PROJECT FOR PROMOTION OF TECHNOLOGY EDUCATION AND DIFFUSION THROUGH DIGITAL FABRICATION LABORATORY (FABLAB) IN BHUTAN

PROJECT COMPLETION REPORT

JANUARY 2024

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CONTENTS

ABBREVIATIONS

Abbreviation	English
AAHS	Arura Academy of Health Sciences
ADB	Asian Development Bank
AMC	Agriculture Machinery Centre
CBA	The Center for Bits and Atoms
CSO	Civil Society Organizations Authority
CNDP2030	Comprehensive National Development Plan 2030
CNR	CNR Bio-FabLab in Punakha
CST	College of Science and Technology
DGI	DGI Fab Lab in Paro
DHI	Druk Holding and Investments
DMO	Destination Management / Marketing Organization
DPL	Dungsam Polymers Limited
DSP	Desuung Skilling Programme
ECED	Electronics and Communication Engineering Department
GNHC	Gross National Happiness Commission
JCC	Joint Coordination Committee
JDS	Japan Development Service Co., Ltd.
JICA	Japan International Cooperation Agency
JNWSFL	Jigme Namgyel Wangchuck Super FabLab
JWPTI	Jigme Wangchuck Power Training Institute
KGUMSB	Khesar Gyalpo University of Medical Sciences of Bhutan
KIP	Key Performance Indicator
LUC	Linked Urban Centre
MOE	Ministry of Education
OJT	On-the-Job Training
PDM	Project Design Matrix
PYFISC	Phuentsholing Youth- Friendly Integrated Service Centre
R/D	Record of Meeting
RSSTEM	Royal Society of STEM
RT-PCR	Reverse Transcription PCR
RUB	Royal University of Bhutan
SOP	Standard Operation Procedures
STEM	Science, Technology, Engineering and Mathematics
TTTRC	TTTRC Fablab in Sarpang
YFISC	Youth-Friendly Integrated Service Center

I. Basic Information of the Project

1. Country

Bhutan

2. Title of the Project

Project for Promotion of Technology Education and Diffusion through Digital Fabrication Laboratory (FabLab) in Bhutan

3. Duration of the Project (Planned and Actual)

From 18th December 2020 to 17th December 2023 (3 Years)

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

The major industries in the Kingdom of Bhutan (hereinafter referred to as "Bhutan") are agriculture and hydropower sales to India, with hydropower sales and related construction sectors driving economic growth. However, the domestic market is small and the development of industries other than the hydropower is limited, and Bhutan suffers from annual trade deficit due to its dependence on imports of all consumable and capital goods from India and other countries. In addition, Bhutan is a land-locked country surrounded by steep mountains, and the high cost of transportation and the long procurement period of goods are hindering the industrial development of Bhutan because of the inaccessibility of each region.

In addition, although Bhutan's population is only about 730,000 (2017), the non-employment rate of urban youth in 2017 was 16.7%, which would become a social problem. Although the government is currently working on industrial diversification from the perspective of job creation, there is a knowledge and skills gap between the young people entering the society and the human resources required by industry.

In response to the above, it is required for the Royal University of Bhutan to improve the quality of higher engineering education in order to produce graduates with practical skills to contribute to the development and creation of industry. On the other hand, although RUB is planning to increase the intake of students for postsecondary education, there is lack of infrastructure in place to provide practical educational opportunities to the increased number of students. The College of Science and Technology (CST), under the Royal University of Bhutan that offers Science and Technology also needs to develop a strong educational program and infrastructure to enable practical education, such as experiments and workshops, in order to produce human resources with practical skills.

To deliver some of such requirements the project was signed in the Records of Discussions (R/D) between the Royal Government of Bhutan and JICA on 5th December 2019, at the request of the RGoB.

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

[Overall Goal]

Solving social issues through digital fabrication by incorporating skill based educational programme in Bhutan.

[Project Purpose]

Develop new educational models and innovation that links technological capacity to the needs of the society and industries by establishing the digital fabrication laboratory at CST.

6. Implementing Agency

College of Science and Technology (CST), Rinchending, Phuentsholing, Bhutan

II. Results of the Project

1. Results of the Project

1-1 Input by the Japanese Side (Planned and Actual)

(1) Total Amount of Input by the Japanese Side:

JPY 190 million

(2) Experts Dispatched:

See Annex 1-1. in accordance with the safety measure rule set by JICA, the experts moved to the project site (Phuentsholing) on 27th April 2022. Dispatch timing and duration of some short-term experts (especially "FabLab Management 2") were adjusted and optimized to achieve the maximum output throughout the project term.

(3) Receipt of Training Participants:

For the list of the trainings and the number of participants, please see Annex 1-3. Besides those in-country trainings, eight project counterparts participated in the training in Japan in September 2022.

The participants to the training in Japan are specified in the special remarks in the Annex 1-2.

(4) Technical Equipment Provided:

JPY 40.4 million. For the detailed list of equipment provided, please see Annex 1-6.

(5) Local Cost for the Activities of the Japanese Experts:

JPY 17,697,000 (= Nu. 10,011,000).

The lists of trainings and events provided before and after the inauguration of the FabLab CST are summarized in Annexes 1-3, 1-4 and 1-5. Also, some equipment was purchased as part of the cost for local activities by the Japanese experts, as summarized in Annex 1-7.

1-2 Input by the Bhutanese Side (Planned and Actual)

(1) Counterparts

For the list of project counterparts, please see Annex 1-2.

Two counterparts, who participated in the training in Japan, left the college in May 2023. Another counterpart, who was nominated but couldn't leave for the same training in Japan, also left in June 2023. In order to respond to such an emerging situation, College has added few new staff as project counterparts.

(2) Office Space for the Project Experts

Before the Chief Advisor was allowed to shift to the project site on the 27th April 2022, the college made an arrangement for his office space in the headquarters of the Royal University of Bhutan in Thimphu.

Upon the arrival of the Chief Advisor in Phuentsholing, the college provided an office space in the IT Department Building until the FabLab was ready for the inauguration in August 2022.

Upon the inauguration of the FabLab CST, experts were provided with the office space in the FabLab.

