Cambodia
Ministry of Education, Youth and Sports (MoEYS)
Institute of Technology of Cambodia (ITC)

Cambodia
Project for Strengthening Engineering Education and Research for Industrial Development in Cambodia

Project Completion Report

March 2024
Japan International Cooperation Agency (JICA)

HM
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Project Completion Report

Project Title: Project for Strengthening Engineering Education and Research for Industrial Development in Cambodia

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Submission Date: 18 March 2024

I. Basic Information of the Project

1. Country: Cambodia

2. Title of the Project:

Project for Strengthening Engineering Education and Research for Industrial Development in Cambodia

3. Duration of the Project:

Planned: From January 2018 to December 2022

Actual: From April 2019 to March 2024

Amendment: From April 2019 to March 2024

Date of Amendment: 10 October 2018

Reason: Due to inevitable circumstances relating to resource mobilization, JICA had to postpone the commencement of the project activities planned for JFY 2018 and would make every consideration on the possibility of commencing the project in April 2019 for the period of five years.

4. Background (from Record of Discussions(R/D)):

4-1. Current State and Issues of the Higher Education Sector in Cambodia

In response to the human resource development needs in the field of engineering in Cambodia, JICA has been implementing several technical cooperation projects with Institute of Technology of Cambodia (ITC). These projects have produced positive outputs, which include a shift from lecture-based to more activity-based practical education utilizing relevant equipment. However, the level of education and research of ITC remains low in the ASEAN region and has large room for improvement.

Meanwhile, local universities such as National University of Battambang (NUBB) and Svay Rieng University (SRU) have not been able to provide qualified engineers for nearby Special Economic Zones (SEZ) due to their limited educational and research capacities. Strengthening engineering education in local universities therefore is also a challenge for the country.

4-2. Development Policies of the Higher Education Sector in Cambodia and the Standing of the Project

In accordance with the National Strategic Development Plan (2014-2018), the Ministry of Education, Youth and Sports (MoEYS) has developed the Education Strategic Plan 2014-2018 (ESP) which aims to strengthen the country's human resources in order to transform the country into a middle-income country by 2030. The government of Cambodia has also developed the Industrial Development Plan 2014-2018 (IDP), which lays out strategies and plans to promote the country's industry sector. Both documents highlight the necessity of strengthening engineering education and research with a view to providing qualified engineers to the industry sector. On this basis, the Minister of MoEYS requested the Government of Japan to support a comprehensive industrial human resource development program, which covers from basic to higher education. The Project for Strengthening Engineering Education and Research for Industrial Development in Cambodia (hereafter referred to as "the Project"), which seeks to enhance the educational and research of engineering education at central and local universities of, therefore corresponds to the priority of the government of Cambodia and is expected to contribute to the development of the industry sector by producing engineers who match the needs of industries.

4-3. JICA's Assistance Policy and Experiences in the Higher Education Sector of Cambodia

The assistance policy of the Government of Japan for Cambodia prioritizes "Human

Resource Development in the Industrial Sector" as one of the assistance programs under the Priority Area 1, "Strengthening of the Basis for Economic Activities".

JICA has to date implemented several industrial human resource development projects in Cambodia such as "Project for Educational Capacity Development of Institute of Technology of Cambodia", "Cambodia-Japan Cooperation Center" and "ASEAN University Network/Southeast Asia Engineering Education Development Network (AUN/SEED-Net)".

4-4. Assistance of Other Development Partners

ARES (the Belgian Government), the government of France and AUF (Agence Universitaire de la Francophonie) provide various assistance to ITC including sandwich Ph.D. scholarship programs. The assistance of ARES for the Center for Technical Service and University Industry Linkage and Cooperation Office of ITC would terminate in 2018.

The World Bank implemented "Education Sector Support Project (2005-2011)", which includes components to reinforce Directorate of Higher Education of MoEYS and to establish an accreditation system of higher education institutions. The World Bank also conducted "Higher Education Quality and Capacity Improvement Project (2011-2015)", and supported research funds and scholarships in the project.

5. Overall Goal and Project Purpose (from Record of Discussions(R/D)

Overall Goal:

Target universities enhance their education and research capabilities, which meet the needs of the industry sector in Cambodia.

Project Purpose:

Institute of Technology of Cambodia (ITC) enhances its education and research capabilities as a national resource institution in the field of engineering.

6. **Implementing Agency**

Institute of Technology of Cambodia (ITC)

Ministry of Education, Youth and Sports (MoEYS)

II. Results of the Project

1. Results of the Project

1.1. Input by the Japanese side: 323 million Japanese Yen (2.14 million USD[1])

1.1.1. Experts:

10 people / 1,936 days in total as shown in the following table. For details on dispatch records, see Annex 1-1.

	Number of experts	Days
Long-Term Expert		
Project Coordinator	1	1,185
Industrial Linkage / Project Coordinator	1	651
Short-Term Expert		
Chief Advisor	1	54
Guidance on LBE implementation	7	47
Total		
	10	**1,937**

In addition to JICA experts, 2 JICA senior advisers visited Cambodia 5 times for a total of 41 days to provide guidance on project operations. A project officer and a project assistant (Cambodian staff) were also employed and engaged in project operations for a total of 3,091 days.

1.1.2. Counterpart training in Japan (and ASEAN countries)

A total of 26 programs were conducted and a total of 48 counterparts visited Japan, Thailand and Malaysia for training and participation in various discussions and meetings. Among these, 20 were travelled within the framework of the LBE Research Grant described below.

Furthermore, 5 faculty members from the ITC and SRU have started studying at Japanese universities during the project period, under the long-term trainee scheme with the aim of

[1] 1USD=¥150.655 (JICA Exchange Rate as of March 2024)

obtaining a Ph.D. For details on dispatch records, see Annex 1-2.

1.1.3. LBE Research Grant

The project has provided financial support for the implementation of Laboratory-Based Education (LBE) since its inception. The total number of LBE research projects undertaken during the project period is 49, with a total of 36 principal investigators (PIs). Approximately USD 837,000 (126 million Japanese Yen as of March 2024) in total has been provided as the LBE Research Grant. For a list of grants, see Annex 1-3.

1.1.4. Provision of Equipment

Equipment procurement for ITC, NUBB and SRU under the project was approximately 104 million Japanese Yen (USD 690,318.94 as of March 2024) in total. These were mainly research equipment for laboratory and fieldwork use and equipment to upgrade the university's network.

1.1.5. Overseas Activity Cost

The Overseas Activity Cost spent over the entire project period was 136 million Japanese Yen (USD 902,724.77 as of March 2024), which was mainly utilized for LBE grants, training in Japan and abroad, and provision of equipment.

1.2. Input by the Cambodian side (Planned and Actual)

The following items were provided as stated in R/D

a) Assignment of necessary academic and administrative staff for implementation of the Project: 58 staff members were involved in project activities. For the list of CP, see Annex 1-4.

b) Provision of office space for experts: ITC allocated office space for the project on campus and equipped it with desks, cabinets, computers, internet, and other necessary items.

c) Provision of maintenance costs of facilities and equipment

d) Provision of running expenses for the implementation of the Project: The C/P covered the costs of organizing LBE committee meetings, seminars, workshops and symposia, as well as travel expenses for research field visits with faculty members from Japanese universities.

e) Scholarship for Master's/PhD courses at ITC for lecturers/prospective lecturers of target universities: Scholarships from the Cambodian Government were implemented successfully. During the project period, the Cambodian Government, with support from the World Bank, provided 21 scholarships for staff from local universities (NUBB/SRU), all of whom enrolled in the master's program at ITC. Details are given in the section of output 2-2.

1.3. Activities (Planned and Actual)

See Annex 1-5. for details.

Competitive funding to implement LBE was initially planned to be provided until the fourth year of the project, but in view of the budget situation and CP requests, it was decided to continue into the final year. As a result, the duration of activities 1.1-1.6 has been extended. The LBE guidelines planned for 1.7 were once completed in FY2022 and therefore no activities were carried out in FY2023.

Regarding 2.6, academic exchanges between ITC and target universities were promoted during the project period through training and participation in conferences. However, the current situation is at the stage of steady networking and concrete preparations for the establishment of an academic association have not yet been made.

Concerning activities 3.4 and 3.5, no concrete activities were undertaken due to the curricular overlap between the periods covered by the undergraduate internships and the periods in which students belong to the LBE Lab, which makes it difficult to implement both at the same time.

2. Achievements of the Project

2.1. Outputs and indicators

Output 1

All indicators 1-1, 1-2, 1-3 and 1-4 were fulfilled, as outlined below.

Output 1: Capabilities of ITC to implement Laboratory Based Education (LBE) are developed.	
Indicators	Achievement
1-1. Each LBE model team develops a patent map of the relevant research field.	All 49 LBE model teams developed patent reviews or patent maps.

1-2. Each LBE model team publishes at least 1 academic paper in average per year in international/regional/ITC journals and/or conferences.	Each LBE model team publishes 2.5 papers per year on average.
1-3. More than 20% of ITC lecturers are confident in conducting LBE.	62.4% of ITC lecturers are "confident" or "very confident" in conducting LBE.
1-4. More than 90% of students in the LBE model teams are satisfied with LBE.	95.0% of respondents rated 3 or more on a 5-point scale in understanding of LBE with positive comments.

1-1. Each LBE model team[2] develops a patent map of the relevant research field.

All LBE model teams have so far developed patent reviews or patent maps prior to the commencement of the research. The number of LBE model teams is as follows.

batch	Number of LBE model teams
1st	9
2nd	14
3rd	8
4th	11
5th	7
Total	**49**

1-2. Each LBE model team publishes at least 1 academic paper in average per year in international/regional/ITC journals and/or conferences.

Over the past five years, the number of academic publications has increased as the number of LBE grants offered has increased. On average, each LBE team publishes 2.5 papers per year, as follows.

[2] LBE model team: A research team comprising a PI who has received an LBE grant provided by the project, as well as other faculty members, postgraduate students, and fifth-year undergraduate students.

Year	International/ Regional conferences/ journals	Poster presentations	Number of LBE model teams	
FY2019	8	0	9	Not achieved
FY2020	38	6	23	Achieved
FY2021	45	1	31	Achieved
FY2022	111	13	42	Achieved
FY2023	136	25	49	Achieved

1-3. More than 20% of ITC lecturers are confident in conducting LBE.

The LBE Committee conducted a survey of 223 full-time ITC faculty in July 2023 and received 125 (56.1%) responses. Around 25.9% of faculty members were found to be involved in LBE activities, either as a member of the LBE committee or as a PI or Co-PI of a model team, respectively. 56.0% of respondents indicated that they "well understand" or "very well understand" LBE, and 62.4% were "confident" or "very confident" about implementing LBE by themselves.

1-4. More than 90% of students in the LBE teams are satisfied with LBE.

The LBE Committee distributed a questionnaire in July 2023 through former PIs to those who had been part of an LBE model team as a student. A total of approximately 250 people were targeted for the survey, but as the survey included students who had already graduated, it was difficult to distribute the questionnaire to all and obtain all responses, so as a result, 60 responses were received, mainly from those most recently enrolled in the LBE model teams. It was quite obvious that respondents were satisfied with their activity in the LBE model teams. 95.0% of respondents rated 3 or more on a 5-point scale regarding their understanding of LBE based on their experience.

Output 2

All indicators 2-1, 2-2, and 2-3 were fulfilled, as outlined below.

Output 2: Capabilities of ITC to strengthen capacities of other universities in LBE are developed.

Indicators	Achievement
2-1. More than 10 LBE seminars are conducted by ITC targeted to the three universities.	10 events/workshops/seminars were organized by ITC
2-2. More than 12 lecturers of SRU and NUBB obtained masters' and/or doctoral degrees in LBE labs in ITC.	14 lecturers of SRU and NUBB obtained master's degrees under the supervision of LBE PIs at ITC.
2-3. The lecturers of SRU and NUBB are satisfied with monitoring and advice by ITC.	77% of survey respondents stated that they understood LBE very well and well, with positive comments about ITC's support.

2-1. More than 10 LBE seminars are conducted by ITC targeted to the three universities.

Over the past five years, seminars have been conducted 15 times for partner universities. The content of these seminars included presentations on the research results of the LBE model team, research ethics, patents, and so forth. Partner universities are also invited to the annual JCC meetings to hear about the progress of the project and share challenges.

Year	Number of events/workshops/seminars to SRU/NUBB/RUPP
FY2019	4
FY2020	5
FY2021	3
FY2022	2
FY2023	4
Total	**18**

2-2. More than 12 lecturers of SRU and NUBB obtained masters' and/or doctoral degrees in LBE labs in ITC.

So far, ITC has hosted 21 lecturers from SRU/NUBB as master's students. Of these, 19 have either been supervised by an ex-LBE PI or have worked in an LBE model team. Of those 19, 14 have already received their degrees and returned to their respective universities to work as faculty

members. The remaining 5 students are expected to return to their respective universities and start working upon graduation.

2-3. The lecturers of SRU and NUBB are satisfied with monitoring and advice by ITC.

The LBE Committee conducted a survey to NUBB/SRU in July 2023. 18 responses were received from the Faculty of Science and Technology and Graduate School, with a response rate of 85.7%. 77% of respondents indicated that they have "very good" and "good understanding" of LBE with the support by ITC. Those r respondents expressed their appreciation for studying at the ITC and participating in seminars and technical support, including network development. Expectations for further collaboration were also expressed, as the ITC has a key role to play in Cambodia's higher education sector. These indicate a certain level of satisfaction with the support provided by ITC to the partner universities.

Output 3

Indicators 3-1 and 3-3 were fulfilled, as outlined below. Regarding indicators 3-2, first draft was developed and to be finalized by March 2024.

Output 3: University-Industry linkage is enhanced at ITC.	
Indicators	Achievement
3-1. ITC exchanges MOUs with more than 30 companies in Cambodia	There were 42 active MoUs with companies during the project period.
3-2. A policy for patents is developed.	The first draft of the policy paper for patent was developed and to be finalized in March 2024.
3-3. Each LBE model team conducts at least 1 activity (consultation, meeting, visit, seminar, workshop, etc.) with the industry sector and the public sector in Cambodia per year.	Each LBE model team conducts more than 1 activity per year on average.

3-1. ITC exchanges MOUs with more than 30 companies in Cambodia.

