokyo and Waseda University)

Related Projects	ASEAN University Network/Southeast Asia Engineering Education Development Network (AUN/SEED-Net) Project Phase 1 (March 2003 – March 2008), Phase 2 (March 2008 – March 2013) and Phase 4 (March 2018 – March 2023), The Project for Educational Capacity Development of Institute of Technology of Cambodia (October 2011 – October 2015), The Project for Enhancement of Engineering Higher Education in Myanmar (October 2013 – October 2018), The Project for Enhancing Technological Universities in Myanmar (2014)

1.3 Outline of the Terminal Evaluation

1.3.1 Achievement Status of Project Purpose at the Terminal Evaluation

The project purpose, "to establish a system for advanced research and education by MIs and JSUs," has shown results to some extent, but there are issues with the implementation of joint graduate school programs. For this reason, it was determined that the effectiveness was medium.

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

If this project strengthens support for the social implementation of these research results, the prospects for the achievement of the project purpose are relatively high, and various other positive impacts are also appearing. As a result, the project's impact was also deemed to be high.

1.3.3 Recommendations from the Terminal Evaluation

Since Phase 4 was expected to be implemented, it was recommended that in Phase 4, the project should address the following:

- To reconsider a strategy for promoting joint education to further encourage mobility programs between MIs
- To reinforce alumni associations to ensure continuity
- To support collaboration between industry and universities so that advice from a more expert perspective can be obtained on patent approval and other issues
- To encourage the aggressive uptake of external money
- To strengthen internal monitoring based on PDM
- To reinforce the management of data on input and output
- To augment the AUN/SEED-Net website to facilitate applications for research projects and matching between researchers for joint research

2. Outline of the Evaluation Study

2.1 External Evaluator

Kaneyasu Ida, Tekizaitekisho LLC

2.2 Duration of Evaluation Study

When carrying out this ex-post evaluation, the study was implemented as described below.

Duration of the Study: October 2020 – November 2021

2.3 Constraints during the Evaluation Study

- Due to the spread of COVID-19, the Japanese consultant was unable to carry out field research and depended heavily on field work conducted by field research assistants who were on site in the member countries. However, many MIs were closed for prolonged periods due to lockdowns and other, and it was difficult for assistants to collect information face-to-face from those at the university, and they often had to resort to online research.
- In Myanmar, after the military takeover of the country that occurred in February 2021, the internet was shut down and contact with local field research assistants and academic staff of the MIs was impossible. As a result, the interviews and other studies that had been planned were not possible. Therefore, information provided in this report regarding Myanmar is limited to the period before February 2021.

3. Results of the Evaluation (Overall Rating: A[5])

3.1Relevance (Rating: ③[6])

3.1.1 Consistency with the Development Plans of ASEAN

During the project period, several policy papers and documents related to ASEAN were adopted and released, including ASEAN+3's *Cooperation Work Plan* (2007-2017), the ASEAN Secretariat's *ASEAN Socio-Cultural Community Blueprint 2025* and the Ninth Conference of ASEAN Education Ministers' *The ASEAN Work Plan on Education 2016-2020*. These papers identified such issues as strengthening inter-university networks among the member countries, promoting credit transfer on the premise that ASEAN is a collective body, and assurance of universities' quality. The increasing role of higher education institutions was also emphasized for the socio-economic development of the region in these papers. This shows that this project is a cooperation project with a purpose aligned with the direction taken by ASEAN. Moreover, AUN has set contributing to higher education in the ASEAN collective as its mission, and is working on creating system framework, such as establishing the ASEAN+3 Guidelines for Foreign Exchange and Mobility and introducing a university certification system. This project was seen as an effort to give substance to this framework.

In CLMV, producing engineering human resources who can contribute to the society and economy and expanding access for students to higher education have been important issues from the beginning of the project. Building an education and research system through networks, which is this project's purpose, addresses this policy issue. In addition, in the ASEAN countries that

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

[6] ③: High, ②: Fair, ①: Low

joined ahead of CLMV[7] (Thailand, Malaysia, Philippines and Indonesia), generating human resources for industry that can meet the needs of more sophisticated industry, by using IT, for example, is seen as important, which is consistent with this project's overall goal of producing human resources for advanced industry. Given these factors, this project is consistent with the policies of ASEAN, AUN and higher education institutions in the individual countries (refer to Appendix 1).

3.1.2 Consistency with the Development Needs of ASEAN

The important needs of MIs in CLMV, excluding Vietnam, were to establish new departments for new engineering fields and set up master's and PhD courses, as well as ensure that academic staff in new engineering fields acquire advanced academic degrees. The founding ASEAN countries and Vietnam had needs such as raising their competitiveness to improve university rankings, globalize, and strengthen industry-university linkage, which is consistent with this project's approach on promoting international programs and strengthening collaboration between industry and universities through collaborative research. Industry-university linkage was also seen as an important activity to link up with Japanese companies operating in these countries.

In interviews with industrial organizations and companies with interest and a track record in cooperating with universities in ASEAN, it was learned that there was a shared need for the development of high-quality human resources in industry who have received a practical education in engineering. This project supported the establishment of systems and environments that serve as institutions developing this kind of workforce, and is thus very consistent. Since the need for innovation, such as collaborative research, differs in the individual countries, we cannot generalize, but in the founding ASEAN countries, collaborative research is gradually gaining recognition as a means of raising technical competitiveness in the private sector. For example, in Indonesia, the mining and manufacturing industries trust the research and investigation capacity of universities, and there is a strong need for cooperation, but the needs are not clear for companies and industrial organizations, which are not aware of the universities' research subjects. According to a study in Vietnam (Ho Chi Minh National Academy of Politics' Survey on Innovation 2016-2019), only 5-10% of university research has been put to practical use, and the National Chamber of Commerce is seeking collaborative research with universities through proposals of technology that could have practical applications. In this sense, companies have a strong need for universities to produce high-quality engineers, and there is a growing need for collaborative research in the founding ASEAN countries and Vietnam, which is very consistent with this project's purpose and approach (refer to Appendix 2).

[7] The five original ASEAN member countries (Thailand, Malaysia, the Philippines, Indonesia and Singapore) are known as the founding ASEAN countries, but in this project, the two universities in Singapore played the same role as JSUs by accepting exchange students, etc., so in this report, founding ASEAN countries refers to the four countries excluding Singapore.

3.1.3 Consistency with Japan's ODA Policy

In regards to cooperation between Japan and ASEAN in education, policies promoting human resource development in the science & technology and engineering fields through AUN/SEED-Net were laid out in the *Japan-ASEAN Summit Action Plan* in November 2011. In the new growth strategies, pursuing scientific and technical diplomacy, such as promoting international collaborative research and scientific and technical cooperation for developing countries, is advocated in the section on Strategies for building a nation based on science, technology and IT. In addition, in the Economic strategies for Asia, utilizing Japan's technology for Asia's growth and expanding Japanese companies' business chances were listed as objectives. In this sense, this project is very consistent with Japan's ODA policy.

The project was sufficiently consistent with the development policies of ASEAN, AUN and ASEAN countries, the needs of this project's MIs, and Japan's ODA policies. Therefore, its relevance was high.

3.2 Effectiveness and Impacts[8] (Rating: ③)

3.2.1 Effectiveness

3.2.1.1 Achievement of Project Purpose

The main objective of Phase 3 was the development of advanced human resources for industry for the sustainable development of ASEAN. The salient features of Phase 3 include the following:

- It continuously supported quality improvement of research and education of MIs in CLMV through provision of scholarships to their academic staff to obtain higher academic degrees - the core initiative in Phases 1 and 2.
- It continued to support joint research programs to build and expand the academic network between ASEAN and Japan.
- It continued to support the publication of AEJ and convening regional conferences to strengthen academic networks
- Its focus was on reinforcing and expanding industry-university linkage and efforts to resolve common regional issues.

The key indicators and results for the project purpose for Phase 3—an advanced system for research and education is established by MIs in collaboration with JSUs—are shown below. Although these indicators do not show numerical targets, the achievements in Phase 3 surpassed those of Phase 1 and 2. Therefore, it is judged that the project purpose was achieved.

[8] The impact is also considered when assessing effectiveness and giving a rating.

Table 1 Achievement of Project Purpose

Project Purpose	Indicators	Actual
Project Purpose	Number of programs at international graduate schools implemented	During Phase 3, 23 courses at 12 universities were started as international graduate school programs. During the Phases 1 and 2, four universities started such programs in English. Many courses were attended by foreign students sent by this project, and in particular, at new MIs in Thailand and MIs in Indonesia, the acceptance of this project's scholarship recipients became the direct catalyst for starting English programs or the acceptance of foreign students. Some programs became popular in neighboring countries since there were no similar courses in their countries.
	Number of joint international graduate school programs implemented	In Phase 3, five universities introduced double degree programs with JSUs, and there was progress with the indicator measuring increases in international graduate school programs, which did not make much progress in Phases 1 and 2. For example, at Shibaura Institute of Technology, twinning programs (intercollegiate transfer system at universities and graduate schools) were actively promoted, and Gadjah Mada University (UGM) has used the project's network to implement an intercollegiate transfer program at the graduate school level. Similarly, Kyushu University and Waseda University introduced double-degree programs and/or other mobility programs with Chulalongkom University (CU), Institut Teknologi Bandung (ITB) and UGM in the field of geological and geo-resource engineering, utilizing the networks built by the project. In addition, there are cases in which close relationships with JSUs, formed through the project's scholarship program and collaborative research, have been utilized. Other mobility programs include 12 student exchange programs, 12 teacher exchange program, and four short-term study abroad and research programs. Phase 1 and 2 were limited to only three foreign exchange programs and teacher dispatch, there were significant improvements in the indicator.

Source: Results of questionnaires given to MIs and interviews.

This project endeavored to 1) promote collaborative research aimed at reinforcing collaboration between industry and universities, 2) encourage collaborative research intended to resolve common regional issues, 3) improve the quality of university research and education by supporting the acquisition of higher degrees, primarily at MIs in CLMV, and 4) strengthen academic networks by publishing an academic journal and holding regional conferences. Below is the description of the extent of these achievements.

(1) Promotion of collaborative research aimed at reinforcing collaboration between industry and universities

AUN/SEED-Net has offered funds for Collaborative Research Program with Industry (CRI) since 2011 during Phase 2 on the condition that financial contribution must be made by the

corporate partner. Joint research with industry was implemented for various objectives, to name a few, productivity improvement, commercialization of new technology and application of new material. CRI has had 47 joint research projects (12 in Phase 2 and 35 in Phase 3). The application competition ratio was 35/80 (2.3x) in Phase 3 and 12/24 (2.0x) in Phases 1 and 2. The budget allocated by the project was 317,298 US dollars, and companies contributed 63,460 US dollars. In Phases 1 and 2, there were views that looking for companies able to contribute would be very difficult, but judging from the number of the implemented projects, which rose from 12 to 35, this program has significantly helped to strengthen collaboration with companies.

Of the 35 CRI-supported research projects, two universities in Vietnam accounted for 14, followed by Indonesia (6) and Malaysia (5). One reason for this was that Hanoi University of Science and Technology (HUST) and Ho Chi Minh City University of Technology (HCMUT), which actively used CRI to boost collaboration with industry, encouraged academic staff to apply for CRI, which increased the number that were accepted. These two universities and some universities in Indonesia utilized their existing networks with companies, which also explains their active pace of applications. At the same time, in Cambodia, Laos and Myanmar (CLM), there are many small- and medium-sized companies and it is difficult to find companies that will actively provide funding, which explains why applications from these countries were low. Of the MIs, 10 universities had experienced joint research with industry using CRI where companies contributed funding, and CRI fulfilled a role in strengthening networks.

Initiatives other than CRI included training in Japan for academic staff to promote industry-university linkage, technology management courses, seminars on industry-university linkage, the establishment of an advisory team to promote industry-university linkage at the secretariat office, and the publication of directories for industry-university linkage for each MI (eight countries), among others. Since internships with companies were widely implemented at MIs, they were not actively facilitated as part of this project's activities, but according to responses to questionnaires[9] (21 universities), all MIs offered internships utilizing AUN/SEED-Net networks and their activities in partnership with 60 Japanese companies and 68 local and foreign companies. In addition, a total of 107 company visits were made to 32 companies (of which 16 were Japanese companies) and technology consultations provided by MIs' academic staff.

According to questionnaires given to 21 universities, project activities related to industry-university linkage were all rated extremely highly, and almost all the universities who responded answered that they were very beneficial or beneficial to some extent. Industry-university linkage is an important issue for universities and interest was high. For example, HUST responded that it became autonomous in 2016 and industry-university linkage was an important policy, but there was not enough expertise, so the series of technology transfers made through this project to MIs

[9] Questionnaire was distributed to 26 universities to collect data and their opinions about the project.

were extremely beneficial. At the University of the Philippines-Diliman (UP), researchers who participated in the technology management course learned about fund procurement, and were then able to secure funding for several research projects. At the Institut Teknologi Sepuluh Nopember (ITS), researchers learned project management methods and then utilized this expertise in a major research project related to electric vehicles, while Institut Teknologi Bandung (ITB) and Chulalongkorn University (CU) used Japan's approach to industry-university linkage as a reference.

(2) Encouragement of collaborative research intended to resolve common regional issues

Collaborative Research Program with Common Issues (CRC) was started from 2011 during Phase 2. Under CRC, various joint research projects in such fields as environmental studies and natural disaster (e.g., typhoon, tsunami and high-tide simulation modeling for different coastal areas in ASEAN countries). In the two years from 2011 to 2012 during which applications were accepted, four of 16 applications were accepted. Initially, the number of applications was not very high since it was difficult to identify common regional issues, but in the Phase 3 period, 138 applications were submitted from MIs in eight countries and 41 were accepted. As a result, 60 papers were produced and 37 presentations made (on average, this amounted to three papers and two research presentations for each joint research).

CRC was particularly active in Vietnam, which had 14 projects, and Malaysia, which had 13. Many of the projects were in the fields of civil engineering (7) and environmental engineering (6), but there were two to five projects in other fields, and there does not seem to have been significant skewing toward a particular field. Since there were not many other joint research projects on common regional issues like CRC, and there were networks of researchers with other MIs, 11 out of 18 universities responded that they actively applied to CRC. Moreover, the 11 universities that carried out joint research in CRC responded that CRC was helpful in spurring extremely high or quite high interest in collaborative research to resolve common regional issues. Given these points, experiences to carry out collaborative research to solve common regional issues was built up. Universities that did not have high CRC application numbers said that this was because they had few students received from MIs and few points of interaction with potential partners in collaborative research, and that they had applied but their proposals were not accepted (due to insufficient skills in writing proposals, for example).

(3) Improvements to the quality of university research and education by supporting the acquisition of higher degrees

From the time it was established, AUN/SEED-Net implemented scholarship program for CLMV members to send their staff to MIs and JSUs to strengthen the CLMV members' education and research capacities; these were continued in Phase 3. There was a total of 540 scholarship

recipients during Phase 3, including 144 PhD recipients, 243 master's recipients and 42 who were not able to earn a degree. The remaining 111 are still in the process of earning degrees. The degree recipient rate was 80.89% for PhD candidates and 96.8% for master's degree candidates. Just under 20% of candidates are unable to earn PhDs, which is more difficult than Master's. The percentage of students earning their master's degree is very high, and overall, the degree recipient rate is also high. Judging from the number of papers and presentations required for graduation at the individual universities, at least 243 papers for master's degrees and 288 for PhDs were completed, for a total of 531 research papers. In addition, in the Collaborative Research Program for Alumni Members (CRA), which is a joint research program that this project's graduates can apply to, 18 presented papers and 21 presentations given. The average length of time needed to earn a degree is 24.42 months for a master's degree and 37.76 months for a PhD, and the percentage of the students who completed within the designated time period was 79% for master's degree students and 68.8% for PhD students. Compared to the scholarship program of Japanese Ministry of Education, Culture, Sports and Science and Technology (MEXT) for foreign students as of 2019,[10] the degree recipient rate during the standard number of years for a master's degree in the engineering field in this program was 92.5% and 59.4% for PhD candidates. The project's degree recipient rate is higher for PhD students although that is lower for master's program students. This shows that AUN/SEED-Net's scholarship program is effective as a scholarship program.

The objective of the scholarship program was not only to encourage students to acquire higher degrees, but to raise the research and education level of MIs, particularly in CLMV, through the acquisition of higher degrees. As a result, they are expected to return to their home universities and contribute to strengthening research and educational capacity of home universities after earning the degree and become an academic staff member. Of the 334 degree recipients from CLMV in Phase 3, 127 (38.0%) returned to their home universities and worked as lecturers and/or researchers. The rate of students returning to their home universities was particularly high in Vietnam and Laos. This was primarily because lecturers were needed in the new engineering fields in Laos and there were many PhD recipients in Vietnam. In Cambodia, Master's degree recipients sometimes could not find a post at their home university, so the rate of return was low and instead they found employment in the government and the private sector.[11] Yet, in Phase 3, measures were taken to select students with higher prospects of finding posts in the university on their return. Therefore, the rate of return would likely be improved. Myanmar has a transfer system for university lecturers and researchers so that they are transferred every few years, so the

[10] https://www.studyinjapan.go.jp/ja/statistics/shinro-and-gakui/data/2019.html (accessed on July 26, 2021)
[11] An increasing number of the returned degree recipients who got employment in the public and private sectors have also contributed to the development of science and technology in their respective countries. For example, the director general of National Institute of Science, Technology and Innovation under the Ministry of Science, Technology and Innovation of Cambodia is one such case in point.

rate of return to home universities was low, but 28 became teachers at other universities, and when including this number, the percentage who became teachers at their home universities was 62.9%.[12] Of those who took paths other than becoming teachers at their home universities, 47 (14.0%) worked in other universities or research institutions, 57 (17.1%) worked in private companies, 20 (6.0%) worked in government institutions, and the jobs of 83 (24.9%) were not known. Some MIs do not necessarily carry out surveys on the career paths of graduates, but since information on the careers of graduates is an indicator for the results of university education in some sense, it is important that universities carry out surveys on career paths.

Table 2 Number of degree recipients from scholarship program by country and rate of return to home universities during Phase 3

Name of country	Number receiving degrees *	Number returning to home universities	Rate of return (%)
Laos	55	39	70.1
Cambodia	132	34	25.8
Myanmar	54	6	11.1
Vietnam	93	48	51.6
Total for CLMV	334	127	38.0
Other	53	21	39.7
Overall total	387	148	38.2

Source: results of questionnaire given to MIs. *Total for PhDs and master's degrees

In the 12 years covering Phases 1 and 2 (including the two-year preparatory period), 218 received PhDs, and in the five years covering Phase 3, 144 candidates received PhDs, with 37.2% of the scholarship recipients in a PhD course. This demonstrates that its role as a program that helps students earn higher degrees grew. Since PhD recipients are likely to become lecturers and researchers, Phase 3 was more effective than Phases 1 and 2 in terms of the program objective of training lecturers and researchers with high degrees.

Moreover, a survey of the universities from which lecturers and researchers graduated (graduate schools) and the percentage of AUN/SEED-Net graduates for six universities in CLMV found that 412 had studied abroad in this project and returned to their home universities to become a lecturer or researcher, and AUN/SEED-Net graduates accounted for 15.1% (412/2,714) of university lecturers and researchers. The percentages were not very high in Vietnam, where the number of lecturers and researchers (PhD holders) was already very high in the universities, and in Myanmar, where lecturers and researchers are transferred. However, the percentage was as high as 56.7% at the National University of Laos (NUOL) and 29.2% at Cambodia's ITC, showing that graduates of this program account for a very high percentage in these two universities.

[12] The whereabouts of half of the returnees in Myanmar are seeking higher education or unknown to the evaluation study team.

The contributions made by returned graduates to their home universities include playing a central role by teaching in newly established programs (for example, the establishment of an environmental engineering program, engineering geology program, and a PhD program for logistics and transportation engineering, and a bachelor's program for materials engineering and industrial engineering in NUOL's Faculty of Engineering; the establishment of an international master's program for construction management at HCMUT and the establishment of a natural disaster course in the civil engineering program; and 18 new courses created at Thammasat University (TU). Many of the returned graduates also contributed to curriculum development and guiding students, as well as playing a key role in conducting collaborative research programs supported by this project. In addition, there were cases in which accepting students from the project became the catalyst for setting up new master's courses, as with seven new courses established at the University of the Philippines Diliman (UP).

(4) Strengthening academic networks by publishing an academic journal and holding regional conferences

In Phase 3, 451 papers were submitted to the ASEAN Engineering Journal (AEJ) and 132 were accepted. Of these, at least 40 papers were international joint papers (according to AUN/SEED-Net's annual report). Until 2016, papers from 10 fields were divided into three books for publication, but beginning in 2017, the fields were consolidated, and it is now issued twice a year in both digital form and as a hard copy. The number of applications was highest for the manufacturing engineering field (65 submissions), followed by chemical engineering (61) and civil engineering (54), but 20 or more have been submitted in other fields as well. There were only 11 submissions in the natural disaster field, which is low, but this is likely because there are still few universities with this field. By university, there were 52 submissions from HCMUT, 33 from HUST, 31 from CU, 32 from ITB, 31 from USM, and 30 from UGM, but there were also 10 universities with few accepted papers, showing that there are significant discrepancies. Universities with low numbers gave as their reasons a low number of the project's scholarship recipients (there were few submissions of papers by students in AUN/SEED-Net's master's degree and PhD programs) and the fact that there are other academic journals.

In Phase 3, AEJ was indexed in Thailand and ASEAN's science index (Thai-Journal Citation Index Centre [TCI] and ASEAN Citation Index [ACI]), which increased submissions from MIs and also increased submissions from universities other than MIs to 67 as AEJ's name recognition and reputation as an academic journal improved. In this project, in 2017, the AEJ editing team was reinforced and a new management system that brought all procedures online was introduced. AEJ also worked to gain inclusion in the Scopus index (the world's largest abstract and citation database for post print documents).

In Phases 1 and 2, the regional conferences were effective in providing AUN/SEED-Net's students a forum to present and submit the papers needed for graduation and providing the results of collaborative research utilizing the network of researchers. During Phase 3 period, a total of 49 regional conferences in 10 fields were held as international academic conferences.

In this project, AEJ and regional conferences were reinforced as a means of strengthening networks, and achievements were made in terms of the number of papers contributed and the number of regional conferences held.

Sufficient results were achieved in promoting collaborative research, which is intended to strengthen industry-university linkage and resolve common regional issues, raising the quality of university research and education by supporting the attainment of higher degrees, particularly at MIs in CLMV, and strengthening academic networks by publishing an academic journal and holding international conferences. As a result, the project purpose of establishing international graduate programs and joint international graduate programs was mostly achieved in view of the achievements on the indicators.

3.2.2 Impacts

3.2.2.1 Achievement of Overall Goal

The overall goal is the advancement and globalization of industry and initiatives to address common regional issues are promoted in Southeast Asia, and the indicators are listed below. The indicators did not show numerical targets to measure to what extent the project achieved the overall goals; however, the impacts generated by joint research is quite significant in comparison with Phases 1 and 2. Thus, it is judged the project generated good impacts.

Table 3 Achievement of Overall Goal

Purpose	Indicator	Actual
Overall Goals	Number of joint patents filed by companies and MIs	There were eight joint patents, based on the results of collaborative research during the project period in 2013-2020 by the 12 universities that responded (six were joint patents with Japanese companies), and there were eight joint patents with companies in Phase 3. Given this, the indicator can be deemed to have been met.
	Number of research outputs utilized to solve common regional issues	As a result of the survey given to researchers on whether social application had been realized in the case of 41 CRC, it was confirmed that there had been specific social application in 15 cases. 36.6% of CRC were utilized, so this was relatively high output relative to the indicator for "utilization in solving common regional issues."
	Number of graduates employed in companies as engineers and researchers	In 2018, 7,599 out of 16,543 students who had earned their bachelor's degrees, 1,275 out of 3,035 who had earned their master's degrees and 174 out of 509 who had earned their PhDs took jobs at private companies. The project targeted

		graduate students. About 40% of master's degree recipients and over 30% of PhD recipients were employed in private companies, showing that the project indirectly contributed to the generation of highly skilled human resources for the industrial sector. As a result, the indicator for the generation of engineers for private companies also showed results (refer to Table 4).

Source: Results of questionnaires given to MIs and interviews with researchers

The research results produced because of the project's collaborative research programs utilized by the public and the private sectors can be recognized as the project's impact. As shown above, the project set the indicator to measure such social impact only for CRC. In this study, we studied all 114 collaborative research projects (CRC, CRA and CRI), and confirmed 29 cases of specific social application. In addition to the aforementioned patents received, other social impacts include cases in which the start of several spinoff companies, commercialization of new, local materials, the spread of new technology and equipment to small- and medium-sized companies and improvements of manufacturing processes. Examples of social application for government organizations include providing geographical distribution data of hazardous substances to government agencies, the development and adoption of new construction methods for public works, the accepted proposal on the use of unutilized resources, the recommendations accepted by the Government on rare minerals and the development of a smart reader and its use in remote education on isolated islands.

In regards to the indicator, the number of graduates employed in companies as engineers and researchers, the table below shows the results of data on the career path of students at the 12 out of 21 universities that were able to provide data. This relates to the indicator on the generation of highly skilled human resources for the industrial sector.

Table 4. Status of employment for graduates from MIs (2018)

Degree	Employment				Continued studying	Looking for a job	Other	Total
	Private sector	Government organization	Research institute, university	Other				
Bachelor's degree	46%	6%	4%	2%	5%	5%	32%	100%
Master's degree	42%	12%	7%	6%	11%	2%	21%	100%
PhD	34%	23%	17%	6%	0%	5%	15%	100%

Source: Results of questionnaires given to MIs

In relationships with companies, the intern program spread considerably, and ties strengthened, but companies were not interviewed about their evaluation of students and graduates. It has

gradually become possible to ascertain the career path of graduates, but it is still difficult to determine the career path of students at universities with many students who look for jobs after graduation. Study methods are issues to address going forward.

Given these points, we have observed favorable results for the overall goals in terms of the advancement and globalization of industry and the promotion of initiatives on common regional issues.

3.2.2.2 Other impacts

(1) Contributions to MIs

In regards to this project's impact on MIs, responses indicated that sending out and receiving the project's scholarship recipients contributed to globalization (16 out of 21 universities) and also had a major impact in reinforcing Japanese and overseas networks other than AUN/SEED-Net (17 out of 21). However, even though this project created many international programs, only five host universities responded that this increased the percentage of foreign students from programs other than this project. Moreover, impacts from joining AUN/SEED-Net were also confirmed. For example, hosted regional conferences raised the recognition of the university (NUOL), it became easier to obtain cooperation from foreign universities including Japanese universities (17 universities) and collaborative research with overseas universities increased (10 universities). In terms of the Memorandum of Understanding (MOU) and the Memorandum of Agreement (MOA) between MIs, a range of cooperation agreements were signed at the university level and engineering department level, including JSUs, with 158 MOUs between MIs and 70 between MIs and JSUs. Not all of these MOUs were directly related to this project, but there is a high probability that the fact that they are MIs was one factor behind agreements between universities.

Other contributions to MIs included the doubling of research projects (ITC), greater reliability of research capacity making easier to acquire research funds from public institutions (HUST), and contributions to university achievements (such as the number of times papers were cited) (five universities). Students participated in almost all collaborative research and such research provided themes to master's degree and PhD students for their papers and academic presentations, thus supporting degree attainment. As such, there was a clear impact on the development of human resources.

In industry-university linkage, there was a case in which joint research and networks between MIs and JSUs led to acquaintance with Japanese companies as well as employee training and acceptance of internships, as well as a case at a university in Malaysia (UM) in which CRI led to the launch of a company and the establishment of a spin-off company. Furthermore, UTM utilized its networks with JSUs, started a technical cooperation project titled "Capacity Development for Technical Vocational Education and Training" and further strengthened its research capacity.

(2) Contributions to shaping and strengthening academic networks

The contributions to academic networks in the region that were identified in this study are outlined below. AUN/SEED-Net researchers were involved in forming many networks.