(3) Space and Necessary Furniture for FabLab

The new space for the Lab was provided on the ground floor of the ECE Lab Building. The construction of the ECE Building was borne by the college and all the interior works were completed by July 2022.

The minimum furniture, including the office desks and shelves, co-working desks and chairs were provided by the college. Besides, room wifi, air-conditioners, electricity bills, sweeper services were all provided by the college.

(4) Provision of the Use of Related Equipment (Software and Hardware)

When necessary, the FabLab was allowed to use the college official vehicles for the transportation of the procured materials and official trip to Thimphu. Also, FabLab could take access to the other equipment available in the other laboratories.

Besides, the project could take access to the web server of the college, and the Zoom meeting URL links were provided when the college hosted the regular project bi-weekly meetings and Joint Coordination Committee meetings.

1-3   Activities (Planned and Actual)

(1)   The project was launched in the middle of the COVID-19 pandemic. Although the project commencement date was set as 18th December 2020 according to the special guidelines of JICA, the arrival of the first long-term expert in Bhutan was delayed to May 2021. Further he was not allowed to move to the project site until April 2022, similarly the movements of the other short-term experts were restricted due to the safety measure of the JICA Bhutan Office.

(2)   Due to the damage of the global supply chain induced by the COVID pandemic, the delivery of the technical equipment was also delayed by a few months. This caused the delay in the establishment of the FabLab, hampering the main platform for technical cooperation. The technical training in Japan was conducted in September 2022, immediately after the inauguration of the FabLab CST. The original plan was to train participants and make them well equipped with the hands-on skills and knowledge on the FabLab and digital fabrication before they left for Japan. The delay of the inauguration also affected the effectiveness of the training in Japan.

(3)   The Japanese side made every possible effort to fill the gap of no expert team in the project site, by hosting a lot of sensitization programs for CST students and the other stakeholders in Thimphu and by hosting the online meetup sessions with various FabLabs in Japan. The programs implemented in Thimphu for the CST students facilitated them to directly start using the machines as soon as they arrived in FabLab CST.

(4)   Though, the actual period of on-site activities of the Japanese experts at FabLab CST was just 15 months from August 2022 to December 2023. Many activities as indicated in the Annexes 1-3 and 1-4 could be conducted. The FabLab CST could host many training programs and remarkable activities supported by the Japanese experts, and the project could complet most of the activities initially planned for the project period. Although it was established as the 6th FabLab in Bhutan, it has been recognized as the most vibrant lab in the country. Also, it has proven its strength and capacity during the Fab Bhutan Challenge 2023 on "Aluminum Waste, Gracefully Braced" in July 2023 during FAB23 Conference in Bhutan by winning the People's Choice Award. It hosted the first in-person FabLab Bhutan Network Meeting in October 2023 and shared its good practices with the other FabLabs in Bhutan.

(5)   Within 15 months of FabLab establishment it was learnt that duration to experience and experiment the FabLab review and its implementation of the first year to improve adoption of best practices are currently underway and could be reflected only next year. For example, FabLab CST had the opportunity to experience only summer vacation and winter vacation just once and is still yet

learning many lessons on the outreach program for local school children. In addition, the FabLab CST will be expected to deliver the FAB23 Conference results, such as assistive technology, circular economy, STEAM education and Fab2.0. The project has not yet addressed the long-term sustainability plan of the lab, which will be discussed continuously within counterpert institutions.

2. Achievements of the Project

2-1 Outputs and Indicators

[Targets]

In the amended R/D agreed on in the 5th JCC meeting in February 2023, the project outputs and Key Performance Indicators (KPIs) were set as described in the table below:

Output	Indicators
1. A global standard FabLab is established as a digital fabrication technology base under the Electronics and Communications Engineering Department (ECED) at CST	1-1. Sustainable business plan, rules and regulations for the operation and management of the FabLab is developed.
	1-2. The lab-based work is integrated into the ECED curriculum.
2. Collaboration and interaction of interdisciplinary lab-based research within CST is enhanced through FabLab	5 number of prototypes developed by integrating and collaborating with other departments.
3. CST collaborates with other colleges, public and private institutions to address social and economic problems of the country using FabLab as a platform	6 number of practical ideas are proposed to the Ministries and to Companies by the students.
4. FabLab functions in CST provide the platform for open innovation for individuals/citizens and schools to work on their own needs, enhance their own skills and develop customized products that address their social and economic problems.	10 number of users (user/visitors) for FabLab visited by other organizations/schools.

[Actual]

(1) Output 1-1 (Achieved): The project has institutionalized the initial business plan, user rules and regulations, and fee policy before the launching of the FabLab CST. Since then, it has revised the fee policy once in response to the emerging needs and has introduced the Project User Registration Form. Also, to meet the global standard of sharing practices, it has developed the web-platform for users to document their projects. The website (https://fablab.cst.edu.bt/) was also introduced by the project as a powerful tool to communicate with the users. Therefore, it could be concluded that this performance indicator is already achieved.

(2) Output 1-2 (Achieved): Since the beginning of the 2023 spring semester, ECE has started bringing the students to deliver its practical sessions, especially in the sessions led by the faculty who was a Fab Academy[1] graduate. Starting in the 2023 autumn semester, ECE has started involving the

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[1]   The Fab Academy is a fast paced, hands-on learning experience where students learn rapid-prototyping by planning and executing a new project each week, resulting in a personal portfolio of technical skills.(https://fabacademy.org/)

other ECE faculty members in the capacity development in digital fabrication skills irrespective of one not being the project counterpart. The Project Manager, who is also an ECE faculty, has performed excellent leadership and started promoting the assistive technology as a major pillar of the activities in the lab. Therefore, it could be concluded that this performance indicator is already achieved.