There were 42 active MoUs with companies during the project period, including some for only a partial period.

3-2. A policy for patents is developed.

ITC's UIL Office is in charge of developing a policy document, "ITC Intellectual Property Policy", which includes patents as follows.

> *Intellectual Property (IP). All outputs of creative endeavor in any field at the Institution for which legal rights may be obtained or enforced pursuant to the law. IP may include:*
> *a) literary works, including publications in respect of Research results, and associated materials, including drafts, data sets and laboratory notebooks;*
> *b) teaching and learning materials;*
> *c)other original literary, dramatic, musical or artistic works, sound recordings, films, broadcasts, and typographical arrangements, multimedia works, photographs, drawings, and other works created with the aid of Institution resources or facilities;*
> *d) databases, tables or compilations, computer software, preparatory design material for a computer program, firmware, courseware, and related material;*
> *e) patentable and non-patentable technical information ;*
> *g) designs including layout designs (topographies) of integrated circuits;*
> *h) plant varieties and related information;*
> *i) trade secrets;*
> *j) know-how, information and data associated with the above; and*
> *k) any other Institution-commissioned works not included above.*

(Extract from Draft ITC Intellectual Property Policy, p. 7.)

According to the report by the UIL Office, the first draft of the "ITC Intellectual Property Policy" was developed in January 2024. The contents will be discussed more and to be finalized in March 2024.

3-3. Each LBE model team conducts at least 1 activity (consultation, meeting, visit, seminar, workshop, etc.) with the industry sector and the public sector in Cambodia per year.

Over the past five years, the LBE model team's activity with industries has increased. On average, each LBE team conducts more than 1 activity per year, as follows.

Year	Number of activities	Number of LBE model teams	
FY2019	-	9	Not achieved
FY2020	37	23	Achieved
FY2021	58	31	Achieved
FY2022	137	42	Achieved
FY2023	186	49	Achieved

2.2 Project Purpose and indicators

All indicators 1, 2 and 3 were fulfilled, as outlined below.

Institute of Technology of Cambodia (ITC) enhances its education and research capabilities as a national resource institution in the field of engineering.	
Indicators	Achievement
1. 80% of ITC graduates by research theses meet LBE criteria.	95.15% of ITC graduates by research thesis met LBE criteria in the project's final year.
2. ITC conducts at least 10 activities (joint research collaboration, training on specific subjects, research funding, equipment donation, etc.) with industry and public sector in Cambodia.	Since FY2021, more than 10 activities have been implemented each year, with the number increasing.
3.More than 80 % of faculty staff members of participating universities are satisfied with LBE led by ITC	88.9% of respondents gave a rating of 3 or more on a 5-point scale regarding their understanding of LBE with ITC support.

1. 80% of ITC graduates by research theses meet LBE criteria.

The percentage of students graduated by research thesis who fulfilled the LBE criteria has increased significantly since the second year of the project, as follows.

Year	LBE criteria met
AY2019-2020	48.25%

AY2020-2021	82.63%
AY2021-2022	97.84%
AY2022-2023	95.15%

2. ITC conducts at least 10 activities (joint research collaboration, training on specific subjects, research funding, equipment donation, etc.) with industry and public sector in Cambodia.

According to the annual report of the ITC's UIL office, the number of activities (joint research collaboration, training on specific subjects, research funding, equipment donation, etc.) with industry and public sector in Cambodia has increased over the years, achieving an indicator of 10. In addition, since 2021, events for/with industries, which are as important activities as the ones mentioned above, have also increased, and are therefore added to the counting of this indicator.

Year	Joint research collaboration/research funding/equipment donation	Training on specific subjects	Events for/with industries
FY2020	1	-	-
FY2021	5	2	4
FY2022	5	2	10
FY2023	1	9	19
Total	**12**	**13**	**33**

3. More than 80 % of faculty staff members of participating universities are satisfied with LBE led by ITC.

The LBE Committee conducted a survey to NUBB/SRU in July 2023. Of the 21 survey targets from the Faculty of Science and Technology and the Graduate School,18 responses were received. It was quite obvious that respondents were satisfied with the LBE activity led by the ITC. 88.9% of respondents gave a rating of 3 or more on a 5-point scale regarding their understanding of LBE with ITC support. In addition, NUBB has actually established a laboratory in Graduate School that incorporates LBE methods.

3. History of PDM Modification

The PDM was revised 3 times during the project period as follows.

(1) The first time (ver. 2.0) was at the Minutes of Meetings dated 9 December 2021. This was because, at first, the PDM did not contain indicators, but the baseline survey conducted afterwards led to the establishment of indicators for project objectives, outputs and activities. In addition, the names of the target departments in the PDM were revised. Due to the restructured master's programs focused on the integrated research fields, the project activities are not limited to the target departments in existence. Moreover, there was a change in the name of the target university.

Main points of amendment of PDM are as follows.

Activities	
Version 1	Version 2
(Objectively Verifiable Indicators) 1-1. ITC establishes LBE model teams at 4 target departments.	(Objectively Verifiable Indicators) 1-1. ITC establishes LBE model teams mainly focused on 4 fields (Electrical and Energy, Geo-resources and Geotechnical, Industrial and Mechanical, Information and Communication).
Rename of the target group	
Version 1	Version 2
University of Battambang (UBB)	National University of Battambang (NUBB)

(2) The second time (ver. 3.0) was at the 5th JCC meeting on 24 March 2023, where the indicator of output 3 was modified. It was the result of discussions that, in view of the CP's situation at the time, it would be more effective for the ITC to develop a policy on patents prior to guidelines specifying the specific patent application process.

Output3	
Version 2	Version 3
(Objectively Verifiable Indicators)	(Objectively Verifiable Indicators) 3-2. A

3-2. A guideline for patent application is developed.	policy for patents is developed.

(3) The third time (ver. 3.1) change was made in July 2023 in monitoring sheet ver. 8, where activity 3-2 was modified in accordance with the modification of ver. 3.0.

Activities	
Version 3	Version 3.1
(Objectively Verifiable Indicators) 3-2. UIL Office develops a guideline for patent application.	(Objectively Verifiable Indicators) 3-2. UIL Office develops a policy for patents.

4. Others

4.1. Results of Environmental and Social Considerations (if applicable)

N/A

4.2. Results of Considerations on Gender/Peace Building/Poverty Reduction, Disability, Disease infection, Social System, Human Wellbeing, Human Right, and Gender Equality (if applicable)

N/A

III. Results of Joint Review

1. Results of Review based on DAC Evaluation Criteria

1.1. Relevance (High)

The project design, which focuses on enhancing education and research capabilities to meet the needs of Cambodia's industry sector is consistent with the following policy of the Cambodian government. Therefore, the evaluation of the Relevance is considered high.

In accordance with the National Strategic Development Plan (2014-2018), the Ministry of Education, Youth and Sports (MoEYS) has developed the Education Strategic Plan 2014-2018 (ESP), which aims to strengthen the country's human resources in order to transform the country into a middle-income country by 2030. The government of Cambodia has also developed the Industrial Development Plan 2014-2018 (IDP), which lays out strategies and

plans to promote the country's industry sector. Both documents highlight the necessity of strengthening engineering education and research to provide qualified engineers to the industry sector.

Furthermore, in the new National Strategic Development Plan (NSDP 2019-2023), the Cambodian government continues to focus on science and technology to support the country's socio-economic development. The strategy cites challenges related to higher education, including that research in STEM fields remains low, research activities in higher education institutions need to be sufficiently encouraged, and the quality of higher education need to meet national and regional market needs. The Industrial Development Policy 2015-2025 also aims to transform and modernize Cambodia's industrial structure from labor-intensive to skills-led and knowledge-intensive industries by 2025. To achieve this, the Government of Cambodia has made human resource development, particularly the enhancement of science and technology education, a top priority.

1.2. Coherence (High)

Coherence is considered high for the following reasons. According to Japan's Assistance Policy for Cambodia (https://www.kh.emb-japan.go.jp/economic/cooperation/japc/japc.htm#jap4), the :Japan's assistance to Cambodia has focused on:

i. development of social and economic infrastructure;
ii. improvement of basic social services like health and medical care;
iii. promotion of agriculture and rural development; and
iv. human resources development

These policies include support for the development of high-level human resources, which is essential for industrial development. In line with the above policies, this project also aims to develop highly capable human resources through the introduction of LBE and enhancement of University-Industry Linkage.

Moreover, the project has developed partnerships with other technical cooperation projects so far. The following are examples.

- The Project for the Development of Entrepreneurs and Business Networking Services

at the CJCC[3]: information sharing on a regular basis, collaboration on establishing an internship scheme, especially for JBAC[4] companies.

- Advisor to the Ministry of Labor: collaboration on establishing an internship scheme, especially for JBAC companies.

- Project for Implementation of Smart City Approach to Solve Urban Issues in Siem Reap: invite to the international symposium organized by the Committee of Life Mechatronics Symposium (CLMS) and LBE model team, conduct project site visit by ITC and Japanese universities to discuss further collaboration.

- Project for Enhancement of Malaysia-Japan Linkage Office at Malaysia-Japan International Institute of Technology: Conducted visits to exchange views on University-Industry Linkage and equipment training.

1.3. Effectiveness (High)

Most indicators of PDM were fully achieved, although some issues remain, such as the finalization of the IP policy document. Many researchers actively participated in LBE activities, especially in the management of the LBE Committee and the research activities of the respective LBE model teams, which led to the smooth implementation of the project activities. Therefore, the evaluation of the effectiveness is considered high.

1.4. Efficiency (High)

With regard to efficiency, the impact of the COVID-19 pandemic was significant but still considered high. Restrictions on international travel and in-country mobility had a negative impact, particularly on short-term training and short-term expert dispatches, as well as on face-to-face activities in the country. Despite this, inputs were flexibly adjusted to achieve the project's outcomes. Inputs such as advanced equipment that was effective in working with industry and equipment to strengthen the network were made, and so forth. These factors suggest that efficiency is high.

[3] CJCC: Cambodia-Japan Cooperation Center
[4] JBAC: Japanese Business Association of Cambodia

1.5. Impact (High)

The impact of the project is considered to be high based on the following situations.

- 49 LBE grants and committees have helped LBEs to take root within ITC's campus, contributing to the development of research and teaching capacity. As a result, ITC has produced human resources with expertise and soft skills, which are expected to contribute to the industry.

- In addition, links with Japanese universities and Japanese and Cambodian companies have been deepened through LBE model teams. As detailed in Chapter 2, 42 MOUs have been signed, and events with industry have been held; therefore, it is expected that the number of autonomous and ongoing relationships and collaborations will increase further.

- The impact of the LBE model team has been transmitted to those regional universities through their faculty members taking degrees at the ITC and also through their participation in the LBE model team. As noted in Chapter 2, 14 faculty members have returned to their respective sending universities. In addition, the establishment of the LBE structure has actually started at NUBB. Given these resources and the environment, continued collaborative research can be expected in the future.

Furthermore, the relationships with Japanese universities established through the LBE team's activities have also contributed to creating sustainable relationships, such as Japanese university faculty members visiting Cambodia under non-JICA schemes and being dispatched as evaluators for the World Bank's HEIP project.

1.6. Sustainability (Moderate)

Sustainability is considered to be moderate based on the following reasons.

The first is in terms of funding, with challenges in recurrent and competitive research funding, laboratory development and equipment maintenance to sustain LBE as a means of improving research and teaching capacity.

The second is on the organizational aspect. The lack of postgraduate students, who are crucial to the LBE activity, is noted in all organizations. In addition, especially in regional

universities, there are few faculty members with PhDs and few students belonging to engineering faculties. In order to further implement LBE in the future, it is necessary to expand and improve the organization under a concrete plan.

On the other hand, the results of the questionnaire to faculty members and students revealed that LBE has been well received as an educational system, especially at ITC, and that the LBE experience has led to increased motivation and confidence among faculty members and students. Such an evaluation is considered to be an essential factor in facilitating the implementation of LBE in Cambodia.

Given these challenges and possibilities, sustainability was rated as moderate.

2. Key Factors Affecting Implementation and Outcomes

Covid-19 had a significant impact on project activities. Project activities in general, such as training in Japan, dispatch of experts, participation in international conferences, procurement of equipment, etc., had to be cancelled or moved online. On the other hand, it should be noted that the increasing use of online tools has broadened the range of project activities in subsequent years, including communication with Japanese universities and companies.

In addition, some faculty members who participated in LBE activities at ITC had moved to other ministries/institutions during the project period. The ITC and the project determined the detailed regulation of the LBE Grant of nominating alternative PI of those LBE model teams to avoid the delay of research activity of students.

3. Evaluation on the results of the Project Risk Management

The Cambodian side, the JICA Cambodia office and the project worked closely together to ensure the project's smooth running during the pandemic of Covid-19.

4. Lessons Learnt

As mentioned above, several factors caused challenges to the project management during the project period. Some, such as COVID-19, were unavoidable, but the project and the Cambodian side have done their utmost to address them each time. In addition, in view of sustainability, challenges such as funding and organizational aspects also remain.

In order to increase the effectiveness of activities with limited resources or unexpected constraints, it is considered necessary to increase the number of collaborators outside the project and to make effective use of online and other tools. More details are provided below.

4.1. Sow seeds for linkage with resources outside JICA

In view of the sustainability of project activities, it is essential to engage in activities that increase the number of partnerships with resources outside of JICA during the project period. During the project, the following examples were observed. These activities can be effectively implemented by making extensive use of the resources provided by projects such as the LBE research grants, the mutual trust relationships with Japanese universities that ITC has established, mainly with CPs who have studied in Japan, and the network of Japanese experts.

- Linkage with Japanese universities:

  Joint research projects funded by the LBE Grant led to collaboration between a team of ITC faculty members and the Committee of Life Mechatronics Symposium (CLMS) of the Institute of Electrical Engineers of Japan (IEEJ). The collaboration has been promoted through activities such as ITC faculty members giving presentations at international conferences in Japan and organizing international symposiums at the ITC. In the project's final year, based on the research results of the LBE team so far, an application was made to SATREPS. Moreover, a visit to the partner university, NUBB, was also conducted to expand collaboration among Cambodian universities and CLMS.