Table 5 Contributions to shaping and strengthening academic networks in respective countries

Name of country	Description
Indonesia	ITS researchers took a central role in establishing the Indonesia Chapter of the Industrial Electronics Society, and AUN/SEED-Net MIs played a core role in setting up the Sustainable Energy and Environment Forum.
Vietnam	Academic staff at the Ho Chi Minh City University of Technology, who were also graduates of AUN/SEED-Net, set up an engineering department for four nearby universities and provided support for improvements to the curriculum.
Myanmar	Since researchers are transferred every three years in Myanmar's system, researchers from the University of Yangon (YU) and Yangon Technological University (YTU) played a central role in organizing the Myanmar Young Researchers Network (MYReN) under the National Association of Principals in 2019 and formed a network of young researchers.
Malaysia	A network in the renewable energy field was formed in 2018 (Malaysian Thermoelectric Society).
Thailand	Members of Kasetsart University (KU) played a key role in establishing the Solid Waste Association of Thailand in 2013, which held dialogues on policy and held seminars. TU also drove efforts to form a collaborative (government-private sector-research institutions) platform for technology development in 2016 by establishing the Thailand Structural Steel Society (TSSS). The Artificial Intelligence Association of Thailand (AIAT) established in 2015 by TU researchers together with other universities is the largest platform in this field.

Source: Results of questionnaires given to MIs and interviews with researchers

Given these factors, the project purpose of establishing a system for the implementation of advanced research and education in a collaboration between MIs and JSUs was achieved at the end of the Phase 3 period in accordance with the indicators of development of international graduate programs and joint international graduate programs. In terms of the overall goal, collaborative research for industry-university linkage and for solving common regional issues, and MIs producing recipients of high degrees (graduate school level) for the private sector achieved favorable results. Furthermore, other impacts such as contributions to MIs and fostering academic networks by MIs were well recognized. As such, the effectiveness and impact of the project were high.

3.3 Efficiency (Rating: ③)

3.3.1 Input

Table 6 Input Chart

	Plan	Actual
Cooperation period	March 2013 – March 2018	March 2013 – March 2018
Input on the Japan side		
Cooperation amount	3,950 million yen	3,860 million yen
Dispatch of experts	4 long-term experts 1 short-term expert For research guidance, etc.	4 long-term experts 1 short-term expert 439
Recipients of short-term training in Japan	Not specified	156
Inputs from Thailand	Allocation of a budget for the costs of Secretariat staff	Allocation of a budget for the costs of Assistant Executive Director and two secretaries
Inputs from MI	Tuition waivers, dormitory fee waivers, compensation for living costs and transportation costs, etc.	Tuition waivers, dormitory fee waivers, compensation for living costs and transportation costs, etc. equivalent to 304.4 million yen (2014-16)
External funding	Not specified	63,459 US dollars (contributions from private companies for collaborative research)

Source: Data from preliminary evaluation, Phase 3 Terminal Evaluation Report, and AUN/SEED-Net Secretariat

3.3.1.1 Elements of Inputs

In terms of project costs, accurate planned costs and actual costs for each project component cannot be fully contrasted, but the cost items such as funding for the dispatch of experts and scholarships were provided principally in line with the initial plan, and the costs for training in Japan and in third countries were kept below the initial plan.

In terms of the costs incurred by MIs for the program to acquire higher degrees, the project covered living costs, medical insurance, book costs and travel costs, and AUN-SEED-Net Secretariat office and host universities reached an agreement whereby the host university would waive or reduce university entrance fees and tuition. Some host universities took steps such as supporting local language learning and reducing or waiving dormitory fees.

In terms of the validity of input amount, a comparison with the scholarship program for foreign students funded by the Japanese government, which is a similar study abroad program, shows that the Japanese government paid the living costs of a foreign student in a Master's program amounting to 144,000-147,000 yen per month (fiscal 2021).[13] AUN/SEED-Net's scholarship program, although there are differences in living costs between Japan and Southeast Asia, paid only 500 US dollars per month partly because of the support from host universities such as tuition waivers and reductions, which means that cost effectiveness of the scholarship program was high.

[13] https://www.jasso.go.jp/sp/ryugaku/tantosha/study_j/scholarship/kokuhi/kyuyo.html (Accessed on July 26, 2021)

3.3.1.2 Project Cost

Project costs were expected to be 3.95 billion yen, but came out to 3.86 billion yen, which is 97.7% of the estimated project cost.

3.3.1.3 Project Period

The project period was five years (March 2013 – March 2018) as planned.

Given this, the project's costs and project period were in line with plan; therefore, efficiency of the project is high.

3.4 Sustainability (Rating: ③)

3.4.1 Policy and Political Commitment for the Sustainability of Project Effects

In Phase 3, the pillars of the project were the scholarship program, joint research programs for industry-university linkage and tackling common regional issues, the publication of AEJ and the organizing regional conferences. In Phase 4, the scholarship program and joint research programs have been integrated into the Collaborative Education Program (CEP) in partnership with companies. As the project was formed as a regional cooperation project, policy and political commitment of the ASEAN, the respective Governments and MIs are critically important to ensure the project sustainability.

As noted in 3.1.1, AUN's policy is to strengthen regional networks. Higher education institutions in the respective countries also highly evaluate the project's role in strengthening networks with ASEAN and Japanese higher education institutions and promoting globalization. Strengthening education and research through inter-university networks is a crucial policy for ASEAN and AUN, so expectations for this project are high. In 2020, ASEAN adopted *Declaration on human resources development for the changing world of works and its roadmap*, which promotes measures to foster human resource development including graduates of higher education. Therefore, the project's objective of fostering advance industrial human resources is clearly in line with ASEAN's policy. In terms of MI needs, MIs in CLM point out the importance of contributions to improving the quality of education and research through collaborative research and the scholarship program within the region. The founding ASEAN countries and Vietnam have high expectations for the reinforcement of networks with Japanese companies and Japanese universities, and reflecting these expectations, the need for support for the publication of AEJ and the holding of regional conferences is high. As shown in Appendix 2, the industrial organizations and the private sector in the member countries express the strong need for technology development useful for their businesses through cooperation with universities. As a result, sustainability is high in terms of the policy or needs of related institutions.

3.4.2 Institutional/Organizational Aspects for the Sustainability of Project Effects

In sustaining the networks formed in this project, it is important that (1) cooperation agreements such as MOU and MOA, which are the premise for universities to systematically carry out activities with other universities, are signed between members, including JSUs, and that (2) alumni organizations for the project's scholarship recipients and researchers are formed in this project.

As regards (1), various cooperation agreements have been signed at the university level and engineering department level, including JSUs, with 158 agreements between MIs and 70 between MIs and JSUs. All the MIs have developed such relationships with other MIs in some form or other. This indicates that the foundation for networks among this project's members has been sufficiently built up. Moreover, in Phase 4, multiple universities and companies formed six consortiums and provided support. The formation of a platform for cooperation with higher sustainability also indicates that sustainability is high.

As regards (2), concerning alumni organizations, the Alumni Support Program (ASP) was started in 2018 on the recommendations made in the ex-post evaluations for Phases 1 and 2 and the Phase 3 Terminal Evaluation Report, and support for alumni organizations' activities was provided on a full scale. Up until this point, of the six CLMV universities sending out large numbers of students to other member universities, alumni organizations were officially established at four universities, with 28 members at HUST, 116 at ITC and 37 at HCMUT[14] when the organizations were established. In addition, these alumni organizations held seminars, hosted meetings specific to the fields, encouraged the sending of their students to Japanese universities, gave advice to Japanese companies and formed cooperative relationships. Since a wide range of members participated in these alumni associations, such as researchers from universities, companies and government organizations who had participated in collaborative research and regional conferences, as well as the lecturers and researchers who had received scholarships. They are expected to become networks for academic collaboration and joint research going forward. There are also moves to set up alumni associations at host universities, not only the universities sending out students. In 2019, an alumni organization was formed at Universiti Teknologi Malaysia (UTM) as well. Plans to form an alumni association were also made at UGM and ITS. As such, efforts to strengthen networks by systematically forming alumni associations began from the end of Phase 3. However, such initiatives were implemented as activities for phase 4, so establishing a financial foundation for the association through donations or the collection of membership fees will be an issue going forward.

[14] There are 51 members as of October 2021.

In addition, more of those students who earned degrees in this program and who earned degrees in phases 1 and 2 and then became lecturers and researchers at their home universities have taken on leadership roles, such as heads of departments. They will be an important human resource in sustaining the systems and organizations for networks formed in this project.

The secretariat office, the management unit for the operation of AUN/SEED-Net, can be sustained, judged by the facts that the scholarship program that was the largest project component would be significantly scaled down after the end of Phase 4, CU express willingness to help maintain the secretariat office and MIs also show their willingness to support the operation of the secretariat office in such forms as the dispatch of their staff and the transfer of a part of its functions to their universities.

3.4.3 Technical Aspects for the Sustainability of Project Effects

This project's key programs are support for the scholarship program, collaborative research, regional conferences, and the publication of the academic journal. Of these, a system for the scholarship program (such as guidelines) has already been established, and the Secretariat office staff have built up expertise in its administration (e.g., recruitment, selection, acceptance). When financial support is available, management is possible after Phase 4. Host universities also have built up experience in providing support for students, which is particularly important in administering the scholarship program, and there are no particular technical issues.

In regards to collaborative research, the founding ASEAN countries and Vietnam can secure research funds with competitive research funds from the government aimed at promoting science and technology, and although the number differs by university, there have been many collaborative research opportunities with local companies. In regards to CLM members, collaborative research is still limited. They need to pursue opportunities for collaborative research utilizing the networks developed with other MIs in founding ASEAN countries.

In regards to collaborative research with Japanese companies, they often have their research functions in Japan, so there is a risk that without ties to JSUs, collaborative research with Japanese companies may be very difficult to be continued. The key issue here is how to provide opportunities for matchmaking and how to continue functions such as intermediation with Japanese companies.

MIs can already gain experiences in holding regional conferences in the ten fields and running them independently. In regards to the publication of AEJ, an online system for applying, screening and peer reviews for the publication of AEJ was set up, and inclusion in the Scopus index meant that a stable number of submissions can be expected, making the sustainability extremely high.

3.4.4 Financial Aspect for the Sustainability of Project Effects

At present, Phase 4 is being implemented, of the program components—collaborative research, the scholarship program, regional conferences, and AEJ publication—the collaborative research and the scholarship program have been consolidated for implementation as the Collaborative Education Program (CEP). In addition, the Alumni Support Program (ASP) is being implemented to strengthen the network of alumni associations, and regional conferences and AEJ are continuing.

In Phase 4, ongoing support is being given to students supported in Phase 3, but the scholarship program was largely scaled down and at present, the project is shifting to CEP, which promotes collaborative degree programs, collaborative research, and industry-university linkage (training and research at companies) through a consortium in which several universities (not limited to MIs) and companies participate. At present, six consortiums have been formed. There are about 10 students in each consortium, so the inputs are on a small scale and there are few scholarship recipients. For this reason, compared to Phase 3, the number of targets is also less than 1/10, and given that tuition waivers and company support is available at each of the universities, this can be continued after the end of Phase 4 if small-scale financial support is available. As mentioned earlier, it would be difficult for the MIs in CLM to maintain the current level of joint research as public research fund is limited in these countries. Therefore, it is desirable to involve these universities at a time when a new consortium is formed by other MIs so that the researchers from these universities can participate in joint research.

The motivation of MIs for AEJ and regional conferences is extremely high, and in response to a question about intentions to continue with this project's programs, 12 universities responded that they definitely wanted to continue AEJ and nine that they wanted to continue regional conferences after the end of Phase 4. Of these, five and three universities, respectively stated that they wanted to continue these programs even if the university provided funding for them. AEJ has already been included in the Scopus index, which makes it relatively easy to secure financial resources by subscription and paper submission fees. The scale of regional conferences needs to be addressed and costs reduced, yet it is possible to continue the program.

There are strong calls from MIs in CLM for the scholarship program to continue, but many respondents to a questionnaire stated that it was difficult for MIs in founding ASEAN countries to provide a budget for scholarships (since a request has to be formally submitted to university authorities for approval, and the fiscal burden will be substantial). Given this, if the scholarship program is to continue within the region, collaboration with other scholarship programs of MIs' higher education institutions would be most feasible. The schemes that we were able to identify in this study are as follows.

Table 7 Scholarship programs provided by governments of founding ASEAN countries

Country name	Overview
Thailand	The Thai International Cooperation Association (TICA) provides scholarships on a small scale to foreign students from Laos and Cambodia. There are at least nine schemes to support Thai students pursuing higher academic degrees both in Thailand and overseas. There have been 1,143 PhD candidates and 412 master's degree candidates, with the US and UK accounting for 70% of students and Japan for 4.7%. The Thai Government also offers scholarships under the Project for the Promotion of Science and Mathematics (PSMT), a program for university lecturers and researchers and others wanting to work in the science and technology field in the public sector in the future. The scheme only covers the science field, so it can be used to strengthen ties between universities in Thailand and Japan.
Malaysia	Through the Malaysia International Scholarship (MIS) program, students from CLMV are accepted at 20 public universities, and acceptance to the PhD course makes it possible to collaborate with four universities that are members of AUN/SEED-Net.
Indonesia	Indonesian Government provides a scholarship program for CLMV, and scholarship recipients can attend UGM (GNB scholarship). The Ministry of Finance has a LPDP Scholarship, and the Ministry of Education has the BUDI Scholarship for Indonesian students, and these programs can be used for students seeking higher degrees in Indonesia, other ASEAN countries and Japan.
Vietnam	In the cooperation program between the Vietnamese government and the Laotian and Cambodian governments, there are scholarship programs that send students from both countries to graduate school in Vietnam. HUST and HCMUT are already receiving students.

Source: Results of questionnaire and interview surveys conducted to higher education institutions

MIs are already waiving entrance fees and tuition related to the acceptance of the scholarship recipients under the project, providing accommodations such as dormitories, and covering part of transportation costs, among other measures, and they responded that similar measures could be taken after the end of Phase 4 as well if the scholarship program continues. Twelve universities also answered that they would proactively consider taking responsibility for some of the cost of the dispatch of their faculty staff to the AUN/SEED-Net secretariat office. Official request must be submitted to MIs for their consideration if such financial support is necessary.

Given these points, the results of Phase 3, can be adequately sustained in Phase 4 while shifting to a new program that meets the needs of MIs.

The ex-post evaluation for the project's Phases 1 and 2 recommended strengthening the alumni associations, reinforcing support for the academic journal, supporting cooperative research, and considering strategies for the period following the project's completion. These recommendations are included as project components and activities in Phase 4, and these project initiatives are making significant contributions to improved sustainability.

No major problems have been observed in the policy background and the institutional/organizational, technical, financial aspects. Therefore, sustainability of the project effects is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project aims to form higher education networks specializing in engineering in the 10 countries making up ASEAN and reinforce the educational and research capacities of engineering universities in the region. Phase 3 was implemented following a preparatory phase and phases 1 and 2. Strengthening the networks in higher education is a shared need for ASEAN and MIs, making this project highly relevant. In Phase 3, universities and companies carried out collaborative research, and researchers at MIs engaged in collaborative research on a broad range of themes, such as natural disaster and the environment. As such, researchers at MIs gained a wealth of experience with industry-university linkage and collaborative research on common regional issues. In the scholarship program, the percentage of students earning PhD, which gives them a high likelihood of becoming lecturers and researchers, was high compared to Phases 1 and 2, demonstrating the program's effectiveness in raising university academic staff. In addition, AEJ, a publication started by AUN/SEED-Net, was indexed by the Thai Citation Index and ASEAN Citation Index, which increased contributions from researchers other than alumni members of AUN/SEED-Net's scholarship program and raised its status as an academic journal. In addition, regional conferences in ten engineering fields supported by the project were effective forums not only for the presentation of research results, but also for considering collaborative research and joint education programs. As a result, this program's returned students and researchers at the MIs engaged in collaborative research took the central role in starting courses for international graduate school programs during Phase 3, and the number of joint education programs between MIs, such as double degree programs, exchange student programs, exchange programs for instructors, short-term study abroad and research programs, increased and were highly effective.

In this ex-post evaluation, we examined whether the 114 collaborative research programs carried out had had an impact and it was confirmed that at least 29 social impacts such as joint patents and concrete contributions to the private sector and government due to technology transfer and other. In regards to industrial human resource development, in 2018 at least 1,275 Master's degree recipients and 174 PhD recipients from MIs found employment with companies, showing that the project also had an impact in producing advanced human capital for industry. These points indicate that the project had satisfactory effectiveness and impact.

The dispatch of experts, project duration and cooperation amount were in line with the plan. Thailand, where the project's secretariat office is located, took on responsibility for appointing an assistant executive director and secretaries and the running costs for the office. MIs also took

steps such as giving exemptions or reducing tuition for the study abroad programs, as initially planned. Given these points, efficiency was high.

The member countries' government institutions and MIs have strong expectations that collaborative research and scholarship programs within the region will raise the quality of education and research and strengthen networks with Japanese companies and Japanese universities. Continuity in the policy aspect is high.

In the institutional aspect, almost all MIs have established MOU/MOA with other member universities. Of the six universities in CLMV, alumni organizations have been formally established at four universities. As such, the foundation for networks among MIs has been built.

In the technical aspect, the publication of AEJ and regional conferences are important, AEJ has extremely high sustainability since its inclusion in the Scopus index in 2019 means that stable contributions can be expected. MIs have built up experience in holding field-specific regional conferences and are already able to run them on their own. They have also gained good experience in conducting joint research with industry through CRI.

In the financial aspect, collaborative research continues as a consortium, including the private sector, a system for running the alumni associations has been set up, and regional conferences and AEJ also continue. On the budget side, the scholarship programs, which account for a high percentage of the budget, are over, and activities with a narrower input scale are now possible. In addition, MIs are very motivated to continue regional conferences and AEJ, including the budget input, so it will be possible to continue these programs on a smaller scale for the conferences. There is also a possibility that MIs would continuously support the functions of the secretariat office. Given these points, it is judged that sustainability is high.

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

4.2 Recommendations

4.2.1 Recommendations to the AUN/SEED-Net Secretariat office and MIs

Securing financial resources to expand and continue alumni organizations

Alumni organization activities were strengthened significantly in Phase 4, but since they were only recently formed. In order to ensure the organization's sustainability, we recommend that the merits for members are maintained by offering appealing services, while also strengthening the organizations of the respective associations so that financial resources can be stably secured by collecting membership fees and donations.

To support such actions, it is recommendable that the secretariat office would collect and distribute useful information from JSUs and other alumni organizations' activities. Also, there are increasing number of graduates of the project's scholarship program at home universities who have taken on leadership roles such as heads of departments. Therefore, it is effective for the secretariat office to encourage these people to play an active role in alumni activities.

Implementation of survey on graduates' career path and evaluation of graduates by companies

In this evaluation study, information on the career path of graduates from MIs was collected. Compared to Phases 1 and 2, more universities carried out career path surveys and the number of graduates whose path could be ascertained increased. The survey's accuracy also improved. However, only about half of the universities are actively surveying career paths. Since career path surveys are important information for career education for students and universities' PR, we recommend that universities systematically carry out surveys (if it is difficult for universities to do this, the engineering department could fill this role). For example, Japanese universities compile and publish career-related information with great accuracy, so this could be a resource for learning their experiences. Moreover, some MIs such as ITB have instituted carry out career path surveys in the university, so it would be effective for the secretariat office to share such experiences to the MIs eager to improve their survey method.

In terms of generating human resources with a high level of education in the advanced engineering field, it is also important to learn how companies evaluate MI graduates, but according to responses to questionnaires, no MIs are currently doing so. Given this, we recommend that MIs collect information from the companies that employ large number of graduates and introduce mechanisms to reflect findings in the education programs. Also, it is important to proactively create opportunities for communication with companies, such as holding events for the exchange of views between MIs and industry organizations, industrial estates, and Japanese business organizations in respective countries. University job fairs can be also a good opportunity to hear opinions. It is recommended that the secretariat office actively help create such opportunities for communication between MIs and companies.

CLM support through active use of founding ASEAN countries' scholarship programs for foreign students

As noted in 3.4.1, MIs in CLM still need more teaching staff to acquired high degrees. As a means of meeting this need, we recommend that scholarship programs for CLM provided by government institutions in founding ASEAN countries be actively used, as described in Table 7 in 3.4.4. During the Phase 4 period, CLM and founding ASEAN MIs and the secretariat office should promote the collaboration with the organizations running the scholarship programs. In addition, JICA began the Innovative Asia program in 2017 and the Innovative Human Resources Development Program in Science and Technology in 2020, provides opportunities for students to enter master's degree and PhD programs in fields in which innovation can be expected, such as the engineering field. Since all MIs in CLM are eligible, we recommend that the active use of these programs be considered. Furthermore, ASEAN is preparing a proposal to develop an intra-ASEAN scholarship program that would be participated in by higher education institutions and

universities in the region. Therefore, there is a possibility that AUN/SEED-Net's scholarship program could align with this program, and it is recommended that AUN/SEED-Net secretariat office and MIs discuss possible cooperation with ASEAN.

4.2.2 Recommendations to JICA

Follow-up support from Phase 4

If the project is ended in Phase 4, MIs have very clear expectations from JICA for cooperation to sustain the project's effects. They want to receive information on matching with Japanese companies and networking with Japanese universities, and also advice and suggestions concerning best practices and models of collaborative research. In regards to support from Phase 4, we recommend considering effective cooperation in light of these strong needs.

4.3 Lessons Learned

Measures to increase effectiveness of a scholarship program

One reason that this project successfully had a major effect is that the project components functioned well together in a mutually complementary way. Specifically, collaborative research programs that lecturers and researchers who had acquired higher degrees in the scholarship program could apply for with their supervisors and fellow students from the university from which they had graduated were offered. Then, regional conferences at which the results of this research could be presented were held periodically, in addition to the publication of an academic journal. This increased the sustainability of researchers' networks, and the utilization of the networks to set up joint education programs between universities succeeded in forming systematic networks. Forming platforms that can maintain relationships between researchers is effective in achieving multi-faceted effects. This kind of framework can be a reference when considering designs for other projects with scholarship component and mechanisms for ensuring the project's sustainability.

This project's scholarship program also helped strengthen industry-university linkage by providing research funding for former students who have returned and implemented joint research with Japanese and/or local companies. In addition, the convening of technical management courses, the holding of seminars on industry-university linkage, and the dispatch of advisory teams to encourage industry-university linkage were all effective in supporting a wide range of industry-academia ties in this project. These initiatives are also useful references.

Appendix 1: Main policies on higher education institutions in key member countries and views on AUN/SEED-Net

Country	Relevant policies	Views on AUN/SEED-Net (respondents)
Laos	Raising engineering staff who can support industrial development is an important policy in the National Plan 2020-2030 for higher education in engineering. In Laos, the Law on Higher Education has gone into effect and teachers and researchers have been given clear roles in providing services to companies and society, so industry-university linkage and responses to regional issues are called for.	This project has made very significant contributions to the development of higher education in the engineering field. When Phase 1 began, the National University of Laos' engineering department had only six PhD holders and five courses in its bachelor's degree program, but at present, its bachelor's degree program has 16 courses, the master's degree program was expanded to nine courses, and there are 56 PhD holders, almost all of whom are AUN/SEED-Net graduates. AUN/SEED-Net is highly praised by those involved in Laos' higher education (Director General, Department of Higher Education, Ministry of Education and Sport).
Cambodia	The Policy on Higher Education Vision 2030 lays out goals to provide high quality higher education, develop curriculum for the training of personnel needed for national development and markets, and strengthen governance. Providing scholarships and expanding STEM are designated as strategies to achieve these goals. Cambodian Higher Education Roadmap 2030 and Beyond lays out a strategy to achieve this vision, and discusses raising the quality of STEM teachers, augmenting education and research facilities at priority universities, and increasing investment in research and innovation. The Education Strategic Plan (2019-2023) and its Reform Strategies lays out the goal of increasing the percentage of students in STEM fields from 27.1% in 2018 to 32% in 2023 by setting up three centers of excellence in science fields and developing curriculum that meets industry's needs.	ITC is Cambodia's most important higher education institution in the engineering field, and it is extremely important that ITC's level be raised through networks with top universities in the region and cooperative relationships with Japanese universities (Deputy Director General of Higher Education, Ministry of Education, Youth and Sport).
Myanmar	The National Education Strategic Plan (2016-2021) consists of nine pillars, and in higher education, the plan aims for access to higher education that meets international standards and contributions to employment and national development. (The current military Government has changed the administrative structure of ministries. The strategic plan is likely revised accordingly.)	The project made major contributions to the development of higher education in Myanmar and the strengthening of research capacity (Director General, Department of Higher Education, Ministry of Education – the responsible agency of higher education at the time of the evaluation study)

Vietnam	The Socio-Economic Development Strategy 2021-2025 discusses strengthening international competitiveness and prioritizes enhancing the level of education and training, including at ICT, and improving science and technology to achieve this. Vietnam has carried out initiatives to reform the quality of higher education since 2019 with ministerial decrees to reform the curriculum at higher education institutions and a ministerial decree on the university certification system.	The project is helping to raise the quality of the two universities (Deputy Head of International Education Division, International Cooperation Department, Ministry of Education and Training).
Indonesia	In Indonesia, cooperation between industry and academia as well as the development of personnel for advanced industry are highly valued, and to achieve this, the Higher Education for Technology and Education (HETI Project 2021-2025), Science and Technology Research Funding Program SBSN 2020 – (multiple years), APBN funding and Kampus Merdeka (emancipated learning program) are implemented.	Through this project, the number of students at Indonesia's MIs who earned PhDs by studying abroad in Japan increased, and there was also progress in accepting foreign students from other ASEAN countries. In particular, by participating in education and research at international standards, the start of graduate programs in English was beneficial for Indonesia (Director of Resources, Directorate General of Higher Education, Ministry of Education and Culture).
Thailand	The 20-Year National Strategy (2018-2037) is a strategy to propel the country from developing to developed status. One of the seven pillars of this strategy is human resource development. The Higher Education, Science, Research and Innovation Policy and Strategy (2020-2070) has four pillars, and research and innovation to solve social issues and raising the international competitiveness of research are related to this project.	This project contributed to the development of personnel in the engineering field in Thailand and other ASEAN countries, and even in Phase 4, the project is contributing to the Thai government's policies (listed to the left), particularly in strengthening ties between industry and academia (Director, Bureau of International Cooperation Strategy, Ministry of Higher Education, Science, Research and Innovation).
Philippines	Centers of Excellence and Centers of Development are strategies aligned with the goal of international research and national construction in the Higher Education Act 1994 and are intended to raise the quality of international research activities and education and increase universities with networks with overseas entities.	There have been reports from UP, DLSU and MSU-IIT, which are MIs, that this project has been effective as a platform for expanding and strengthening collaborative research. The project is expected to strengthen open networks through which AUN/SEED-Net supports engineering networks in individual countries going forward (International Affairs Division, Commission on Higher Education).

Malaysia	Of the 10 pillars in the *Malaysia Education Blueprint 2015-2025* (Higher Education MEB [HE]), international competitiveness and talent development are listed.	The project contributes to the ASEAN Engineering Journal, industry support with research, and revitalizing research and education in the region (Director, Education Malaysia Division, Department of Higher Education, Ministry of Higher Education).

Appendix 2: Needs for industry-academia collaboration in industry

Country	Name of responding organization, company	Needs
Laos	Two electric power companies, a sugar refining company, and four major telecommunications companies	These companies want practical training of engineers (joint degree programs with the Chamber of Commerce and Industry and others, revisions to joint curriculum, etc.), research that helps small- and medium-sized companies, which account for the vast majority of the private sector, and the establishment of a contact point for industry-university linkage at universities.
Cambodia	Waste disposal company, elevator manufacturing company, machine control company, startup support company (four companies)	All four companies are managed by graduates of ITC and AUN/SEED-Net. Their main concern is the generation of talented employees, and up until this point, their cooperation has consisted of taking on interns and providing backup support for student projects, among other. They are also interested in companies providing scholarships since this could be adopted if there was a guarantee that the students would take a job with the company. However, only large companies need staff at the graduate school level. Students are very interested in startups, so this is an area that support can be expected from in the future.
Vietnam	Association of Young Vietnamese Managers	Universities have the technology, so the Association would like them to take a more strategic approach to the ways in which they spread technology to private sector companies. The Association would like personnel for industry who have soft skills and a strong interest in addressing the changing business environment (statement at a British Council seminar, March 21, 2021).
	Vietnam's Chamber of Commerce and Industry	Universities need to create technology that is more practical and that can potentially lead to business. At the same time, the government should work to create a platform for technology transfer linking companies and universities, and at this point, universities contribute only a small amount to companies' innovation. According to a 2016-2019 survey by the Ho Chi Minh National Academy of Politics, only 5-10% of research was utilized in business. Research needs to be more proactive about commercialization (statement on August 18, 2019).
	Japanese company	The main purpose of affiliations with universities is to train young personnel and strengthen relationships with related organizations in Vietnam.