(3) **Output 2 (Achieved)**: The project hosted and collaborated in Makeathons, Ideathon and Fab Challenge a few times and produced a few prototypes in the multidisciplinary setting and the list of the events and the number of prototypes are as follow:

- First Makeathon (October 2022) : 8
- Ideathon "Fab for the Lab" (November 2022) : 3
- Mini-Makeathon "Let's Make Something Small But Useful" (March 2023) : 2
- 10th Annual Green Tech Challenge (May 2023) : 5
- Fab Bhutan Challenge "Aluminum Waste, Gracefully Braced" (July 2023) : 8
- Highway Market Outlet Makeathon (October 2023) : 6
- Workshop for Low-cost Assistive Devices (November 2023) : 3

The above number of prototypes were made in collaboration with the students from multiple departments. Besides, the college provided opportunities to the students with assignments on prototyping solutions in their mini-projects and final-year projects. Since these projects are implemented by the student groups from a single department, the number of such projects are not included as an indicator. Even so, it could be concluded that this performance indicator is already achieved.

(4) **Output 3 (Achieved)**: The project hosted the open innovation events involving stakeholders other than CST staff and students. It includes the Tarayana Foundation for Green Tech Challenge (May 2022), local SEN (Special Education Needs) Schools for Fab Bhutan Challenge (July 2023), and Chhukha Dzongkhag Administration for Highway Market Outlet Makeathon (October 2022). The list of the ideas presented to the public/private entities by the students through such initiatives are as follow:

- 2 award-winning ideas were taken by the Tarayana Foundation together with their prototype as cold storage;

- 8 prototype assistive devices were presented by the Fab Bhutan Challenge participants, to the wider audience during the FAB23 Conference, including the Minister of Education and officials of the SEN Division;

- 6 prototype outlet ideas were prototyped in the Highway Market Outlet Makeathon and presented to the officials, engineers and architects of Chhukha Dzongkhag.

With the above three cases combined, 16 ideas were already presented to the public/private entities by the students. Besides the ideas led-by the students, the FabLab CST presented a few more ideas to CSOs, local youth centre and other FabLabs. Therefore, it could be concluded that this performance indicator is already achieved. However, with regards to the number of the ideas which are taken for production and deployment, they are yet to achieve full scale production.

(5) **Output 4 (Achieved)**: For the project, "users" were decined as those who came to the lab from outside the college campus after their first visit for an orientation or study tour hosted by their schools. For this, our earlier orientation in autumn 2022 led to the presence of five local students to the winter school outreach programs, and eight students returned to another program after they participated in the first winter program during the same winter vacation. Since there is no more winter vacation before the project completion, it is not able to count the number of repeaters any more. As FabLab CST is 5km away from the main town where most of the population is concentrated, it makes it difficult for the commuters to reach the lab. However the following are some of the activities that are worth noting:

○ The mother of one of the SEN school students who was invited to the mini-makeathon as need-knower in March 2023 visited the lab for making second assistive devices for her child;

○ One local entrepreneur in Phuentsholing town, after his first visit to the lab for orientation came to use ShopBot four times by paying monthly subscription membership fee in May 2023;

○ Two student startups from the Gedu College of Business Studies, visited the lab in March 2023 for 3D-printing and laser-cutting, also came to use the SLA printer in October 2023.

○ There were three groups of students from the Arura Academy of Health Sciences who came to build their awareness aids (food pyramid and pie chart) to be taken during their internship in Samtse and Trashigang, using the laser-cutter.

Besides the above activities, the FabLab staff went out to the daily living area to host workshops and trainings on 3D-printing, 3D-scanning and Pi-top coding, in collaboration with the local youth center. These programs were successful in attracting the local children and youth. Therefore, it could be concluded that this performance indicator is already achieved.

2-2 Project Purpose and Indicators

[Target]

By the time of completion, the project was supposed to make the situation where "Sustainable business plan, rules and regulations for the operation and management of the FabLab are implemented in CST."

[Actual]

The project drafted the initial business plan, user rules and regulations, and fee policy before the launching of the FabLab CST and implemented them. Since then, it has revised the fee policy once in response to the emerging needs. It has introduced the Project User Registration Form as well. To meet the global standard of sharing practices, it has developed the web-platform for users to document their projects.

Currently as majority of the users are CST students, the FabLab could only apply minimum material usage and machine usage fees to students. The College is exploring means to finance such support mechanisms to students fund the lab as an additional revenue source. The project is of the opinion that for the purchase of the spare parts and the investments in the new machines the College will provide funds and would explore other project grants. So far College could not initiate any project proposals for grant but is hopeful to submit in the future.

In addition, because most of the users are CST students, the machines remain idle until 3pm every day. Based on this issue, it is addressed to further enhance the sustainability of the project are as follows:

1) Utilization of the machines between 10 am and 3 pm to create additional revenue flow;

2) Staff allocation from 5 to 7 pm to supervise the machine usage by the student users.

3) Student users are not sensitized enough to follow the rules, regulations and procedures set by the lab. They come almost at the last minute without knowing their responsibilities for project registration, online booking of the machines, clean-up after usage, and documentation.

Therefore, the project is of the opinion that the current business model be subject to revision after the discussions among the counterparts.

The web-platform (https://fablab.cst.edu.bt/), introduced by the project is a powerful tool for the users to make reservation on the scheduled trainings and events, to make reservations on the machines and rooms, and to work on documentations on their projects. However, the number of the projects documented on the Project Gallery of the website is much less than the actual number of user projects. It is observed more effort would be required to sensitize the users and monitor their projects.

Therefore, the conclusion is that, although the target is already met, it will take a while to see the long-term business sustainability of the FabLab CST.

3. History of PDM Modification

Project Design Matrix was modified once during the 5th Joint Coordination Committee meeting in February 2023, it was on fixing of the project period and the numerical indicators of the KPIs and there was no change in the narrative summaries.

4. Others

4-1 Results of Environmental and Social Considerations (if applicable)

(1) The fact that almost anything can be made with digital fabrication has very important implications for environmental and social considerations. Depending on these ideas, one could prototype solutions to any environmental and social issue. Also, there is a risk that the users work on the prototypes that may harm the environment and the society. In order to reduce and minimize such risk, the project has developed the FabLab CST Project User Registration Form in April 2023 and started overseeing the user-led projects.

(2) Since the opening of the FabLab, the project has managed to address some of the concerns on waste management. The lab started collecting the aluminum cans thrown along the national highway from February 2023 with the help of student users, and converted them to aluminum ingots using an electric furnace. Also, the project started using the cardboards for mock-modeling and upcycling paper waste. As for upcycling of the plastic waste, the FabLab assisted a student group to make a prototype filament-maker from PET bottles in their final-year project in 2023.