  LBE's model team activities and the collaboration between the project and other Japanese organizations, described below, have led to collaboration between several Japanese universities, the project and the ITC. For example, the University of Yamanashi has provided scholarships to ITC students and faculty members, implemented short- and long-term study programs, and conducted collaborative fieldwork in the provinces of Cambodia. Kitami Institute of Technology (KIT) sent visiting faculty members to the ITC and conducted classes for students. They also participated in seminars to attract Cambodian students to study at KIT. In addition, Japanese university faculty members who have experience in dispatching short-term project experts to Japanese universities have been conducting activities to invite students belonging to LBE teams to Japanese universities, making effective use of the

JST[5] Sakura Science Exchange Program and JASSO[6] Student Exchange Support Program.

- Linkage with industries

  During the project period, the links between ITC researchers and industries were strengthened, mainly through the activities of the LBE model team and the University-Industry Linkage Office. In addition, in collaboration with the JBAC, several companies have visited the ITC and have started discussions on future collaboration. These include signing MoUs, conducting regular seminars at ITC, staff exchanges, participation in classes as lecturers and cooperation in research activities. These resources range from those provided by companies to utilizing project funds from other donors.

- Linkage with other Japanese organizations / JICA projects

  Various Japanese organizations, including other JICA projects, were one of the opportunities for collaboration with Japanese universities and industry. For example, the Project for the Development of Entrepreneurs and Business Networking Services at the CJCC introduced companies and universities to ITC and the project. Moreover, they coordinate the discussion between ITC and CJCC on entrepreneurship education.

  The Study in Japan Global Network Project in ASEAN by the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) in 2019, which has an office at the Royal University of Phnom Penh (RUPP), introduced Japanese universities at various events supported by the LBE project, and organized seminars on studying in Japan for Cambodian students. The relationships established there led to the later dispatch of visiting teachers and other activities.

  In addition, there was cooperation with the Japan Foundation (JF) in addition to increasing students' curiosity about Japan. The Faculty of Geo-resource and Geotechnical Engineering of ITC organized a regional conference of AUN/SEED-Net in September 2023, where the JF introduced the Japanese language and culture to the students. Such comprehensive activities, including information on Japanese culture and

[5] JST: Japan Science and Technology Agency
[6] JASSO: Japan Student Services Organization

study abroad, should stimulate students' interest in Japan and Japanese university education and support the background of familiarity with LBE.

4.2. Utilization of the online resources

Smooth communication between ITC and partner universities was originally crucial to the project activities and since project implementation, an upgrade of the network of these universities has been planned. From the first year of the project, while network equipment procurement was being coordinated, the COVID-19 pandemic started, which had a serious overall impact on project inputs and activities. However, as the equipment procurement process continued to progress, several meetings, seminars and LBE model team communication and research activities were facilitated.

Although the equipment was originally introduced with the assumption of strengthening networking among Cambodian universities, the benefits were already evident in the post-covid era, with online activities being activated globally. Combined with this background, the ITC and the project became active not only in domestic activities but also in online communication with Japanese universities, including international conferences and symposia.

As a side effect, the improved network environment has enabled the partner universities to operate their student learning management systems more efficiently. With the number of students at each of the target universities increasing year by year and the need to strengthen the network remaining, maintaining an appropriate network environment, albeit with limited resources, will help to broaden the project's activities.

5. Performance

The project and JICA senior advisor were able to maintain good communication and cooperation with the implementing agencies, and in June 2022, the project chief adviser, JICA senior advisor and project coordinator were awarded medals by the Government of Cambodia.

6. Additionality N/A

IV. For the Achievement of Overall Goals after the Project Completion

1. **Prospects to achieve Overall Goal:** Target universities enhance their education and research capabilities, which meet the needs of the industry sector in Cambodia.

ITC-1: More than 80% of companies which hired ITC graduates are satisfied with their work performance.

The situation supporting the achievability of the indicators is as follows.

As background, the employment rate of ITC students has always been high, for example, in a career survey conducted in March 2023 among 689 graduates of the class of 2022, 76% of the 566 respondents were employed and 17% went on to higher education. Although the employment rate immediately after graduation alone does not give an indication of the level of job satisfaction by employers, the high employment rate may suggest that ITC students are continuously highly regarded by companies.

In addition, ITC holds an 'industry consortium' every year and incorporates the voices of companies into its curriculum. Furthermore, LBE, which has been promoted through project activities, cultivates not only students' expertise but also their soft skills such as leadership and communication. Cases have also been observed during the project period where graduates of LBE model teams have been promoted to managers and other positions at an early stage of their employment, and where graduates have returned to graduate school while still affiliated with their companies.

If these conditions and activities continue, the possibility of achieving the indicators may increase.

ITC-2: The number of joint research conducted with industries increases.

The activities of the UIL offices have stimulated the ITC's promotional activities to companies year by year. In fact, as indicated in Project Purpose 2, the number of joint research projects was 1 in the second year of the project but increased to 5 in the third and fourth years. In the final year of the project, the number was reduced to 1 again, so the situation is unavoidably fluid, depending on the research funding. However, as the Cambodian government's intention is to encourage industrial collaboration, it is expected that there will be a trend towards more collaboration with companies in the future, using government research funds that are

scheduled to be implemented in the future, as well as resources such as international donors.

SRU, NUBB and RUPP: The three universities continue joint research with LBE team leaders in ITC.

During the project period, faculty members from SRU and NUBB were involved in the LBE model teams and conduct joint research with ITC. In addition, academic collaboration between ITC and the respective universities was strengthened, including acquiring master's degrees at ITC by faculty members from partner universities, as well as PhD studies at Japanese universities. It is expected that the ITC will continue to take the lead in collaborative research with universities, making effective use of these assets. It is also necessary to consider measures to actively involve the RUPP in the future.

2. Plan of Operation and Implementation Structure of the Cambodian side to achieve Overall Goal

The above activities are expected to be followed up mainly by the LBE Committee, which was established during the project period. Its activities include:

- Encouraging researchers to secure competitive and other research funding to continue LBE activities effectively.
- Monitoring the activities of the University-Industry Linkage Office.
- Coordinating with partner universities.

3. Recommendations for the Cambodian side

For ITC, in order to involve more students in LBE activities, it is recommended that undergraduate curricula are reviewed, postgraduate programs are expanded, and admissions publicity is strengthened. With regard to undergraduate students in particular, it would be essential to consider integration and collaboration with internship subjects, which are currently the focus of the second semester of the final year of study.

Concerning University-Industry Linkage, it would be helpful to deepen each activity by ensuring:

- Faculty members have more opportunities to visit industries.

- Keeping the discussion and relationship going, not a single occasion.
- Faculty members try to convey the value of academia while understanding the value of industry.

For partner universities, especially for NUBB and SRU, there are still many challenges in terms of facilities and human resources. Still, it is necessary to strategically increase the number of faculty members with postgraduate degrees under a recruitment plan and to work on attracting students.

4. Monitoring Plan from the end of the Project to Ex-post Evaluation

In order to assess the achievement of the Overall Goal, Ex-post Evaluation will be conducted after three (3) years of project completion as one of requirements of the Japanese Official Development Assistance (ODA) scheme.

ANNEX 1: Results of the Project

ANNEX 1-1: List of Dispatched Experts

ANNEX 1-2: List of Trainings

ANNEX 1-3: List of LBE Grants

ANNEX 1-4. List of CP

ANNEX 1-5. Activities

ANNEX 2: List of Products (Report, Manuals, Handbooks, etc.) Produced by the Project

ANNEX 2-1: LBE Implementation Plan

ANNEX 2-2: LBE Guideline Ver. 4

ANNEX 3: Project Design Matrix (All versions of PDM)

ANNEX 3-1: PDM ver. 1.0

ANNEX 3-2: PDM ver. 2.0

ANNEX 3-3: PDM ver. 3.0

ANNEX 3-4: PDM ver. 3.1

ANNEX 4: R/D, M/M, Minutes of JCC Meeting (copy) (*)

ANNEX 4-1: R/D_26 Sep 2017

ANNEX 4-2: MM for R/D modification_24 Oct 2018

ANNEX 4-3: MM for modification of PDM_09 Dec 2021

ANNEX 4-4: MM of 1st JCC

ANNEX 4-5: MM of 2nd JCC

ANNEX 4-6: MM of 5th JCC

ANNEX 5: Monitoring Sheet (copy) (*)

ANNEX 5-1: Monitoring Sheet Version 1

ANNEX 5-2: Monitoring Sheet Version 2

ANNEX 5-3: Monitoring Sheet Version 3

ANNEX 5-4: Monitoring Sheet Version 4

ANNEX 5-5: Monitoring Sheet Version 5

ANNEX 5-6: Monitoring Sheet Version 6

ANNEX 5-7: Monitoring Sheet Version 7

ANNEX 5-8: Monitoring Sheet Version 8

ANNEX 5-9: Monitoring Sheet Version 9

(Remarks: ANNEX 4 and 5 are internal reference only.)

Separate Volume: Copy of Products Produced by the Project

Annex 1-1. List of Dispatched Experts

* Honorific titles are omitted

JICA Long-Term Experts	Position	From	To	Days	
Sasaki Chikako	Project Coordinator	2019/04/03	2022/06/30	1,185	
Miyake Chiho	Industrial Linkage / Project Coordinat	2022/06/20	2024/03/31	651	
JICA Short-Term Experts	Associated Task	From	To	Days	Japanese University
Takada Jun-ichi	Chief Advisor	2019/06/26	2019/06/29	4	
*Total 54days		2019/12/14	2019/12/19	6	
		2020/03/25	2020/03/30	6	
		2022/03/09	2022/03/17	9	
		2022/06/19	2022/06/25	7	
		2023/04/22	2023/05/02	11	
		2023/10/09	2023/10/13	5	
		2024/02/04	2024/02/09	6	
Inaba Kazuaki	Guidance on LBE implementation	2019/11/05	2019/11/09	5	Tokyo Institute of Technology
Watanabe Koichiro	Guidance on LBE implementation	2020/01/15	2020/01/21	7	Kyushu University
Aoki Hirooki	Guidance on LBE implementation	2022/12/13	2022/12/18	6	Chitose Institute of Technology
Lim Yuto	Guidance on LBE implementation	2022/11/27	2022/12/04	8	Japan Advanced Institute of Science and Technology
Sasaki Eiichi	Guidance on LBE implementation	2023/01/26	2023/02/01	7	Tokyo Institute of Technology
Yonezu Kotaro	Guidance on LBE implementation	2023/02/28	2023/03/08	9	Kyushu University
Tsuji Takeshi	Guidance on LBE implementation	2023/09/20	2023/09/24	5	University of Tokyo
JICA Senior Advisor	Position	From	To	Days	
Nakano Kyoko	JICA Senior Advisor	2019/06/23	2019/06/29	7	
		2019/11/24	2019/11/30	7	
Watanabe Koichiro	JICA Senior Advisor	2022/03/12	2022/03/24	13	
		2022/06/19	2022/06/27	9	
		2023/09/20	2023/09/24	5	