Indonesia	Mineral resources company	University technology is extremely important in the mineral resource field, and we have signed MOU and requested joint research and advisor roles. We did not know about the AUN/SEED-Net scholarship program, but we are interested and want this to be promoted to companies.
	Major public construction corporation	The infrastructure repair and reinforcement materials of Japanese companies are expensive and can't be used, so there is a need for localized products that are competitive in Indonesia. Companies have graduates of Japanese universities, and these graduates have Japanese friends from university working on this kind of product development, so the networks are in place. MIs can make use of these ties with Japanese universities.
	Semiconductor manufacturing company	There are many research needs, and we are cooperating with ITB. As a company, we have study abroad programs to overseas universities and ITB. Although they are currently suspended due to COVID-19, we have full scholarships. When conditions improve, we could collaborate with AUN/SEED-Net on scholarships and other aspects.
	Publicly-managed mining company	We are very familiar with AUN. They are an important partner in our research. We have not considered scholarships until now, but it is a good idea, and we would like someone to come to headquarters to explain it officially.
Thailand	Federation of Thai Industries (FTI)	According to a survey of member companies, collaborative research is seen as one option for technology development. The difficulty is that large companies want to conduct research without sharing information openly, but small- and medium-sized companies want technology cooperation with universities but lack the funds and engineers necessary for this. This means that matching is important. One method is to actively use the science parks established by the government (providing one-stop services for industry-university linkage), and another possibility is to apply for the funding for industry-university linkage that FTI provides to small- and medium-sized companies. In addition, 60% of the research funds for the National Research Council of Thailand (NRCT), the government's organization for providing research funds, are provided to applied research, and support for small- and medium-sized companies is not sufficient, but it could be used on a project basis. Applications for these funds could be encouraged for environmental and cyclical-type technology.
Philippines	Philippines' Chamber of Commerce and Industry	Universities are expected to meet needs such as a university curriculum that fits the knowledge and skills that companies require, a good understanding of business, training and interns by universities and companies, and joint research. The Chamber of Commerce and Industry has a sub-committee for each field, such as higher education and vocational training, and provides this kind of cooperation. In addition, we have a cooperative relationship with the Japanese Chamber of Commerce and Industry in the Philippines through the Philippines-Japan Business Council, and cooperation is possible, including with Japanese companies.

Malaysia	White paper on Malaysia's participation in international standards technology in energy sector (March 2019)	The results of interviews with companies showed that the need for industry staff in the energy field is not for specific skills and technology, but to raise the comprehensive capacity of staff. It is also important to improve curriculum content so that it meets international standards.
	Clair Report No.471 Progress of Malaysia's economic industry policy to aim at being a developed country by 2020 (2018, August)	The utilization of employees with practical skills, high-quality employees who meet international standards, and employees who have received an education overseas; labor productivity has grown 2.3% a year (2011-2015), and the educational programs were improved to raise it to 3.7% in 2016-2020 (4.1% in the service industry, 3.0% in the manufacturing industry).

Kingdom of Thailand

FY2020 Ex-Post Evaluation Report of Japanese ODA Loan

"The Eighth Bangkok Water Supply Improvement Project"

External Evaluator: Hajime Sonoda, Global Group 21, Japan, Inc.

0. Summary

"The Eighth Bangkok Water Supply Improvement Project" (hereinafter referred to as "the Project") was implemented to satisfy the pressing water demand of Bangkok Metropolitan Area by strengthening the water production capacity and developing/expanding water intake, transmission, and distribution facilities and distribution pipes of the Metropolitan Waterworks Authority (hereinafter referred to as the "MWA"), thereby contributing to the improvement of the living environment of the residents in the area. The Project is highly relevant with the development policy, development plan, and development needs of Thailand and the Bangkok Metropolitan Area, both at the time of planning and ex-post evaluation. The Project is also highly relevant with Japan's ODA policy at the time of the planning. Therefore, relevancy of the Project is high. The outputs were generally as planned except for the installation of pipelines, and the project cost was within the plan. However, since the length of the pipeline installed was less than planned and the project period was longer than planned, the efficiency of the Project is fair. As a result of the Project, the water production capacity of MWA increased as planned and the amount of water supply increased. This, together with the expansion of reservoirs and pumping facilities and the laying of water distribution pipes implemented under the Project, led to an improvement and expansion of MWA's water supply services. This has had an impact on improving the living environment and public health, and water users are highly satisfied with the results. In addition, the Project has provided an alternative water source to groundwater, which is considered to contribute to the mitigation of land subsidence. In summary, the effectiveness and impacts of this Project are high. No major problems have been observed in the institutional/organizational, technical, financial aspects of the operation and maintenance of the Project. Therefore, sustainability of the project effects is high.

In light of the above, the Project is evaluated to be highly satisfactory.

1. Project Description

Project Location

Bangkhen Water Treatment Plant

1.1 Background

The Bangkok Metropolitan Area, consisting of Bangkok Metropolitan Administration (BMA) and five surrounding provinces, is the political and economic center of Thailand with a population of approximately 10.8 million people (2016), and MWA was operating water supply systems in BMA, Nonthaburi Province, and Samut Prakan Province. The maximum water demand was 5.13 million m^3/day in 2008, and was expected to reach 6.27 million m^3/day in 2017 according to the projection made in 2008. However, the capacity of the water production facilities in 2010 was 5.52 million m^3/day, so there were concerns that supply and demand would be tight and water shortages would occur. On the other hand, JICA had supported the water supply sector in the Bangkok Metropolitan Area through a total of 11 Japanese ODA loan projects and two technical cooperation projects.[1] Against the background of the above, the Thai government requested a yen loan project from Japan in 2008 to develop waterworks, including the expansion of water treatment plants, and the loan agreement for this project was signed in 2009.

1.2 Project Outline

To satisfy the pressing future water demand of Bangkok Metropolitan Area by strengthening the water supply capacity and developing/expanding water intake, transmission, and distribution facilities and distribution pipes of MWA, thereby contributing to the improvement of the living environment of the residents in the area.

[1] Eleven Japanese ODA Loan Projects from ”Bangkok Water Supply Improvement Project” (June 1979) to “Seventh Bangkok Water Supply Improvement Project” (September 1999) with total loan amount of 100,819 million Yen, Technical Cooperation Project “The National Waterworks Technology Training Institute Project” (1985 – 1991), “The National Waterworks Technology Training Institute Project (II)” (1994 – 1999).

Loan Approved Amount/ Disbursed Amount	4,462 million yen / 4,410 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	December 2009 / December 2009
Terms and Conditions	Interest Rate: 0.8% (other than consulting services) 0.01% (consulting service) Repayment Period: 15 years (Grace Period: 5 years) Conditions for Procurement: General Untied
Borrower / Executing Agency	Metropolitan Waterworks Authority / Metropolitan Waterworks Authority (MWA)
Project Completion	October 2016
Target Area	Bangkok, Nonthaburi Province, Samutprakan Province
Main Contractors	Summit Grade Limited Partnership (Thai) /St Power Engineering Corp., Ltd. (Thai)(JV), Summit Grade Limited Partnership (Thai)
Main Consultants	Nihon Suido Consultants Co. Ltd. (Japan) / TEAM Consulting Engineering and Management., Ltd. (Thai) / Asdecon Corporation Ltd. (Thai)
Related Studies	MWA Master Plan (Revised on 2008) (MWA)
Related Projects	"Technical Assistance Related to Eighth Bangkok Water Supply Improvement Project" (2010 – 2013) 11 Japanese ODA Loan Projects from "Bangkok Water Supply Improvement Project" (June 1979) to "Seventh Bangkok Water Supply Improvement Project" (September 1999). "The National Waterworks Technology Training Institute Project" (1985 – 1991), "The National Waterworks Technology Training Institute Project (II)" (1994 – 1999).

2. Outline of the Evaluation Study

2.1 External Evaluator

Hajime Sonoda, Global Group 21 Japan, Inc.

2.2 Duration of Evaluation Study

The ex-post evaluation study for the Project was conducted over the following period.

Duration of the Study: October 2020 to November 2021

Duration of the Field Survey: March 2021 (by local research assistants)

2.3 Constraints during the Evaluation Study

Due to the pandemic of COVID-19, the external evaluator did not travel to Thailand, and the interviews with the Executing Agency, the field inspection of the water supply facilities constructed under the Project, and the interviews with the water users were conducted through

local research assistants.

3. Results of the Evaluation (Overall Rating: A[2])

3.1 Relevance (Rating: ③[3])

3.1.1 Consistency with the Development Plan of Thailand

At the time of planning of the Project (2009), the Government of Thailand was formulating the 10th National Economic and Social Development Plan as policies for economic and social development. In this plan, "conservation of natural resources and the natural environment" was positioned as one of the priority areas, pointing out the necessity of improving waterworks. On the other hand, since the 1970s, MWA has been promoting the phased development of waterworks facilities based on its water supply master plan, including the expansion of water treatment plants (WTPs) to increase water supply capacity, the construction of transmission and distribution pipes to expand the water distribution area, and the rehabilitation of transmission and distribution pipes to reduce water leakage. The Project is positioned as the "The Eighth Bangkok Water Supply Improvement Project" in the revised master plan prepared by MWA in 2009.

At the time of the ex-post evaluation (2021), the Government of Thailand, through the 12th National Economic and Social Development Plan (2017-2021), aims to achieve economic growth and reduce inequality based on the principles of "the sufficiency economy philosophy," "sustainable development, and "human-centered development," as well as development through productivity improvement through local knowledge and innovation. Its infrastructure and logistics development strategy mentions the spread of water supply facilities throughout the country, improvement of efficiency in water consumption, and promotion of technological innovation. In addition, the revised master plan of MWA (see above) shows a plan for phased development of water supply facilities to meet the increase in water demand until 2027, even after the Project.[4]

Based on the above, the Project is consistent with Thailand's development plan both at the time of planning and ex-post evaluation.

3.1.2 Consistency with the Development Needs of Thailand

As mentioned in "1.1 Background," at the time of planning, there was concern that the Bangkok Metropolitan Area would experience water shortages due to widening gap between demand and supply of water. At the time of the ex-post evaluation, the two WTPs expanded by

[2] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[3] ③: High, ②: Fair, ①: Low
[4] MWA started the 9th Water Supply Improvement Project in 2017, and the water production capacity of Mahasawat WTP will be further increased by 1.5 times to meet the increasing water demand. As of April 2021, its construction has not yet started. At the time of the ex-post evaluation, MWA is preparing a new master plan.

the Project are fully utilized (see "Effectiveness"), and expansion of the Mahasawat WTP is planned to cope with further increase in water demand (see footnote 4). In addition, the water transmission and distribution facilities (pump facilities and distribution reservoirs) included in the Project are expected to continue to be utilized in the future to meet the increasing water demand due to population growth.

Based on the above, the Project is relevant with the development needs of Bangkok Metropolitan Area at the time of planning, and the need for the Project has been maintained at the time of ex-post evaluation.

3.1.3 Consistency with Japan's ODA Policy

At the time of planning, "Japan's Economic Cooperation Program for the Kingdom of Thailand" (2006) positioned "responses to issues that emerge with maturing of society" as a priority area, and support for solving urban problems and strengthening environmental management systems as development issues. In response to this, JICA had set a policy to carry out urban development projects in an organized manner to improve urban life and environment in Thailand. In view of the above, the Project is consistent with Japan's ODA policy at the time of planning.

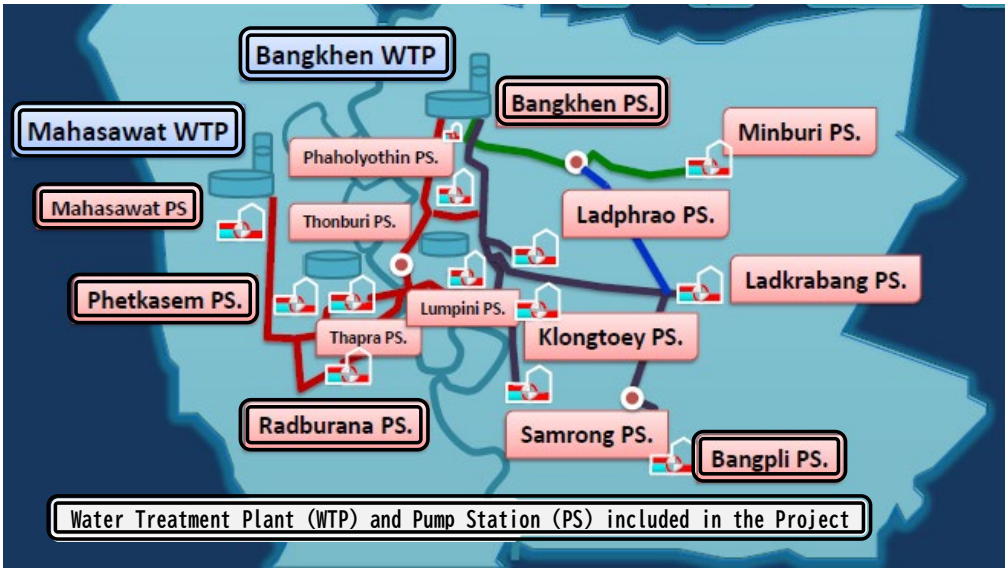
Based on the above the Project has been highly relevant to the country's development plan and development needs, as well as Japan's ODA policy. Therefore, its relevance is high.

3.2 Efficiency (Rating:②)

3.2.1 Project Outputs

In the water supply system operated by MWA in the Bangkok Metropolitan Area, Bangkhen WTP (water production capacity: 4 million m^3/day), which uses the Chao Phraya River as its source, and Mahasawat WTP (water production capacity: 1.6 million m^3/day), which uses the Mae Khlong River as its source, produce about 95% of the total water. The water supply area covers Bangkok, Nonthaburi Province, and Samut Prakan Province, which are divided into east and west by the Chao Phraya River. Mahasawat WTP supplies water on the west bank of the river and Bangkhen WTP supplies water on the east bank of the river, and the water transmission and distribution facilities on both banks are connected by a water transmission tunnel that crosses the Chao Phraya River. Water from both plants is distributed through 14 pumping stations. Most of the pumping stations are equipped with reservoirs.

The Project was to expand the service area of the MWA by expanding the major WTPs, expanding some pumping stations and reservoirs as needed, and laying new pipelines to meet the increased water demand until 2017. The planned and actual outputs of the Project are shown in Table 1.



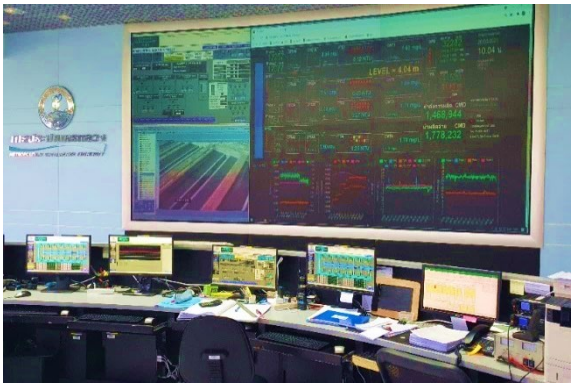
Note: Sam Lae pumping station for raw water intake is outside the scope of the above map.
Two small pumping stations are not shown.

Figure 1: Overall view of Bangkok's water supply system

Table 1 Planned and Actual Outputs

Plan	Actual
Expansion of Mahasawat WTP*	
Raw water pumps (150 m^3/min x 2 units)	As planned
Transmission pump (300 m^3/min x 1 unit)	As planned
Expansion of capacity (400,000 m^3/day)	As planned
Reservoir	As planned
Expansion of Bangkhen WTP	
Raw water pumps (358 m^3/min x 2 units)	As planned
Transmission pumps (300 m^3/min x 3 units)	To be completed by December 2021
Expansion of capacity (400,000 m^3/day)	As planned
Filter press (400,000 m^3/day)	As planned
Electrical substation（69/6.6kV, 15MVA）	As planned
Installation of additional pumping equipment	
Distribution pump at Bang Plee PS (125 m^3/min x 1 unit)	As planned
Raw water pump at Sam Lae Intake (500 m^3/min x 1 unit)	As planned
Expansion of distribution reservoir	
Reservoir at Rat Burana PS (40,000 m^3)	10,000 m^3
Reservoir at Petch Kasem PS (40,000 m^3)	As planned
Installation of pipelines	
Water distribution main（112km）	74km
Water distribution branch（875km）	470km
Consulting services	
Detail design, bidding documents*	As planned
Supervision (except for Mahasawat WTP and pipelines)	
Supervision (Mahasawat WTP) *	

Source: Information provided by JICA and MWA
Note: *Output not covered by the ODA Loan
WTP=Water Treatment Plant, PS=Pumping Station




SCADA system[5] (left) and reservoir (right) at Mahasawat WTP


Raw water pump (left) and transmission pump (right) at Bangkhen WTP

As a result of the Project, both Bangkhen and Mahasawat WTPs were expanded to add 400,000 m^3/day of water production capacity each, as planned. Since the completion of detailed design by 2010 till the construction of various parts of the Bangkhen WTP during 2011 – 2017, the situation changed as MWA carried out necessary emergency works in many sections of the WTP. As a result, there were significant design changes in the power supply and water production facilities at Bangkhen WTP, which significantly increased the construction period and project cost for the expansion of the plant. The expanded facilities at Mahasawat and Bangkhen WTPs became operational in January 2013 and June 2016, respectively.[6] According to the site inspection of both WTPs and interviews with MWA field staff, in the facility design of the Project, there were some issues related to the efficiency and safety in operation and maintenance.[7] The staff at the WTPs pointed out that some of these issues

[5] SCADA（Supervisory Control And Data Acquisition）system is a system that collects and monitors information obtained from devices and equipment that make up a large facility or infrastructure in one place using a network, and controls it as necessary.

[6] The completion of some pumping facilities at both WTPs was delayed, but this did not affect the operation of the expanded water treatment facilities (see footnote 9).

[7] At the Mahasawat WTP, the weir (Parshall Flume) has a small drop and the chemical dosing there is inefficient, and the chlorine dosing capacity is insufficient, so MWA had to add equipment. In addition, float switches (sensors to detect level of water) for the submersible pump were not selected according to the water quality and frequently failed, and the SCADA system requires more time for data processing due to system design, making it difficult to switch operations quickly according to the situation. At the Bangkhen WTP, the chlorine injection equipment is a combination of inexpensive equipment, which causes frequent failures. In addition, the size of the chlorine/activated carbon storage room and the sludge dewatering facility and the layout of the equipment are inconvenient for operation and maintenance,

could have been prevented if sufficient consultations had been conducted during the detailed design and if the design of existing facilities and experience in their operation and maintenance had been reviewed and reflected into the detailed design.

For the six pumps planned for both WTPs,[8] contracts were terminated by MWA in November 2014 due to significant construction delays caused by the poor implementation capacity of the first contractor hired in September 2011. Of these, the contract for the two raw water pumps at Mahasawat WTP was signed in March 2016 and the construction under the new contract was completed in May 2018.[9] For the four transmission pumps at both WTPs, it took time to prepare the bidding documents to comply with the Public Procurement and Supplies Administration Act, which was enacted in 2017, and new contracts were signed in December 2019 for Mahasawat WTP and March 2020 for Bangkhen WTP. The water transmission pump for Mahasawat WTP was completed in June 2021. As of August 2021, the water transmission pumps for Bangkhen WTP are scheduled to be completed in December 2021.

The reservoir at Rat Burana Pumping Station (PS) was planned to be expanded to a storage capacity of 40,000 m^3, but after re-examining the required storage capacity in terms of both necessity and cost reduction, it was reduced to 10,000 m^3. The distribution reservoir is located at the connection point between the water transmission network from Bangkhen WTP and Mahasawat WTP, and by integrating water from both plants, stable water distribution is possible even with a small distribution reservoir capacity. Although the project cost was reduced by this change, the construction period of the distribution reservoir more than doubled and was completed in October 2016 due to the abovementioned design changes.

A total of 51 contracts, including 30 contracts for water distribution branches and 21 contracts for water distribution mains, were drawn for the construction of water pipelines under the Project but not covered by the ODA Loan. The water distribution network was completed between October 2010 and May 2013, with a total length of 470.0km, which was 54% of the planned length. In addition, the water distribution main installation was completed between June 2010 and January 2016 depending on the contract, and the actual pipe length of 73.5km was 66% of the planned length. The main reason for the lower-than-planned pipe length was that the implementation of the Project was postponed in some areas as a result of coordination with the investment plans for streets, sewage, drainage by the Bangkok Metropolitan Administration, the Department of Highways of the Ministry

and the lighting in the sedimentation tank is dark and the sample collection point is in a hidden location, making it unsafe to work.

[8] Three transmission pumps for Bangkhen WTP, and two raw water pumps and one transmission pump for Mahasawat WTP. Two raw water pumps at the Bangkhen WTP were procured under a separate contract along with the raw water pumps at the Sam Lae Intake.

[9] After the completion of the expansion work at this WTP, the capacity of the raw water pumps was insufficient, so MWA had to temporarily install several small pumps to compensate them. On the other hand, the four transmission pumps were planned as backup pumps to ensure that the existing pumping facilities at the two plants could pump water with increased stability. As the existing pumps were used to pump water from the two plants, and as of March 2021, the delay in their completion has not been a constraint to pumping water from the two plants.

of Transport, and the Department of Rural Roads of the Ministry of Transport. The planed pipelines that were not realized under the Project will be constructed, outside the scope of the Project, as soon as the coordination with the relevant organizations is completed.

The consulting services were carried out as planned under the following three contracts. Detailed design and construction supervision of the pipeline installation were carried out directly by MWA.

① Detailed design and bidding support for the entire project except for the pipe laying (completed in January 2010, not covered by the ODA Loan)

② Construction supervision of the ODA Loan portion (other than pipe laying and Mahasawat WTP) (completed in September 2020, subject to the ODA Loan)

③ Construction supervision of the Mahasawat WTP which was started in advance (completed in June 2014, not covered by the ODA Loan)

As a part of JICA's technical cooperation related to the Project, "the Technical Assistance Related to Eighth Bangkok Water Supply Improvement Project" was implemented from October 2010 to March 2013,[10] and as a part of this cooperation, knowledge on pipe laying such as improvement of construction supervision and introduction of non-excavation method was transferred. Part of the water main installation in the Project was carried out using non-excavation methods, and it is inferred that the knowledge gained through the technical cooperation was utilized.

3.2.2 Project Inputs

3.2.2.1 Project Cost

The total project cost was planned to be 21,099 million yen with ODA Loan of 4,462 million yen. The actual amount (including some estimated amounts) was 20,586 million yen (98% of the plan with ODA Loan of 4,410 million yen) (Table 2).

The cost of laying the pipelines was almost in line with the planned project cost (excluding price increases), but the output was 55% of the plan; the total planned length of the water distribution branches and water distribution mains was 987 km, while the actual output was 544 km, which means low efficiency. According to MWA, the construction cost increased compared to the output due to unexpected price escalation of labor and construction material, and increased night works due to worsening traffic congestion. Although the actual total project cost was almost same as the plan, if the pipeline laying length, which was 55% of the plan, had reached

[10] In this technical cooperation, with the aim of improving MWA's capacity to operate and maintain waterworks facilities by sharing the technology and experiences of Japanese water utilities, training in Japan and dispatch of short-term experts were made by the water utilities of Osaka Prefecture, Nagoya City, and Tokyo Metropolitan Government. Osaka Prefecture provided technical support on water production and transmission, Nagoya on water distribution management, and Tokyo on measures against non-revenue water.

100% of the plan, it is estimated that the total project cost would have been about 29,000 million yen,[11] which is about 1.4 times higher than the plan. Therefore, the efficiency of the project cost is judged to be fair.

Table 2: Planned and Actual Project Cost

(Unit: million yen)

	Planned Amount			Actual Amount		
	Total	Loan	MWA	Total	Loan	MWA
Bangkhen Water Treatment Plant, Reservoir, Pumping equipment	4,338	3,508	830	6,634	4,102	2,532
Mahasawat Water Treatment Plant	2,117	0	2,117	2,532	0	2,532
Pipeline	9,680	0	9,680	9,026	0	9,026
Consulting Services	475	364	111	579	308	271
Price escalation	2,334	395	1,939	0	0	0
Physical contingency	929	195	734	0	0	0
Tax, Administration	1,109	0	1,109	1,699	0	1,699
Others	116	0	116	116	0	116
Total	21,099	4,462	16,637	20,586	4,410	16,176

Source: Prepared from materials provided by JICA and MWA.
Note: Actual results are compiled based on MWA's questionnaire responses. For some contracts that were not completed, the final contract amount was used.

3.2.2.2 Project Period

The Project was planned to be implemented over a period of 53 months, from the signing of the loan agreement in September 2009 until the completion of all construction and consulting services in January 2014. In fact, the loan agreement was signed in December 2009. The completion dates for each component are as follows.

Bangkhen WTP expansion:	Started operation in June 2016 (water transmission pumps to be completed in December 2021)
Mahasawat WTP expansion:	Started operation in January 2013 (water transmission pumps to be completed in June 2021)
PS distribution reservoir expansion:	October 2016
PS pump expansion:	April 2013
Pipeline installation:	June 2016
Consulting service:	June 2016

[11] Since the actual cost for pipe laying of 9,026 million yen was for 55% of the total length. To finish the remaining 45% of the pipe laying, additional cost of approximately 7,385 million yen (9,026 million yen / 55% x 45%) would be needed. By adding taxes and administrative costs (14%), the total additional cost is estimated to be 8,419 million yen. Adding this amount to the actual total project cost, the adjusted total project cost would be 29,005 million yen, which is 137% of the planned 21,099 million yen.

As for the main factors that affected the project period, the design changes of the Bangkhen WTP, the cancellation of the contracts for the pumping facility of the WTPs, and the design change of the distribution reservoir have been mentioned above. The following can be pointed out as other factors.

- Extension of construction period due to floods in 2011: The floods in Thailand caused by the 2011 monsoon inundated parts of Bangkok. The Mahasawat WTP construction site and part of the pipe laying site were submerged in water, and the construction of other sites was severely affected due to the disruption of the city's road network. Regarding the extension of the construction period due to the floods, the Cabinet decided to exempt the public works from compensation for delay for 180 days for civil works and 120 days for equipment procurement. The contract period of all construction contracts for the Project has been extended accordingly.

- Labor shortage since 2013: New policies by the Thai government have led to a significant increase in the minimum wage in Thailand since 2013. The wage gap between Bangkok and the provinces has narrowed, resulting in a labor shortage in Bangkok. As a result, the labor market became a seller's market and it became difficult to secure an appropriate workforce at the expected wages. As a result, the construction period of many public projects, including the Project, was extended by 150 days to cope with the shortage.

- The construction contract for the raw water pumps for the Bangkhen WTP more than tripled the construction period (from 22 months planned to 68 months actual) due to the contractor's severe financial difficulties caused by the minimum wage increase.

Of the Project, the Bangkhen and Mahasawat WTPs started operation in June 2016 and January 2013, respectively, and this can be considered as the completion date of the WTPs. On the other hand, the expansion of the distribution reservoirs, enhancement of pumps at the pumping stations, and installation of pipelines are for the development of water transmission and distribution facilities, and their effects can be obtained independently from the expansion of the two WTPs. Therefore, the completion of the two WTPs cannot be regarded as the completion of the entire Project, and it is appropriate to define the time of completion of the entire Project as the time when the operation of the two WTPs started and the completion of the expansion of the distribution reservoir, pump reinforcement, and the installation of pipelines at the pumping stations are all completed. Based on the above, it is judged that the Project was completed in October 2016 (completion of the expansion of the distribution reservoir at the pumping station) and the actual project period is 6 years and 11 months (83 months).[12]

[12] Regarding the completion date of the Project, MWA and JICA agreed in September 2020 to redefine the completion

On the other hand, in the Project, the contract period was extended for 180 days for civil works and 120 days for equipment procurement due to the floods in 2011. This is due to force majeure caused by natural disasters and should be excluded from the judgment of efficiency. Therefore, the project period is 77 months, which is 83 months minus 180 days (6 months), or 145% of the planned 53 months. Based on the above, the efficiency of the project period is fair.