(3) In the Fab City Summit 2023 held as part of the FAB23 Conference in Thimphu, in July, Bhutan declared its membership to the Fab City Global Initiative. This is the country's commitment to install the circular economy at different levels from individual household/office to community, to the city and then to the whole country. The project considered the introduction of the Precious Plastic machines to achieve self-sufficiency at the FabLab and the college levels, by consulting with the FabLab Nepal, an early adopter in the South Asian Region. However, it be concluded that the full implementation of plastic upcycling machines (pelletizer, injection mold, sheet press etc.) could not be realized during the remaining short duration of the project. It is still hoping that the plastic resource circulation could be achieved in the near future as part of a new project.

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)

(1) The fact that almost anything can be made with digital fabrication has very important implications that it could be applied to any sector, any thematic area, and any cross-cutting issue, and that it's all up to the ideas of the users. Also, it could be a tool to empower the socially vulnerable groups, by involving them as a maker or as a designer. Therefore, the project has endeavored to involve the users, not as just beneficiaries, but as designers, co-creators and so-called "need-knowers".

(2) One peculiar case in the project is Assistive Technology. Even before the establishment of the FabLab, the project experts conducted the needs survey in the community and identified assistive devices for the Special Education Needs (SEN) students and for the persons with disabilities as a potential area to promote the use of digital fabrication in the community. This led to the invitation

of the two experts from FabLab Shinagawa and the mini-makeathon for assistive devices for particular children in March 2023. In this open innovation event, the children, their associated teachers and parents involved were regarded as need-knowers and jointly worked on the co-design of the customized assistive devices. This experience further led to the hosting of the Fab Bhutan Challenge in July 2023 with the same SEN schools, debut to the EMPOWER Conference in Chennai in October 2023 and then to the workshop on low-cost assistive technology using the locally available materials in November 2023. Assistive technology has emerged as a main pillar of the activities of the FabLab CST throughout the project implementation period.

III. Results of Joint Review

1. Results of Review Based on DAC Evaluation Criteria

(1) Relevance

After the earlier achievements made by the FabLab Bhutan, there was a conducive policy and institutional environment for FabLabs in Bhutan. In March 2019, the Cabinet agreed on the roll-out of FabLabs across the country and based on this policy direction, Bhutan and the Fab Foundation of the United States agreed to bring the third Super FabLab of the world to Bhutan. Also, in the 14th International FabLab Conference (FAB14) in July 2018, it was unanimously agreed that Bhutan would host the same conference in 2022. Despite the delay caused by the COVID-19 global pandemic, the Super FabLab (Jigme Namgyel Wangchuk Super FabLab) and other three local labs (DGI, CNR and TTTRC) were inaugurated in June 2022, and the International FabLab Conference (FAB23) was successfully hosted in Bhutan in July 2023. The promotion of digital fabrication and FabLabs has been driven by the government and it makes a great difference from the cases of many other countries. The establishment of the FabLab CST could be regarded as part of this trend.

Despite the initial vision of bringing the second FabLab to Phuentsholing, it became the sixth FabLab in Bhutan. However, it has been recognized as the most vibrant FabLab in the country and won the People's Choice Award in the Fab Bhutan Challenge in July 2023. Its activities were thanked by the Fab Foundation and MIT Centre for Bits and Atoms.

In 2019, the Royal Government of Bhutan and JICA agreed on the Comprehensive National Development Plan 2030 (CNDP2030). It was about the grand design of the national land use and was treated as a flagship report of the government. This report brought the concept of "Linked Urban Centre (LUC)" to support the people in rural and urban areas, and wrote that the tertiary education institutions and the technical training institutes should be linked to the LUCs. With regards to the FabLab, it wrote,

> "The spontaneous motivation from villages and local people is key to realizing the effort needed for regional development. In LUCs, colleges and technical institutes will support the

development of human resources for entrepreneurs. If a fab lab collaborates with the technical training institute, this will provide an incubation centre for people who are willing to develop their ideas in order to resolve the social problems in their locality. Each centre will be interlinked in order to create a platform for entrepreneurship as a base for regional promotion in collaboration with a DMO, private companies and a banking organization." (Ministry of Works and Human Settlements. 2019. "The Project for Formulation of Comprehensive Development Plan for Bhutan 2030: Final Report.")

In the case of the southwestern part of Bhutan, the report recommended that Phuentsholing should be the LUC with CST specializing in engineering, health and science education and with the Arura Academy of Health Sciences (AAHS) specializing in the promotion of health and welfare. Based on this recommendation, the FabLab CST has endeavored to bring the CST and AAHS students together to promote e-health and assistive technology.

While the FabLab could address the "long-tail" of the small and fragmented demands of the people, it could give customized solutions to many of the development needs and therefore it could contribute to the achievements of many of the UN Sustainable Development Goals and ensure that no one would be left behind. It also demonstrates that once the needs are identified, the solutions could be designed by the need-knowers together with the other users. Such important learning was made by the Japanese expert team, before the establishment of the FabLab CST, by conducting rapid needs assessment in its constituency. Further among many potential needs identified, Assistive Technology emerged as a main pillar of its activities.

(2) Coherence

This project could work as a catalyst to facilitate the activities initiated by the other development partners. It could provide the enabling environment for rapid prototyping locally, and in some circumstances it could produce small components which would otherwise be unavailable in the local market due to its limited requirement and demand.

The most successful collaboration with the other development cooperation programs was the one with the JICA volunteers. For example, the FabLab CST supported a JICA volunteer on handicraft development from Draktsho Vocational Training Centre for Special Children and Youth in the production of small components in 50-100 units for stuffed animal dolls. Such a mechanism of design was coordinated to facilitate the income generation programs for youth with disabilities. The volunteer conducted creative design of boxes for display of the handicrafts for sale and also brought the Draktsho students to the hands-on workshop during FAB23 Conference where they made 3D-printed assistive devices on the spot and provided them to the students with disabilities.