Annex 1-2_List of Trainings

JFY	Training period	JICA scheme	Name of training	Training institutions/ Resources	Location	No. of participants	participants name
Trainings / trips funded by JICA							
1. Trainings and Meetings							
2019	2019/07/28- 2019/08/03	国別研修 C/P Training	KCCP 2022 The Project for Strengthening Engineering Education and Research for Industrial Development in Cambodia	JICA, Kyushu Univ. Tokyo Tech, etc.	Japan	7	H.E. Dr Om Romny, H.E. Dr Phol Norith, H.E. Thum Saravuth, H.E. Sieng Emtotim, Mr. Loek Virak, H.E. Po Kimtho, Dr. Chea Ratha
2019	2019/08/31- 2019/09/09	Business trip	Research Discussion (LBE Grant)	Osaka Univ., Doshisha Univ.	Japan	1	Mr. Siv Ratha
2019	2019/12/01- 2019/12/11	Business trip	Research Discussion (LBE Grant)	Kyushu Univ.	Japan	1	Ms. Heng Muoy Yi
2019	2019/12/01- 2019/12/15	Business trip	Research Discussion (LBE Grant)	Kyushu Univ.	Japan	1	Dr. Eng Chandoeun
2019	2020/01/31- 2020/02/6	Business trip	Research Discussion (LBE Grant)	Yokohama National University	Japan	1	Dr. Sry Vannei
2019	2020/03/03- 2020/03/07	Business trip	2020 8th International Electrical Engineering Congress (iEECON) (LBE Grant)	iEECON, Chiang Mai	Thailand	2	Dr. Chrin Phok Dr, Vai Vannak
2022	2022/08/29- 2022/09/11	Business trip	LMS Conference and Research Discussion (LBE Grant)	IMEC, IEEJ, U. of Fukui, etc	Japan	1	Dr. Chrin Phok
2022	2022/08/29- 2022/09/07	Business trip	LMS Conference and Research Discussion (LBE Grant)	IMEC, IEEJ, U. of Fukui, etc	Japan	1	Mr. Hel Chanthan
2022	2022/09/11- 2022/09/15	Business trip	2022 IEEE International Conference on Power System Technology (POWERCON2022) (LBE Grant)	POWERCON2022, KL	Malaysia	1	Mr. Chhlonh Chhith
2022	2022/09/25- 2022/10/03	Business trip	Research Discussion (LBE Grant)	Kyushu Univ.	Japan	2	Dr. Seang Sirisokha Dr. Kret Kakda
2022	2022/09/27- 2022/10/13	Business trip	Equipment training and research discussion (LBE Grant)	Rigaku, IKEE, Kyushu Univ.	Japan	2	Dr. Yos Phanny Dr. Eng Chandoeun
2022	2022/12/04- 2022/12/17	Business trip	Research Discussion (LBE Grant)	Hokkaido Univ.	Japan	1	Dr. Boeut Sophea
2022	2023/02/01- 2023/02/08	Business trip	Research Discussion (LBE Grant)	Tokyo Tech	Japan	1	Dr. Doung Piseth
2022	2023/02/12/- 2023/02/25	Business trip	Research Discussion (LBE Grant)	Tokyo Tech	Japan	1	Dr. Ngeth Rithea
2023	2023/05/15- 2023/05/18	Business trip	UIL and iKohza discussion	MJIIT	Malaysia	3	Dr. Bun Kim Ngun Dr. Yos Phanny Dr. Yin Molika
2023	2023/08/27- 2023/09/09	Business trip	Research Discussion (LBE Grant)	MJIIT	Malaysia	1	Mr. Heng Ratha
2023	2023/08/29- 2023/09/05	Business trip	Research Discussion (LBE Grant)	Chulalongkorn University	Thailand	1	Dr. Bun Saret
2023	2023/08/30- 2023/09/07	Business trip	LMS Conference and Research Discussion (LBE Grant)	IMEC, IEEJ, U. of Tokyo, etc.	Japan	1	Dr. Pec Rothna
2023	2023/09/03- 2023/09/09	Business trip	Precision Lab Training	MJIIT	Malaysia	3	Dr. Chan Sarin Mr. Keo Chivorn Mr. Ly Leangchheng
2023	2023/09/04- 2023/09/12	C/P Training	KCCP 2023 The Project for Strengthening Engineering Education and Research for Industrial Development in Cambodia	JICA, Tokyo Tech	Japan	7	H.E. Sok Khorn Dr. Bun Kim Ngun Dr. Eng Chandoeun Dr. Khoeurn Kimleang Dr. Chea Ratha Mr. Hem Suntrakwadh Mr. Phat Panhvoan
2023	2023/11/26- 2023/12/02	Business trip	SEM Training, research discussion	MJIIT, USM	Malaysia	3	Dr. Eng Chandoeun Ms. Chea Monyneath Ms. Sreng Laymey
2023	2023/12/12- 2023/12/17	Business trip	SWSM 2023 (LBE Grant)	Chulalongkorn University	Thailand	1	Dr. Bun Saret
2023	2024/01/14- 2024/01/20	Business trip	Research Discussion (LBE Grant)	Yokohama National University	Japan	2	Dr. Chhith Saosometh Dr. Sry Vannei
2023	2024/02/15- 2024/02/19	Business trip	2024 International Conference on Robotics, Engineering, Science, and Technology (LBE Grant)	RESTCON 2024, Thailand	Thailand	1	Mr. Sorn Darong
2023	2024/02/28- 2024/03/03	Business trip	16th International Conference on Knowledge and Smart Technology (LBE Grant)	KST 2024, Thailand	Thailand	1	Dr. Khon Kimsrornn
2023	2024/02/19- 2024/02/27	Business trip	The 18th Regional Geoscience Conference of Southeast Asia	GEOSEA 2024, Thailand	Thailand	1	Dr. Eng Chandoeun
Trainings funded by JICA - Long-term Training in Japan							
2021	2021/9/-	Long-term training	STI	Tokyo Tech	Japan	1	Mr Nou Sotheany (ITC)
2022	2022/9/-	Long-term training	STI	Tokyo Tech	Japan	1	Mr Sin Sotheavuth (SRU)
2023	2023/9/-	Long-term training	STI	Tokyo Tech	Japan	1	Mr Kong Sela (ITC)
2023	2023/9/-	Long-term training	STI - SEED Net	Hokkaido Univ.	Japan	1	Mr Roeun Daro (ITC)
2023	2023/9/-	Long-term training	STI - SEED Net	Kyushu Univ.	Japan	1	Mr Say Sokvireak (ITC)
Trainings funded by JICA - Training at ITC							
2019	2019/11/07	Short-term expert	Seminars on Smart Farming and Engineering Design Thinking for Innovative Products	JICA Short Term Expert	Cambodia	N/A	ITC
2023	2023/10/10	Short-term expert	LBE Project Seminars 1) Research Collaboration with Industry – Personal Experiences – 2) Ethics for Responsible Research Activity	LBE Project Chief Advisor	Cambodia	50	ITC/NUBB/SRU
Trainings funded others							
2019	2019/08/18- 2019/08/20	N/A	Participate The 25th AUN/SEED-Net Steering Committee Meeting	SEED-Net fund	Thailand	3	Dr. ChunhiengThavrith Ms. Ly Soda Dr. Hul Seingheng
2022	2022/08/29- 2023/90/11	N/A	LMS Conference and Research Discussion	LMS fund	Japan	2	Dr. Ket Pinnara Ms. Oum Sotheara
2022	2022/11/18- 2023/12/04	N/A	Research Discussion at Tokyo Tech	Tokyo Tech fund	Japan	1	Dr. Phun Veng Kheang

Annex 1-3. List of LBE Grants

No.	Batch	Name (Sir, Given)	Position	Gender (M/F)	Faculty / Department	Research Title	Budget FY2019	FY2020	FY2021	FY2022	FY2023
1	1	KIM Bunthern	Lecture	M	Electrical and Energy Engineering (GEE)	MPPT control of a standalone 3-phase variable speed induction generator using PWM-VSI and low voltage batteries storage for single-phase load	$8,630.00				
2	1	AM Sok Chea	Deputy Head of Department	M	Electrical and Energy Engineering (GEE)	Optimization design for wireless power transfer and its control system	$8,700.00				
3	1	VAI Vannak	Researcher	M	Electrical and Energy Engineering (GEE)	A low-cost device for estimating energy production of a PV system in faulty conditions	$8,200.00				
4	1	PEC Rothna	Lecturer-Researcher	M	Electrical and Energy Engineering (GEE)	Development and Design of Monitoring System for Data Collection and Analysis	$8,700.00				
5	1	KRY Nallis	Dean of Faculty of GGG	F	Geo-Resources and Geotechnical Engineering (GGG)	A Development of Geological Mapping at Te Teuk Pus Hot Spring, Kampong Speu Province, Cambodia	$9,169.00				
6	1	ENG Chandoeun	Researcher-Lecturer	M	Geo-Resources and Geotechnical Engineering (GGG)	Depositional Environment and Reservoir Characterization of Outcrops in Oil and Gas Prospect, Northern Tonle Sap Lake, Onshore Cambodia	$11,224.00				
7	1	KRUY Sothea	Lecturer	M	Industrial and Mechanical Enginerrng (GIM)	Development of Recycle Plastic Machines to Boost Recycling Application in Cambodia	$8,150.00				
8	1	LIV Yi	Research Lecturer	M	Industrial and Mechanical Enginerrng (GIM)	Establishing a platform for studying Cambodian railway track geometry irregularities	$10,560.00				
9	1	CHHUN Sophea	Master program coordinator/ researcher	F	Information and Communication Engineering (GIC)	Real-life and Real-time Video-based Human Tracking and Grouping	$7,585.00				
10	2	VAI Vannak	Researcher	M	Electrical and Energy Engineering (GEE)	Development of Open-Source Tool for Teaching and Research in Distribution System Topology with Distributed Generation		$14,920.00			
11	2	ENG Chandoeun	Researcher-Lecturer	M	Geo-Resources and Geotechnical Engineering (GGG)	Distribution of black shale and sandstone formations for hydrocarbon potential in northern Tonle Sap Lake, Onshore Cambodia		$14,996.00			
12	2	PEC Rothna	Lecturer-Researcher	M	Electrical and Energy Engineering (GEE)	Development of Control and Monitoring System for Efficient Cultivation and Growing Modeling of Mushroom in Cambodia		$15,000.00			
13	2	KRET Kakda	Lecturer-Researcher	M	Geo-Resources and Geotechnical Engineering (GGG)	Mapping of hydrothermal alteration associated with porphyry Cu-Au and epithermal gold deposits using ASTER and Landsat 8, northeast Cambodia.		$14,977.00			
14	2	CHRIN Phok	Head of the Department of GEE	M	Electrical and Energy Engineering (GEE)	Pesticide and temperature control in durian farm by using Glocal Control System		$14,718.00			
15	2	KIM Bunthern	Lecturer-Researcher	M	Electrical and Energy Engineering (GEE)	Assessing the local power quality using data logger and the development of a single-phase voltage stabilizer.		$13,843.00			

Annex 1-3. List of LBE Grants

No.	Batch	Name (Sir, Given)	Position	Gender (M/F)	Faculty / Department	Research Title	Budget FY2019	FY2020	FY2021	FY2022	FY2023
16	2	NGETH Rithea	Lecturer	M	Telecommunication and Network Engineering (GTR)	Implementation of Data Transmission Testbed Focused on Channel Access Protocol Design with Physical-layer Network Coding for Low Latency Transmission		$13,200.00			
17	2, 3	YOS Phanny	Vise Dean of Faculty of GGG	M	Geo-Resources and Geotechnical Engineering (GGG)	Geothermal Source and Reservoir Investigation in Te Teuk Pus Area, Phnom Te Village, Sangke Sap Commune, Oral District, Kampong Speu Province, Cambodia		$10,040.00	$21,070.00		
18	2, 3	SIV Easeng	Lecturer-Researcher	M	Industrial and Mechanical Enginerrng (GIM)	Design and built a light weight of mini electric vehicle		$21,336.00	$8,630.00		
19	2, 3	SEANG Sirisokha	Lecturer-Researcher	F	Geo-Resources and Geotechnical Engineering (GGG)	Hydrothermal alteration, Mineralization, Fluid inclusion, Geochemistry, and Geochronology of Porphyry Cu-Mo-Au Prospect, Ratanakiri, Cambodia		$17,256.00	$10,463.00		
20	2, 3	BUN Saret	Lecturer-Researcher	M	Hydrology and Water Resources Engineering (GRU)	Addressing Water Scarcity in a Rural Community of Cambodia through Groundwater Use		$15,000.00	$15,000.00		
21	2, 3	SRY Vannei	Lecturer	M	Industrial and Mechanical Enginerrng (GIM)	Composite 3D Printing based on Filament Developed from Natural Fiber		$15,988.00	$14,012.00		
22	2, 3	VONGCHANH Kinnaleth	Lecturer-Researcher	F	Industrial and Mechanical Enginerrng (GIM)	Investigation of mixing ratio of biomass to wasted cooking oil used as binder for producing solid fuel for community use in Cambodia		$14,165.00	$14,031.00		
23	2, 3	THOURN Kosorl	Vice Head of DTC	M	Telecommunication and Network Engineering (GTR)	Non-intrusive appliance load monitoring and diagnostics in residential homes			$15,500.00		
24	3, 4	VAI Vannak	Lecturer-Researcher	M	Electrical and Energy Engineering (GEE)	Planning and Operation of Active Distribution Systems			$18,158.00	$11,842.00	
25	3	CHAN Rathborey	Lecturer-Researcher	M	Hydrology and Water Resources Engineering (GRU)	Development of Electrocoagulation Reactor Integrated Sedimentation for Turbidity and Color Removal from Industrial Wastewater			$15,000.00		
26	3	TITH Dara	Researcher	M	Information and Communication Engineering (GIC)	Proof-of-Concept of Applying Blockchain Technology for Decentralized Identification Management of Medical System			$14,925.00		
27	3, 4	ENG Chandoeun	Lecturer-Researcher	M	Geo-Resources and Geotechnical Engineering (GGG)	Geological and geophysical studies of hydrocarbon potential in Tonle Sap Basin, Onshore Cambodia			$17,308.00	$12,663.00	
28	3, 4	KRET Kakda	Lecturer-Researcher	M	Geo-Resources and Geotechnical Engineering (GGG)	Integration of Landsat-8, ASTER, and Sentinel-2 for mapping of mineral prospective map, hydrothermal alteration and geological structures for porphyry copper and epithermal gold deposits in the north Cambodia.			$19,701.22	$10,279.22	
29	3, 4	TAN Reasmey	Deputy Director of Research and Innovation Center	F	Chemical and Food Engineering (GCA)	Development of Cambodian Fermented Cucumbers by using Freeze-Dried Lactic Acid Bacteria with their Potential Use as Aromatic and Bacteriocin-producing Starters			$20,627.00	$9,373.00	
30	3, 4	KET Pinnara	Lecturer-Researcher	F	Hydrology and Water Resources Engineering (GRU)	Prototype of Low-cost and Smart In-vessel Composter for converting Spent Mushroom Substrates to Bio-Organic Fertilizer			$18,610.00	$11,390.00	

Annex 1-3. List of LBE Grants

No.	Batch	Name (Sir, Given)	Position	Gender (M/F)	Faculty / Department	Research Title	Budget FY2019	FY2020	FY2021	FY2022	FY2023
31	3	EANG Khy Eam		M	Hydrology and Water Resources Engineering (GRU)	STUDY OF ACID MINE DRAINAGE (AMD) IN CAMBODIA AND ITS COUNTERMEASURES			$14,996.00		
32	4	BOEUT Sophea	Lecturer-Researcher	F	Geotechnical Engineering (GGE)	SUBSURFACE MAPPING OF SOIL BEARING CAPACITY IN PHNOM PENH AREA, CAMBODIA				$14,996.08	
33	4	PHUN Veng Kheang	Head of Master Program	M	Master of Transport Engineering	How the Poor Commute in Cambodian Cities and Their Intention towards Public Transport System				$14,350.00	
34	4	CHAN Rathborey	Lecturer-Researcher	M	Hydrology and Water Resources Engineering (GRU)	Influence of locally made effective microorganisms (EM) on the treatment of domestic wastewater using conventional septic tank				$15,000.00	
35	4	BUN Saret	Lecturer-Researcher	M	Hydrology and Water Resources Engineering (GRU)	Kinetic and Influence of Iron Co-Presence on Arsenic Removal from Groundwater				$15,000.00	
36	4	CHRIN Phok	Head of GEE	M	Electrical and Energy Engineering (GEE)	Smart farming for qualified vegetable using mechatronics techniques				$14,990.00	
37	4	SEANG Sirisokha	Lecturer-Researcher	F	Geotechnical Engineering (GGE)	Geological, Geochemical Characteristics and Genesis of Gold Mineralization, Gemstone and Rare Earth Element in Ratanakiri, Kampot, and Pailin province, Cambodia				$14,998.08	
38	4	YOS Phanny	Head of RU	M	Geo-Resources and Geotechnical Engineering (GGG)	Physical properties and Mineralogy of ancient brick from temples at Sambor Prei Kuk area, Kampong Thom, Cambodia.				$14,970.00	
39	4	SROY Sengly	Lecturer-Researcher	M	Chemical and Food Engineering (GCA)	Assessment on nutritional profiles, storage stability and sensory evaluation of dried fish powder made by low-value small fish species				$15,000.00	
40	4	DOUNG Piseth,	Lecturer-Researcher	M	Civil Engineering (GCI)	Evaluation of Mechanical Behavior of Post-Installed Bundled Reinforcement Used for Concrete Connections				$14,900.00	
41	4	NGETH Rithea	Lecturer-Researcher	M	Telecommunication and Network Engineering (GTR)	Design and Implementation of Health Data Collection Communication Protocol Using Physical-Layer Network Coding				$14,980.00	
42	4	VALY Dona	Lecturer-Researcher	M	Information and Communication Engineering (GIC)	Plagiarism Detection System for Khmer Language				$14,380.00	
43	5	CHHITH Saosometh	Vice-Head of GIM	M	Industrial and Mechanical Enginerrng (GIM)	Experimental Identification of Hardening Behavior of G300 Steel Grade					$14,996.00
44	5	HEU Rina	Lecturer-Researcher	F	Water and Environmental Engineering (WEE)	Development of locally-produced ceramic pot filter for household groundwater purification in rural Cambodia					$15,040.00
45	5	KHON Kimsrornn	Lecturer-Researcher	M	Electrical and Energy Engineering (GEE)	Optimal energy-management system in smart-building					$14,149.00