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

At the time of planning, the financial internal rate of return (FIRR) and economic internal rate of return (EIRR) for the expansion of WTPs by the Project were calculated to be 10.2% and 21.4%, respectively, based on the following assumptions.

Cost	FIRR:	Project cost, water supply cost, and maintenance cost
	EIRR:	Project cost, water supply cost, and maintenance cost (economic costs)
Benefit	FIRR:	Water tariff revenue
	EIRR:	Willingness to pay for increased water use (existing customers)
		Cost savings from alternative water sources (new customers)
Project life:		30 years from start of operation

The updated FIRR and EIRR are 10.1% and 22.2%, respectively, after recalculation based on actual costs and benefits using the same assumptions in the ex-post evaluation. The difference from the original figures is due to the revision of the project cost, water supply cost, and water supply volume in consideration of the actual results since the original plan.

Based on above, both the project cost and project period exceeded the plan. Therefore, efficiency of the Project is fair.

3.3 Effectiveness and Impacts[13] (Rating: ③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

The purpose of the Project was to meet the pressing water supply demand in Bangkok Metropolitan Area. At the time of planning, the following indicators were set for the WTPs: water production capacity, average daily water production, maximum daily water production, and estimated beneficiary population. This section analyzes the achievement status of these indicators

of the Project as the commencement of operation of both WTPs. Since the uncompleted water pumps were planned as a backup facility and both WTPs have maintained the planned water production capacity without any problem since they started operation, it is considered that there is no problem in redefining the completion date of both WTPs in the Project in this way. On the other hand, in the ex-post evaluation, the project completion date was determined by taking into account the fact that the Project includes both WTPs and water transmission / distribution facilities.

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

for the WTPs. For the water transmission and distribution facilities (additional pumps, expansion of reservoirs, and installation of pipelines), no indicators were set at the time of planning, but their contribution to the Project objectives will be analyzed based on their utilization.

3.3.1.2 Water Treatment Plants

Table 3 shows the planned and actual water production capacities, average daily water production, and maximum daily water production of the Bangkhen and Mahasawat WTPs, which were expanded by the Project, and the entire MWA. The two plants are the WTPs accounting for 90% of the total water production capacity and about 95% of the total water production of the MWA.

Table 3: Planned and actual performance of the indicators for WTPs

(Unit: million m^3/day)

	Baseline 2008	Target 2016	2012	2013	2014	2015	2016	2017	2018	2019	2020
Bangkhen WTP (the expanded facilities start operation in June 2016)											
Water production capacity	3.60	4.00	3.60	3.60	3.60	3.60	4.00	4.00	4.00	4.00	4.00
Average daily water production	3.39	3.66	3.40	3.23	3.53	3.64	3.62	3.93	3.70	3.94	3.97
Maximum daily water production	3.58	3.88	3.94	3.59	3.95	4.03	3.95	4.24	4.12	4.19	4.24
Mahasawat WTP (the expanded facilities start operation in January 2013)											
Water production capacity	1.20	1.60	1.20	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
Average daily water production	1.07	1.47	1.15	1.48	1.34	1.45	1.47	1.40	1.36	1.47	1.59
Maximum daily water production	1.17	1.56	1.48	1.70	1.53	1.69	1.68	1.53	1.54	1.64	1.72
Total MWA											
Water production capacity	-	-	5.52	5.92	5.92	5.92	6.72	6.72	6.72	6.32	6.32
Average daily water production	-	-	4.96	5.05	5.19	5.46	5.44	5.67	5.38	5.72	5.84
Maximum daily water production	-	-	5.66	5.52	5.75	6.02	5.84	6.13	5.93	6.17	6.23

Source: Material provided by JICA for baseline and target, material provided by MWA for actual.
Note: The shaded area is the figures that are above the target value for 2016.

As a result of the Project, the water production capacity of the Mahasawat WTP increased from 1.2 million m^3/day to 1.6 million m^3/day, and that of the Bangkhen WTP from 3.6 million m^3/day to 4.0 million m^3/day. This is in line with the plan and the achievement of the planned water production capacity is high. However, its realization was delayed by one to two and a half years from the planned time (February 2012 for Mahasawat WTP and December 2013 for Bangkhen WTP).

The average daily water production in 2020 increased to 117% for Bangkhen WTP and 149% for Mahasawat WTP compared to 2008. The combined total of both WTPs increased to

125%. Compared to the 2016 target set at the time of planning, as of 2016, the Bangkhen WTP slightly fell short of the plan (98.9% target achievement rate), while the Mahasawat WTP was on target (100% target achievement rate).

The maximum daily water production for both WTPs has achieved the target for 2016, and reached 106% and 108% of the production capacity of Bangkhen and Mahasawat WTPs in 2020, respectively.

At the time of planning, it was assumed that the Project would benefit about 1.25 million people based on the per capita water supply.[14] The capacity of the water production facilities added by the Project was 800,000 m^3/day as planned. Both plants produced water at their full capacity,[15] and the capacity utilization rate (water production divided by water production capacity) in 2020 was 99.3%, which means that about 794,000 m^3/day of additional water was produced by the Project. This is equivalent to about 14% of the total water production of 5.84 million m^3/day in the same year. Therefore, the estimated beneficiary population is calculated to be about 1.16 million, which is equivalent to 14% of the total water supply population of 8.28 million by MWA (at the end of 2019). This is 93% of the target of 1.25 million people. As the water from both plants is supplied to the entire MWA water supply area, MWA's total water supply population of 8.28 million people have actually benefited.

As described above, the achievement rate of the indicators set for both WTPs is high. In addition, since 2016, Bangkok has maintained 24-hour water supply and has not experienced any serious water shortage except for the period of temporary water shutdown due to flood, etc. Therefore, the expansion of both WTPs is considered to have fully achieved the target.

3.3.1.3 Transmission and Distribution Facility

Changes in water distribution volume of the three PSs strengthened by the Project among the water distribution pumping stations operated by MWA, and the overall distribution volume are shown in Table 5. The Project enhanced the distribution reservoir at the Petch Kasem PS, the distribution reservoir at the Rat Burana PS, and the distribution pump at the Bang Plee PS.

Overall, there was a 17% increase in water distribution during the period 2012 – 2020. The increase by pumping station was 50% at the Phet Kasem PS, 20% at the Bang Plee PS, and 7% at the Rat Burana PS. The difference in the increase rate by PS reflects the difference in the rate of population increase in the areas covered by each PS. It is believed that the facilities of the Project were utilized at all pumping stations and contributed to the increase in the volume of water distributed.

[14] Calculated based on average water supply per capita, including all uses and leakage, as 641 liters/day.
[15] The facility utilization rate (water production divided by water production capacity) was 82% for the Bangkhen WTP and 92% for the Mahasawat WTP in 2016, and has been maintained above 85% since then, reaching 99% by 2020.

Table 4: Changes in the volume of water distributed by pump stations

(Unit: 10,000 m^3/day)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	Increase 2012～2020
Petch Kasem PS	24	27	34	36	33	35	34	37	36	50%
Rat Burana PS	42	41	42	43	44	44	41	43	45	7%
Bang Plee PS	35	39	37	37	40	41	38	40	42	20%
All PSs of MWA	474	483	461	493	513	541	527	547	553	17%

Source: Material provided by MWA

About 470 km of water distribution branches was laid under the Project. MWA is supplying water to about 8.28 million people in 2019 with a total of 36,453 km of distribution branches, which means that the connected population per 1 km of distribution branch is about 227 people. Based on this, it is estimated that about 107,000 people have newly come to use the water supply system by the Project. This is equivalent to 1.3% of the 8.28 million people served by the MWA.

MWA manages the water quality according to a Water Safety Plan with an aim to ensure that water production and transmission meet the WHO guidelines for drinking-water quality. According to the data of MWA for September 2020, the water quality of Bangkhen and Mahasawat WTPs was within the standard values for all water quality items. In addition, more than 95% of the samples collected from faucets in the water supply area in 2019 were within the standard range for turbidity and more than 99% were within the standard range for residual chlorine concentration.

From the above, it can be concluded that the objective of the project, “to meet the pressing water supply demand in Bangkok Metropolitan Area,” has been fully achieved.

3.3.2 Impacts

3.3.2.1 Intended Impacts

The intended impact of the Project was “improvement of living environment and sanitary conditions” caused by the improvement of water supply service (expansion of water supply area and improvement of water supply service in existing water supply area), which is the outcome of the Project. As broader impacts, changes in household life and socio-economic conditions resulting from these improvements are also expected. After an overview of the improvement of water supply services by the Project, based on the results of the qualitative survey[16], the economic and social impacts of the Project were analyzed in the areas where MWA’s

[16] In order to understand the nature and manifestation of typical impacts, as a qualitative survey, the following were interviewed through a local research assistant on the current water supply services in MWA, the changes in water supply

water supply service was provided before the Project (existing water supply areas) and in the areas where MWA's water supply service was newly provided by the Project (expanded water supply areas).

(1) Changes in water supply service

Among the outcomes, the expansion of the water supply area was realized by the installation of distribution pipelines under the Project (water supply expansion area). The beneficiary population is estimated to be about 107,000 (see "Effectiveness"), which is equivalent to 1.3% of the total population of 8.28 million (2019) who receive water from MWA.

The Mahasawat and Bangkhen WTPs account for 95% of the total water supply of the MWA (see "Effectiveness"), and water from both WTPs is provided to the entire service area of the MWA. The per capita water supply increased from 565 liters/day in 2006 to 705 liters/day in 2019.[17] Therefore, the increase in the amount of water supplied by both WTPs is considered to have contributed to the improvement of water supply service for the entire existing water supply area. In addition, the Project increased the number of distribution reservoirs at two distribution PSs and the number of distribution pumps at one PS. This has contributed to the stabilization of water distribution in the distribution areas of each PS, and is considered to have led to the improvement of water supply services. It should be noted that, in parallel with the Project, MWA has been implementing projects such as the reinforcement of distribution PSs and the repair and installation of distribution mains and distribution branches, with an investment of about 25 billion yen planned and implemented from 2013 to 2022. It is also working to reduce leakage by using the Water Leakage Management Application System, which manages leakage in each Distribution Management Area. In addition, water quality management is being strengthened through a real-time water quality monitoring system. The improvement of water supply services in existing water supply areas is a synergistic effect of the Project and these projects.

According to interviews with residents about the water supply service, the water pressure is generally good, but in areas where the population is growing rapidly, the water pressure may drop depending on the time of day. Water quality is also generally good, but some residents pointed out that the water is sometimes hard and over-chlorinated. Most of the residents were

services before and after the Project, and the associated changes in their daily life and business operations.

Target areas: Bangkok, Samut Prakan Province, Nonthaburi Province, where "MWA's water supply service was provided before this Project (existing water supply area)" and "MWA's water supply service had been newly provided by the Project (expanded water supply area)."

60 residents (24 male and 36 female): Individual and group interviews with several people at each of an existing water supply area and an expanded water supply area in the three target areas.

12 business operators: Individual interviews with business operators at three schools (elementary, junior high, and university), three medical institutions, and six commercial facilities (large-scale commercial and recreational facilities, stores, factories, etc.)

[17] Per capita water supply is the total water supply of MWA divided by the total population served, which is different from per capita water use. The figure for year 2006 was calculated from the forecast by MWA at the time of planning, and the figure for year 2019 was calculated from the actual value.

satisfied with MWA's customer service and water rates, including advance notice of water shutoffs and prompt response to water leaks. Ninety percent of the residents interviewed said they were "very satisfied" or "satisfied" with MWA's water service. On the other hand, most of the business operators were also generally satisfied with the water pressure and quality. However, some hospitals and large commercial facilities conduct their own water quality tests and may add chlorine on their own if the residual chlorine concentration is not sufficient. In the existing water supply areas, all residents and businesses reported that the water pressure and water quality had improved compared to 10 years ago.

(2) Impacts in existing water supply areas

Most of the residents are equipped with pumps to compensate for the water pressure, but since the water pressure has improved, they no longer need to use the pumps as often as before. No significant changes in the amount and frequency of water use in households were reported. Businesses such as hospitals, schools, and ice factories reported that they stopped using groundwater because of the improved water pressure of MWA's water service. As a result of the improved water quality, most of the residents and businesses such as schools reported that they now drink tap water that they did not drink before, after passing it through a water purifier that is connected to the faucet for use. Households that use the water purifiers have reduced the purchase of bottled drinking water, leading to a reduction in water-related expenditures. The improved water pressure and quality of MWA's water supply service is greatly welcomed by many businesses, as they consider it important for their business to have stable access to water of more reliable quality.

(3) Impact on expanded water supply area

Before being connected to the water supply service of MWA, the Subdistrict Administrative Organization provided water supply service using groundwater as the source. In the past, water was often cut off and there were sometimes disputes with neighbors over the use of water due to low water pressure. Water quality was poor, and the first water that came out of the faucet was so cloudy that they had to leave it running until it was clean or use chemicals to improve the water quality. Being connected to the MWA's water supply service has eliminated these problems and increased the convenience about water.

Residents did not report any significant changes in the amount and frequency of water use in their households. Some residents who used to buy bottled water for drinking are now using tap water for drinking using water purifiers after being connected to MWA's water supply service. In addition, some residents reported that a laundry store has been established in the neighborhood and that they have started selling foods at home. The improvement in water quality was highly appreciated, and all of them believe that it has led to improved sanitation in their homes. However,

residents have always been very careful about sanitation and drinking water management, and waterborne diseases have rarely occurred before being connected to the MWA's water supply service, so no particular changes were reported concerning their health.

Before connecting to MWA's water supply service, the offices used groundwater from on-site wells and rainwater. Some schools still use mainly groundwater, but most of them use MWA's water service. No specific changes in water use associated with the changes in water sources were reported. Universities reported that water management has become easier with MWA's water service. Most of the business appreciated the improvement in water pressure and quality, as it is important for their operation to have stable access to water of more reliable quality.

From the above, although the expanded water supply area was smaller than planned due to the lower-than-planned length of the distribution pipes, it can be concluded that the expected impact of the Project has been realized to some extent in both existing and expanded water supply areas.

3.3.2.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

According to MWA, all the construction works of the Project were carried out in accordance with the guidelines set by the Bangkok Metropolitan Administration with due considerations for environmental and social aspects, and no particular problems were encountered. In addition, the expansion of the WTPs and pumping facilities were both carried out within the premises of MWA and did not cause any environmental or social problems. In addition, the sludge generated at the two WTPs has been properly disposed of.

Through this project, the use of groundwater is believed to have been suppressed due to the improvement and expansion of water supply services using surface water as the source. In Bangkok, groundwater abstraction has increased since the 1980s due to rapid economic growth and population increase, and subsidence of the land in the city, which was originally low in elevation, became a major problem. In 1977, the government enacted the Groundwater Act, which established Groundwater Area and Critical Zone, and introduced a system of water extraction regulation and tolling, as well as encouraging the conversion of water sources from groundwater to surface water through the construction of waterworks. At the time of the ex-post evaluation, land subsidence in Bangkok continues to be 1 to 2 cm per year depending on the district, but the Project can be regarded as contributing to its control.[18]

[18] Groundwater extraction in the Bangkok Metropolitan Area, which reached 1 million m^3/day in 1997, decreased to 400,000 m^3/day in 2008. On the other hand, since it is estimated that 107,000 people have newly come to receive water supply services in the water supply expansion area of the Project, and the per capita purified water supply is 705 liters/day in 2019, and the residents reported that the amount of water used did not change significantly before and after the project (see 3.2.2.1(1) and (3)), it is estimated that groundwater extraction has been reduced by about 75,000 m^3/day.

(2) Social Impact

The expansion of the water production facilities and pumping facilities under the Project were all carried out within the premises of the existing facilities of MWA, and no land acquisition or resettlement occurred. No land acquisition or relocation of residents was required for the installation of the pipelines which was carried out after coordination with the relevant organizations that manage and own the land.

To summarize the effectiveness and impacts of the Project, it has improved and expanded water supply services by increasing the water production capacity of the MWA, enhancing the reservoir and pumping facilities, and installing water transmission mains and water distribution branches. This has had an impact on improving the living environment and sanitation conditions, and water users are highly satisfied. The Project provided an alternative source of water to groundwater and contributes to the reduction of land subsidence, and there is no significant undesirable impact on the environment and society. In summary, the effectiveness and impacts of the Project are high.

3.4 Sustainability (Rating: ③)

3.4.1 Institutional/Organizational Aspect of Operation and Maintenance

MWA, a state-owned enterprise under the jurisdiction of the Ministry of Interior, is responsible for the operation and maintenance of the Project and consists of nine departments, which are, the Governor's Office, Administration, Finance, Planning and Development, Engineering and Construction, Water Production and Transmission, Eastern Services, Western Services, and Information Technology. The number of employees is 4,303 permanent and 1,075 contractual (as of September 30, 2019).

MWA has been providing water supply services in the Bangkok Metropolitan Area for more than 50 years since its establishment in 1967. In the 4th MWA Management Strategies (2019-2021), MWA has been working on financial stability by expanding the service area, strengthening organizational capacity through the use of IT, and developing a stable water supply system by improving distribution pipes and monitoring water quality. In the 5th MWA State Enterprise Plan (2020-2022), MWA is working on stable water supply, organizational adaptability, building sustainable partnerships with stakeholders, improving financial administration, etc. MWA also has risk management, internal controls, internal audit systems, CSR and environmental initiatives, and has won various awards in Japan, demonstrating its high level of organizational strength.[19]

[19] According to the 2019 MWA Annual Report, in the same year the following were awarded: AREA 2019 for Health Promotion and Corporate Governance Category, 2019 Outstanding Public Information Center Award, 2019 Public Sector Excellence Award for Service Development and Corporate Governance, Honorable Prize for Transparent Organization from the 8th NACC Integrity Awards

The Project is operated by the Raw Water Transmission System Department, Bangkhen WTP Department, Mahasawat WTP Department, Water Distribution Pumping Station Department, Water Transmission and Distribution Control Department, etc. under the Deputy Governor for Water Production and Transmission. The maintenance of facilities and equipment will be carried out by Electrical System Maintenance Department, Mechanical System and Civil Maintenance Department, Instrument and Automation System Maintenance Department, etc., under the supervision of the same Deputy Governor. MWA's system for operation and maintenance has clearly defined the roles for each department, and from the actual operation and maintenance performance, it is believed that the system is adequate for operation and maintenance.

Based on the above, there are no institutional/organizational issues in the operation and maintenance of the Project.

3.4.2 Technical Aspect of Operation and Maintenance

MWA has introduced advanced technologies such as advanced water treatment using activated carbon, District Metered Area (DMA)-based water pressure and leakage management, and real-time water quality monitoring. MWA provides various training programs mainly for MWA staff at the Waterworks Technical Training Center (renamed in 2017 to MWA Waterworks Institute of Thailand), which was established with JICA's technical cooperation. The training conducted in 2019 includes executive training, IT utilization, Water Safety Plan (water purification and water quality management), leakage management, labor standards, pipeline installation, and automatic control. External lecturers from universities and international organizations are also invited. Training is also provided to the staff of other waterworks companies in the country. In addition, the technical cooperation related to the Project has provided extensive technology transfer on advanced water treatment, risk management manuals, and leakage reduction and distribution management, etc. This is considered to have contributed to the operation and maintenance of the Project through the strengthening of MWA's technical capabilities.

The Bangkhen WTP obtained international standards (ISO, HACCP) for quality management and environmental management, and the Mahasawat WTP as well obtained international standards for environmental management and sanitation management. During the site visit, the on-site staff at the water treatment and pumping stations were judged to have appropriate knowledge about operation and maintenance.

Based on the above, the technical level of MWA is sufficiently high, and there are no technical issues regarding the operation and maintenance of the Project.

3.4.3 Financial Aspect of Operation and Maintenance

MWA's income and expenditure for 2017-2019 are shown in Table 6. Revenues, mainly

from water tariffs, are much higher than expenditures, with an annual operating profit of around 7,000 million Baht (approximately 21 billion Yen). The operating profit margin is 34-38%, indicating that MWA's waterworks business is highly profitable. With a current ratio of 371-511% and a debt ratio of less than 27%, MWA's financial safety is high enough. In addition, the site inspection did not report any particular financial constraints for the operation and maintenance of the Project. Therefore, there are no financial issues in the operation and maintenance of the Project.

Table 5: MWA's Financial Performance

(Unit: million Baht)

	2017	2018	2019
Operating Revenues	18,850	18,801	19,510
Water sales	16,785	16,631	17,349
Water meter fees	955	971	985
Water connection fees	407	397	386
Work contract revenues	443	541	506
Other operating income	260	261	284
Operating Expenses	11,651	11,636	12,944
Raw materials and consumables	2,429	2,184	2,312
Personal cost	3,499	3,623	3,902
Depreciation	4,345	4,493	4,770
Other operating expenses	1,378	1,336	1,960
Operating Profit	7,199	7,165	6,566
Non-Operating Profit	369	354	437
Net Profit	7,568	7,519	7,003
Operating Profit Margin	38%	38%	34%
Current Ratio	371%	484%	511%
Debt Ratio	27%	24%	24%

Source: Material provided by MWA
Note: Operating Profit Margin: Operating Profit / Operating Revenue
Current Ratio: Current Assets / Current Liabilities
Debt Ratio: Liabilities / Capital

3.4.4 Status of Operation and Maintenance

According to the site inspection and interviews with the field staff, some of the water production, transmission and distribution facilities that were expanded and upgraded by the Project have malfunctioned, but MWA has been able to repair them and the capacity of the facilities has generally been maintained adequately. The major repairs that MWA has completed and those repairs in progress as of June 2021 are as follows.

- The repairs completed

- At Mahasawat WTP, installation of additional facilities for dosing chemicals such as flocculant and chlorine, repair of damaged submersible pumps were made.
- At Bangkhen WTP, repair of the remote-control device for the sedimentation tank was made. In addition, due to a chlorine gas leak at the chlorine injection facility, the equipment was damaged by the gas, and the valves, chlorine gas cylinder scales, and gas detection and alarm devices were repaired.
- Leaks in reservoirs at two pumping stations were repaired.

➢ The repairs in progress (as of June 2021)

- Bids are being prepared for the repair of a crack in the floor (K-Floor) of one of the 14 filtration tanks at Bangkhen WTP. As a result of this failure, the water production capacity of the plant has been reduced by nearly 10% since November 2020.
- Sam Lae PS: The installed raw water pump is not in operation as of June 2021 due to bearing and lubrication system failure, and is awaiting repair while spare parts have been ordered from the manufacturer. The raw water pump is useful for efficient intake of water during the time when the salinity of the river, which is the water source, is low.

Based on the above, no major problems have been observed in the institutional/ organizational, technical, financial aspects and current status of the operation and maintenance. Therefore, sustainability of the Project effects is high. The problems at the WTPs are expected to be repaired, and it is judged that they will not affect the sustainability of the Project.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The Project was implemented to satisfy the pressing water demand of Bangkok Metropolitan Area by strengthening the water production capacity and developing/expanding water intake, transmission, and distribution facilities and distribution pipes of MWA, thereby contributing to the improvement of the living environment of the residents in the area. The Project is highly relevant with the development policy, development plan, and development needs of Thailand and the Bangkok Metropolitan Area, both at the time of planning and ex-post evaluation. The Project is also highly relevant with Japan's ODA policy at the time of the planning. Therefore, relevancy of the Project is high. The outputs were generally as planned except for the installation of pipelines, and the project cost was within the plan. However, since the length of the pipeline installed was less than planned and the project period was longer than planned, the efficiency of

the Project is fair. As a result of the Project, the water production capacity of MWA increased as planned and the amount of water supply increased. This, together with the expansion of reservoirs and pumping facilities and the laying of water distribution pipes implemented under the Project, led to an improvement and expansion of MWA's water supply services. This has had an impact on improving the living environment and public health, and water users are highly satisfied with the results. In addition, the Project has provided an alternative water source to groundwater, which is considered to contribute to the mitigation of land subsidence. In summary, the effectiveness and impacts of this Project are high. No major problems have been observed in the institutional/organizational, technical, financial aspects of the operation and maintenance of the Project. Therefore, sustainability of the project effects is high.

In light of the above, the Project is evaluated to be highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency (MWA)

- MWA should complete the water transmission pumps at the Bangkhen WTP, which is included in the scope of the Project, as soon as possible to guarantee reserve water transmission capacity to ensure smooth water transmission at all times.
- MWA should immediately repair the faulty filter floor of the Mahasawat WTP to restore the water production capacity of the plant, and the raw water pump at Sam Lae PS will be repaired as soon as possible to restore the pumping capacity. Also, consideration needs to be given to safety improvements, such as adding lighting equipment to the sedimentation tank at the Bangkhen water treatment plant.
- MWA should install the pipelines that could not be constructed under the Project as soon as possible, in coordination with the relevant organizations.

4.2.2 Recommendations to JICA

JICA should encourage the implementation of the above recommendations by MWA and monitor the implementation status.

4.3 Lessons Learned

<u>Involvement of operation and maintenance staff in the design of facility expansions</u>

In the two WTPs expanded in the Project, there were some design issues that affected the efficiency and safety in the operation and maintenance of some facilities. Some of these issues could have been prevented if the design and experience of operation and maintenance of the existing facilities had been sufficiently referred to, for example, by seeking the opinions of the

on-site staff of the WTPs during the detailed design. Therefore, in the projects to expand existing facilities, it is important to provide sufficient opportunities to hear the opinions of the engineers and operators who operate and maintain the existing facilities, and to conduct the design with sufficient reference to the specifications and capabilities of the existing facilities and their various experiences in operation and maintenance.

Comparison of the Original and Actual Scope of the Project

Items	Plan	Real
1. Project Outputs	Expansion of Mahasawat WTP Raw water pumps (150 m^3/min x 2 units) Transmission pump (300 m^3/min x 1 unit) Expansion of capacity (400,000 m^3/day) Reservoir Expansion of Bangkhen WTP Raw water pumps (358 m^3/min x 2 units) Transmission pumps (300 m^3/min x 3 units) Expansion of capacity (400,000 m^3/day) Filter press (400,000 m^3/day) Electrical substation（69/6.6kV, 15MVA） Installation of additional pumping equipment Distribution pump at Bang Plee PS (125 m^3/min x 1 unit) Raw water pump at Sam Lae Intake (500 m^3/min x 1 unit) Expansion of distribution reservoir Reservoir at Rat Burana PS (40,000 m^3) Reservoir at Petch Kasem PS (40,000 m^3) Installation of pipelines Water distribution main (112km) Water distribution branch (875km) Consulting services Detail design, bidding documents, supervision	Expansion of Mahasawat WTP as planned as planned as planned as planned Expansion of Bangkhen WTP as planned To be completed in December 2021 as planned as planned as planned Pumping equipment as planned as planned Reservoir Reservoir at Rat Burana PS (10,000 m^3) as planned Pipelines Water distribution main (74km) Water distribution branch (470km) Consulting services as planned
2. Project Period	September 2009 – January 2014 (53 months)	December 2009 – October 2016 (77 months excluding the period of force majeure due to floods, 145% of the planned period)
3. Project Cost	ODA Loan 4,462 million Yen Fund from Thai side 16,637 million Yen Total 21,099 million Yen Exchange rate: 1Baht ＝2.80Yen (April 2009)	4,410 million Yen 16,176 million Yen 20,586 million Yen 1Baht ＝3.09 Yen (Average rate applied for the disbursement of ODA Loan)
4. Final Disbursement	March 2017	

Islamic Republic of Pakistan

FY2020 Ex-Post Evaluation Report of Japanese Grant Aid Project

"The Project for Energy Saving in Water Supply System in Lahore"

External Evaluator: Hajime Sonoda, Global Group 21 Japan, Inc.