The other activities was the co-creation of the educational tool to pregnant mothers, together with a JICA volunteer on physiotherapy from Jigme Dorji Wangchuk National Referral Hospital. She

brought her idea of the tool to the FabLab CST, and after one-hour guidance, she completed the design with Tinkercad. Based on her 2D data, the design was produced using the ShopBot with the help of the plywood board. After finishing and painting, the design was delivered to her in Thimphu.

The collaborations with the JICA volunteers not only benefited them, but also benefited the FabLab CST. The first volunteer who visited the lab in December 2022 also provided the CST staff and their family with the basic tailoring training. This ignited the usage of the textile machines and they have become one of the most frequently-used machines in the lab. The second volunteer participated in the Fab Bhutan Challenge in July 2023 and made a considerable contribution to the prototyping of assistive devices, bringing the perspectives of physiotherapists into the co-design process.

These collaborations were made possible with the initial support by the volunteer unit of the JICA Bhutan Office. It provided an opportunity to make them aware of the potentials of the FabLab and will also provide an avenue to brief the new JICA volunteers about digital fabrication and FabLabs in Bhutan as part of their in-country orientation program upon arrival in the country.

Such collaborations with the JICA Volunteer Program and other important collaborations with the other development cooperation programs such as Technical Cooperation Projects, JICA Partnership Program, and Grant Aid, are some avenues in future that could be explored. The Fablab CST and the College have also collaborated with JICA E-Health Project as a partner with ideation and prototyping of the wearable devices in their project scope from the commencement. Such collaborative approach of JICA-related projects went a long way to connect its programs to the FabLab CST with win-win outcomes to the program and the lab.

Under the above circumstances, the project took into consideration the existing JICA programs and acted proactively to contribute to the goal achievement. One such case, alignment to the recommendations made in the CNDP2030, was already mentioned in the sub-section (1) above. In addition, the project led the FabLab CST to host the FabLab Bhutan Network Meeting in October 2023. The frequency of such meetings was defined as one of the KPIs for the JICA Development Policy Lending (Yen Loan) signed in May 2023. Based on the agreement between the RGoB and JICA, Druk Holdings and Investments, owner of the JNWSFL, has been a responsible agency on this indicator, hosting a network meeting on a quarterly basis with an in-person meeting at least once a year. However, DHI has hosted only online meetings and found that it does not function as a platform for all six FabLabs in Bhutan to share their best practices and concerns, and discuss the collective actions to promote digital fabrication across the country. Based on the importance of such initiatives the FabLab CST took an initiative in hosting the two-day face-to-face meeting for the first time and contributed to achieving one of the KPIs of the budget support to RGoB.

The project has also always borne in mind the Grassroot Grant Assistance of the Embassy of Japan provided to FabLab Bhutan in 2020. This GGA supported the FabLab to strengthen its capacity for woodwork and the machines were handed over in May 2022. But the FabLab Bhutan, which the name was changed to FabLab Mandala in November 2021, was dissolved in August 2022 and all the equipment was handed over to Desuung Skilling Programme. DSP and its new FabLab, "Choego FabLab", have to bear the responsibility to ensure its accountability to the Embassy. Therefore, the project has made every effort to cooperate with the Choego FabLab even before its formal inauguration in November 2023. The project hosted the joint workshop to revive the first Fab2.0 prototypes (CNC milling machine and 3D printer made in Bhutan) at FabLab CST in July 2023, and invited the manager to the FabLab Bhutan Network Meeting in October 2023. The Pi-top Bootcamp for engineering college students and the subsequent Pi-top training at Phuentsholing Youth-Friendly Integrated Service Centre (PYFISC) in September and October 2023 intended to support Choego FabLab to revive the use of their Pi-top devices succeeded from FabLab Mandala.

The collaboration with the PYFISC in the delivery of trainings on 3D printing and Pi-top coding was also a local-level supplement to UNICEF. Through the Department of Youth and Sports of the Ministry of Education, UNICEF donated Pi-top kits and 3D printers (UP mini ES) to four YFISCs in 2019 and 2020, however due to the COVID-19 pandemic, the YFISCs were forced to shut down and many of the staff and youth volunteers left the centre. To make the matter worse, FabLab Bhutan, who UNICEF and MOE had expected to play a pivotal role in the training and in operation and maintenance of the devices and the machines also dissolved. The project was aware of the situation and proactively approached the local Youth Centre to revive the usage of the devices and the machines.

(3) Effectiveness

All the indicators for outputs and project purpose are already met as described in the II-2 above. It is worth noting with establishment of FabLab CST and the number of activities hosted within 15 months since its inception as shown in Annexes 1-3 and 1-4 has demonstrated very successful achievements thus far with such establishments.

If looking back at the project purpose, the phrase "by establishing the digital fabrication laboratory at CST" is already achieved. In the meantime, when it comes to the phrase "new educational models and innovation that links technological capacity to the needs of the society and industries," the project has also made these cases for the student users to interact with need-knowers of the society either on their sites or at FabLab:

○ JICA Experts' Visit to Startup Center, Stroke Survivor, YiGA Chocolate in Thimphu (July 2022);

○ Mini-Makeathon "Let's Make Something Small But Meaningful" (March 2023);

- ○ Fab Bhutan Challenge "Aluminum Waste, Gracefully Braced" (July 2023);

- ○ Highway Market Outlet Makeathon (October-November 2023)

- ○ Mini-Project for Making Assistive Devices for a Local Female Tailor in Kamji (November 2023)

Besides in some of the final-year projects, for which the students frequently used the machines in the lab, visited and interviewed their potential users to reflect their perspectives on the design. The Architecture students use the lab for model creations and to develop their final-year thesis models.

However, College is exploring ways and means to achieve successful linkages and collaboration with industries to address their needs. The MoU with some of the industries are already signed but effective collaboration with activities are yet to be realized. The project found that the student study tours and study visits to the local industries and students on-the-job training are a continuous process in practice in the College. Some faculties based on the need initiated student industrial visits for exposure to know how, it was realized that the student exposure to the industries should not be undertaken independently. All local tours to the local industries to be carried out through the modules which are prescribed with such tours for the students of all the programmes. The planners of the student exposure visits should be sensitized to FabLab and digital fabrication.Through such practices it is concluded that at least 70 to 80 percent of this outcome is achieved. Further plans are underway by the College to diversify the income sources for the College, providing solutions and expert services to local industries is being identified as one key strategy for the College to generate revenue in future. Through such initiatives, use of FabLab CST is inevitable.