Annex 1-3. List of LBE Grants

No.	Batch	Name (Sir, Given)	Position	Gender (M/F)	Faculty / Department	Research Title	Budget FY2019	FY2020	FY2021	FY2022	FY2023
46	5	TY Boreborey	Head of Master Program	F	Chemical Engineering	Development of monitoring and controlling of IoT-based aquaponics system using green energy (Acronym: Smart Aquaponic Project)					$15,000.00
47	5	PICH Bunchoeun	Lecturer-Researcher	M	Geo-resources and Petroleum	Fluid Inclusion and Geochronology of Igneous Rock at Memot Prospect, Choam Tamao Commune, Memot District, Tboung Khmum Province, Cambodia.					$14,948.32
48	5	SANG Davin	Lecturer-Researcher	F	Water and Environmental Engineering (WEE)	Development of Electrocoagulation-Floatation (ECF) Reactor for Removal Turbidity, Color, and Oil & Grease from Slaughterhouse Wastewater					$15,000.00
49	5	OR Chanmoly	Director of RIC	M	Energy Technology and Management research unit	Optimization of Algae Cultivation for Biofuel Production in Cambodia					$14,985.00
							$80,918.00	**$195,439.00**	**$238,031.22**	**$219,111.38**	**$104,118.32**

Total **$837,617.92**

Annex 1-4. List of CP

	Name		Title
1	H.E. Dr	OM Romny	Project Director
2	H.E. Prof	PO Kimtho	Project Director
3	Dr	CHUNHIENG Thavarith	LBE Committee Chairperson
4	Dr	BUN Kim Ngun	LBE Committee Chairperson
5	Dr	BUN Long	LBE Committee Vice-chairperson
6	Dr	SIM Tepmony	Director of Graduate School
7	Dr	OR Chanmoly	Director of Research and Innovation Center / PI of LBE Grant
8	Dr	ENG Chandoeun	Dean of Faculty of Geo-resource and Geotechnical Engineering / PI of LBE Grant
9	Dr	CHRIN Phok	Head of the Department of Electrical and Energy Engineering / PI of LBE Grant
10	Mr	LAY Heng	Head of the Department of Information and Communication Engineering
11	Dr	NGUON Kollika	Head of Department of Industrial and Mechanical Engineering
12	Dr	CHAN Sarin	Head of Department of Industrial and Mechanical Engineering
13	Mr	HAN Virak	Dean of Faculty of Civil Engineering
14	Dr	IN Sokneang	Dean of Faculty of Chemical and Food Engineering
15	Dr	CHHUON Kong	Dean of Faculty of Hydrology and Water Resources Engineering
16	Dr	YOS Phanny	Head of Material Science and Structure Research Unit / PI of LBE Grant
17	Dr	DOUNG Piseth	Head of Material Science and Structure Research Unit
18	Dr	SRANG Sarot	Head of Mechatronics and Information Technology Research Unit
19	Dr	VALY Dona	Head of Mechatronics and Information Technology Research Unit / PI of LBE Grant
20	Dr	KRET Kakda	Head of Energy Technology and Management Research Unit / PI of LBE Grant
21	Dr	TAN Reasmey	Head of Food Technology and Nutrition Research Unit / PI of LBE Grant
22	Dr	PHAT Chanvorleak	Head of Food Technology and Nutrition Research Unit
23	Dr	SIEV Sokly	Head of Water and Environment Research Unit
24	Dr	PENG Chanthol	Head of Water and Environment Research Unit
25	Dr	MITH Hasika	Head of Master Agro-Industry
26	Dr	TY Boreborey	Head of Master Agro-Industry / PI of LBE Grant
27	Dr	LIM Sovanvichet	Head of Master Materials and Structures
28	Dr	PEC Rothna	Head of Master Mechatronics and Information Technology / PI of LBE Grant
29	Dr	KIM Bunthern	Head of Master Energy Technology and Management / PI of LBE Grant
30	Dr	KET Pinnara	Head of Master Water and Environmental Engineering / PI of LBE Grant
31	Dr	PHUN Veng Kheang	Head of Master Transport Engineering / PI of LBE Grant
32	Dr	HENG Rathpisey	Head of Master Mobile Technology
33	Dr	YIN Molika	Head of University-Industry Linkage Office
34	Mr	SIEANG Phen	Head of Cooperation and International Relation Office
35	Dr	AM Sok Chea	PI of LBE Grant
36	Dr	VAI Vannak	PI of LBE Grant
37	Dr	KRY Nallis	PI of LBE Grant
38	Dr	KRUY Sothea	PI of LBE Grant
39	Dr	LIV Yi	PI of LBE Grant
40	Dr	CHHUN Sophea	PI of LBE Grant
41	Dr	NGETH Rithea	PI of LBE Grant
42	Dr	SIV Easeng	PI of LBE Grant
43	Dr	SEANG Sirisokha	PI of LBE Grant
44	Dr	BUN Saret	PI of LBE Grant
45	Dr	SRY Vannei	PI of LBE Grant
46	Dr	VONGCHANH Kinnaleth	PI of LBE Grant
47	Dr	THOURN Kosorl	PI of LBE Grant
48	Dr	CHAN Rathborey	PI of LBE Grant
49	Dr	TITH Dara	PI of LBE Grant
50	Dr	EANG Khy Eam	PI of LBE Grant
51	Dr	BOEUT Sophea	PI of LBE Grant
52	Dr	SROY Sengly	PI of LBE Grant
53	Dr	DOUNG Piseth,	PI of LBE Grant
54	Dr	CHHITH Saosometh	PI of LBE Grant
55	Dr	HEU Rina	PI of LBE Grant
56	Dr	KHON Kimsrornn	PI of LBE Grant
57	Dr	PICH Bunchoeun	PI of LBE Grant
58	Dr	SANG Davin	PI of LBE Grant

Annex 1-5. Activities (Planned and Actual)

Activities / Sub-Activities		2019				2020				2021				2022				2023				2024			
		Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅰ	Ⅱ	Ⅲ	Ⅳ
Output 1: Capabilities of ITC to implement Laboratory Based Education (LBE) are developed.																									
1.1 ITC establishes LBE model teams in target fields.	Plan																								
	Actual																								
1.2 Each LBE model team develops a research plan.	Plan																								
	Actual																								
1.3 Each LBE model team develops a patent map.	Plan																								
	Actual																								
1.4 Each LBE model team prepares a research proposal.	Plan																								
	Actual																								
1.5 Each LBE model team conducts research according to the research proposal.	Plan																								
	Actual																								
1.6 Each LBE model team submits academic papers to regional and/or international journals and/or conferences.	Plan																								
	Actual																								
1.7 The LBE model teams develop a LBE guideline.	Plan																								
	Actual																								
Output 2: Capabilities of ITC to strengthen capacities of other universities in LBE are developed.																									
2.1 ITC regularly meets SRU/NUBB/RUPP and gives seminars on LBE.	Plan																								
	Actual																								
2.2 SRU and NUBB in collaboration with ITC prepare human resource development plans of existing/prospective lecturers to be trained by the Project based on the long-term strategies to strengthen STEM-related faculties/departments of each university.	Plan																								
	Actual																								
2.3 ITC selects potential ITC master's/doctoral candidates, who are/will become lecturers of SRU and NUBB.	Plan																								
	Actual																								
2.4 The selected candidates participate in LBE model teams as graduate students at ITC and produce theses based on the research.	Plan																								
	Actual																								
2.5 ITC continuously monitors and provides advice to the lecturers of SRU/NUBB who have obtained degrees at ITC.	Plan																								
	Actual																								
2.6 Together with SRU, NUBB and RUPP, ITC prepares for the establishment of domestic academic societies in the targeted field.	Plan																								
	Actual																								
Output 3: University-Industry linkage is enhanced at ITC.																									
3.1 University-Industry Linkage (UIL) Office prepares materials/database that present ITC's	Plan																								

	research seeds and research capabilities based on LBE.						Actual	
	3.2 UIL Office develops a guideline for patent application.						Plan	
							Actual	
	3.3 UIL Office regularly meets with private/state-owned companies to seek opportunities for and implement collaboration such as joint research, joint lecture, and internship.						Plan	
							Actual	
	3.4 LBE model team leaders assist 5th year students to find internship opportunities, which are related to their LBE activities.						Plan	
							Actual	
	3.5 Students in LBE participate in internships with appropriate TORs at relevant companies.						Plan	
							Actual	

INSTITUTE OF TECHNOLOGY OF CAMBODIA

IMPLEMENTATION PLAN OF LABORATORY-BASED EDUCATION INTO INSTITUTE OF TECHNOLOGY OF CAMBODIA

PLAN (2019-2023)

MARCH 2022

Table of Contents

1. Objectives of Implementation of Laboratory-based Education into Institute of Technology of Cambodia.

1.1. Background

ITC has a mission to nurture students with a high-quality education in the fields of engineering, sciences, and technologies and to develop innovative technology transfer. Students are provided with a strong scientific base and technical know-how and skills which allow their integration and evolution in the labor market. Based on the decision of the annual board meeting, the future orientation of ITC is to expand the engineering education area and develop research platforms in order to sustain the development of the country. This requires strengthening the basic scientific knowledge, developing research programs in connection with the private sectors as well as national and international stakeholders, supporting communities, fostering economic development through entrepreneurship programs, and helping our graduate students integrating the global economy. According to the new ITC Strategic Plan (2021-2030) which lead this university to become a public administrative institution with excellence in teaching, research innovation and technology transfer to the community, two main objectives are targeted to be achieved by 2030 as the following:

- To train 17200 students with high qualification towards the Cambodia Vision 2030
- To implement 175 applied projects with technology transfer and start-up for harmonization and development towards the Cambodia Vision 2030

In responding to this new strategic plan (2021-2030), an engineering educational system called Laboratory-Based Education (hereinafter refered to as “LBE”) from Japan is proposed to implement into ITC. This LBE is expected to enable students to learn how to find and solve practical problems, make good communications, and lead logical discussions. LBE concurrently encourages faculty members to keep updating research outputs in order to provide resources to improve the knowledge of students and keep great ongoing researches cooperation with the industries. The implement of LBE in ITC could help to accelerate and ensure this university achieves the ultimate objectives of the new strategic plan by 2030.

1.2. Introduction of LBE.

LBE has been implemented in Japanese universities as common engineering education style for a long time. The characteristic of this education style is uniquely emphasizing research activities, communication, and interaction inside each laboratory that has hierarchical structure, starting from faculty members, researchers, graduate program students as well as engineering program students as shown in Figure 1. Upper stage (senior) members supervise and take care of junior (lower stage) members. For example, in a laboratory, faculty members have to concurrently provide academic guidance and suggestion to graduate/engineering students. Graduate students are expected to assist engineering students. LBE allows students to obtain not only expertise and problem-solving ability but also soft skills such as management and communication skills through practical education and research. Various interactions such as assistance to academic staff’s research by students, teaching to younger students by senior students, and mutual learning among students allow them to improve their communication skills, cooperativeness, management skills, and leadership. Human resources equipped with such skills are very highly valued by companies,

public sectors, incubators, investors, and higher education institutions for their future careers after graduation.

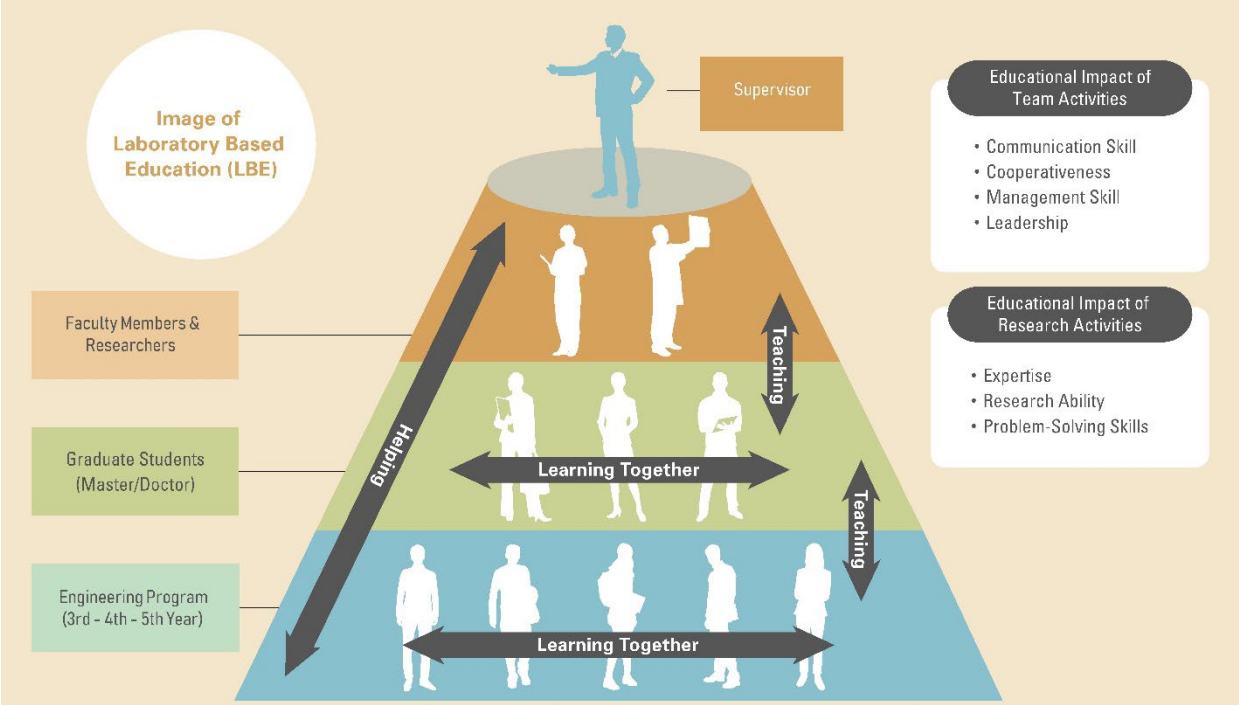


Figure 1. Image of Laboratory-Based Education (LBE)

1.3. Expected outcomes

The implementation of LBE in ITC is expected to additionally support and improve the existing academic system of ITC in producing capable human resources as well as increasing the product outputs. The main target of implementation of LBE is to further strengthen the capacity of graduate students as well as final year engineering students. In the meantime, ITC will also expand this implementation to engineering program student in 3rd and 4th year to prepare and familiarize them for the research work. With this objective in mind, the output from LBE implementation is expected as the following:

- **Sharpening research field to align with the national development plan:** Many students ranging from 3rd year of engineering program to graduate program are expected to involve with research field and research topic that is necessary for developing the country.
- **Strengthening research capacity of students and faculty staffs:** Since LBE involves a wide range of students in research works and research activities in the institute, we expect that the research capacity of students will increase significantly.
- **Increasing the number of publications:** Research is the basis for engineering education. The LBE can improve the quality of research. Therefore, numerous good publications will be generated through research by LBE teams in each academic year.
- **Widening Future Career Path of the Student:** it is also expected that the implement of LBE will also provide addional option for the student to select their future career path. Student can either choose between industrial path (Involving with SME: small and medium enterprise) or academic path (involving with LBE)

- **Increasing Number of Research Fund Source:** the increasing number of capable human resource come with the potential sources of research fund. LBE fund will be used as the first ignition of this system to allow research works possible to impove ITC human resource capacity. After a few years of implementations, ITC is expected to produce a significant amount of capable human resources who are able to apply for other external research funds from other organization.