0. Summary

"The Project for Energy Saving in Water Supply System in Lahore" (hereinafter referred to as "the Project") was implemented in Lahore, Punjab with the objective of restoring production capacity and improve the energy efficiency of the water supply facilities by rehabilitating 105 aging tubewells operated by the Lahore Water and Sanitation Agency (hereinafter referred to as "WASA-Lahore"), thereby contributing to the stable and sustainable water supply service in Lahore. The Project is highly relevant with Pakistan's development plan, and development needs, both at the time of planning and ex-post evaluation. The project is also highly relevant with Japan's ODA policy at the time of the planning. Therefore, relevancy of the Project is high. The outputs of the Project were generally realized as planned and the project cost was within the plan, while the project period exceeded the plan. Therefore, efficiency of the Project is fair. The degree of achievement of energy efficiency improvement and well capacity restoration by the Project is high, and the residents have welcomed the reduction of water shutoffs due to tubewell pump problems and the improvement of water pressure because of the Project. Although the possibility that the Project has affected the groundwater level cannot be denied, it is pointed out that WASA-Lahore has been working to control the groundwater decline in various ways, and such impact of the Project may have been mitigated. Thus, no significant environmental/social impacts are observed. Therefore, effectiveness and impact of the Project are high. The technical assistance provided as part of the Project has expanded the activities of the energy audit team of WASA-Lahore and has contributed to the proper operation and maintenance of tubewells. No major problems have been observed in the institutional/organizational, technical, financial aspects. Therefore, sustainability of the project effects is high.

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

1. Project Description

Project Location

One of the tubewells constructed by the Project

1.1 Background

Lahore of Punjab Province, the second largest city in Islamic Republic of Pakistan (hereinafter referred to as "Pakistan"), is the provincial capital of Punjab with an urban population of about 11.27 million (2017) and the economic center of the province. The population of the urban area has been increasing at an annual average of about 3% from 1975 to 2010, and the water supply coverage in the urban area was as high as 89% (2014) owing to the construction of tubewells utilizing groundwater sources. On the other hand, the tubewell facilities were aging because they had operated beyond their service life, and the water supply volume was declining because they were not able to pump the amount of water they were designed to.

These tubewells had been constructed since 1977, mostly in the 1990s, and by 2014, their pumping capacity had significantly decreased due to aging pumps and other factors. In addition, the energy efficiency for pumping had deteriorated and the energy consumption required to operate these pumps had increased. At WASA-Lahore, which operates the water supply and sewerage services in Lahore, the electricity cost reached about 45% of the operating cost in 2012, putting pressure on the finances. Therefore, the reduction of electricity costs of tubewells was an urgent issue.

Against the above background, the Government of Pakistan requested Japan in 2012 to provide grant aid assistance for the renewal of tubewells in Lahore, and an Exchange of Notes for the Project was signed in 2015.

1.2 Project Outline

The objective of the Project is to restore production capacity and improve the energy efficiency of water supply facilities by renewing them, thereby contributing to the stable and sustainable water supply service in Lahore, Punjab Province.

Grant Limit / Actual Grant Amount	2,611 million yen (Detail Design: 57 million yen, Main Component: 2,554 million Yen) / 2,452 million yen (Detail Design: 57 million yen, Main Component: 2,395 million Yen)
Exchange of Notes Date /Grant Agreement Date	Detail Design: January 2015 (E/N and G/A) Main Component: June 2015 (E/N and G/A)
Executing Agency	Lahore Water and Sanitation Agency (WASA-Lahore)
Project Completion	January 2018
Target Area	Lahore, Punjab Province
Main Contractor(s)	Tobishima Corporation
Main Consultant(s)	NJS Co., Ltd.
Procurement Agency	none
Basic Design/Preparatory Survey	June 2013 – July 2014
Related Projects	"Project for Improving the Capacity of WASAs in Punjab Province" (Technical cooperation: July 2015 – June 2018)

2. Outline of the Evaluation Study

2.1 External Evaluator

Hajime Sonoda, Global Group 21 Japan, Inc.

2.2 Duration of Evaluation Study

The ex-post evaluation study for the Project was conducted over the following period.

Duration of the Study: October 2020 – November 2021

Duration of the Field Survey: January – February 2021 (by a local consultant)

2.3 Constraints during the Evaluation Study

Due to the pandemic of COVID-19, the external evaluator did not travel to Pakistan, and the interviews to WASA-Lahore, the field inspection of the tubewell facilities constructed under the Project, and the interviews to the water users were conducted by a local consultant.

3. Results of the Evaluation (Overall Rating: A[1])

3.1 Relevance (Rating: ③[2])

3.1.1 Consistency with the Development Plan of Pakistan

The National Drinking Water Policy, formulated by the Government of Pakistan in 2009, aimed to provide safe drinking water to all citizens by 2025. The Punjab Drinking Water Policy approved in 2011, which was formulated in response to the national policy, aimed to provide safe, affordable, and adequate amounts of drinking water to all residents by 2020, and called for promoting organizational and management reforms of water and sewerage corporations in each city. Furthermore, the Punjab Water Policy, a new policy for the water resources sector in Punjab approved in 2018, states that the strategy is to provide safe drinking water in all urban and rural areas by promoting the development of surface water and sustainable use of groundwater while taking balance between the development and conservation of water resources, between infrastructure development and environment, and between demand and supply of water, taking into account the province's scarcity of surface water resources and over-reliance on groundwater.

Based on the above, the Project, which aims to improve the energy efficiency of water supply facilities and provide stable water supply services, is consistent with Pakistan's development plan both at the time of planning in 2014 and ex-post evaluation.

3.1.2 Consistency with the Development Needs of Pakistan

As mentioned in "1.1 Background", the renewal of aging tubewells and improvement of energy efficiency were important issues in Lahore at the time of planning. In addition, chlorine injection was not functioning at two-thirds of the tubewells, and it was necessary to equip appropriate chlorine injectors in conjunction with the renewal of the tubewells. Furthermore, arsenic removal equipment was planned to be installed to cope with the increasing arsenic concentration in the groundwater.[3]

At the time of ex-post evaluation, the tubewells upgraded by the Project were responsible for 20% of the total water supply of WASA-Lahore, and the necessity of the Project was maintained at the time of ex-post evaluation. In addition, the importance of the Project in terms of energy efficiency is maintained because the electricity consumption of the tubewells has been reduced by the Project, which accounts for 40% of the total expenditure of WASA-Lahore. (See section "3.3 Effectiveness and Impact")

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

[2] ③: High, ②: Fair, ①: Low

[3] In Lahore, arsenic contamination of groundwater was confirmed around year 2000, and in a survey conducted in 2010, 85% of tubewells were found to have arsenic levels exceeding the WHO's Guidelines for Drinking-water Quality. In response to concerns about health hazards, WASA-Lahore constructed arsenic removal facilities near tubewells with arsenic concentrations exceeding 20 μg/liter, and started a project in 2012 to supply drinking water and kitchen water using public water taps at the facilities. At the time of ex-post evaluation, WASA-Lahore has installed arsenic removal facilities at all the applicable tubewells and is providing drinking water to the residents for free.

According to the master plan prepared by WASA-Lahore in 2019,[4] water demand in Lahore is expected to increase by about 40 percent over the next two decades. As the depleting groundwater alone is not enough to meet this demand, WASA-Lahore has decided to build a water treatment plant using the irrigation canals that pass through the outskirts of Lahore as its source of water. As the first step, construction of a water treatment plant with a capacity of 245.5 thousand m^3/day is underway availing a loan from the Asian Infrastructure Investment Bank, to be completed by the end of 2024.[5] In addition, the above master plan proposes a phased construction of water treatment plants using surface water as its source by 2040. In the areas where water supply with surface water starts, the production of existing tubewells will be suppressed[6]. However, conversion of the water source from groundwater to surface water is expected to take a long time, and the need for the Project will be maintained for the time being.

Based on the above, the Project is relevant with the development needs of Pakistan both at the time of planning and ex-post evaluation.

3.1.3 Consistency with Japan's ODA Policy

Japan's Country Assistance Policy for Pakistan (April 2012) sets out "Ensuring Human Security and Improving Social Infrastructure" as a priority area, and the Project is positioned in the "Water and Sanitation Security Program" under the "Sanitation and Environmental Improvement" development agenda of the Policy. The JICA Country Analytical Paper states that the program will consider comprehensive support for the improvement of water supply and sewerage facilities in Punjab, the improvement of operation and maintenance capacity of executing agencies, and the improvement of organizational management system and financial structure, with the aim of sustainable utilization of water resource and establishment of water supply and sewerage operation and maintenance system. Therefore, the Project is relevant with Japan's ODA policy at the time of planning.

Based on the above, the Project has been highly relevant to the country's development plan and development needs, as well as Japan's ODA policy. Therefore, its relevance is high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

The outputs of the Project were generally realized as planned (Table 1).

[4] "Preparation of Master Plan for Water Supply, Sewerage and Drainage System for Lahore, Volume-1 Final Master Plan Report-Water Supply, Main Report" February 2019, MM Pakistan (Pvt.) Ltd.
[5] This water purification capacity is equivalent to about 14% of the total water produced in 2020.
[6] Seven of the 105 tubewells of the Project are located in the target area of the first phase.

Table 1: Planned and Actual Outputs

	Plan	Actual
Output by Japanese side ・ Renewal of tubewell ・ Installation of tubewell pump ➢ Discharge 6.8m^3/min. ➢ Discharge 5.1m^3/ min. ➢ Discharge 3.4m^3/ min. ・ Pumping station building ・ Pump accessories and electrical equipment ・ Connection pipe installation ・ Energy audit equipment ・ Consulting services	 105 locations 105 locations 41 units 55 units 9 units 105 locations 105 locations 105 locations, 3,600m 2 sets Detail design, supervision of procurement and construction, technical assistance on energy audit equipment	 As Planned
Output by Pakistani side ・ Gate and fence ・ Arsenic removal facility	 105 locations 105 locations	 Borne by Japanese side As planned (Addition) Installation of connection pipes other than those borne by the Japanese side

During the detailed design and construction phases, many design changes were required according to the actual site conditions, such as changing the location of the tubewells and the location and length of the pipes connecting to the water distribution network. The main design changes made since the planning were as follows.

- Changes in some site locations according to construction methods: Most of the changes in the location of tubewells were due to technical reasons, such as the choice of construction method according to the geologic characteristics of the site, adjustment with the surrounding conditions (existence of high voltage lines, interference with other tubewells in the vicinity, etc.), while some of the changes were due to lack of understanding from landowners and neighbors. According to the consultant of the Project, WASA-Lahore had not sufficiently confirmed with the owners and managers of the planned sites in writing before the construction, nor had confirmed the intention of the surrounding population through consultation with local residents. According to WASA-Lahore, opposition from local residents arose at 17 tubewells, but WASA-Lahore responded by adjusting the site locations and persuading residents through influential people and politicians.

- Changes in connecting pipe length due to site changes: The location and length of

connecting pipes were changed at a number of tubewells due to changes in the location of tubewells and due to many errors in the information provided by WASA-Lahore as the inventory of existing facility was not well maintained.

- Increase in pump head with changes in pump specifications: During the detailed design, WASA-Lahore requested to increase the pump head of tubewells (the height at which the pump can pump-up water) in order to ensure adequate water pressure even at the end of the distribution network, and the pump specifications were changed accordingly[7].

- Change in the head of some pumps according to the groundwater level: At the time of the preparatory survey, the specifications and head of the tubewell pumps were determined according to the groundwater level at the site, and the plan was made in order to optimize the pump operation efficiency and the impact on the groundwater level.[8] After construction, depending on the results of the initial operation, head of some tubewells was reduced to increase pump efficiency. Namely, during construction, the groundwater level of some tubewells was found to be much higher than expected, and the pump head was adjusted by removing one impeller (pump blade) to reduce the possibility of pump failure and the decrease of energy efficiency due to excessive pumping. The removed impellers are stored by WASA-Lahore and will be re-installed when the groundwater level or well efficiency decreases, based on the results of energy audits. Impellers were removed at 56 tubewells.

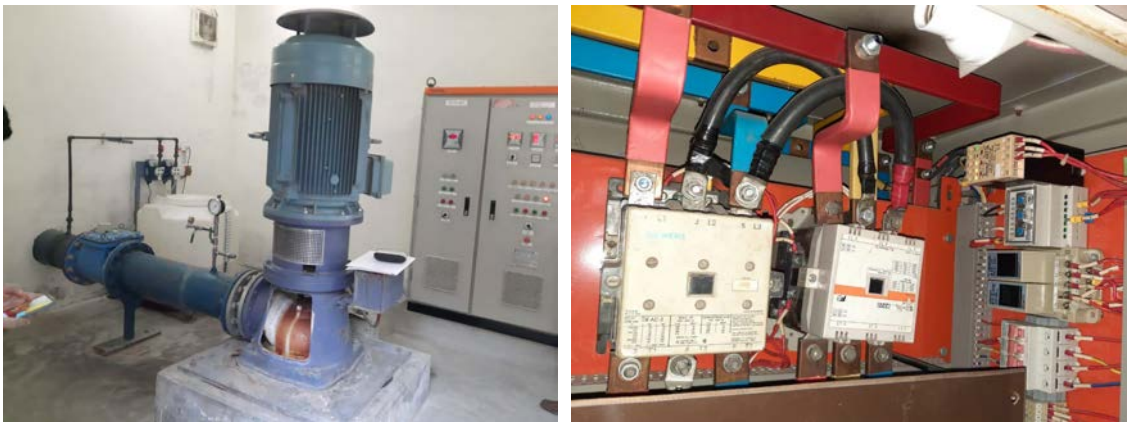
All the design changes of the Project, including the above, were in line with the planning policy at the time of the preparatory survey, and were made after the technical review by WASA-Lahore, JICA and the consultant, and therefore are considered appropriate. According to WASA-Lahore, the selection criteria of the target tubewells and the quality of construction and equipment were good.

Through the technical assistant by the consultant (the Soft Component), technical guidance on energy auditing was provided to 30 staff members of the Energy Management Cell and Maintenance Section of WASA-Lahore. This helped them to understand the importance of selecting pump specifications and heads according to the availability of groundwater, and how to use the energy audit equipment provided by the Project to monitor the operation and energy use of the tubewell. The participants also gained a better understanding of how to propose appropriate and efficient operation and maintenance of pumps and renewal of facilities. In the examination

[7] If the pump head is small, the water pressure (discharge pressure) at the pump discharge and the water distribution water pressure will be small. If the water pressure is insufficient at the end of the water distribution network, users are likely to use private pump and sewage in the ground could be drawn into the distribution pipes, causing serious sanitary problems. At the time of the preparatory survey, the Project was planned with a discharge pressure of 10 m, referring to the fact that the pump discharge pressure of the existing tubewell was around 10 m, and WASA-Lahore agreed with this.

[8] The groundwater level in Lahore has been decreasing year by year, and the Project was planned based on the expected groundwater level in 2031.

conducted at the end of the technical guidance, the percentage of correct answers of the target staff on energy audit was 85%. According to WASA-Lahore, the content and methodology of the technical guidance was appropriate, and the technical materials such as manuals and formats prepared in the process are very useful and being applied even at the time of ex-post evaluation.



Tubewell constructed by the Project (right: inside of control panel, left: pump)

Arsenic removal facility constructed by the Pakistani side

3.2.2 Project Inputs

3.2.2.1 Project Cost

The total project cost was planned to be 3,110 million yen (Japanese side: 2,611 million yen, Pakistani side: 499 million yen). The output was generally realized as planned, and the project cost was 3,091 million yen which was within the plan (99% of the plan; 2,452 million yen for the Japanese side and 638 million yen for the Pakistani side).

After the start of construction, the project cost increased due to the increase in work quantities for the connection to the arsenic removal facilities constructed by WASA-Lahore and to the existing water distribution network because of the changes in the drilling location of the tubewells. The changes in the drilling location were partly due to insufficient information provided by the Pakistani side at the time of detailed design. Therefore, the Pakistani side

shouldered the cost for the increase in the length of the connecting pipes, resulting in an increase in the cost for the Pakistani side. As a result of competition and the aforementioned design changes, the actual cost of the Project on the Japanese side was 94% of the planned cost, and the total project cost was almost as planned. The Pakistani side carried out the installation of connecting pipes and arsenic removal facilities, and shouldered the cost for power receiving and transforming facilities.

3.2.2.2 Project Period

The Project was planned to be implemented over a period of 28 months from the contract with consultant in January 2015 to April 2017, including detailed design and bidding period. In fact, the Project was completed in January 2018, 34th month after the consultant contract in April 2015, which was 121% of the planned period.

The reason why the implementation period exceeded the plan was that the bidding for the main contract was delayed due to the time required to obtain banking arrangements from the Pakistani side, and the time needed to find an alternative site for one tubewell at the end of the construction period.

As a result, although the project cost was within the plan, the project period exceeded the plan. Therefore, efficiency of the Project is fair.

3.3 Effectiveness and Impacts[9] (Rating: ③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

The purpose of the Project was to improve energy efficiency and restore production capacity by renewing such tubewell pumping stations where production capacity had declined, while selecting pumps appropriate for the groundwater level and design capacity. The results of the indicators set at the time of planning are shown in Table 2.

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

Table 2: Planned and actual operational and effectiveness indicators

	Baseline (2013)	Target (2020)	Actual (2020)
Indicator 1: Average energy efficiency (kWh/m^3)	0.317	0.202	0.213
Indicator 2: Total daily water production (m^3/day)	261,349	516,753	376,273
Indicator 3: Average daily operating hours (hour/day)	14.6	14.6	10.82
Reference Indicator: Average water production per operating hour (m^3/hour)	17,901	35,394	34,776

Source: Material provided by JICA for baseline and target, material provide by WASA-Lahore for actual figures.

Note: Indicators are based on the 105 tubewells covered by the Project.

Energy efficiency: Based on the data obtained from the energy audit conducted in 2019-2020 for each tubewell.

Daily water production: Calculated by multiplying the water production per operating hour measured during the energy audit for each tubewell by the daily operating hours.

Daily operating hours: Based on the actual operating hours recorded at each tubewell.

Water production per operating hour: The baseline value for 2013 was recalculated for the final selected tubewells. Since the total capacity of pumps remained the same despite the replacement of the target tubewells, the target values at the time of the preparatory survey were adopted as they were.

(1) Improvement of energy efficiency

Before the Project, the average energy efficiency of the target tubewell pump was 0.317 kWh/m^3. In the Project, it was planned to lower this to 0.202 kWh/m^3. This was expected to reduce the electricity consumption by 36.3%. As a result of the energy audit conducted by WASA-Lahore after the Project, based on the latest audit results, the average energy efficiency of the tubewells covered by the Project was calculated to be 0.213 kWh/m^3, which means a 32.8% reduction in electricity consumption.[10] Based on this reduction, it is estimated that 9.6 million kWh of electricity and 260 million rupees (some 250 million Yen) of electricity cost was saved in 2020.[11] This is equivalent to about 6% of the electricity expenditure of WASA-Lahore in 2020.

The achievement level of energy efficiency improvement is calculated to be 90% based on the actual performance (32.8% reduction in electricity consumption) against the targeted improvement (36.3% reduction). During the detailed design, the head of the tubewell pump was increased in response to the request of WASA-Lahore, but in the process of design modification, it was found that this would reduce the energy efficiency. After this modification, the energy efficiency of the tubewells targeted by the Project was expected to be 0.229 kWh/m^3, but in fact, the efficiency has been improved beyond this expectation.

The energy audit after the Project pointed out that the energy efficiency of three of the 105 tubewells was particularly low (0.39-0.58 kWh/m^3), and that the reason for this was the partial blockage of the water distribution network to which the tubewells were connected. The problem has

[10] WASA-Lahore conducts an annual energy audit for each tubewell, and the latest data is from the audits conducted in 2019-2020. A weighted average was calculated based on the volume of water delivered from each tubewell.

[11] Calculated assuming electricity consumption of 29.2 million kWh for the 105 tubewells and electricity tariff of Rs. 27 per kWh in 2020.

been solved for one of the three tubewells, but it is taking time to identify and remedy the problem in the distribution network for the remaining two tubewells. Excluding these three tubewells, the average energy efficiency would improve to 0.210 kWh/m^3.

Based on the above, the degree of achievement of energy efficiency improvement by the Project is judged to be “high”.

(2) Restoration of tubewell capacity

Before the Project, the 105 target tubewells could pump only about half of their design capacity. The Project planned to restore the pumping capacity of the tubewells by renewing the tubewells and pumps, and to achieve water production of 516,753 m^3 per day, assuming the same operating hours as before the Project (14.6 hours/day).

The actual average water production per operating hour (2020), which is a reference indicator, reached 98% of the plan, indicating that the pumping capacity of the target tubewell pumps has recovered as planned. However, due to the decrease in the average daily operating hours from 14.6 hours per day before the project to 10.8 hours per day in 2020 for reasons to be explained later, the total daily water production was 376,273m^3, only 73% of the planned value. It should be noted that the total daily water production in 2020 was 144% of that in 2013.

According to WASA-Lahore, the standard operating hours for tubewell pumps in 2013 were 20 hours in summer and 18 hours in winter, but this has been gradually reduced since 2014 due to the noticeable drop in groundwater levels and the managerial pressure of power expenditures. Since April 2019, the operating hours have been 12 hours in summer and 10 hours in winter. When the Project was planned, the tubewells were designed with a projection that the groundwater level would drop to some extent, but at some tubewells, the actual groundwater level had dropped more than projected.

The objective of “restoration of tubewell capacity” itself was almost achieved in terms of average water production per operating hour. Total daily water production, which was used as one of the indicators at the time of planning, was only 73% of the planned value, but this was because the average daily operating hours were shorter than assumed at the time of planning and were not due to any defects in the facilities or equipment of the Project. Based on the above, it is judged that the level of achievement of tubewell capacity restoration by the Project is “high”.

3.3.1.2 Qualitative Effects (Other Effects)

(1) Reduction in the number of pump failures

Prior to the Project, the motors of the target 105 tubewells burned out and had to be rewound once every three years on average. The main reasons for this were the unstable power supply, the lack of protection circuits against voltage fluctuations, or even if there were such circuits, they were sometimes wired to bypass them to continue operation, and the use of motors that were not fully repaired. According to WASA-Lahore, the aging pumps were experiencing

major failures every 1,800 to 2,000 hours of operation (once every 5 to 6 months assuming 12 hours of operation per day), requiring major repairs including rewinding of the motors. The failures were also caused by cavitation due to excessive pumping by pumps that did not match the groundwater level.[12]

The 105 target tubewells of the Project have been completed for more than three years, but most of the repairs have been to replace relays and bearings, and the motors have never been rewound. Nearly 40% of the tubewells have not needed any repairs for three years. This is because, in addition to being the new facilities and equipment, the protective devices that detect abnormalities such as voltage fluctuations and motor temperature and activate protection are functioning properly, and preventive maintenance and repairs are generally carried out appropriately (see section "3.4 Sustainability").

In the interviews with the operators and maintenance staff conducted during the field inspection of 50 of the 105 target tubewells of the Project,[13] most of them said that the tubewells of the Project had almost no problems, while the previous or other existing tubewells required overhauling every six months. About 500 tubewells not covered by the Project had 84 major repairs in the two years period of 2019-2020. According to WASA-Lahore, the frequency of major repairs is decreasing year by year as preventive maintenance becomes more established.

The reduction in the number of pump failures is believed to have led to a reduction in maintenance costs for WASA-Lahore. According to WASA-Lahore, the maintenance cost has been reduced by about 20% in the tubewells covered by the Project compared to the previous years.[14]

(2) Soft component (technical guidance on energy audit)

In line with the technical guidance by the Project, an energy audit team consisting of seven members, led by the Director of Electricity, is conducting energy audits under the supervision of the Deputy Managing Director of Operation and Maintenance of WASA-Lahore.[15] The team measures pump operating conditions and energy use at about 100 tubewells per month using the equipment of the Project to prevent over-pumping, conserve electricity. The report is sent to the relevant operation and maintenance sections when abnormalities are detected or when the need for repair or preventive maintenance of pump facilities is identified. According to WASA-Lahore, adjusting valves to control over-pumping can save 3 kW of power per controlled

[12] Cavitation is a phenomenon in which bubbles are generated due to a decrease in pressure inside the pump or suction piping, resulting in a decrease in discharge volume, abnormal noise, and vibration.
[13] From the 105 tubewells, 50 tubewells were selected in consideration of geographical balance, and a local consultant visited the sites to conduct field inspections and interviews with the operator.
[14] One motor rewinding would cost 60,000 to 85,000 yen, depending on the size of the pump, and if this were to be done once every three years for the 105 tubewells, it is estimated that approximately 2.5 million yen per year would have been required. The Project is thought to have saved such maintenance and management costs.
[15] The team was established in 1992, but at that time its main task was to analyze and check the electricity bills of each tubewell.

tubewell.[16] So far, 29 over-pumped tubewells have been controlled, saving about 12,000 kWh per year, equivalent to about 340,000 yen per year in electricity costs, or 9.86 million yen per year for the 29 wells, assuming 11 hours of operation per day per tubewell. The information obtained from the energy audit is also used to determine when to replace energy inefficient tubewell pumps. Since 2017, 47 tubewell pumps have been replaced based on the results of the energy audit.

3.3.2 Impacts

3.3.2.1 Intended Impacts

The Project was expected to contribute to the sustainable and stable water supply services in Lahore. The following section analyzes the contribution of the Project to the improvement of water supply services of WASA-Lahore.

As of 2020, WASA-Lahore has 596 tubewells producing 878.3 million m^3 of water per year and supplying about 750,000 households (Table 3). In response to the increasing demand for water due to population growth, WASA-Lahore has been constructing new tubewells every year to increase water production. Water production from the 105 tubewells renewed by the Project (376,000 m^3 per day) accounts for 21% of WASA-Lahore's total water production in 2020. The Project has increased the water production of the target tubewells by 115,000 m^3/day (see Table 2), which is equivalent to 6.4% of the total water production of WASA-Lahore in 2020.

Table 3: Number of wells and total water production of WASA-Lahore

	2013	…	2018	2019	2020
Number of tubewells	484	…	557	570	596
Total daily water production (thousand m^3 / day)	1,805	…	1,765	1,702	1,796
Number of households served	614,159	…	701,652	717,020	745,680

Source: Material provided by WASA-Lahore

According to WASA-Lahore, the Project has greatly improved the water supply service especially in five districts of the city (Gulbeg, Sabzazar, Walled City, Township and Jorey pul). Before the Project, there were severe water shortages in these districts, and many people complained about low water pressure and water cutoffs. After the Project, there were almost no complaints and trust was built with the residents.[17] Since the water distribution system in WASA-

[16] The most efficient way to control excessive pumping is to adjust the pump head by removing impellers, as was done in the implementation phase of the Project. However, since this requires removing the pump itself, which cannot be done easily, only adjustment by valves has been done so far.

[17] There are 34 water distribution districts in WASA-Lahore. However, a hydrologically independent distribution network has not been formed for each distribution district, and information on the amount of water production and the hours of water supply for each district was not available. In addition, the tubewells renewed by the Project are widely distributed in Lahore. Therefore, it was difficult to quantitatively analyze the contribution of the Project to the

Lahore is a direct pumping system without elevated water tanks, problems with the tubewell pump can easily lead to a drop in water pressure at the faucet and water cutoffs.

According to the interviews with the residents in the five districts mentioned above,[18] the tubewells that were upgraded by the Project had fewer problems than the previous ones, and there have been no more long-term water cutoffs, and the water pressure has been improved. It was also reported that the improved water supply service has led to improved sanitation and convenience in daily life. All the respondents were satisfied with the current water supply service of WASA-Lahore and highly appreciated the Project. On the other hand, it was pointed out that leaks from water distribution pipes are not repaired promptly and that houses far from tubewells have low water pressure and would need new tubewells.

All the interviewees obtain drinking water from the arsenic removal facility attached to the tubewell. Information about the health hazards caused by arsenic contamination of groundwater and the availability of arsenic removal facilities was widely disseminated among the residents, and many of them are using the arsenic removal facilities. According to WASA-Lahore, each arsenic removal facility provides 3,500 to 6,000 liters of drinking water per day, which means that each household uses 3 to 5 liters of drinking water per day, assuming an average of 1,200 households per arsenic removal facility.[19] Therefore, it is unlikely that the facilities alone provide enough drinking water for all residents, and it is presumed that they purchase drinking water separately.