(4) Efficiency

The project spent approximately JPY 190 million for the implementation, compared to the initial plan of contribution by the Japanese side as approximately JPY 230 million. However, even in the initial plan, this project was the smallest JICA technical cooperation project in the last five years.

Slow disbursement was mainly caused by the delay in the opening of the FabLab. It was due to the delay in the procurement of the equipment, which was affected by the deterioration of the global supply chain ignited by the COVID-19 pandemic.

The pandemic also affected the activities of the Japanese experts. For the first six months after the project commenced, the long-term expert was not allowed to be dispatched from Japan. For the remaining eleven months, all the experts were not allowed to move to the project site due to the security policy of the JICA Bhutan Office. Despite the above circumstances, the experts made every possible effort to keep the project running, by hosting the Online Meetup Session Series and by hosting workshops/training for the CST students in Thimphu who were also affected by the

pandemic. The experts also ensured that the FabLab Mandala in Thimphu would surely host Pre Fab Academy in November to December 2021 and then Fab Academy in January to July 2022 as one and only national node in Bhutan. With this earlier coordination and instruction, four project counterparts completed the Fab Academy 2022 and facilitated the activities of the FabLab CST in one way or another.

Another reason for slow disbursement was caused by the difficulty in procurement of additional equipment in a timely manner. The equipment provided in the initial installment was the standard set of machines required for the standard FabLab. However, after the opening of the FabLab CST in August 2022, the project faced the emerging demand for additional equipment, such as Precious Plastics machines, Pi-top foundation kits and robotics kits, "Fab-in-a-Box" and equipment for metal processing. Also, due to the characteristics of the FabLab in the engineering college, the project has come to learn that it should increase the stock inventory of the electronics parts. While it could procure the woodworking equipment which could be procured locally, the other items were subjected to import and in most cases, it would take more than half a year to receive the delivery. Considering the remaining period for project implementation, the project was forced to give up the procurement of such equipment and consumables because of the high risk of delivery failure.

For these reasons, the project concentrated on the activities that could be done with the resources available and that could be achievable within the remaining project period. Even so, the project met all the performance indicators in the last 15 months after the opening of the FabLab.

With regards to the cost-efficiency per se, these two cases about the cost-benefit of the co-design are worth noting.

○ In July 2023, Asian Development Bank released its assessment on the cost-effectiveness of the Fab Bhutan Challenge hosted by the five FabLabs in Bhutan. ADB concluded that the solutions pitched in the challenge would have invaluable benefits, including saving lives and preserving culture. In addition, it emphasized that it could raise the economic productivity of farmers, weavers, and students entering all other professions. It further states, "Setting just those projected economic benefits against the expected costs of refining and implementing the challenge solutions and program budget, the Fab Bhutan Challenge projects are an excellent investment. Our benefit-cost analysis suggests that in ten years, the economic return on the Fab Bhutan Challenge will be between $5 and $12 per dollar spent, depending on how many of the solutions take hold. Even if several solutions fail, the overall economic return is outstanding – far surpassing the threshold rate that is typically required for publicly-funded economic development projects." Mian Thomas and Namgyal Tsheden Gyaltshen. "FAB23 demonstrated how investing in innovation is critical for Bhutan's economic aspirations." *Kuensel.* 29th July 2023.

○ In October 2023, FabLab CST hosted the Highway Market Outlet Makeathon in collaboration with the Chhukha Dzongkhag and CST-Tech Incubation Centre. It was participated by 28 CST students and 10 local vendors. The total cost that the project spent was Nu. 66,240, including the cost for hosting the second presentation to the engineers and architects who would actually design the outlets. Chhukha Dzongkhag will allocate Nu. 500,000 for the design and building of the new model outlets along the Chuzom-Rinchending section of the National Highway.

Therefore, we could conclude that the project performed high efficiency.

(5) Impact

As cost-efficiency of the co-design of a solution to social issues based in a local FabLab as a platform was highlighted in FAB23, more open innovation events similar to Fab Bhutan Challenge and makeathon are expected to come in the next few years, concurrently with the growing popularity of STEAM education.

The human resources developed in the project, most of whom were the CST students, could contribute to scaling up of the FabLab Bhutan Network. Based on their hands-on experience at FabLab CST, the CST students have contributed to the program implementation by the JNWSFL in Thimphu as summer/winter interns and OJTs, and one graduate has been recruited by the JNWSFL in summer 2023.

The project also supported the FabLab CST to host the first FabLab Bhutan Network Meeting in face-to-face mode in October 2023 and to share its good practices with the other FabLabs in the country, including the nationwide roll-out of Assistive Technology and the FabLab-youth centre collaboration. Following the CST model of linking FabLab to engineering education, Jigme Namgyel Engineering College, another engineering college of RUB in southeast Bhutan, also had a plan to install a mini FabLab in their campus. The project advised JNEC on the selection of the contractor and the machines.

Thus, it is expected that the FabLab CST would play a pivotal role in the human resources development and in making precedents in prototyping solutions to the issues of the community. As the STEAM education is further promoted in Bhutan, CST and its FabLab could offer an attractive opportunity for the Class 12 passouts to further enhance their capability.

The project identified some potential challenges whereby there is no assurance either from DHI/JNWSFL and Royal Society of STEM (RSSTEM), the two apex bodies for FabLabs and the promotion of STEAM education in Bhutan, could successfully secure the financial resources to keep the momentum after the FAB23 Conference. Although it was agreed that in-person meetings

of the FabLab Bhutan Network should be conducted twice a year and a Fab Festival annually, the sources of funding is yet to be determined.

Second, the Fab Foundation and MIT Center for Bits and Atoms have provided support both technically and financially to the DHI/JNWSFL, DGI, CNR Bio-FabLab, and TTTRC, in parallel to the JICA's support to CST. It is expected as the planning and schedule of the Fab Conference changes, focus and attention are expected to change. For the last three years, the Fab Foundation and CBA have extended their support to develop FabLabs in Bhutan. It is also expected all the labs shall be made to explore means to ensure their financial sustainability on their own thereby affecting Bhutan's capacity to stay connected to the global FabLab network.