2. Current Situation and Challenges

2.1. Statistic data of students, staffs, and research lab in ITC (2020)

Department	FY	GCA	GCI	GEE	GGG	GIC	GIM	GRU	Grad. Student	Total
N° Eng. (Tech.) Student	2456	508 (205)	420 (160)	357 (136)	132	127	340 (71)	294 (17)	107	4741 (589)
N° Ph.D. Staffs	3	15	12	14	10	2	12	17	-	85
N° Lab (Research Lab)	3 (0)	8 (2)	3 (1)	9 (5)	6 (3)	7 (1)	10 (4)	3 (3)	-	49 (19)

2.2. Supervising System

- In each department, multiple fifth years students (I5) will be assigned to a specific supervisor (faculty members) who is responsible for their research work and thesis writing.
- The assignment for the supervision of master students follows 3 different ways depending on their research activities. 1) An applicant applies to research proposed by a lecturer or a laboratory. 2) An applicant has a research proposal and prefer to work with a lecturer or in a laboratory. 3) An applicant has a general-purpose about a research topic without clear objective, nor contacted lecturer/laboratory. For the last way, the applicant is interviewed by the Graduate School and appointed to observe a few laboratories before assigning the supervisor.
- The assignment for the supervision of doctoral students follows 2 different ways depending on their research activities and mobility (sandwich program or double-degree program). 1) An applicant applies to a research project and grant proposed by a lecturer or a laboratory. 2) An applicant has a research proposal with or without a research grant. In this second case, the doctoral direction committee will assign supervisors for the applicant after evaluating their primary proposal defense.

2.3. Challenges

Currently, the number of faculty members with Ph.D. at ITC is 85. Despite this significant number, some of these members have obligation in administration and management section. It is insufficient for supervising all the students in each department. As the result, the student will not be assigned to a specific supervisor until they are in the last year of their engineering study. This could affect the research capability of the student as their period of involving research work is very limited.

Limited research topic, experiment, and field studies due to a lack of financial support. Without additional funding, the research topic usually requires to use the same equipment, the same material that usually available in each laboratory. The student will also choose the nearest field studies, usually in Phnom Penh, to do their research. These factors will limit research innovation and new findings in each department, especially, those who require high-cost material or components for experiment work and also those who involve long-distance field studies (in the province).

3. Action Plan for Implementing LBE in ITC

Sustainable implementation of LBE requires effort of everyone in ITC. ITC need to act as a whole to promote lab-based research by improving research activities, improving teaching/learning toword high quality and increasing cooperation with other stakeholder.

3.1. Implementing LBE in ITC & Key improvements

- Lab-Based Education is expected to improve the supervising system of ITC. The implementation of LBE will further increase the interaction between members of each research team of ITC. By using the principle of senior students teach younger students, faculty staff can recruit younger students into the research work to promote communication with the senior student. Faculty staff can provide necessary lectures or training to the students if needed. Research progress of all students can be monitor in a weekly seminar or research progress and research outcome presentation. This allows students to get involved in research work relatively early in their academic life which increases their research capacity and innovation later on in their study.
- LBE research grant as well as any other grants that each individual team earned, can be used as financial support for research work in various categories including research equipment, consumables, travel costs, etc. This allows the students to have more posibility in selecting their research topic which led them to new research innovation. The students are also able to present their research outcome internationally with the financial support of this grand through the conference proceeding and journal paper publications which are very useful for their future study.

3.2. Improving Teaching and Learning towards high quality

Key Strategic Actions

- **Set criteria of LBE, develop a LBE guideline, and disseminate the guideline for implementation to each faculty and research unit for by August 2022:**
  - ✓ To enhance the research supervision: based on the regular activities reports, students and supervisor conduct a clear work plan and gather their research results in order to ensure the continuity of research activities.
  - ✓ To empower the research dessimination: the students are encourage to communicate their research result via seminar, conference, article publication and patent application. These activities open the visibilies to their futher career and grant seeking.
  - ✓ To increase the quality of research performances of students and supervisors : The new student's supervision hierarchy system is well integrated into ITC for both undergraduate programs and graduate programs to further enhance the quality of the current supervision system.
  - ✓ To improving problem solving, critical thinking, practical skills : Every member understands their obligations and responsibilities in helping the down level teammates which leads to a smooth process of mentoring at every level.
  - ✓ To increase the rate of success in research study of undergraduate and graduate students: By allowing graduate students to lead some breakdown research work, they can archeive their research objects timely and empower the teammates.
  - ✓ To enhance the soft skills of undergraduate and graduate students: management, communication, team work and leadership skills, self-improvement are built within the research team.
- **Reform and/or revise the research-based Master program with clear requirements and rules focued on LBE implementation by a new academic year of 2022:**
  - ✓ To promote students to choose the research-based master program: through out the available funded research topics for each academic year, students are able to conduct the research, since the first year, with assigned supervisors who are expertised in the most relevant field to the student's research interest.
- **Organize promotion events with ITC reseachers for 5th year undergraduates students at least 2 times per year:**
  - ✓ To valorize the enrollment in research based program: the students who archieve the publications above the graduation requirement within the defined period shall be merit an award.

3.3. Improving research activities.

Key Strategic Actions

- **Provide leadership in engineering disciplines through research in line with international standards:** under the supervision of faculty staff, senior students are encouraged to lead and support junior students in research activity which improves their research capacity as well as their leadership skills in return.
- **Support opportunities for the development of research methods:** research outcomes are monitored regularly through the seminar, discussion, and report. Any sign of research problems such as slow research progress, conflicting results, etc., will be raised to discuss to find the solution and revision if necessary.
- **Promote research publications in scientific journals:** the outcomes of research activities provide useful data and methods for developing publication. Faculty staff and students are encouraged to develop scientific papers using results from their research work.
- **Encourage, support, and promote research activities in the Institute by providing information on sources of funding for research:** LBE fund is crucial for maintaining research activities. However, the availability of other internal and external funding is required in order to sustain the research activities for long term.
- **Strengthen and expand research cooperation with public and private institutions, industries and partner universities:** increasing the quality and quantity of people involving in research in ITC together with new equipment under LBE funding, ITC has enough resource to incorporate with public and private institutions and partner universities in terms of joint-research and trainings.
- **Support and disseminate knowledge exchange between member of each research team:** one of the targets of implementing LBE system in ITC is to promote the interaction among faculty members and students in research activities, discussion, and join-research work to improve the research capacity of all involved members.
- **Ensure annual research reports for management:** a summary of overall research activities in ITC will be developed to showcase the research outcomes, research challenges, effectiveness of LBE implementation in research, etc. These factors are vital for monitoring and adjusting short term strategic plan for the next academic year to achieve constant improvement in research work.
- **Participate in the development of quality graduate program curriculum:** Closely work with Graduate School to develop quality graduate program curriculum by implementing LBE system to increase more interaction between students.

3.4. Increase cooperation with industries and others.

Key Strategic Actions

- **Organizing Seminar for lecturers and students:** As part of our collaboration with industries, experts and speakers from some companies come to ITC to host seminars and conferences and sometimes to provide short training. Our teachers and students can benefit from this.
- **Joining Seminar and workshop Organized by other organization/ Ministries/Universities (domestic and overseas):** Many seminars and workshops are organized by any organization, ministries, universities and representatives of ITC were invited to join those seminars and workshop in order to gain knowledge on the relevant topic.
- **Inviting Enterprise to visit ITC:** Numerous enterprises visit ITC with the aim of seeking future collaborations with ITC and development of joined project
- **Visiting enterprise by ITC lecturers and students:** A number of enterprises have been visited by ITC lecturers and studentsto strengthen the collaboration and provide the knowledge of workplace to students in the relevant skills
- **Training for Industries:** Technical knowledge from the research work in ITC can be transferred to the industries through the training work.
- **Organizing Event/Seminar/Meeting:** the opportunities for strengthening the relation between ITC and the industries can be obtained from these kinds of event. These organized events are also a great chance for discussing future collaboration between both parties.
- **ITC Alumni meeting:** all departments at ITC (GGG, GCA, GCI, GIM, GEE, GRU, GIC …) have organized the annual alumni meeting with former students and lecturers in each department.This event give the opportunities to students to meet their seniors to strengthen the relations, exchange knowledge and good idea, strengthen the collaboration between students and lecturer/enterprises as well as find the external fund.
- **Short term training by industries:** providing a short term training on related technical skills and issue certificate.

4. Monitoring of Implementing LBE in ITC

The monitoring of the effectiveness of LBE is necessary after implementing LBE at ITC. The evaluation of successful implementation should be focusing on several key factors of improvements in ITC which including involvement of research work, Interaction between the faculty member, and cooperation companies.

4.1. Interactions Between All Categories of Members in Each Faculty

As LBE requires all member categories of each faculty to help and support the member category below them consecutively, the interactions of all members should be significantly increased. The monitoring of interaction should be assessed on the student activitieswithin the faculty which could be in the form of group discussion, seminar, lecture, and training.

Target numbers of LBE involvement under LBE project:

Indicator by 2023			
Number of students as LBE member	Ratio of theses met LBE criteria/research theses	Ratio of success (graduated on time/enrolled)	Number of graduated member of LBE employed by the industries
300	80%	80%	200

4.2 Quantity and Quality of Students involving in Research Work.

Since all students : engineer degree (from 3rd, 4th, and 5th years), master degree, doctoral degree are encouraged to participate in specific research work under the supervision of faculty staff, many students can improve their research skills. This is beneficial for younger students, especially from 3rd and 4th year, in which they are exposed to research work early in their student life. As a result, they should be able to deliver a great research outcome later on for their thesis in the final year. With the contributions from students, faculty staff will have enough resources to deliver effective research progress and research outcome. The indicators for monitoring the improvement of research activities are involving the increased number of researches in various categories including research for development, technology transfer, excellence center, incubation project, start-up project, etc.

Target numbers of research related activities:

Indicator by 2023				
Research for Development	Research for Technology Transfer	Research for Incubation Project	Research for Start-up Project	International Publications
110	5	3	1	70

4.3. Number of Cooperation with the Companies

The cooperation with the company should begin with the agreement of students for internships in the company to increase the practical knowledge of the students. While it is important to monitor the quality of the student in terms of knowledge and skill, it is also vital to monitor the number of jobs offers by the company for the students.