According to the data from WASA-Lahore, arsenic concentration exceeding the WHO drinking water quality guideline (10 μg/liter) has been detected in about 60% of the 105 tubewells on the Project, while no E. coli have been detected and there are no major problems with the water quality. On the other hand, E. coli was detected in 6% of the water samples collected from faucets throughout the city (2,690 total samples in 2020), and the residual chlorine concentration was below the standard in 48% of the samples (3,276 total samples in 2020). Since no E. coli was detected in the tubewells of the Project and all the chlorine disinfection facilities are operating properly, the cause of the problem may be contamination in the aging water distribution network or inadequate chlorine disinfection facilities in other tubewells.

3.3.2.2 Other Positive and Negative Impacts

The Project was judged to fall under Category C under the “Guidelines for Environmental and Social Considerations of the Japan International Cooperation Agency” (promulgated in April 2010), as it is judged to have minimal undesirable impact on the environment.

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improvement of water supply service in each district.

[18] Group interviews in each district by the local consultant: 15 people in total, including 3 women.

[19] In total, WASA-Lahore has 594 wells supplying water to 750,000 households, and arsenic removal facilities have been installed alongside each tubewell.

(1) Impacts on the Natural Environment

According to the groundwater level contour map provided by WASA-Lahore, the groundwater level in Lahore has continued to decline since 2015. The rate of decline of the groundwater level had increased from 0.3m per year in the 1960s to 0.8m per year in the 2000s and 1.0m per year in the 2010.[20]

In order to avoid impact on the groundwater level at sites with significant groundwater level declines, the Project deployed pumps with smaller pumping capacities at lower groundwater levels and pumps with larger pumping capacities at higher groundwater levels, taking into account the projected groundwater levels by areas. In response to the rapid decline in groundwater levels in 2018, WASA-Lahore has been working on controlling groundwater pumping by putting in place the following measures to mitigate the decline in groundwater levels. As a result, the decline in groundwater level in 2019 and 2020 was moderate.[21]

- The water used for ablution in about 200 mosques is being reused for watering of parks and green spaces. Groundwater sprinkling in parks and green spaces has been stopped and water from irrigation canals is being used.
- At about 400 car wash sites, about 70% of water has been saved by implementing water reuse. Water supply to carwashes without reuse facilities was stopped.
- A water storage tank of about 7,000m^3 was constructed in the park to store flood water and use it for street cleaning and watering of parks and green areas. In the future, it is planned to build similar reservoirs at 10 more locations.
- The operation time of tubewell pumping facilities has been reduced to encourage water conservation.
- Commercial water tariffs were increased in 2017 and collection of groundwater user fees for private tubewells started in 2018.

Due to the limitation in using groundwater, WASA-Lahore is in the process of shifting to surface water use (see section “3.1 Relevance”). In addition, the construction of a new group of tubewells in the northern and northwestern parts of the city is being considered to prevent further groundwater level decline in the city center.

According to WASA-Lahore, the rapid decline in groundwater levels through 2018 can be attributed to an increase in the number of tubewells in response to increased water demand. The

[20] Lahore’s Groundwater Depletion – A Review of the Aquifer Susceptibility to Degradation and its Consequences, S. Kanwal, etc. (Technical Journal, University of Engineering and Technology Taxila, Pakistan Vol. 20 No. I, 2015)
[21] For example, in the Mazang Chungi area in the center of Lahore, the groundwater level dropped by about 20 meters between 2015 and 2018, but no further drop in the groundwater level was observed in 2019 and 2020.

Project is a renewal of the existing tubewells and does not contribute to the increase in the number of tubewells. However, since most of the tubewells covered by the Project were put into operation during 2017, and the total water production of the 105 tubewells covered by the Project increased by more than 40% compared to 2013 (see section "3.3 Effectiveness") and accounted for 20% of the total water production of WASA-Lahore, it is possible that the Project contributed to the sharp drop in groundwater levels seen in 2018. On the other hand, it can be pointed out that WASA - Lahore is taking various efforts to control the groundwater decline and as a result, the impact of the Project on the groundwater decline may have been mitigated.

Other than the impact on groundwater described above, no other environmental impacts of the construction and operation of the Project have been identified.

(2) Impacts on Social Aspect

Most of the 105 targeted tubewells were constructed on the same site as the tubewells to be renewed, and many of them are public land for parks, schools, etc. WASA-Lahore leases the land free of charge, and when the tubewells are no longer in use, the land is cleared and returned to the landowners. None of the tubewells were installed on rented private land.

In Lahore, neighbors generally tend to welcome tubewells because the closer to the tubewells, the better the water supply service. However, some neighbors may oppose them because they are concerned about the vibration and noise caused by pump operation and the aesthetic aspect. According to WASA-Lahore, 17 tubewells in the Project encountered opposition from local residents, but this did not become a major problem as the well drilling locations were adjusted and persuasion was made through local influential people and politicians. There have been no complaints after the completion of the Project.

(3) Other Impacts

As a result of the Project, WASA -Lahore's electricity expenditure is considered to have been saved by about 10%, and maintenance expenditure has also been reduced (see section "3.3 Effectiveness"). This, along with the fact that a large number of tubewells were renewed through a grant aid, is considered to have had a positive impact on the finances of WASA-Lahore. It is also estimated that this has reduced greenhouse gas (CO_2) emissions by about 5,400 tons per year in 2020.[22]

In addition, through the Project, WASA-Lahore has acquired a methodology to properly plan the capacity and drilling depth of tubewells according to the groundwater conditions. This has been used during the construction of other tubewells and is believed to have led to more efficient investment in WASA-Lahore's tubewells.

[22] This estimation was made based on an estimated reduction in electricity use in 2020 at 9,600 MWh, and the greenhouse gas emission rate from electricity generation at 0.566 tons/MWh.

To summarize the effectiveness and impact of the Project, the energy efficiency of the tubewells has been improved through the Project, and the power expenditure of WASA-Lahore has been reduced by about 10%. The restoration of the tubewell capacity was almost achieved in terms of water production per operating hour, while the total water production per day was only 73% of the planned value because the operating hours per day were reduced compared to the planning assumption. The water production by the Project accounts for about 20% of the total water production by WASA-Lahore. The Project has been welcomed by the local residents because it has reduced the number of water shutoffs due to tubewell pump problems and improved the water pressure. Although the possibility that the Project has affected the groundwater level cannot be denied, no other significant unfavorable impact on the environment and society is identified. Therefore, the effectiveness and impact of the Project are high, as the objectives of the Project are achieved as planned.

3.4 Sustainability (Rating: ③)

3.4.1 Institutional/Organizational Aspect of Operation and Maintenance

WASA-Lahore, which operates and maintains the Project, was established in 1976 and provides water and sewerage services within the service area of Lahore, the capital of Punjab Province. About 7,000 employees, including about 300 engineers, work under three Deputy Managing Directors in charge of Finance, Administration and Revenue, Operation and Maintenance, and Engineering, who are placed under the Managing Director.

Under the leadership of the Deputy Managing Director of Operations and Maintenance, the jurisdictional area is divided into eight areas, each of which is responsible for the daily maintenance and management of water, sewage, and drainage facilities. At each tubewell, operators work 24 hours a day in three shifts. One additional operator is assigned to every two tubewells for contingency. On the other hand, the Director of Tubewell Maintenance is responsible for the maintenance and management of the pumping facilities of the tubewells and sewage pumping stations, and the Director of Electricity is responsible for the operation and maintenance of the electrical facilities for water and sewage.

At the time of ex-post evaluation, WASA-Lahore has outsourced the maintenance of all the tubewells. A three-year maintenance contract has been made from October 2019 with a private company for the 105 tubewells of the Project. The company is responsible for preventive maintenance and repairs, has all spare parts in stock, and responds to problems 24 hours a day. Minor repairs to control panels, electrical equipment, and mechanical equipment can be done within three to four hours, and major repairs can be done within 24 hours. WASA-Lahore will monitor the company's activities, frequency of breakdowns, and response time to breakdowns. If the company fails to respond within the stipulated time, it will be fined 5,000 rupees (about 3,500 yen) per incident. As no problems were found in the operation and maintenance status of the

Project (see below), this outsourcing seems to have been carried out properly.

Based on the above, there are no particular issues in the institutional and organizational aspects of the operation and maintenance of the Project. It should be noted that the operation of the tubewells in three shifts has resulted in a large number of employees, and the personnel cost, which accounts for 40% of the total expenditure of WASA-Lahore, has become a major financial burden. For this reason, WASA-Lahore is hiring fewer new permanent employees and increasing the number of contract employees, and is planning to introduce automatic operation using the SCADA system.[23] The SCADA system has been introduced in seven tubewells on a trial basis and will be expanded from next fiscal year onwards, depending on financial resources.

3.4.2 Technical Aspect of Operation and Maintenance

During the field inspection, it was determined that most of the operators working at the 50 tubewells had a proper understanding of the well operation and the procedures for routine and preventive maintenance. In addition, all the 105 tubewells are being properly operated and maintained (see below).

In 2019, 1,265 employees received various training at WASA-Lahore's training center. For tubewells, 32 engineers were trained on operation and maintenance of electrical equipment and 287 tubewell operators were trained on chlorine disinfection. On the other hand, the field inspection showed that, although WASA-Lahore is working on training of operators, some of the operators, especially those employed on contract-bases, were not considered to have received sufficient training.

On the other hand, Al Jazari Academy, established by the Punjab Housing, Urban Development & Public Health Engineering Department in Lahore, has strengthened its training system with the support of JICA's technical cooperation "Project for Improving the Capacity of WASAs in Punjab Province" (July 2015 - July 2018).[24] This project worked on the retraining of staff, including engineers and managers, of water and sanitation agencies (WASAs) in five cities in the province and water and sewerage corporations in small and medium-sized cities. In this project, Al Jazari Academy's training system for "operation and maintenance of tubewell facilities (hydraulic analysis, water quality management, safety measures)", "leak detection", "operation and maintenance of sewage and drainage facilities", "operation and maintenance of electro-mechanical equipment", "business planning" and "asset management" was established and the capacity of instructors was strengthened. As part of these efforts, a training system for Punjab was established. In addition, as part of this project, water and sewerage corporation staff from each

[23] SCADA（Supervisory Control And Data Acquisition）system is a system that collects and monitors information obtained from devices and equipment that make up a large facility or infrastructure in one place using a network, and controls it as necessary.

[24] The Provincial Government of Punjab established the Punjab Water Supply and Sewerage Academy in Lahore in 2009 with the aim of improving the capacity of water utilities in Punjab. Later, the academy was renamed as Al-Jazari Academy after the historical Pakistani inventor and engineer Al-Jazari.

city in Punjab received training at Al Jazari Academy, and the dissemination of the results in the workplace was promoted. According to the completion report of this project, the results of the training in “operation and maintenance of electrical equipment” and “operation and maintenance of mechanical equipment” have been utilized at WASA-Lahore. Since the completion of this project, Al Jazari Academy has continued to provide training to each water and sewerage corporation, and in 2020, 36 engineers from WASA-Lahore were trained in the operation and maintenance of electrical equipment for the operation and maintenance of tubewells. In addition, the results of the training on “business planning” are being utilized, as new Key Performance Indicators (KPIs) for WASA-Lahore have been established and are being monitored on an ongoing basis. In addition, the “Project for Improving the Capacity of WASAs in Punjab Province (Phase 2)” (scheduled from February 2021 to February 2024) was launched in February 2021, and activities are being implemented to improve the quality of training at Al Jazari Academy and WASA-Lahore’s training center.

Compared to the technical guidance through the soft component of the Project, which focused on capacity building for improving the energy efficiency of tubewell facilities, the above technical cooperation project is indirectly strengthening the capacity of a broader range of water and wastewater operations through Al Jazari Academy. There is no overlap between the two projects in terms of the technical scope of capacity building. WASA-Lahore recognizes that Al Jazari Academy plays a decisive role in strengthening the technical capacity of the organization and highly appreciates JICA’s technical cooperation.

The soft component of the Project has expanded the activities of the energy audit team and has contributed to the proper operation and maintenance of each tubewell (see section “3.3 Effectiveness”). According to WASA-Lahore, the team can conduct its own training on energy auditing for new staff, and the technology is well rooted.

The company entrusted with the maintenance of the Project is a general construction company headquartered in Lahore, and is considered to have sufficient technical capabilities, as no particular problems have been observed in the maintenance of the Project.

From the above, there are no major issues in the technical aspects of the operation and maintenance of the Project, but the need to enhance training for operators hired as contract employee is pointed out.

3.4.3 Financial Aspect of Operation and Maintenance

Water and sewerage tariff of WASA-Lahore for general households have not been increased since 2004. As can be seen in Table 4, water and sewerage charges income for FY2017-FY2019 are only about half of operating expenditures, which are supplemented by Urban Immovable Property Tax allocations and subsidies from the provincial government. Tariff revenues increased significantly from FY2017 to FY2018, and according to WASA-Lahore, this

was due to higher commercial tariff, the introduction of a residential floor-based tariff system, and improved tariff collection through the introduction of outsourcing. Power expenditure accounts for 40% of the total expenditure in 2020 and the increase in power tariffs has led to an increase in power expenditure. Maintenance costs including outsourced costs are decreasing in FY2019, and according to WASA-Lahore, this is partly due to the construction of new tubewell facilities and fewer breakdowns because of the Project.

Table 4: Income and Expenditure of WASA-Lahore

(Unit: million rupees)

	FY2017	FY2018	FY2019
Water and sewage charge income	3,527	5,086	5,522
Other income	724	556	756
Operating revenue	**4,252**	**5,642**	**6,278**
Personnel expenses	3,329	4,200	4,376
Maintenance and management expenses (including outsourcing expenses)	1,307	1,405	986
Power expenses	3,380	3,500	4,395
Other expenses	399	842	908
Operating expenditure	**8,415**	**9,948**	**10,665**
Operating expenditure	-4,164	-4,306	-4,387
Operating balance (carry over from previous year)	232	102	96
Provincial government subsidies	2,196	2,618	2,626
Allocation from Urban Immovable Property Tax (Provincial Government)	1,838	1,681	1,718
Accumulated surplus	**102**	**96**	**52**

Source: Material provided by WASA-Lahore

For the past decade, WASA-Lahore's water and sewerage tariff revenues have failed to cover its expenditures, and even with the addition of the allocation from Urban Immovable Property Tax collected by the Provincial Government, it has been in the red. To make up for this deficit, the provincial government has continuously provided subsidies of over 2 billion rupees per year. The reason for the continuing deficit is that water and sewage tariffs for households have been frozen since 2004, despite annual increases in electricity prices, petroleum lubricants and lubricant prices, and labor costs. The financial situation of WASA-Lahore is becoming very difficult because the provincial subsidy amount has been kept at the same level despite the increasing deficit. For this reason, WASA-Lahore, under the direction of the Resource Mobilization Committee, the body that looks after the financial resources of the provincial

government, has prepared a business plan to reach the break-even point within three years through gradual increases in water and sewerage tariff and expenditure cuts. This business plan was sent to the Cabinet Committee of the provincial government in 2019 for approval. At the time of ex-post evaluation, the provincial government is still considering whether WASA-Lahore should go ahead with the rate hike proposed in the said business plan or raise the subsidy amount so that the provincial government can fully cover the deficit.

Thus, the finances of WASA-Lahore are not sound as it relies heavily on government subsidies. However, according to the field visit, there were no financial constraints that would pose a direct problem to the operation and maintenance of the tubewells of the Project, and the necessary consumables and replacement parts were supplied in a timely manner and appropriate maintenance work was being done. From the above, it can be said that there are no major financial issues in the operation and maintenance of the Project, while, from a mid- to long-term perspectives, it is necessary to improve the financial health of WASA-Lahore.

3.4.4 Status of Operation and Maintenance

All of the 105 tubewells covered by the Project are in operation. However, as of January 2021, three tubewells are not in operation due to problems with the water distribution network or power supply. In addition, one tubewell, which requires changing the location of its connection to the distribution network, has been in operation for a few hours. At each tubewell, periodic inspections of the electro-mechanical equipment are carried out according to the maintenance schedule of WASA-Lahore. There is a maintenance standard that each tubewell is inspected every 2,000 hours of operation, and generally the tubewells are inspected twice a year.

One-third of the 50 tubewells inspected in the field had been operated without any repairs and were in perfect working order. Almost all the tubewells were thoroughly cleaned except for one. No major repairs were made to any of the tubewells, and minor repairs such as replacement of protective relays (13 tubewells), replacement of bearings (8 tubewells), and replacement of breakers (5 tubewells) were made. In addition, there were 11 tubewells and 7 tubewells where the flow meter and pressure gauges were still out of order, respectively. However, since flow meter and pressure gauges are used only during energy audits, they have not interfered with daily operations. Daily inspections and preventive maintenance are generally carried out properly. Periodic addition of lubricant, which had been pointed out during the defect inspection in 2019, has been sufficiently implemented, but some tubewells were found to have lubricant added more frequently than required. The operations, the inspections and routine maintenance performed were recorded, but there were four tubewells that were not provided with official logbooks for recording and are using ordinary notebooks instead. Overall, all 50 tubewells were judged to be in “good” or “satisfactory” conditions for operation and maintenance, and no tubewells were judged to be in “not good” or “bad” condition.

The energy audit equipment provided by the Project is being fully utilized. Some of the equipment has broken down, but all of them have been repaired or updated.

Based on the above, no major problems have been observed in the institutional/ organizational, technical, financial aspects and current status of the operation and maintenance. Therefore, sustainability of the Project effects is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The Project was implemented in Lahore, Punjab with the objective of restoring production capacity and improve the energy efficiency of the water supply facilities by rehabilitating 105 aging tubewells operated by WASA-Lahore, thereby contributing to the stable and sustainable water supply service in Lahore. The Project is highly relevant with Pakistan's development plan, and development needs, both at the time of planning and ex-post evaluation. The project is also highly relevant with Japan's ODA policy at the time of the planning. Therefore, relevancy of the Project is high. The outputs of the Project were generally realized as planned and the project cost was within the plan, while the project period exceeded the plan. Therefore, the efficiency of the Project is fair. The degree of achievement of energy efficiency improvement and well capacity restoration by the Project is high, and the residents have welcomed the reduction of water shutoffs due to tubewell pump problems and the improvement of water pressure because of the Project. Although the possibility that the Project has affected the groundwater level cannot be denied, it is pointed out that WASA-Lahore has been working to control the groundwater decline in various ways, and such impact of the Project may have been mitigated. Thus, no significant environmental/social impacts are observed. Therefore, effectiveness and impact of the Project are high. The technical assistance provided as part of the Project has expanded the activities of the energy audit team of WASA-Lahore and has contributed to the proper operation and maintenance of tubewells. No major problems have been observed in the institutional/organizational, technical, financial aspects. Therefore, sustainability of the project effects is high.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency (WASA-Lahore)

(1) As for the two tubewells (C Block Muslim Town and Queen's Road) among the tubewells constructed by the Project, whose energy efficiency is still low due to blockage of the distribution network, it is necessary to identify the location of the blockage in the distribution network and resolve the blockage. In addition, one tubewell (Saadi Park), which is not being fully utilized due to lack of connection to the water distribution network at an appropriate

location, needs to be better utilized by constructing an appropriate connection pipe.

(2) Some operators of tubewells, especially those employed on contract, are considered not to have received sufficient training, and it is necessary to provide appropriate training to all operators including contract employees.

(3) The following issues need to be addressed for more efficient and sustainable use of limited groundwater.

- Strengthen measures to control groundwater use, including water reuse, and continuously monitor groundwater levels and adjust pump operating hours as necessary to prevent a sudden drop in groundwater levels.
- As for water sources, gradual shift to surface water will be promoted. An appropriate combination of groundwater and surface water will be realized to balance the availability of water resources and water demand.
- Improve the water distribution network by renewing old distribution pipes, sectorizing water distribution areas, using elevated water tanks, reducing water leakage, and maintaining facility inventories.
- Reduce water demand by setting appropriate tariffs, promoting the use of water meters, and reuse of water.

(4) WASA-Lahore will strive to improve financial health based on the results of the provincial government's review of the proposed business plan.

4.2.2 Recommendations to JICA

JICA will encourage the implementation of the above recommendations by WASA-Lahore and monitor the implementation status.

4.3 Lessons Learned

Preparation for an infrastructure development project in an urban area

In the Project, it was not uncommon to look for an alternative site for the planned site where the understanding of the landowners and the surrounding residents were not gained at the time of the construction of the tubewells, or to take time to obtain the understanding of the surrounding residents. Therefore, in a project to construct an infrastructure facility such as a tubewell in a city, it is important that the executing agency obtains sufficient confirmation from the owner/manager of the site in writing at the planning stage, as well as confirms the intentions of the surrounding population through consultation with local residents and carefully explains the project so as to obtain their cooperation in advance.

Islamic Republic of Pakistan

Fiscal 2020 Ex-Post Evaluation Report

Japanese ODA Loan “Lower Chenab Canal System Rehabilitation Project”

External evaluator: Namura Ayako, Tekizaitekisho LLC

0. Summary

This project is intended to expand agricultural production by rehabilitating the existing irrigation facilities and drainage facilities in the Lower Chenab Canal (hereinafter referred to as “LCC”) in the central area of Punjab Province and establish and foster farmer organizations (hereinafter referred to as “FO”) that can be responsible for operating and maintaining the facilities, thus contributing to an increase in the income of farmers in the target area.

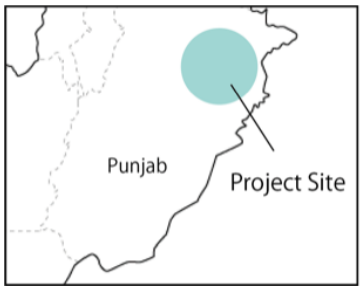
For Pakistan, where agriculture is still a key industry, the implementation of this project is sufficiently aligned with Pakistan’s development plans and sector policies, the need to secure water for agriculture by establishing irrigation facilities, and Japan’s aid policy. Therefore, the project is highly relevant. The project’s efficiency is fair. This is because the project period far exceeded the plan, although project costs were within plans.

The area that benefited, the cropped area by main agricultural product, and the collection rate for water charges exceeded the levels set in the appraisal, and effectiveness is thus deemed to be high. Although improved income for small farmers, which had been anticipated as an impact of this project, could not be confirmed in statistical data, rehabilitation work done in this project made it possible to secure irrigation water, and the increase in the cropped area and the fact that some small farmers shifted to cash crops suggests that the project may have contributed to higher agricultural income. Moreover, other impacts were confirmed, such as the start of new businesses and education - particularly an increase in expenditures on education costs for girls. No negative impacts were confirmed. As a result, we concluded that the project effectiveness and impact are high.

This project’s operation and maintenance (hereinafter referred to as “O&M”) did not have any significant technical or financial issues; however, there were challenges in both institutional/organizational aspect of O&M and status of O&M, and going forward, these aspects should be further reinforced. Accordingly, the sustainability of the effects resulting from this project is fair.

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

1. Project Description



Map of Project Location

Distributary Rehabilitated by the Project

1.1 Background

The Lower Chenab Canal (LCC) in the central area of Pakistan's Punjab province is one of Pakistan's oldest water irrigation systems, developed in the 19th century during the British colonial period. It has the largest irrigation area (1,240,000 ha) in Punjab province, the center of irrigated agriculture. However, as the irrigated area expanded, the facilities' capacity shortage became increasingly obvious, and the efficiency of water use fell and agricultural productivity was damaged as channels were eroded and facilities became more decrepit. As a result, remodeling and rehabilitating the irrigation facilities were urgent issues.

Irrigation channels and drainage channels in the uppermost part of the LCC had been repaired in "the National Drainage Program Project," funded with loans from JBIC. LCC Part B, which covered the lower part of the LCC (irrigated area of 610,000 ha), needed rehabilitation work on its flow capacity, which had declined with age, following the uppermost part. In addition to remodeling and rehabilitating the water channels, fairly and efficiently distributing water and operating and maintaining the water channels were essential if agricultural productivity were to be improved. In terms of the long-term utilization of the water channels that had been built, it was essential that an appropriate O&M system be established. Since the establishment of the Punjab Irrigation and Drainage Authority (hereinafter referred to as "PIDA") in 1997, the Punjab government had promoted institutional reform, namely, Irrigation Management Transfer (hereinafter referred to as "IMT"), which centered on moving control over water management to the farmers. The project had supported this reform and also supported efforts to improve the capacity of the FOs.

1.2 Project Outline

This project is intended to expand agricultural production by rehabilitating the existing irrigation facilities and drainage facilities in the Lower Chenab Canal (LCC) in the central area of Punjab province and establish and foster farmers' organizations (FOs) that is responsible for operating and maintaining the facilities, thus contributing to the increase in the income of farmers in the target area.

Loan Approved Amount/Disbursed Amount	12,523 million yen / 11,619 million yen	
Exchange of Notes Date / Loan Agreement Signing Date	August 2005 / August 2005	
Terms and Conditions	Interest Rate Repayment Period (Grace period Conditions for Procurement	1.3 % 30 years 10 years) General untied
Borrower / Executing Agency(ies)	The President of Islamic Republic of Pakistan/ Punjab Irrigation and Drainage Authority[1]	
Project Completion	March 2018[2]	
Target Area	Lower Chenab Canal System (Part-B) in central part of Punjab province	
Main Contractor(s)[3]	-	
Main Consultant(s)	National Engineering Services Pakistan Limited (Pakistan) / National Development Consultants (REGD) (Pakistan)	
Related Studies (Feasibility Studies: F/S), etc.	-	
Related Projects	Japanese ODA Loan: "National Drainage Program Project" by World Bank, Asia Development Bank and Japan Bank for International Cooperation (March 1997) Technical Cooperation Project: "Water Management Advisor for Punjab Province" (2006-2008) "Project for Strengthening Irrigated Agriculture through Participatory Irrigation Management in the Punjab Province" (2009-2013)	

[1] This organization was disbanded in May 2019, and the work is essentially carried on by the Punjab Irrigation Department (PID).
[2] Refer to "3.2.2.2. Project Period."
[3] A contractor whose contract amount exceeds one billion yen.

2. Outline of the Evaluation Study

2.1 External Evaluator

Namura Ayako, Tekizaitekisho LLC

2.2 Duration of Evaluation Study

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

Duration of the Study: October 2020 – November 2021

2.3 Constraints during the Evaluation Study

Due to the global spread of COVID-19, the survey in Pakistan by External Evaluator was cancelled and instead, local assistant was utilized to carry out surveys in Pakistan remotely. This resulted in some constraints in collecting data. In addition, it was found that baseline data or information on data sources to examine the impact were not identified at the appraisal, and the statistical data or materials that would enable a quantitative examination of the impact in the ex-post evaluation was not compiled in Pakistan. Accordingly, the impact was assessed using qualitative information.

3. Results of the Evaluation (Overall Rating: B[4])

3.1 Relevance (Rating: ③[5])

3.1.1 Consistency with the Development Plan of Pakistan

At the time of the appraisal, Pakistan's government had established a water resource development strategy in its *Ten-Year Long-Term Development Plan (2001-2010)* and emphasized the importance of securing enough water to meet increased demand for water in the future. At the time of the ex-post evaluation, the government had established *Pakistan 2025: One Nation - One Vision, a long-term development plan*. The security of energy, water and food was designated as one of the pillars of this plan, and ensuring water supply through greater efficiency of water distribution, water conservation and reuse was emphasized in the plan.