Third, the national trend of migration of the Bhutanese to Australia and other countries could hamper the earlier investment in the human resources development made by RSSTEM and JICA. For example, TTTRC already lost two Fab Academy graduates who had been expected to play a key role in the operation and management of the lab. Similarly, Choego FabLab lost one Fab Academy from 2022 to Japan. Out of the ten staff hired at FabLab Bhutan in 2019, five went out to Australia or Canada. Our project also let three CST staff, who had been officially appointed as the project counterpart, left for Australia.

Although the project impact is potentially large, it could be concluded that it depends on a few external conditions besides the budget allocation to the FabLab CST.

(6) Sustainability

The project spent much time in achieving the target performance indicators in just 15 months after the inauguration and was successful in demonstrating the potentials of FabLab even in such a short period of time. It was realized that CST should find its own way to reconstruct a realistic and sustainable business model, by making a choice in the list of activities by the project and mobilizing the financial and human resources available. Currently the project has not spent much time for the discussion on the business and financial sustainability of the lab.

It is also expected that the close relationship and collaborations with the community stakeholders, especially with the local special education needs (SEN) schools, the Arura Academy of Health Sciences, and local tailoring training center, which were initiated by the Project Manager, will be sustained with her strong leadership and ownership. It was learnt from the FAB23 Conference as many speakers pointed out that the long-term business sustainability of the community-based lab would depend on the support from the community stakeholders to the lab, and the Project Manager has acted accordingly. In addition, it should be added that it would also depend on the characteristics of the fab manager and instructor and the uniqueness of the lab itself. The FabLab CST started as a lab with a strength in electronics works. As the project proceeded, however, it has

built a good track record of activities in the area of tailoring and assistive technology, and has now been recognized nationwide and internationally as the most vibrant lab in Bhutan.

As the lab serves as laboratory facilities for the programmes, it has the potentials to secure funding from the College for lab use and project related works. With regards to the user retention, the project has targeted the first- and second-year students in its delivery of human resources development program and installed a mechanism whereby the senior and junior students interact and teach each other for mutual teaching/learning in the group. Such facilitation facilitates the senior students teaching junior students and sharing their skills and knowledge with the new student users. Also, even if the students and staff leave CST, existing students could use the FabLabs with ease. The project has emphasized this ubiquitousness of the global FabLab network in the training and workshop.

In March 2023, the project opened the bank account for the FabLab and developed a template for the invoice for fee collection and the receipt for the payment. Further in April, it institutionalized the Project User Registration Form and the Activity Log Sheet to monitor the activities of the users. With these forms and templates combined, the FabLab started collecting the machine usage and material usage fees. Also, in May 2023, they received a monthly subscription user for the first time and collected the subscription fee. Thus the project has already established the fee collection system and mechanism. When the college students work on the prototyping as part of college curriculum or for the open innovation events funded by the external sponsors, there already exists a channel for the lab to get revenues from the prototyping by the students. As a result, FabLab collected Nu.28,278.60 in its bank account as of 31st October 2023.

However, with the fee collection from machine usage and material usage alone, the FabLab could only recover the cost for the purchase of materials and it is not enough to invest in new equipment and purchase spare parts especially when the lab has to import from other countries. The project is aware of this reality and took actions to write proposals for project-based grants in the last stage of the project. It is expected that the team would continuously explore grant and fund through projects. The lab could also explore opportunities for project grant as well as deepening the partnerships with various development partners for the FabLab could contribute to the prototyping activities in their ongoing projects. The lab is optimistic to achieve its result through such effort. It has the possibility to consider involving other FabLabs for collective actions for capacity development in proposal writing and for sensitizing the development partners to FabLabs.

CST must also be aware that the FabLab should keep track of all the prototyping projects initiated by student users, collect machine usage and material usage fees without delay, undertake finance and accounting processing, and control budget for externally funded projects. In addition to this, if it searches for external grants and partnership opportunities alone, it must further be engaged in the additional jobs such as writing project proposals, coordinating with partners, preparing partnership

arrangements, and working for customer acquisition to maximize the running time of the machines in the lab. These various activities for community outreach, partnership building and business expansion cannot be undertaken by one technical staff alone. Under these circumstances, it is necessary for the College to proceed the discussions on the business sustainability of the FabLab, not only in terms of finance, but also in terms of staffing and organizational structure.

The procurement of machines, materials and consumables for the FabLab will be integrated into the public procurement system of the College. Besides, it will be the responsibility of the counterpart to institutionalize the use of the college credit card to purchase necessities on the e-commerce platform and advocate for the joint procurement system with the other FabLabs and fabrication spaces in the country. Although the project repeatedly raised the issue of joint procurement to the DHI/JNWSFL and agreed with the other local labs on the necessity for such system in the FabLab Bhutan Network Meeting hosted by the Project in October 2023, it was learnt that DHI/JNWSFL is a private entity and is able to purchase the necessities according to their own procurement mechanism.

2.   Key Factors Affecting Implementation and Outcomes

(1)   In the project planning phase, the COVID-19 pandemic was not taken into consideration as the external conditions in the Project Design Matrix when the RGoB and JICA signed the Records of Discussion (R/D) in December 2019. The project preparation was carried out while no one could expect when the situation would get back to normal and JICA would be ready to let the long-term expert leave Japan. It was agreed between CST and JICA that the date of project commencement was set as 18th December 2020.

(2)   When the project commencement date was set as 18th December 2020, it was expected that, based on the experience in the national election in 2018, the next national election in 2023 would have been completed by October 2023 and the project could host mass-gatherings to disseminate the project outcomes after that. However, in August 2023, the Election Commission of Bhutan announced that the national assembly election would be held between November 2023 and January 2024 and forcing to refrain from hosting meetings and seminars that would mobilize the public.

(3)   The first long-term expert, Chief Advisor, was finally dispatched to Bhutan in mid May 2021. After a month-long mandatory and voluntary quarantine, he started his activities in Thimphu. On the other hand, due to the delay in the delivery of equipment, the launching of the FabLab CST with full-set of machines was postponed from late June to early August, and then to late August.