Target numbers of cooperation:

Indicator			
Seminars, joining seminars and workshops	Research projects collaborated with the stakeholders	Lecturers and students involving in the industries research project	stakeholders that have MOU with ITC
-At least 10 seminars per year	-At least 7 projects per year	-At least 50 students per year	-At least 3 per year

Guidelines For Laboratory-Based Education (LBE) At Institute of Technology of Cambodia (ITC)

Ver. 4

Preparation, Implementation and Monitoring

Editorial Supervisor: LBE Committee

I. Introduction

a. Background

ITC has a mission to nurture students with a high-quality education in the fields of engineering, sciences, and technologies and to develop innovative technology transfer. Students are provided with a strong scientific base and technical know-how and skills which allow their integration and evolution in the labor market. According to the new ITC Strategic Plan (2021-2030) which lead this university to become a public administrative institution with excellence in teaching, research innovation and technology transfer to the community, two main objectives are targeted to be achieved by 2030 as the following:

- Reach 100% of students in high quality and become outstanding human resources in line with Cambodia Vision 2030
- Implement projects that transfer technology by 10% from the annual rate to 2030

In responding to this new strategic plan (2021-2030), an engineering educational system called Laboratory-Based Education (hereinafter referred to as “LBE”) from Japan is proposed to implement into ITC. This LBE is expected to enable students to learn how to find and solve practical problems, make good communications, and lead logical discussions. LBE concurrently encourages faculty members to keep updating research outputs in order to provide resources to improve the knowledge of students and keep great ongoing researches cooperation with the industries. The implement of LBE in ITC could help to accelerate and ensure this university achieves the ultimate objectives of the new strategic plan by 2030.

b. Benefits of LBE in higher education focused on fields of Engineering and Science

LBE is an education system centered on team research and activities which opposed to coursework. LBE focuses on knowledge and technology transfer through research involvement of research activities and requires to work closely among team members with supervisions from a team leader. LBE brings benefits in students, faculty members, and ITC as followings;

- Students
  - Gain soft skills for communication, cooperation, management and leadership.
  - Cultivate research abilities, expertise, and problem solving skills
  - Publish papers
  - Gain presentation skills by experience of joining the local or international conference presentations

- Gain knowledge on advanced technology and trends in the world
- Have opportunities of joining multiple events such as workshops, seminars, conferences and etc.
- Develop network

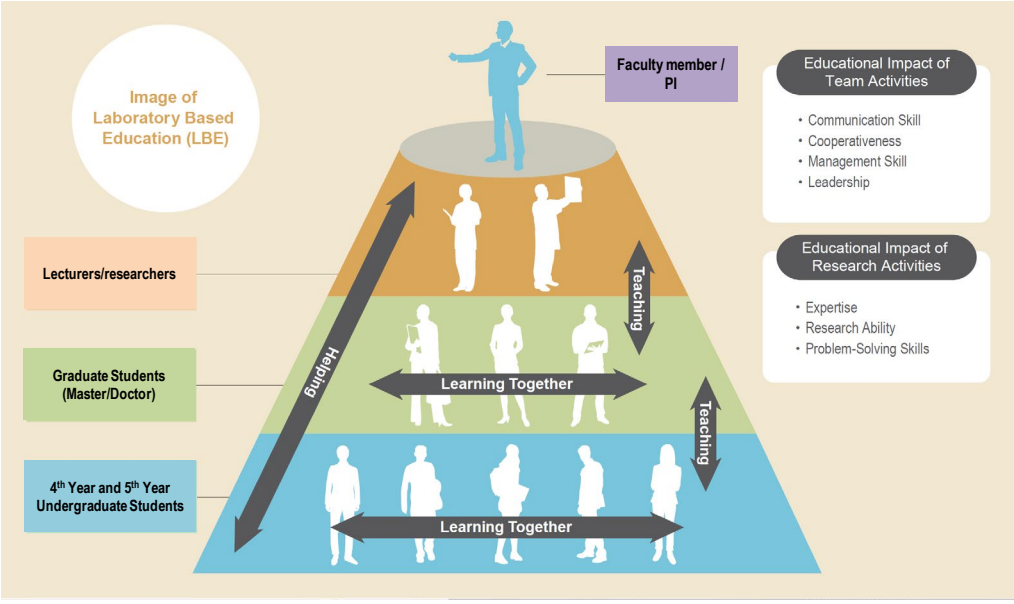
➢ Faculty Members
- Enhance quality of research activities
- Publish high qualified research papers
- Gain international recognitions as a researcher

➢ ITC
- Gain recognition by communities and industries both locally and internationally
- Strengthening partnership with industries and other higher institutions
- Raise competitive funds
- Gain system (management of projects systematically) and facilities (research equipment) in education and research fields
- Enhance the research activities

➢ Industries and Society
- Solve problems for society
- Industries can use advanced equipment of ITC and get consultation from ITC experts for development of their service and business.

c. LBE in the context of ITC

Laboratory Based Education (LBE) is implemented by the majority of universities in Japan and has been proved to generate research, patents, and publications both nationally and internationally. The picture below depicts the model of LBE adapted to ITC context.



Laboratory (lab.) means a "research team." LBE is research team based, not based on rooms furnished with equipment. Structure of each laboratory is hierarchical; senior students assist juniors in understanding research and producing theses, while the PI is responsible for the whole education and research conducted in his/her laboratory.

There are four levels of hierarchies in the structure depicted in the above picture:

- Principal Investigator (PI) and Co-PI
- Lecturers/Researchers
- Graduate Students (Master or Doctor)
- Undergraduate Students (4th and 5th Year)

II. Insights of LBE

a. LBE Lab

Rather than individual research laboratory, LBE lab refers to research laboratory which focus on a specific research theme of the research units of the Institute of Technology of Cambodia. Currently, there are five research units namely Energy Technology and Management; Food Technology and Nutrition; Material Science and Structure; Mechatronics and Information Technology; and Water and Environment. One LBE lab can consist of more than one principal investigator (PI). Annex 1 provides more detail on the LBE lab currently in operation in ITC.

b. People

PI and Co-PI

A Principal Investigator (PI) is the primary individual responsible for the preparation, conduct, and administration of a research project. Co-PIs are key personnel who have

responsibilities similar to that of a PI on research projects.

The roles and responsibilities of PI and Co-PI are listed below.

Supervision of research

- Lead the student(s) in the development of a personalized and focused study program;
- Advice the student(s) in the development of a realistic timetable for her/his (their) work;
- Assist the student(s) in the definition of his research project in a global and interdisciplinary perspective;
- Assist the student(s) in her/his (their) preparation, if necessary, of scholarship applications studies;
- Receive the student(s) regularly to take stock of the progress and quality of his journey;
- Provide feedback to the student's written work;
- Regular meeting with student(s) and researcher(s);

Obligations towards graduate school

- Be responsible for the quality of the student's work;
- Evaluate the work done by the student;
- Authorize the submission of the thesis;
- Participate in the evaluation of the thesis defense.

Organization of events

- Convene and chair the meetings of the research committee, in the presence or not of the student;
- Ensure consultation within the group: student, director, co-director and external consultant(s) if applicable;
- Report on the progress of the student in his educational path and research for thesis;
- Chair the interdisciplinary seminars on the research project of the student.

Research budget

- Prepares the technical and financial proposal and may collaborate with others in its preparation;
- Identifies all available financial resources in direct support of this or other research endeavors (other support)
- Proposes cost sharing through contributed effort or other approved mechanisms and seeks approval from appropriate University officials.
- Manage the utilization of the research budget

- Initiate purchases

To be granted the status of PI or Co-PI, faculty members need to have the following qualifications:

Requirement of PI

- Be a PhD degree holder
- Belong to one of the faculties of ITC
- Belong to one of the research units of ITC

Requirement of Co-PI

- No specific requirement
- Can be from other university or other private sector

Lecturer/Researcher

Lecturers are those faculty members who belong to one the faculties of ITC. Researchers are those who belong to one of the research units of ITC. Both lecturer and researcher who participate in the LBE team does not necessarily hold a PhD degree. The roles and responsibilities of lecturer/researcher are listed in the following table

Research students

Students may refer to graduate and undergraduate students. Student membership is not limited only to ITC students, however for the students from other institutions, the condition of the usage of ITC facility should be agreed between ITC and sending institution in advance.

c. Facilities

Researchers have duty to keep research facility in their laboratory in good conditions for effective conduct of research work. The following guidelines can be put in place to properly manage the facilities.

- Regular clean of research equipment by all research member of the lab. It is encouraged to make such clean every week
- Keep good record of inventory of the laboratory
- Ensure that new equipment is installed properly according to the user manual by getting support from the central service for technical services
- Hands-on training on the utilization of the equipment needs to be conducted to all new research members.
- Implement good bookkeeping on the movement of equipment inter-laboratory

- technical service
- Assign a responsible person for equipment
- Mange use of equipment (user, schedule, consumables, purpose, etc)
- Use the efficient power supply for equipment and consider backup for electricity cut off
-

d. Activities

Below are major activities that can make a laboratory become dynamic. Both PI and research students have obligations to make them happen.

Publication	All the researchers, either at the level of Doctorate, Master or undergraduate, are somehow preparing for their future professional. Publication is one of the most valuable assets. Researchers are encouraged to publish as many as possible. The more they publish, the more they give visibility to their work. Hence, the more their research work is read and cited.
Participation to the conferences	In the same way that it is important to publish the research work, it can be formative to participate in conferences. Researchers will be able to discover, before their publication, the results of other researcher's work, which may be useful to the completion of their thesis. In addition, they will make themselves known and have the opportunity to meet researchers interested in the same topics as them.
Organization of the seminar	Lab seminars are a good occasion that allows students/ researchers to present their work to members of their laboratory or to people outsiders and compare their ideas. It is a good opportunity for researchers to contact researchers outside the laboratory and to make known the direction of their work. It is also an opportunity for researchers to be familiar with the organization of scientific events.
Registration to the research network	The profession of researcher requires keeping informed of publication notices, conferences and major events that punctuate the life of the discipline. Networks, more or less formal, are one of the distribution channels of this information. They are also important tools to mobilize for the future professional integration.
Capacity building	Researchers are encouraged to attend supplementary training courses which have interdisciplinary nature. This can help researchers to broaden their scientific culture. Graduate school of ITC may have a predefined subjects that can help researchers for the selection.

e. Research budget

Research budget is very important to keep the laboratory moving forwards. PI is the main responsible person to find and manage the budget.

Sources of budget

The availability of the research budget may differ according to research fields. The following sources are the most common ones.

- Direct funding from the ministries
- Special designed projects with development agencies like LBE, HEIP projects
- Open call for research applications by different research programs
- Collaboration with industries
- Providing service to industries and other organizations

Utilization of the budget

The utilization of the research budget needs to conform with financial guideline of the funding agencies and of ITC. However, the following types of budget utilization are the most common.

- Purchase of research equipment
- Purchase of laboratory consumable
- Purchase of documentation
- Mobility of students and researcher
- Field trips
- Travel cost for both international and national
- Insurance

f. Research topics for students

Research topics are usually proposed by PI. However, students may discuss their research interest with their prospect PI in order to elaborate a sound research topic. The cruciality and work load of the research topic may vary depending on the education program of the research students. However, the following characteristics are the most common ones for a research topic.

- Research topics should have novelty except topics for collaborations with companies
- Research topics should be in line with research direction of ITC research units and of research and innovation center
- Research topics should benefit to society, community and industries, and/or contribute to improving current issues

III. Tips for successful LBE

a. Set Vision and Mission of the Lab. and objectives of research

Each lab. or research team should set a clear vision and mission. A lab. leader or supervisor clearly explains new research members at the beginning;

- Vison and mission of lab.
- Objectives of a research team
- Definitions and advantages of LBE

b. Structure of Research Team Members

A research team should consist at least a supervisor/ lab. leader and students. However, LBE effectively works when a team consist with faculty members and a number of students with multiple grades, especially with graduate students. A supervisor manages and check progress of research of each member and faculty members can give advices or assist students. Senior students can mentor junior students and students in a same grade can interactively cooperate each other.

c. Selection of research students

Having passionate research members in the team is crucial to have a quality research work. Below are some tips for selecting research students.

- Recruit students with high motivation and research interests
- Conduct guidance and orientation for lab. and research and explain benefits of joining LBE
- Use of digital platform in order to announce the call for research projects
- Recruit Master and PhD. students as much as possible

d. Selection of research team

While selecting research students is crucial for a successful implementation of LBE, selection of a laboratory is equally important to students. Below are the tips for students when selecting a research team.

- Choose a thesis subject that fascinates him to avoid professional dropout
- Learn about the work and research interests of PI
- Contact the PIs to discuss their subject of research
- Meet PIs who may be interested in the subject
- Take into consideration the personality of the PIs
- Maintain good relationships with PIs
- Know the different styles of supervisory

- Invite with foreign researchers with the related theme of research if possible
- Consider PI availability

e. Quality

Quality on all aspect of the laboratory is a crucial factor for successful LBE. PI is the main responsible person to ensure this quality. Below are the most common aspects whose quality need to be ensured.

- Research work (topics, methodologies, novelty, innovation etc.)
- Publication (presentation, poster, paper, thesis, book chapter etc.)

f. Others

- A mentor for a student may help for smooth communication among research team
- Allowing a short provisory experience in lab. may be helpful for students
- Provide study and work space for students and team members

IV. LBE Certificate

In order to recognize research students who participate in the research activities in LBE lab, a certificate of completion will be delivered. This certificate will be granted mainly to engineering students while it's also applicable to master and PhD students if they wish. To be eligible, research students need to fulfill the following requirement:

- A student has own supervisor
- A student writes a thesis with research-oriented topic
- A student is given or write by himself a research proposal with detail of;
  - Research topic
  - Goal of research
  - Tasks as a research member
  - Expected acquisitions
- A student belongs to a research team, which consists of one or more supervisors and other research students
- A student needs to make presentation in the internal seminar organized by the research team
- Time spanned of the student in research team must be at least 5 months (this duration can be accumulated if student participates in the research team for more than one time)
-

The completion certificate will be signed by LBE committee chair and dean of faculty

where research students belong to.

In order to obtain the completion certificate, the following procedure needs to be followed:

- Within two weeks after completion of the research activities, PIs submit necessary of document to Head of Departments / Dean of the Graduate School (in case of Master students) for requesting the certificate. Submitted document shall include:
    - Application of LBE Certificate
    - Monthly schedule of lab seminar ((Any format, clearly indicating the date and topic of seminar/meeting.)
    - Final report
- After reviewing application documents at the department, the Department / Graduate School will produce the certificate with the signature of the Dean of the Faculty
- The department will submit signed certificate to LBE Committee Chairperson within 2 weeks after the submission of the application from PIs.
- After the signature by LBE Committee Chairperson, the signed certificate will be returned to each Department / Graduate School.
- The department / Graduate School will hand over certificates to PIs.