In Punjab province, at the time of the appraisal, the provincial government had established *the Irrigation Development Strategy 2004 in Punjab Province*. One of the provincial government's priorities was rehabilitation of existing irrigation facilities so that they could be used long term and more efficiently. At the time of the ex-post evaluation, *the Punjab Water Policy 2018* developed by the Punjab Irrigation Department (hereinafter referred to as "PID") identified the security of water as a crucial issue for Pakistan, and designated "increasing the amount of usable water" as

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

[5] ③: High, ②: Fair, ①: Low

one of its goals. The government decided to secure the water supply by reducing water loss in the irrigated regions and distribute irrigation water. At the time of the appraisal, the Government of Punjab province promoted IMT, aiming to "encourage the participation of beneficiaries" and "effectively operate and maintain irrigation facilities through improving the capacity of government organizations in charge of water management and reforms of institutional systems." However, *the Punjab Water Policy 2018* laid out guidelines that questioned the effects of the reformed management system[6], and the responsibility of management of irrigation facilities was again moved to PID (for details, refer to "3.4 Sustainability") as of abolishment of PIDA in May 2019. In other words, due to the provincial government's policy reversal, the system for operating and maintaining irrigation facilities with farmers taking the main role had been discontinued although it had been the goal at the time of the appraisal. On the other hand, the provincial government promoted IMT at the appraisal and during the project implementation period, and it cannot be concluded that the provincial government's policy change hurt the relevance of this project.

As noted above, the development plans and policies of the State and Punjab province's governments at the time of appraisal and the ex-post evaluation specified securing irrigation water and the fair distribution of water as important issues in one of the water policies. Thus, this project is consistent with Pakistan's development policy and plans.

3.1.2 Consistency with the Development Needs of Pakistan

At the time of the appraisal, water use was inefficient due to the decrepit nature of irrigation facilities in Pakistan, and agricultural productivity was low. Accordingly, it was important to secure a stable supply of agriculture water by building irrigation facilities, efficiently use agricultural water by building a voluntary O&M system run by a farmers' organization. Even at the time of ex-post evaluation, the agricultural sector in Pakistan is still a key industry, and securing water to support agricultural production and efficiently using water remained important issues. Accordingly, remodeling and rehabilitating irrigation facilities to secure usable water is consistent with development needs in Punjab province. Small farms still account for a high percentage of agriculture and the agricultural productivity is low[7] in the project's target region; therefore, a stable

[6] This policy states that the lessons learned from a review of the results of reforms to the irrigation management system through efforts made thus far by the PIDA, AWB and FO to establish and strengthen functions should be utilized, adapted to fit social and political conditions in the Punjab province, and the system reformed so that it is easy for PID and water users to accept.

[7] A comparison of productivity for key agricultural goods in 2018-2019 shows that productivity of wheat in India's Punjab province was 5.2 t/ha, cotton was 0.8t/ha, sugarcane was 81.8 t/ha and rice was 6.2 t/ha (data is all from 2018-2019 data from India's Punjab provincial government: https://agri.punjab.gov.in/?=agriculture-statistics), while productivity for key agricultural goods in

supply of irrigation water is essential in ensuring that small farmers, who have low agricultural income, have adequate harvests of agricultural products. In this respect as well, this project addresses the need for higher income for small farmers.

3.1.3 Consistency with Japan's ODA Policy

At the time of the appraisal, Japan's *Mid-term Strategy for Overseas Economic Cooperation Operations (2005)* stated that a crucial area for Pakistan was improving access to social and economic services in rural areas and regional cities, where there was significant poverty. *Country Assistance Policy for Pakistan (2005)* identifies the development of a sound market economy as an important area for Japan's assistance for Pakistan, and decided to support the development of agricultural and rural sectors with the aim of expanding labor absorption capacity and reducing poverty.

This project has been highly relevant to the Pakistan's development plan/the Punjab province's sector policy and strategy, and development needs, as well as Japan's ODA policy. Therefore, its relevance is high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

This project targets the Lower Chenab Canal (LCC) Part-B (irrigated area of 610,000 ha) in the central area of Pakistan's Punjab province, developed in the late 19th century during the British colonial period. The project consists of four parts: 1) civil engineering work, 2) institutional reforms (support for the establishment and development of a farmers' organization), 3) on-farm research and development and 4) consulting services. The project target areas are shown in Figure 1.

Punjab province in Pakistan was 2.8 t/ha for wheat, 0.62 t/ha for cotton, 62 t/ha for sugar cane and 2.1 t/ha for rice (Pakistan's Statistical Department, Pakistan Statistical Yearbook 2019).

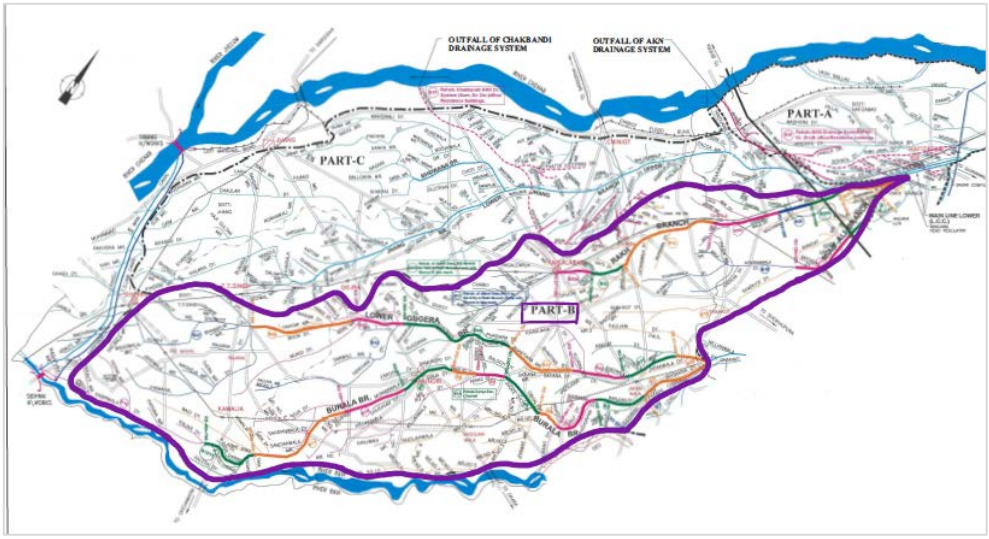


Figure1. Target Area by the Project
Source: Compiled by Evaluator based on PID related document

1) Civil Engineering Work

The civil engineering work carried out in this project consisted of four parts: i) remodeling and rehabilitating the branch canal, ii) rehabilitating distributaries/minors, iii) lining works of the distributaries/minors and iv) rehabilitating drainages. The table below compares the plans for the civil engineering work and the actual results[8].

Table 1. Comparison of Plans and Results for Engineering Work

Work	Plans			Results		
	Related document (1)*1	Related document (2)*2	PID plan*3	Results from initial plans	Results from extension works	Total
i) Remodeling and rehabilitating branch canals	375 km	402.6 km	381 km	381 km	-	381 km
ii)Rehabilitating distributaries/ minors	2,158 km	1,586.1 km	1,501 km	1,501 km	304.83 km	1,805.83 km
iii) Lining works of distributaries/ minors	321 km	342.8 km	992.06 km	992.06 km	307.84 km	1,229.9 km
iv) Rehabilitating drainage system	399 km	401.4 km	-	Rehabilitating structures		

Note *1: Related document (1) refers to JICA's documents at the time of the appraisal.
*2: Related document (2) refers to the document agreed between JBIC and PID at the time of appraisal. Since the data was given in miles, it was converted to km using 1 mile = 1.60934 km. The document did not describe the detailed work for (4), and only the full length of the drainage channels was noted.
*3: From PID.

Source: JICA related documents and PID responses to questionnaires

[8] Since several different plans were identified for the project, it was difficult to identify the reasons why these disparities occurred. Therefore, several different plans, including the plans identified in JICA related documents and perceived by PID, are shown in Table 1.

In this civil engineering work, the yen appreciated during the project period, which resulted in an extra 2.5 billion rupees in the budget. This was added to the budget for the civil engineering work, covering (ii) 304.83 km in work to rehabilitate the distributaries/minors and (iii) 307.84 km in work to line the distributaries (lining works and side protection). The extension works of civil engineering involved selecting the distributaries/minors that the supply of irrigation water was particularly failing to reach and carrying out rehabilitation, as well as carrying out the lining works. In this term, the change in scope was appropriate[9].

Information related to the civil engineering plans differs depending on the documents referenced in Table 1. A comparison of the plans (related materials (1)) and results shows that "i) remodeling and rehabilitating the branch canals" was almost entirely in line with the plan; on the other hand, the results for "ii) rehabilitating distributaries/minors" came in far below the planned figures, even when including extension works. The results for "iii) lining works of the distributaries/minors" came in well above the plans. The plans for "iv) rehabilitating the drainage systems included rehabilitation to the drainage channels, but rehabilitation work for the drainage channels by PID had not been originally planned; instead, village road bridges where the target drainage channels were located, inlet, and repairs to buildings had been planned. This section compared the plans and results for related document (1), but the planned values differ depending on the referenced documents. In particular, the plan of "related document (1)" and the one PID had perceived, which makes it difficult to determine the factors of the discrepancies between the planned values and results[10].

2) Institutional Reform (support for establishment of farmers' organizations and capacity building)

The institutional reform, as a technical support, was carried out as planned to launch the farmers' organizations, provide training for the FO's standing committees and general body members, and conduct regular monitoring and performance evaluations of the FOs[11]. With cooperation from PID, PIDA carried out training for FO members on operations on methods for operating and maintaining channels (operation of outlet (division works), methods for checking condition of outlets, type of outlet structure),

[9] The implementation of this project improved the volume of irrigation water in the tail of the target distributaries/minors (PID questionnaire, results of FO interviews) and the change in scope enhanced the project's effect, and is thus deemed appropriate.

[10] A comparison to the plans as perceived by PID shows that work to "ii) rehabilitating distributaries/minors" and "iii) lining works of distributaries/minors" were carried out as planned when including the extension works. PID also perceived that these civil engineering works were carried out as planned.

[11] From responses to PID questionnaires.

the collection of water charge (Abiana), methods for fairly allocating irrigation water and measuring the water flow, and methods for resolving disputes, among other subjects. Almost all former FOs[12] interviewed in the survey conducted during the ex-post evaluation stated that this training had been effective.

However, the actual number of FOs established fell somewhat short of the planned number. The actual number slightly undercut plans because a lawsuit was filed during the process of establishing FO; therefore, a total of 26 FOs was not formed in LCC (East) and LCC (West). The FOs were made up of the chairs of the water user associations, known as Khal Panchayat (KP) that manages watercourses. However, disputes over the selection of KP chairs and formal objections when FO presidents were selected among the members of the FO standing committee led to court cases and FO were not established[13].

Table 2. Number of FO Established by Project

	Planned number	Actual number	
		1st Tenure	2nd Tenure / through project completion
LCC (East)	85	84	72
LCC (West)	67	65	54
Total	152	149	126

Note: LCC (East): First Tenure: April 2005 – December 2009; Second Tenure: February 2011 – February 2016
LCC (West): First Tenure: July 2007 – April 2011; Second Tenure: December 2013 – December 2016

3) On-farm Research and Development

The on-farm research and development (hereinafter referred to as "R&D") was implemented by the University Agriculture Faisalabad (UAF)[14], and as planned, trials and research on the bed-furrow planting for wheat, water analysis, drip irrigation system,

[12] Details are provided in "3.4 Sustainability." Since FO are currently disbanded, the phrase of "former FO" is used when discussing the conditions as of the ex-post evaluation in this report. In the ex-post evaluation, nine former FOs were interviewed and site surveys were carried out. For each FO, about five farmers located at the head, middle reaches and tail, respectively, were interviewed, for a total of about 15 farmers. The nine former FOs consisted of four areas in LCC (West) and five areas in LCC (East), including three areas where the former FOs did not perform very well. By branch, four FOs from the Rahk Branch, two FOs from the Lower Gugera Branch, two FOs from the Burala Branch and one I FO from the Mian Ali Branch/Upper Gugera Branch were targeted. Former FO members were chairs of Khal Panchayat, water use associations for the watercourses, and a total of 205 members from nine FOs participated in these interviews, including a chairman who had been a member of the former FO's standing committee, office managers, treasurer and committee members. Since almost all of the chairs of Khal Panchayat are male, all of the participants ended to be male, and the main profession was agriculture. Although there was some difference depending on the FOs and farmer, the average area of agricultural land owned by the farmers in the areas where the interviewed FOs were overseen was 0.5 – 2.8 ha.

[13] From responses to PID questionnaires. The distributaries that were not managed by the FOs were put under the supervision of the PID (Administrator/Executive Engineer).

[14] An agreement on the on-farm R&D component was signed between PIDA and the Pakistan Agriculture Research Council (PARC) on 15 September 2006; however, since PARC was based in Islamabad, UAF, which participates as a working group member, actually took responsibility for the on-site activities.

skimming well technology and laser land leveling were carried out in the distributaries/minors of the project target area. As initially planned, the on-farm R&D component was carried out at the three distributaries of Mongi, Killianwala and Khurianwala. As this project's duration was extended, the same activities were also carried out at the distributaries of Khikhi, Dijkot and Shahkot as the second phase (2012 – 2015). According to UAF, the objective of this project was research and development, and involved the examination of whether new technology helped to resolve farmers' issues and the collection of data. In this respect, adequate data on these agricultural management activities was collected and the research objectives were achieved. Moreover, at the targeted distributaries, cutting-edge water management technology was adopted, and contributed greatly to the improvement of productivity for key crops[15]. In particular, the laser land leveling technique was recognized by farmers as being extremely effective in conserving water and was utilized in 90% of the targeted areas. However, small farmers could not purchase the equipment as it is expensive, so after the project ended, many famers rented the equipment[16].

4) Consulting Service

A consultant in charge of construction supervision was procured, and the detailed design, preparation of bidding documents, assistance with bid evaluation, and construction work supervision were carried out as planned.

3.2.2 Project Inputs

(Refer to "Comparison of key plans/results" at the end of the report for details.)

3.2.2.1 Project Cost

Project costs were forecasted at 14,733 million yen (ODA Loan Portion: 12,423 million yen) at the time of the appraisal; however, actually totaled 13,697 million yen (ODA Loan Portion: 11,619 million yen), below plans (93% of the planned amount). As discussed below, delays with the civil engineering work led to an extension in the project period, and consulting service fees also increased significantly; however, the yen strengthened during the project implementation period, and as a result, project costs were kept below the initial planned amount. The increase in project costs in the local currency due to the effect of yen appreciation affected both the increase in output and the increase in the construction period.

[15] From responses to questionnaires given to UAF and interviews with farmers who participated in the agricultural management pilot project (about 70).
[16] From interviews with farmers who participated in the on-farm R&D component.

3.2.2.2 Project Period

The project period was initially 77 months, from August 2005, when the Japanese ODA loan was signed, to December 2011, when support for the institutional reform was complete. However, the actual project period was 152 months, from August 2005 to March 2018[17], significantly over the planned period (197% of the planned period). In particular, there were delays with the civil engineering work, and of the 56 packages[18] in this project, including the additional construction work, 25 packages were delayed. Moreover, court cases led to delays with the components for the institutional reform, which lengthened the support for FO that were slow to be formed, meaning that it took longer than planned to complete the project.

The main reasons that the project period was delayed are[19] that the civil engineering work was not carried out smoothly due to the limited number of staff members of contracted company and insufficient capacity of its supervision work. These factors resulted in the change of contractors through rebidding for six packages that initially were contracted out to two contractors. Moreover, the frequent transfer of responsible officials and staff of both PIDA and the consulting company meant that it took a long time to grasp the current status and progress of the project, leading to delays in decision making and challenges in building relationships with each other.

Moreover, the financial difficulties experienced by the provincial government led to suspending payment to companies engaged in various development projects through the second half of 2009. The price of construction-related supplies skyrocketed and contractors sued the Punjab government for this increase, resulting in delays to the construction work as well. Record-breaking flooding occurred in 2010 and 2014, causing turmoil along the supply routes for various materials, and workers from the regions that suffered the flooding could not return to work sites, which delayed progress with the construction.

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

(1) Financial Internal Rate of Return (FIRR)

The Financial Internal Rate of Return (FIRR) was not calculated for this project at the time of the appraisal.

[17] While PID recognizes that the project was completed in June 2016, it is judged that the project was completed in March 2018 since the activity for Institutional Reform was completed in March 2018 based on the PID's responses to the questionnaire.

[18] Of the 56 packages, work for six packages were bid again to change the contractor, and when excluding this overlap, the construction amounted to 50 packages.

[19] JICA related materials and responses to questionnaires given to PID

(2) Economic Internal Rate of Return (EIRR)

The Economic Internal Rate of Return (EIRR) for this project at the time of the appraisal was 16.2%. Table 3 shows the preconditions for calculating EIRR. Recalculations in the ex-post evaluation showed that the EIRR was 22.6%, higher than the EIRR at the time of the appraisal. This was primarily because the area cultivated with major agricultural crops increased as a result of this project's implementation, and production of the major crops increased over the target at the time of the appraisal. In EIRR calculations, revenue from increased agricultural crops is calculated as a benefit on the condition that the increase in agricultural production was brought by this project; however, it should be noted that the increase in agricultural production is affected by many factors.

Table 3. Preconditions for EIRR Calculations

Costs:	Project costs (excluding taxes), O&M costs
Benefits:	Revenue from increase in agricultural crops
Project life:	30 years[20]

Although the project cost was kept within the plan and an increase in project outputs and various external factors were observed, the project period exceeded the plan. Therefore, efficiency of the project is fair.

3.3 Effectiveness and Impacts[21] (Rating: ③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

In this project, the area benefited, the cropped area, Abiana (water charge) collection rate, and production volumes of major crops are set as indicators measuring the project's effect[22]. The increase in water volume derived from rehabilitation work to irrigation channels in this project was only noted in the rainy season (Kharif: May-September). The volume of water in rivers is extremely low in the dry season (Rabi: October to April of the following year); thus, it was considered that remodeling the channels would have a very limited effect in increasing water. As a result, indicators were limited to the rainy season[23]. The baseline and targets

[20] While the PID's related documents set the project life as 40 years, the JICA's related document at the time of the appraisal defined it as 30 years. Therefore, this report applied 30 years for project life.
[21] Sub-rating for Effectiveness is to be put with consideration of Impacts.
[22] The target was set at five years after the project's completion according to the JICA's related documents, but when the ex-post evaluation was carried out, the 2019-2020 data was the most recent. Therefore, these figures were applied.
[23] From JICA related documents at the time of the appraisal.

for operation and effect indicators as well as the actual figures as of the ex-post evaluation are shown in Table 4.

Table 4. Operation and Effect Indicators

Indicator	Baseline	Target	Actual	
	2001-2004 average	2015	2015-2016	2019-2020
		5 years after project completion	Year in which project was completed	4 years after project completion
(1) Area benefited by the project (ha) *1*2	456,684	519,694*3	497,226*4	563,926
(2) Cultivated Area by major crops (ha)*1				
Rice	45,510	67,810	193,778	80,000
Cotton	55,475	55,475	56,651	35,000
Maize	95,639	95,639	41,721	87,500
Sugarcane	103,842	103,842	70,415	173,000
Fodder	92,965	97,644	78,147	126,500
Oilseed	22,481	33,723	5,781	42,867
Other (fruit, vegetables, other)*5	40,772	65,561	50,733	19,059
(Reference) Wheat*4	-	-	384,598	570,000
(3) Abiana collection rates (%)	44*2	60	-	LCC (East) 65*6 LCC (West) 70*6
(4) Production volume of major crops (tons/year)*1				
Rice	67,241	121,602	385,380	65,960
Cotton	59,629	65,797	93,932	44,590
Maize	218,124	240,810	215,569	209,400
Sugarcane	5,078,668	5,607,241	3,932,649	4,571,660
Fodder	1,212,890	1,406,632	1,107,596	2,291,300
Oilseed	9,888	16,416	7,000	8,160
(Reference) Wheat*4	-	-	1,274,844	793,860

Source: The baseline figures and targets are from documents provided by JICA. The figures at the completion were provided by the executing organization's Project Completion Report (PC-4). The figures at the ex-post evaluation were provided by PID.

Note *1: Figures are for the rainy season.

*2: The figures for "area benefited by the project" are the figures totaling the area cultivated of major agricultural crop listed in the table (from JICA's related document at the time of the appraisal).

*3: According to documents agreed on between Japan and Pakistan at the time of the appraisal (dated 22 February 2005), both the baseline and target for the area benefited by the project is 607,573ha, the irrigated area in LCC Part-B (namely, the project's target area). This is likely because the Pakistan side felt that cropping intensity would improve through the project implementation, but the rehabilitation work would not affect an increase in the irrigated area.

*4: Since the targets for this project are only for the rainy season, wheat during the dry season is not included in the baseline.

*5: pulses, gram, fruit, vegetables (rainy season)

*6: The figure for LCC (East) is the average for 2005-2017, the period in which FOs were set up. Similarly, the figure for LCC (West) is the average for 2007-2018.

"(1) the area benefited by the project" at the time of the ex-post evaluation was 563,926 ha, above the target of 519,694 ha. Looking at "(2) the cultivated area by major crops", it is found that the cultivated area exceeded the target at the time of the

ex-post evaluation for rice, sugarcane, fodder and oilseed, but those did not reach the targets for cotton, maize, and fruit and vegetables[24]. A more detailed survey would be needed to specify the causes since the cultivated area fluctuates somewhat every year, and according to UAF's views, there are many factors behind the changes in the acreage under cultivation and possible factors are the increase in production costs and the shift to other crops as a result of higher temperatures. In addition, interviews with former FO members carried out during the ex-post evaluation showed that the acreage under cultivation increased for sugarcane and wheat (dry season) due to an increase in the amount of irrigation water in the watercourses thanks to the project, as well as higher market prices. The same conditions may have occurred in the areas targeted by the project.

"(3) the Abiana collection rates[25]" in LCC (East) and LCC (West) were 65% and 70%, respectively, and both exceeded the target of 60%. A contributing factor is that the irrigation water was supplied through the project and farmers have to pay Abiana. In addition, the training for Abiana collection provided to FO members may contribute to achieving the target[26]. Depending on the period, the Abiana collection rate undercut 60%, but this was primarily because i) when the supply of irrigation water was disrupted, farmers refused to pay Abiana[27], ii) there were farmers who were inveterate non-payers of Abiana, and iii) there was no legal actions to Abiana defaulters so effective countermeasures cannot be taken[28].

Regarding "(4) Production volume of major crops", a comparison of the planned production volume by major agricultural crop and the figures at the time of the ex-post evaluation shows that production volume for crops other than fodder undercut the plan. According to UAF, multiple factors are at play in fluctuations of production volume for agricultural crops, similar to acreage under cultivation, and thus a more detailed survey and document research are needed to specify the factors behind the fluctuation. Possible factors are changes in cropping patterns due to fluctuations in production costs, a rise in temperature, difficulties in obtaining good seed, and the status of pest extermination, among others. However, according to interviews with

[24] In JICA's related documents at the time of the appraisal, the context or reason for setting these targets was not noted; however, given that the targets for cotton and maize are set with the same cultivated area as the baseline, it was likely assumed that the cultivated area would increase more for rice, fodder and oilseed than for cotton and maize.

[25] The Abiana collection rate fluctuated somewhat depending on the year; therefore, the average during the rainy season from the year when FO were first set up to the most recent year was used as the actual value for LCC (East) and LCC (West). Depending on the period, the collection rate for Abiana undercut 60%. One of the reasons may be farmers refused to pay water use fees when the supply of irrigation water was disrupted, according to interviews with FO members.

[26] Response to PID/PKPA questionnaires and interview with former FOs members.

[27] When the amount of irrigation water supplied from watercourses was low, water use fees were reduced in some cases (response to PKPA questionnaire).

[28] This was according to responses to questionnaires given to PID and PKPA and interviews with FO members.

former FO members, as with the cultivated areas, the increase in the amount of irrigation water in the watercourses due to the project and higher market prices increased the production volume for sugarcane and wheat (dry season), and farmers in some areas shifted from cotton to sugarcane. As shown in Figure 2 to Figure 5, if we look at the cultivation patterns over the years in the Punjab province, cotton has been on the decline in recent years, but cultivation of sugarcane has gone up and down in recent years, and rice remained at the same level around the completion of the project but has been increasing in recent years. Since production volume for agricultural crops fluctuates in this way, more detailed surveys are needed to identify the causes[29].

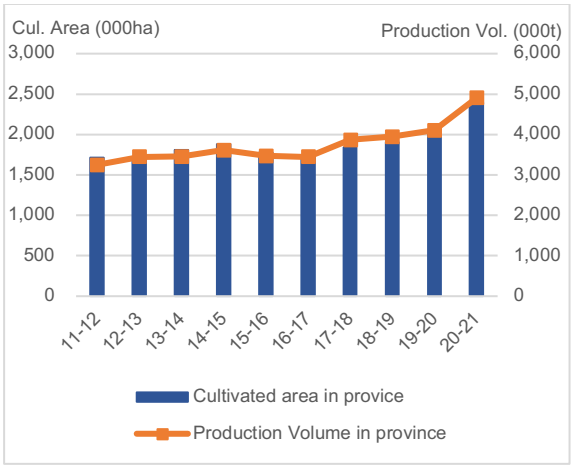


Figure 2: Trend of Cultivated Area and Production Volume of Rice in Province

Source: Statistical data provided by Punjab Agriculture Crop Reporting Service

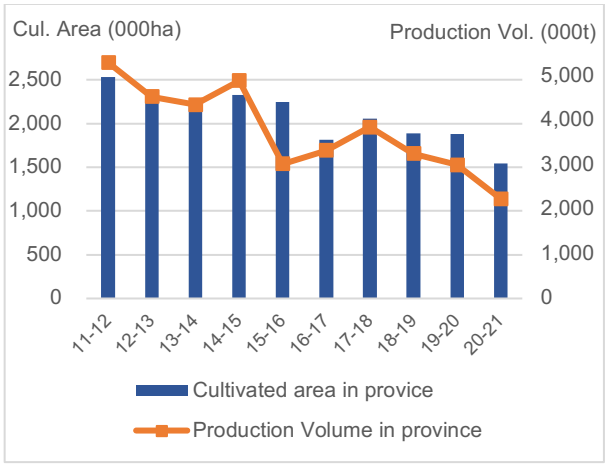


Figure 3: Trend of Cultivated Area and Production Volume of Cotton in Province

Source: Statistical data provided by Punjab Agriculture Crop Reporting Service

[29] The Pakistani government continues to view rice as its main agricultural product for the acquisition of foreign currency, and there has been no major change in government policies (website for the Agriculture Department of the Government of the Punjab: http://www.agripunjab.gov.pk/strategy; accessed on 24 July 2021). The decrease in acreage under cultivation and production volume for rice in the area targeted by the project cannot be due to the impact of government policy. Moreover, there were no major changes observed in the cropping patterns in the Punjab province, so a more detailed survey is necessary to explore the decrease in cultivated areas and production volume for rice in the areas targeted by the project.

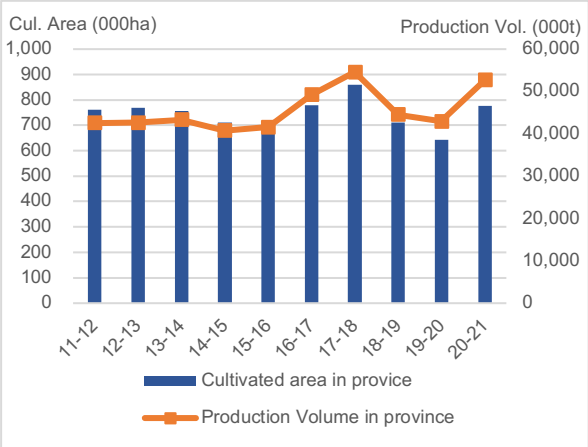


Figure 4: Trend of Cultivated Area and Production Volume of Sugarcane in Province

Source: Statistical data provided by Punjab Agriculture Crop Reporting Service

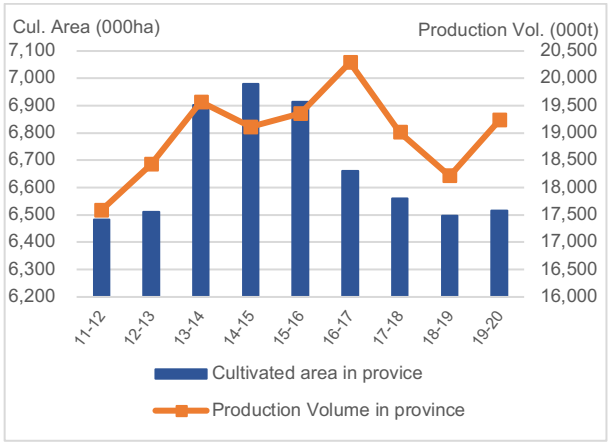


Figure 5: Trend of Cultivated Area and Production Volume of Wheat in Province

Source: Statistical data provided by Punjab Agriculture Crop Reporting Service

3.3.1.2 Qualitative effect (Other effects)

(1) Reduction in salinity

At the time of the appraisal, it was expected that lining work on the channels in this project would reduce salinity in areas targeted by the project. According to PID, the lining work on channels carried out in this project did lead to a reduction in salinity and water logging in the targeted area, and former FO members also confirmed that there was no salinity. Moreover, this project minimized seepage and percolation losses, and thus, increase the availability of irrigation water at the tail.