Project Design Matrix (PDM)

22 April 2020 (Version 1.0)

Project Title: The Project for Strengthening Engineering Education and Research for Industrial Development in Cambodia
Duration: April 2019 to March 2024
Target Group：Institute of Technology of Cambodia (ITC), Svay Rieng University (SRU), University of Battambang (UBB), Royal University of Phnom Penh (RUPP)

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
(Overall Goal) Target universities enhance their education and research capabilities, which meet the needs of the industry sector in Cambodia.	ITC 1. More than 80% of companies which hired ITC graduates are satisfied with their work performance. 2. The number of joint research conducted with industries increases. SRU, UBB and RUPP 3. The three universities continue joint research with LBE team leaders in ITC.	1. Survey 2. Record of LBE team 3. Record of LBE team	
(Project Purpose) Institute of Technology of Cambodia (ITC) enhances its education and research capabilities as a national resource institution in the field of engineering.	1. 750 ITC graduates write their theses through LBE. 2. ITC conducts at least 10 activities (joint research collaboration, training on specific subjects, research funding, equipment donation, etc.) with industry sector and the public sector in Cambodia. 3. More than 80 % of faculty staff members of participating universities are satisfied with LBE led by ITC.	1. Record of LBE team 2. Record of LBE team 3. Survey by the Project Team	・Lecturers trained in LBE continue to work in each university/institution
（Outputs） 1. Capabilities of ITC to implement Laboratory Based Education (LBE) are developed.	1-1. Each LBE model team develops a patent map of the relevant research field. 1-2. Each LBE model team publishes at least 1 academic paper in average per year in international/regional/ITC journals and/or conferences per year. 1-3. More than 20 % of ITC faculty staff members are confident in conducting LBE. 1-4. More than 90 % of students in the LBE model teams are satisfied with LBE.	1-1. Record of LBE team 1-2. Record of LBE team 1-3. Survey by the Project Team 1-4. Survey by the Project Team	
2. Capabilities of ITC to strengthen capacities of other universities in LBE are developed.	2-1. More than 10 LBE seminars are conducted by ITC targeted to the three universities. 2-2. More than 12 faculty staff members of SRU and UBB obtained masters' and/or doctoral degrees in LBE labs in ITC. 2-3. The faculty staff members of SRU and UBB are satisfied with monitoring and advice by ITC.	2-1. Project Monitoring Report 2-2. Project Monitoring Report 2-3. Survey of the Project Team	
3. University-Industry linkage is enhanced at ITC.	3-1. ITC exchanges MOUs with more than 30 companies in Cambodia.A guideline for patent application is developed.Each LBE model team conducts at least 1 activity (consultation, meeting, visit, seminar, workshop, etc.) with the industry sector and the public sector in Cambodia per year.	3-1. Record of MOU 3-2. Project Monitoring Report 3-3. Project Monitoring Report	

(Activities) 1-1 ITC establishes LBE model teams at 4 target departments. 1-2 Each LBE model team develops a research plan. 1-3 Each LBE model team develops a patent map. 1-4 Each LBE model team prepares a research proposal. 1-5 Each LBE model team conducts research according to the research proposal. 1-6 Each LBE model team submits academic papers to regional and/or international journals and/or conferences. 1-7 The LBE model teams develop a LBE guideline. 2-1 ITC regularly meets SRU/UBB/RUPP and gives seminars on LBE. 2-2 SRU and UBB in collaboration with ITC prepare human resource development plans of existing/prospective lectures to be trained by the Project based on the long-term strategies to strengthen STEM-related faculties/departments of each university. 2-3 ITC selects potential ITC master's/doctoral candidates, who are/will become lecturers of SRU and UBB. 2-4 The selected candidates participate in LBE model teams as graduate students at ITC and produce theses based on the research. 2-5 ITC continuously monitors and provides advice to the lecturers of SRU/UBB who have obtained degrees at ITC. 2-6 Together with SRU, UBB and RUPP, ITC prepares for the establishment of domestic academic societies in the targeted fields. 3-1 University-Industry Linkage (UIL) Office prepares materials/database that present ITC's research seeds and research capabilities based on LBE. 3-2 UIL Office develops a guideline for patent application. 3-3 UIL Office regularly meets with private/state-owned companies to seek opportunities for and implement collaboration such as joint research, joint lecture, and internship. 3-4 LBE model team leaders assist 5th year students to find internship opportunities, which are related to their LBE activities. 3-5 Students in LBE participate in internships with appropriate TORs at relevant companies.	Inputs 1. JICA a) Long-term experts: Chief Advisor and Project Coordinator b) Short-term experts from Japan and/or ASEAN countries c) Research funds for LBE d) Provision of equipment for LBE e) Short-term training of academic/technical staff in Japan and/or ASEAN countries 2. Cambodia a) Assignment of necessary academic and administrative staff for implementation of the Project b) Provision of office space for experts c) Provision of maintenance costs of facilities and equipment d) Provision of running expenses for the implementation of the Project e) Scholarship for Master's/PhD. courses at ITC for lecturers/prospective lecturers of target universities.	Preconditions

Project Design Matrix (PDM)

1 July 2021 (Version 2.0)

Project Title: The Project for Strengthening Engineering Education and Research for Industrial Development in Cambodia
Duration: April 2019 to March 2024
Target Group：Institute of Technology of Cambodia (ITC), Svay Rieng University (SRU), National University of Battambang (NUBB), Royal University of Phnom Penh (RUPP)

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
(Overall Goal) Target universities enhance their education and research capabilities, which meet the needs of the industry sector in Cambodia.	ITC 1. More than 80% of companies which hired ITC graduates are satisfied with their work performance. 2. The number of joint research conducted with industries increases. SRU, NUBB and RUPP 3. The three universities continue joint research with LBE team leaders in ITC.	1. Survey 2. Record of LBE team 3. Record of LBE team	
(Project Purpose) Institute of Technology of Cambodia (ITC) enhances its education and research capabilities as a national resource institution in the field of engineering.	1. 80% of ITC graduates by research theses meet LBE criteria. 2. ITC conducts at least 10 activities (joint research collaboration, training on specific subjects, research funding, equipment donation, etc.) with industry and public sector in Cambodia. 3. More than 80% of faculty staff members of participating universities are satisfied with LBE led by ITC.	1. Survey by the Project team 2. Record of LBE team 3. Survey by the Project Team	・Lecturers trained in LBE continue to work in each university/institution. ・The number of ITC graduates by research theses increases continuously.
（Outputs） 1. Capabilities of ITC to implement Laboratory Based Education (LBE) are developed.	1.1. Each LBE model team develops a patent map of the relevant research field. 1.2. Each LBE model team publishes at least 1 academic paper in average per year in international/regional/national journals and/or conferences. 1.3. More than 20% of ITC faculty staff members are confident in conducting LBE. 1.4. More than 90% of students in the LBE model teams are satisfied with LBE.	1-1. Record of LBE team 1-2. Record of LBE team 1-3. Survey by the Project Team 1-4. Survey by the Project Team	
2. Capabilities of ITC to strengthen capacities of other universities in LBE are developed.	2.1. More than 10 LBE seminars are conducted by ITC targeted to the three universities. 2.2. More than 12 faculty staff members of SRU and NUBB obtained masters' and/or doctoral degrees in LBE labs in ITC. 2.3. The faculty staff members of SRU and NUBB are satisfied with the support by ITC.	2-1. Project Monitoring Report 2-2. Project Monitoring Report 2-3. Survey of the Project Team	
3. University-Industry linkage is enhanced at ITC.	3-1. ITC exchanges MOUs with more than 30 companies in Cambodia. 3-2. A guideline for patent application is developed. 3-3. Each LBE model team conducts at least 1 activity (consultation, meeting, visit, seminar, workshop, etc.) with the industry and public sector in Cambodia per year.	Record of MOU Project Monitoring Report Project Monitoring Report	

(Activities) 1-1. ITC establishes LBE model teams mainly focused on 4 fields (Electrical & Energy, Geo-resources & Geotechnical, Industrial & Mechanical, Information and Communication). 1-2. Each LBE model team develops a research plan. 1-3. Each LBE model team develops a patent map. 1-4. Each LBE model team prepares a research proposal. 1-5. Each LBE model team conducts research according to the research proposal. 1-6. Each LBE model team submits academic papers to regional and/or international journals and/or conferences. 1-7. The LBE model teams develop a LBE guideline. 2-1. ITC regularly meets SRU/NUBB/RUPP and gives seminars on LBE. 2-2. SRU and NUBB in collaboration with ITC prepare human resource development plans of existing/prospective lectures to be trained by the Project based on the long-term strategies to strengthen STEM-related faculties/departments of each university. 2-3. ITC selects potential ITC master's/doctoral candidates, who are/will become lecturers of SRU and NUBB. 2-4. The selected candidates participate in LBE model teams as graduate students at ITC and produce theses based on the research. 2-5. ITC continuously monitors and provides advice to the lecturers of SRU/NUBB who have obtained degrees at ITC. 2-6. Together with SRU, NUBB and RUPP, ITC prepares for the establishment of domestic academic societies in the targeted fields. 3-1. University-Industry Linkage (UIL) Office prepares materials/database that present ITC's research seeds and research capabilities based on LBE.	Inputs 1. JICA a) Long-term experts: Chief Advisor and Project Coordinator b) Short-term experts from Japan and/or ASEAN countries c) Research funds for LBE d) Provision of equipment for LBE e) Short-term training of academic/technical staff in Japan and/or ASEAN countries 2. Cambodia a) Assignment of necessary academic and administrative staff for implementation of the Project b) Provision of office space for experts c) Provision of maintenance costs of facilities and equipment d) Provision of running expenses for the implementation of the Project e) Scholarship for Master's/PhD. courses at ITC for lecturers/prospective lecturers of target universities.	

3-2. UIL Office develops a guideline for patent application. 3-3. UIL Office regularly meets with private/state-owned companies to seek opportunities for and implement collaboration such as joint research, joint lecture, and internship. 3-4. LBE model team leaders assist 5th year students to find internship opportunities, which are related to their LBE activities. 3-5. Students in LBE participate in internships with appropriate TORs at relevant companies.		Preconditions

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Project Design Matrix (PDM)

24 March 2023 (Version 3.0)

Project Title: The Project for Strengthening Engineering Education and Research for Industrial Development in Cambodia
Duration: April 2019 to March 2024
Target Group：Institute of Technology of Cambodia (ITC), Svay Rieng University (SRU), National University of Battambang (NUBB), Royal University of Phnom Penh (RUPP)

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
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(Project Purpose) Institute of Technology of Cambodia (ITC) enhances its education and research capabilities as a national resource institution in the field of engineering.	1. 80% of ITC graduates by research theses meet LBE criteria. 2. ITC conducts at least 10 activities (joint research collaboration, training on specific subjects, research funding, equipment donation, etc.) with industry and public sector in Cambodia. 3. More than 80% of faculty staff members of participating universities are satisfied with LBE led by ITC.	1. Survey by the Project team 2. Record of LBE team 3. Survey by the LBE Committee	・Lecturers trained in LBE continue to work in each university/institution. ・The number of ITC graduates by research theses increases continuously.
（Outputs） 1. Capabilities of ITC to implement Laboratory Based Education (LBE) are developed.	1.1. Each LBE model team develops a patent map of the relevant research field. 1.2. Each LBE model team publishes at least 1 academic paper in average per year in international/regional/national journals and/or conferences. 1.3. More than 20% of ITC faculty staff members are confident in conducting LBE. 1.4. More than 90% of students in the LBE model teams are satisfied with LBE.	1-1. Record of LBE team 1-2. Record of LBE team 1-3. Survey by the Project Team 1-4. Survey by the Project Team	
2. Capabilities of ITC to strengthen capacities of other universities in LBE are developed.	2.1. More than 10 LBE seminars are conducted by ITC targeted to the three universities. 2.2. More than 12 faculty staff members of SRU and NUBB obtained masters' and/or doctoral degrees in LBE labs in ITC. 2.3. The faculty staff members of SRU and NUBB are satisfied with the support by ITC.	2-1. Project Monitoring Report 2-2. Project Monitoring Report 2-3. Survey of the Project Team	
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Project Design Matrix (PDM)

18 July 2023 (Version 3.1)

Project Title: The Project for Strengthening Engineering Education and Research for Industrial Development in Cambodia
Duration: April 2019 to March 2024
Target Group：Institute of Technology of Cambodia (ITC), Svay Rieng University (SRU), National University of Battambang (NUBB), Royal University of Phnom Penh (RUPP)

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2. Capabilities of ITC to strengthen capacities of other universities in LBE are developed.	2.1. More than 10 LBE seminars are conducted by ITC targeted to the three universities. 2.2. More than 12 faculty staff members of SRU and NUBB obtained masters' and/or doctoral degrees in LBE labs in ITC. 2.3. The faculty staff members of SRU and NUBB are satisfied with the support by ITC.	2-1. Project Monitoring Report 2-2. Project Monitoring Report 2-3. Survey of the Project Team	
3. University-Industry linkage is enhanced at ITC.	3-1. ITC exchanges MOUs with more than 30 companies in Cambodia. 3-2. A policy for patents is developed. 3-3. Each LBE model team conducts at least 1 activity (consultation, meeting, visit, seminar, workshop, etc.) with the industry and public sector in Cambodia per year.	3-1. Record of MOU 3-2. Project Monitoring Report 3-3. Project Monitoring Report	

(Activities) 1-1. ITC establishes LBE model teams mainly focused on 4 fields (Electrical & Energy, Geo-resources & Geotechnical, Industrial & Mechanical, Information and Communication). 1-2. Each LBE model team develops a research plan. 1-3. Each LBE model team develops a patent map. 1-4. Each LBE model team prepares a research proposal. 1-5. Each LBE model team conducts research according to the research proposal. 1-6. Each LBE model team submits academic papers to regional and/or international journals and/or conferences. 1-7. The LBE model teams develop a LBE guideline. 2-1. ITC regularly meets SRU/NUBB/RUPP and gives seminars on LBE. 2-2. SRU and NUBB in collaboration with ITC prepare human resource development plans of existing/prospective lectures to be trained by the Project based on the long-term strategies to strengthen STEM-related faculties/departments of each university. 2-3. ITC selects potential ITC master's/doctoral candidates, who are/will become lecturers of SRU and NUBB. 2-4. The selected candidates participate in LBE model teams as graduate students at ITC and produce theses based on the research. 2-5. ITC continuously monitors and provides advice to the lecturers of SRU/NUBB who have obtained degrees at ITC. 2-6. Together with SRU, NUBB and RUPP, ITC prepares for the establishment of domestic academic societies in the targeted fields. 3-1. University-Industry Linkage (UIL) Office prepares materials/database that present ITC's research seeds and research capabilities based on LBE.	Inputs 1. JICA a) Long-term experts: Chief Advisor and Project Coordinator b) Short-term experts from Japan and/or ASEAN countries c) Research funds for LBE d) Provision of equipment for LBE e) Short-term training of academic/technical staff in Japan and/or ASEAN countries 2. Cambodia a) Assignment of necessary academic and administrative staff for implementation of the Project b) Provision of office space for experts c) Provision of maintenance costs of facilities and equipment d) Provision of running expenses for the implementation of the Project e) Scholarship for Master's/PhD. courses at ITC for lecturers/prospective lecturers of target universities.	

3-2. UIL Office develops a policy for patents. 3-3. UIL Office regularly meets with private/state-owned companies to seek opportunities for and implement collaboration such as joint research, joint lecture, and internship. 3-4. LBE model team leaders assist 5th year students to find internship opportunities, which are related to their LBE activities. 3-5. Students in LBE participate in internships with appropriate TORs at relevant companies.		Preconditions

Note: LBE indicates as a structure and a way of educating students through research activities while LBE model teams indicate as research teams granted by the Project