3.3.2 Impact

3.3.2.1 Intended Impacts

The impacts expected in this project were improvements in the living standards of local residents, and an increase in the income of small farmers (landholdings of 5 ha or less) in particular. Statistical data on the increase in farmers' income (including data on the incomes of small farmers [landholdings of 5 ha or less] in the areas targeted by the project) was difficult to obtain as the relevant organizations in the Punjab had not compiled the information. The PID and Punjab Khal Panchayat Authority (hereinafter referred to as "PKPA") believe that the project's impacts included improvements in the income level of farmers in the areas targeted by the project due to higher production volumes for agricultural crops and an increase in agricultural income, an increase in farmland prices and a resulting rise in tax

revenue[30], the start of new businesses such as livestock raising, an increase in fruit cultivation and a rise in farmers starting aquafarming[31].

According to interviews with former FO members, agricultural income increased, land values rose, farmers started new businesses such as livestock raising, fisheries, and dairies, spending on education increased (in particular, spending on the education of girls increased), buildings were enlarged, and it became possible to purchase tractors and motorcycles. According to interviews with former FO held in the ex-post evaluation, the average monthly revenue of farmers is 25,000-35,000 rupees. Since data on the average monthly income of farmers at the time of appraisal was not available[32], it is difficult to compare this to the situation before the start of the project. Also, the improvement of agricultural income involves multiple factors such as rising prices of agricultural products. Given these factors, however, interviews with former FO members and the views of PID/PKPA suggested that there is a possibility that the implementation of this project may have had some effect on the revenue of small farmers, although the extent of this project's contribution cannot be clearly laid out.

In addition, interviews with FOs confirmed that the participation of women in farmer organization activities did not increase as a result of the implementation of this project[33].

3.3.2.2 Other positive and negative impacts

This project, at the time of the appraisal, was classified as Category B because it did not fall into the sensitive sectors, sensitive characteristics and sensitive areas, and it was judged that the undesired impact on the environment would not significant, according to JBIC Guideline for Confirmation of Environmental and Social Considerations (April 2002). Resettlement and land acquisitions did not occur due to this project. However, when the construction was carried out, part of a forest was logged to clear land. This was because when the lining work was designed, the need to cut down trees and forests on the berm[34] of channel was confirmed. Also, work had to be done so that vehicles could pass on the roads alongside the canal bank. Trees

[30] However, the fixed asset tax only applies to landowners with 5 ha or more in land, so the impact was likely limited in the project's targeted area, where many farmers own less than 5 ha in land.
[31] Questionnaires to PID and PKPA
[32] At the time of the appraisal, the JICA's related document simply noted that "an increase in the income of small farmers, many of whom are categorized as poor, is expected" with no specific data. The ex-post evaluation also attempted to obtain the statistical data of agricultural income; however, such data does not seem to have been compiled in the province.
[33] There were cases in which women's work in agriculture exceeded due to changes in cultivation patterns, but there were also cases in which their work decreased (when the amount of vegetables cultivated increased, agricultural work opportunities for women increased, but in other cases, there was either no change or their work decreased). In this case as well, this project's implementation and the impact on women were not confirmed.
[34] A flat strip of land, raised bank, or terrace bordering a river or canal (https://languages.oup.com/google-dictionary-en/: access on 14 September 2021.)

were replanted along the canals by the provincial government in line with the regulations of the Forestry Department. Therefore, there was no impact on the environment[35].

In terms of production volume by major agricultural product, production was lower than the level anticipated at the time of the appraisal in the case of some crops; however, the area benefited by the project, cultivated area of major agricultural crop, and the Abiana collection rate exceeded the level anticipated at the time of appraisal. Therefore, effectiveness is considered high. The expected impact of this project was "improvement in income for small farmers." The results of interviews with PID and former FOs confirmed impacts such as an increase in the supply of irrigation water as a result of the rehabilitation work carried out in this project, which led to an increase in the cultivated area, possible contributions to an increase in agricultural revenue, the start of new businesses, an increase in spending on education (particularly for girls), the expansion of buildings, and the purchase of new tractors and motorcycles. In addition, negative impacts from the project were not confirmed. Given the above, this project has mostly achieved its objectives. Therefore, effectiveness and impacts of the project are high.

3.4 Sustainability (Rating: ②)

3.4.1 Institutional/Organizational Aspect of Operation and Maintenance

(1) Punjab government's shift in policy on operation and management systems

PIDA was established as a result of the Punjab Irrigation and Drainage Authority Act 1997. The Area Water Board (AWB) under the jurisdiction of PIDA was set up as an organization to operate and maintain branch canals under the IMT pursued in the Punjab from 2005, while FOs and Nari Panchayat[36] were established with responsibility over distributaries/minors and KP with responsibility over watercourses. Thus, the framework for operating and maintaining irrigation channels was set up with the participation of farmers. However, PIDA were disbanded under the Punjab Khal Panchayat Ordinance, issued on 22 May 2019 (issued as the Punjab Khal Panchayat Act on 13 December 2019), and at the same time, the activities of AWB, FO, Nari Panchayat and KP were also suspended, and subsequently these organizations were essentially disbanded.

The reasons for dismantling PIDA were that (1) the inadequate O&M of irrigation facilities, (2) the low Abiana collection rate[37], (3) increasing incidences of water theft,

[35] Response to PID questionnaire and collection of follow-up information

[36] This word is used as is since there is no set English translation. Nari Panchayat is water use associations set up for minors and are made up of the chairmen of Khal Panchayat in the area. Their main functions were to approve rehabilitation plans of minors, participate in the construction bidding process of channels, supervise the work, formulate warabandi (water rotation plans), and support FOs.

[37] The target Abiana collection rate was set at 60% for this project; however, responses to questionnaires given to PID indicated that the Abiana collection rate needed to be maintained at 80% if FOs were to

(4) elite capture in PIDA and FO managed areas, (5) the number of FOs involved in misappropriation of Abiana or unable to perform their duties, (6) inadequate record keeping which was indicated in Auditor's report, and (7) there were FOs that had significant water theft due to falsification of records on outlets and the management committees were ordered to cease operations[38].

Since PIDA's dismantling, irrigation facilities were constructed, operated and maintained under the systems shown in the table below. The O&M of irrigation facilities was under the jurisdiction of PID from the main canal to the distributaries/minors. Abiana was collected by FOs and a certain percentage was paid to PIDA/AWB. However, after PIDA was disbanded, Abiana was collected by the province's Revenue Department.

Table 5. Construction, O&M Systems for Irrigation Facilities

	2005 - May 2019		From June 2019	
	Construction	O&M	Construction	O&M
Main	PIDA/PID	PIDA/PID	PID	PID
Branch		AWB		
Distributaries/ Minors		FO/Nari Panchayat		
Watercourse	Punjab Agriculture Department	Khal Panchayat	Punjab Agriculture Department	Khal Panchayat
Drainage	PID	PID	PID	PID

Source: JICA related documents, responses to PID questionnaires

The Punjab Khal Panchayat Act 2019 (hereinafter referred to as "PKP Act 2019"), established in December 2019, stipulated the establishment of Khal Panchayat (KP)[39] to operate and maintain watercourses and the establishment of the Punjab Khal Panchayat Authority (PKPA). This Act stipulates the roles and responsibilities of KP and PKPA, as well as the O&M of irrigation facilities at the local level as shown below.

- The role and responsibility of KP is to prepare warabandi (water rotation plans) and mediate disputes between farmers concerning water distribution.
- PKPA conducts election of the chairman of KP, mediates disputes over water between farmers, supports the implementation of rotation plans for water distribution, distribute Abiana bills and encourage farmers to make timely payments.

be financially independent. According to Pakistan's newspaper reports (*Dawn*), the average Abiana collection rate carried out by FOs was 45%, which was lower than 70%, the average when collections were carried out under PID's jurisdiction. This corroborates one of the reasons that the PIDA was dismantled.

[38] Responses from PID's Strategic Planning/Reform Unit

[39] The Khal Panchayat set up under IMT policy through 2019 were dismantled and Khal Panchayat with the same name need to be newly established.

- PID's Canal Officer (in reality, PID's Executive Engineer, Sub-Divisional Officer and Sub-Engineer overseeing each district) is responsible for operating and maintaining distributaries/minors and coordinating with KP.

While the new system was announced as described above, as of the time of the ex-post evaluation, the system was still in a transition period. Although PKPA was established, there had been little progress in appointing PKPA field officers. Moreover, the KP established under IMT policy had been dissolved, and at the time of the ex-post evaluation, KP mandated under the PKP Act 2019 had not yet been established. In other words, O&M of the watercourses is not being carried out in a systematic way, and at the time of the ex-post evaluation, farmers were doing the O&M on a volunteer basis[40].

(2) PID's O&M system

PID has divided the irrigated area into eight irrigation zones, with the Chief Engineer overseeing each zone. The regions targeted by this project is under the control of the Faisalabad Irrigation Zone, and the LCC (East) Circle and LCC (West) Circle account for two of the five "Circles" making up this irrigation zone. 1,216 employees are assigned to the LCC (East) Circle (of which 461, or 38%, are engineers) and 1,124 to the LCC (West) Circle (of which 541, or 48%, are engineers)[41]. In the Faisalabad Irrigation Zone, the Chief Engineer has the top position, the Superintending Engineer is the head of the Circles, and below that Executive Engineers, who are the heads of Divisions, are appointed. They supervise technical staff as well as monitor the O&M of the channels in the zone that they supervise.

(3) Current issues with staffing for operations and maintenance

As such, engineers who oversee the organization are appointed and run the organization, while the current challenge of human resources is that there are not enough technical staff, in particular the staff known as "Beldars", who are responsible for daily maintenance of channels (i.e., cutting/trimming berms, desilting channels, removing hindrances [such as trees that have fallen in the channels] and other). There are areas in which daily maintenance is insufficient[42]. In the site survey implemented in the ex-post evaluation, farmers, in all nine zones in which interviews were carried out, stated that current O&M is insufficient, and that water theft is increasing[43].

[40] From interviews with former FO members.
[41] About 35,000 employees are assigned in the PID overall.
[42] For example, in the Lower Gugera Canal Division of the LCC (East) Circle, 114 Beldars are appointed, but there about 3-4 Beldar appointed to each distributary, which are 9 km to 36 km in length. Therefore, the number needs to be increased if the channels are to be properly managed.
[43] According to PID, the fines and criminal cases have been registered against culprits involved in water theft.

At the same time, PID recognizes that the number of staff assigned to the organization, which is approved by the provincial government, is sufficient, and after PIDA was dismantled, there was no significant change in the number of PID staff. Staff at the field level are assigned from within the approved number and deal with situations within the current system[44].

As such, there are some issues with the current O&M of facilities.

3.4.2 Technical Aspect of Operation and Maintenance

Before PIDA was dismantled, FOs were responsible for the O&M of distributaries/minors; however, in cases in which FO's skills and knowledge were insufficient for operating and maintaining them, PID would offer technical support and help solve issues. Thus, no specific technical challenges were observed[45].

PID, at present in charge of operating channels from the main canals to distributaries/minors, has been responsible for operating and maintaining them for many years. Therefore, its technical staff have built up experience and knowledge about construction, O&M of irrigation facilities. In this respect, there are no major issues on the technical side with operating and maintaining main canals, branches and distributaries/minors. Even in the period in which FOs were responsible for operating and maintaining distributaries/minors, the engineers of PIDA and PID provided the technical support for O&M to FOs. Therefore, the PID has kept the capacity to operate and maintain distributaries/minors. Moreover, the PID stipulates the training that new hires and junior, senior and upper-level engineers should take, and engineering schools offer training[46]. In light of this, there are no issues with sustainability on the technical aspect of O&M.

3.4.3 Financial Aspect of Operation and Maintenance

(1) Before PIDA's abolishment

Before PIDA's abolishment, PIDA, AWB and FOs were mainly responsible for operating and maintaining branch canals and distributaries/minors; therefore, this section describes the financial conditions of AWB and Abiana collection at FOs. PKPA took over this part of PIDA's responsibilities; the PKPA's financial condition will be explained later, together with that of PIDA, in the next section.

According to AWB's financial materials[47], approximate 30% of the total expenditure allocated for the channel maintenance, which cover costs such as desilting, bank

[44] Responses to PID questionnaires
[45] Responses to PID questionnaires and interviews with FO members
[46] Responses to PID questionnaires
[47] Provided by PID/PKPA

strengthening, repair of outlets in FY2016-2017; on the other hand, the percentages had declined to 10% around in FY2018-2019. Every year a certain percentage, 33-50% of the Abiana collected, are paid to the PIDA. As noted above, it has been pointed out that the collection rate for Abiana was low although financial materials indicate that the income from Abiana collected within AWB were managed to balance between income and expenditures.

Table 6. Financial Conditions in AWB (East) (West)[*1]

(Unit: Million Rs.)

	AWB LCC (East)			AWB LCC (West)		
	FY 16-17	FY17-18	FY 18-19	FY 16-17	FY17-18	FY 18-19
Income						
Opening Balance	0.092	3.947	21.525	7.326	5.923	4.491
Recovery of Abiana	136.924	128.646	112.926	86.679	64.003	53.975
Total	137.016	152.163	134.451	94.005	69.926	58.466
Expenditure						
Paid To PIDA (Abiana Share)	44.971	50.39	48.926	32.047	36.218	27.049
Salary of staff	21.917	21.515	19.124	23.982	16.221	12.396
Office Expenditure	7.506	5.58	1.709	7.559	1.516	0.99
POL Expenditure	1.346	1.722	1.364	6.104	1.469	0.811
Repair of Vehicle	2.238	1.003	0.451	1.301	0.079	0.208
Repair of Assets	2.959	0.107	0.032	0	0.008	0.01
Other Expenditure	4.541	0.207	1.987	0.005	1.302	0.377
Desilting	19.839	10.152	4.984	4.983	2.786	2.564
Bank Strengthening	11.834	6.421	5.879	10.316	4.644	1.924
Repair of Outlets	15.918	13.971	1.74	1.784	0.938	0.631
Others	-	-	-	-	0.064	0.502
Total	133.069	111.068	86.196	56.034	29.028	47.462
Closing Balance	3.947	21.525	48.255	5.923	4.491	11.003

Source: PID
Note *1: Portion for three years before PIDA was dissolved.

The important issue to examine the FO's financial condition is Abiana collection rate. In order to ensure the financial independence of FOs, 80% of Abiana needed to be secured, but the collection rate for Abiana has averaged 61% thus far, and the collection rate for each of the five districts under AWB's jurisdiction (with the Faisalabad irrigation district seen as one district) only exceeded 80% for one district. This indicates that most FOs are not financially independent.

Table 7. Average Abiana Collection Rate of FOs by AWB Jurisdiction Wise

AWB	Abiana Collection rate
LCC (East) Faisalabad (Dry season 2004-05 to dry season 2018-19)	63%
LCC (West) Faisalabad (Rainy season 2007 to dry season 2018-19)	69%
LJC Sargodha (Rainy season 2007 to dry season 2018-19)	89%
Derajat, DG. Khan (Rainy season 2007 – dry season 2018-19)	33%
Bahawalnagar (Rainy season 2000 – dry season 2018-19)	65%
LBDC, Sahiwal (Dry season 2011-12 to dry season 2018-19)	52%
Overall average	61%

Source: Responses to PKPA questionnaire

(2) After PIDA abolishment

To grasp the situation after PIDA dismantlement, the financial conditions of PIDA and PKPA (partially PIDA) were examined. Income and expenditures for the past three years for the PID Faisalabad Irrigation Zone, which has jurisdiction over the area targeted by the project, is shown in the table below. Of this, O&M costs for irrigation facilities in the LCC Part B, which were rehabilitated in this project, reached 83 million rupees in FY2018-2019 (4% of total expenditures for the Faisalabad Irrigation Zone) and 60 million rupees (3%) in FY2019-2020. After the PIDA was dismantled in May 2019, there was little fluctuation in the total budget for PID's Faisalabad Irrigation Zone; however, according to the PID, the current budget for O&M is sufficient to cover the cost of operating and maintaining the irrigation facilities.

Table 8. Income and Expenditures for PID Faisalabad Irrigation Zone

(Unit: million Rs.)

	FY 18-19	FY 19-20	FY020-21
Income	2,307	2,015	1,855
Expenditures	2,263	1,993	1,118*
(of which operating and maintenance costs for LCC Part B)	83	60	-

Source: Responses to PID questionnaire
Note*: Through middle of fiscal 2021

PIDA/PKPA's budget (income) and expenditures are shown in the table below. In the last fiscal year before the PIDA was dismantled, the budget was not approved by the government,[48] and as a result, expenditures exceeded income from Abiana and a loss of about 30 million yen was posted. Income from Abiana was no longer available from FY2019-2020, when the PKPA was newly established, and PKPA's only revenue source was the budget provided by the government. Personnel costs accounted for about 90% of the spending, followed by travel costs (5%).

[48] According to PKPA, the reasons for this are not known.

Table 9. PIDA/PKPA's budget and expenditures

(Unit: million Rs.)

	PIDA	PKPA	
	FY 18-19	FY 19-20	FY20-21
Budget	(264[*1])	249	287
Income from Abiana[*2]	124	-	-
Expenditures (actual)	163	174	116[*3]

Source: Response to PKPA questionnaire

Notes *1: For various reasons, the government did not approve a budget (PKPA questionnaire).

*2: Revenue from the collection of water use fees was posted through FY18-19, when PIDA was dismantled.

*3: Actual figures through August 2021.

The Punjab Water Policy 2018 pointed out that the Rs.135/acre in annual Abiana only covers about 10-12% of the O&M costs; however, as of the ex-post evaluation, annual Abiana had doubled to Rs.270/acre. Although this level is still not sufficient for Abiana alone to cover the cost of O&M, all-out efforts were made to increase Abiana to secure funds for O&M of irrigation facilities in Punjab province. Moreover, the shortfall in O&M costs for the irrigation channels is made up for from the province's budget[49]. In light of this, the PID has committed to securing the budget for the O&M of irrigation facilities from the main canal to distributaries/minors, and there are no issues with sustainability on the financial aspects.

3.4.4 Status of Operation and Maintenance

In the ex-post evaluation, a site survey of nine sites under the jurisdiction of former FO was carried out. The results showed that the O&M condition of the channels was not good overall, and confirmed that irrigation water is not reaching the farmers at watercourse[50]. While conditions differ depending on the channels, the following issues were found.

- Desilting and weed removal from channels, which is part of the maintenance work for distributaries/minors, is not being appropriately carried out by Beldars, PID's technical staff.
- Irrigation water is not being adequately supplied to the watercourses at tail due to water theft at head of distributaries/minors, damage and failure to perform repairs on structures and channel banks, and lack of cleaning, among factors.

[49] From PID responses

[50] Of the nine FOs visited during the ex-post evaluation, irrigation water did make it to farmers at the tail in four cases, and in the remaining five cases, farmers at the tail were unhappy with the amount of irrigation water supplied. Moreover, eight FOs stated that the system for operating and maintaining the irrigation facilities during the PIDA era resulted in better O&M conditions for the channels, and wanted the farmer participation-type O&M system to be restored.

- PID staff are confirming the status of damage to channels and breakage of structures, but there are cases in which repairs take time[51].
- When PDA/FO managed the distributaries/minors, in the event of issues such as the suspension of the supply of irrigation water, water theft and problems with facilities, information was immediately passed on to the FO president, who represented the farmers, and the issues were address promptly. Under the current system, farmers often hesitate to contact the PID Engineers who are in charge of the districts and physically the PID's office is 100 km or more away from farmers, which makes it difficult to communicate conditions on the ground and issues to PID employees[52]. Accordingly, even when problems do occur, PID staff are unable to respond promptly, which results in poor maintenance and management conditions.
- There are cases in which farmers at head use political connections to (illegally) obtain priority in receiving water.

Due to COVID-19, lockdowns were temporarily imposed in Lahore, and PID and PKPA employees worked on a shift schedule. They were unable to carry out O&M at the regular level, but overall there was no major impact. Under the current system, the Punjab province's Revenue Department is in charge of Abiana collection. In light of the impact of COVID-19, steps were taken to lower Abiana, and revenue from Abiana may decline[53].

Figure 6. Irrigation Water Reaching Watercourses from Lukhuana Distributary

Figure 7. Good O&M Conditions at Padhyara Distributary

Figure 8. Insufficient Water Supply at Minor

[51] In particular, the cross-regulator cables set up at the Burala Branch's head works, which was repaired in this project, was broken, and the regulator stops midway, unable to move further, which restricts the flow volume. As a result, irrigation water is not delivered to the tail. At present, PID is arranging for repairs and repairs are urgently required.
[52] Interviews with former FO members
[53] From PID responses

Figure 9. Damaged Side Protection at Tulwala Distributary

Figure 10. Damaged Cross-regulator Cable at Burala Branch

Only two years have passed since the O&M system was moved to a new system; therefore, the system is still being established in this transition period. Since the appointment of staff by PID and PKPA at the field level needs to be expedited, it was determined that there are some challenges for O&M of irrigation facilities in terms of institutional/organizational aspect. There were no technical issues with operations and maintenance, and on the financial aspect, PID is committed to securing a budget for the O&M of irrigation facilities; therefore, no major problems in the financial aspect. On the other hand, some minor problems have been observed in term of the institutional/organizational aspect and current status. Therefore, sustainability of the project effects is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project is intended to expand agricultural production by rehabilitating the existing irrigation facilities and drainage facilities in the Lower Chenab Canal (LCC) in the central area of Punjab Province and establish and foster farmer organizations (FO) that can be responsible for operating and maintaining the facilities, thus contributing to an increase in the income of farmers in the target area.

For Pakistan, where agriculture is still a key industry, the implementation of this project is sufficiently aligned with Pakistan's development plans and sector policies, the need to secure water for agriculture by establishing irrigation facilities, and Japan's aid policy. Therefore, the project is highly relevant. The project's efficiency is fair. This is because the project period far exceeded the plan, although project costs were within plans.

The area that benefited, the cropped area by main agricultural product, and the collection rate for water charges exceeded the levels set in the appraisal, and effectiveness is thus deemed to be high. Although improved income for small farmers, which had been anticipated as an impact

of this project, could not be confirmed in statistical data, rehabilitation work done in this project made it possible to secure irrigation water, and the increase in the cropped area and the fact that some small farmers shifted to cash crops suggests that the project may have contributed to higher agricultural income. Moreover, other impacts were confirmed, such as the start of new businesses and education - particularly an increase in expenditures on education costs for girls. No negative impacts were confirmed. As a result, we concluded that the project effectiveness and impact are high.

This project's O&M did not have any significant technical or financial issues; however, there were challenges in both institutional/organizational aspect of O&M and O&M status, and going forward, these aspects should be further reinforced. Accordingly, the sustainability of the effects resulting from this project is fair.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

(1) PID should review the condition of the current system for O&M, identify issues and respond appropriately. PID recognizes that the O&M of irrigation facilities with the number of employees authorized is sufficient; however, the results of interviews of former FOs and site surveys show that there are issues with the O&M of irrigation facilities. In particular, the status of maintenance and management at the field level should be ascertained and the issues outlined. The results of the ex-post evaluation indicate that the issues likely to be identified are 1) the shortage of Beldars should be resolved to the extent possible, and efforts are made to appropriately operate and maintain distributaries/minors (including training of Beldars), 2) support for farmers should be augmented at the field level by assigning employees at PKPA's field level, and 3) efforts should be made to set up Khal Panchayat (KP) to manage the watercourses. As regards the establishment of KP, the PKP Act 2019 does not stipulate whether it is the PID, PKPA or the Punjab Agriculture Department that has authority or the responsibility of setting up KP. As a result, discussions need to be held with the related organizations to confirm the process for setting up KP.

(2) The results of the site survey carried out in the ex-post evaluation indicated that the parts of the cross-regulator remained broken. This should be addressed quickly and efforts need to be made to ensure that irrigation water reach the watercourses.

(3) After this project was implemented, the O&M system for irrigation facilities was returned to the system led by government administrators that had been in place through 2005. Going forward, PID should examine the effects of a system with

farmer participation and a system led by government administrators and reach ideas about a better O&M system for irrigation facilities.

4.2.2 Recommendations to JICA

When the PID examines the effects of an O&M system with farmer participation and a system led by government administrators, the results should be used to build up knowledge about the O&M of irrigation facilities for use in project plans for other projects.

4.3 Lessons Learned

Grounds for identification/calculation of important figures when planning and confirmation of agreements with executing agency

In this project, the content of the civil engineering work (length of target canals/distributaries/minors) and figures for operation indicators at the time the project was planned differed in the Japanese documents prepared at the time of the appraisal and the agreement with Pakistan (English). Moreover, the planned values[54] as perceived by Pakistan differed from the figures noted in these related documents, which made it difficult to compare the planned values and actual values and analyze the disparities. Similarly, the information sources and conditions for calculations that formed the basis for the calculation of baseline figures and targets for the indicators used to measure the project's effect were not laid out. Thus, this made it difficult to determine whether the figures obtained at the time of the ex-post evaluation could be compared. Accordingly, it is important to confirm output and values for indicators with the partner country at the time of the plan and to identify the conditions for the figures set, grounds for calculations, and the source of the data so that before-and-after comparisons can be accurately made.

End

[54] In Pakistan, a project document designated by the government, called PC-1, is prepared, but the full length of the rehabilitated canal/distributary/minor and other data is not provided here, and the length of the repaired channels according to Pakistan was the figure noted in the project completion report submitted by the consulting company which worked on the project. This figure was referenced in bid documents and civil engineering work specifications.

Comparison of key plans/results

Item	Plan	Actual
(1) Project Output 1） Civil engineering work	(1) Remodeling and rehabilitation of branch canal: 375 km (2) Rehabilitation of distributaries/minors: 2,158 km (3) Lining works of distributaries/minors: 321 km (4) Rehabilitation of drainage: 399 km	(1) Remodeling and rehabilitation of branch canal: 381 km (2) Rehabilitation of distributaries/minors:1,805.83 km (3) Lining works of distributaries/minors: 1,229.9 km (4) Rehabilitation of drainage: village road bridges VRC (12), inlets (30), building repairs (7)
2） Institutional Reform	• Support for launch of organizations • Establishment of FO standing committee • Training for management committee members • Regular monitoring of FOs • Performance evaluation • Number of FO established LCC (east) 85 LCC (west) 67	• In line with plan • Number of FO established LCC (east) 72 LCC (west) 54
3） On-farm R&D	Tests and research as described below • Bed-furrow planting for wheat • Analysis of agricultural water • Drip irrigation system • Skimming well technology • laser land leveling Carried out in the distributaries in Mongi, Killianwala and Khurianwala	• In line with plan In addition to Mongi, Killianwala, and Khurianwala, this was implemented in the distributaries in Khikhi, Dijkot and Shahkot.
4） Consulting services	• Detailed design • Preparation of documents related to bids • Assistance with bid evaluations • Supervision	• In line with plan
(2) Project Period	August 2005 – December 2011 (77 months)	August 2005 – March 2018 (152 months)

Item	Plan	Actual
(3) Project Cost		
Amount Paid in Foreign Currency	500 million yen	Unknown
Amount Paid in Local Currency	14,233 million yen (8,133 million rupee)	Unknown
Total	14,733 million yen	13,687 million yen
ODA Loan Portion	12,523 million yen	11,619 million yen
Exchange Rate	1 rupee ＝1.75 yen (as of February 2005)	1 rupee＝1.23 yen (2005-2016 average)
(4) Final Disbursement	February 2016	