(4)   However, the pandemic also brought positive factors to project implementation. First, the International FabLab Conference in Bhutan, which had been initially scheduled in August 2022, was postponed to July 2023, replaced by the FAB17 in Bali, Indonesia, in October 2022. That gave the project sufficient time to accumulate experience by the time Bhutan hosted the FAB23. Second,

JICA signed a loan agreement with the RGoB on Development Policy Lending in May 2023 as a fiscal support for Bhutan to tackle post-pandemic recovery. As mentioned earlier, one of the KPIs for the DPL was about the FabLab Bhutan Network, which gave the platform to share the experience of FabLab CST with other FabLabs in Bhutan for scaling up.

(5) After the Japanese experts shifted to the project site, the transformation of higher education suddenly emerged as the agenda for immediate actions for the RUB colleges in August 2022. The CST officials and faculty members had to respond to the requests and requirements set by the transformation team who joined the College. That caused the Project Director not to join in the delegates for technical training in Japan, and the opportunities for discussions on important topics with regards to the operations and management of the project were missed. It should be noted that the teaching faculties were busy with their delivery of regular class and practical sessions. If the new assignments with higher priority were added to their work portfolio, other responsibilities would be set aside and that caused the delay in the discussion on the sustainability of the FabLab.

(6) However, positive aspects of this transformation are also worth noting. First, the transformation team shared the concerns of the machines left underutilized until the students come to use them after 3 pm, and with the personal capacity of the Chairman, the team started connecting local businesses to the lab. Second, the integration of the Mechanical Engineering Department to the CST college is expected to add a few metal processing equipment to the department laboratories. These events will work positively for the sustainability of the FabLab.

3. Evaluation on the Results of the Project Risk Management

(1) Risk Management Results

For the adverse situation during the pandemic in Thimphu, the JICA experts responded by hosting a series of Online Meetups with Japanese FabLabs and a Japanese startup born out of a FabLab in Japan. They also delivered an online lecture during the lockdown in the capital in early 2022. The Chief Advisor hosted training sessions on 3D modeling every Saturday from July to November 2021, targeting mainly the CST students who were forced to remain in Thimphu because the college was in the red zone. He also coordinated to ensure that the FabLab Mandala would host the Pre-Fab Academy and then Fab Academy from November 2021 to July 2022, as well as the hands-on training on laser-cutting and 3D printing for the CST students in January 2022. These adaptations helped the FabLab CST to tap the primary users in the early stage of its operations, bringing Fab Academy graduates and the ex-participants to the machine operations.

It could have raised the issue of shifting the project commencement date or extending the project completion date in the 5th JCC meeting in February 2023. But they didn't do it because it had been only six months since the opening of the FabLab and we thought that we would need to see at least one whole year to see the project outputs.

In response to the 2023 national election, the project endeavored to bring open events, such as Highway Market Outlet Makeathon, Pi-top Training at Phuentsholing YFISC and FabLab Bhutan Network Meeting to October 2023, and to focus on the in-campus activities, such as Workshop on Low-Cost Assistive Technology and other workshops initiated by JICA experts, which only targeted the CST staff and students.

(2) Results of the Use of Lessons Learned from the JICA Project in the Past

This project is not about the establishment of a "new higher education institution" but the establishment of a "new laboratory." In preparing the plan of activities, the project should take into consideration the staffing and budget of the recipient, and should also take into account the collaboration with the existing FabLab in Thimphu. In addition, the project activity plan should be reviewed flexibly according to the actual situation of the recipient through periodic recognition checks.

Regarding the technical level of the faculty members, CST already hired a person who already has experience working in a FabLab, as a prospective instructor. The technical level of the faculty members will be assessed at the timing of the project commencement, and if necessary, intensive efforts should be made to improve their skills in the initial stage.

As described earlier, during the early stage of the project, the team collaborated with the FabLab Mandala in the delivery of Pre Fab Academy, Fab Academy and hands-on training for CST students. In addition, it also jointly hosted the online training on 3D modeling for children affected by the national lockdown in March 2022 and brought new JICA volunteers and staff to the orientation on digital fabrication at FabLab Mandala. After it was dissolved and the equipment was handed over to the Choego FabLab, collaborated with them for the revival of the first Fab2.0 CNC milling machine and 3D printer made by FabLab Mandala (FabLab Bhutan) in July 2023. When the DHI/JNWSFL hosted the FAB23 in July 2023, the project supported the FabLab CST to collaborate with the organizer and hosted the Fab Bhutan Challenge and a few side events during the FAB23 conference.

The project has also utilized the human resources developed in the earlier efforts by the FabLab Bhutan. The team invited two ex-FabLab Bhutan staff to Phuentsholing for the production of the wood altar with ShopBot in October 2022 and for the delivery of the micro:bit workshop (January 2023), Pi-top and TinyML bootcamps (September and October 2023), as an instructor. The FabLab CST has acted as a liaison between the former FabLab Bhutan staff and the current staff and managers of the FabLabs in Bhutan.

Flexible review and revision of the plan of operations were achieved in the framework of project bi-weekly meetings online, and major changes were discussed in the JCC meetings. Besides, the core management team of the FabLab CST, which consisted of the Manager (Project Manager),

the Lab Technician and the Chief Advisor, met even more frequently for planning and implementation of the activities on a weekly basis.

The Lab Technician, who was also the former staff of the FabLab Bhutan, took the Fab Academy and graduated in 2022. He provided the technical backstopping for all the users throughout the project implementation period.

It was unfortunate that the project was not so successful in mobilizing the faculty members on a large scale, except for the ECE faculties, who were sensitized by the above Lab Technician in the spring and autumn semesters in 2023.

However, there is one remarkable case in the assessment and development of their skills in the early stage. The project assessed the level of utilization of the machines and identified that the textile machines must have potential to attract the staff as well as students. Therefore, the project hosted Basic Tailoring Training for the CST staff and family in December 2022 and trained 46 participants. Currently the textile machines (sewing machine, interlocking machine and digital embroidery machine) have been one of the most popular machines in the FabLab CST, and this has become one of the distinctive features of the lab compared to the other five labs.

4. Lessons Learnt

(1) When it considers a technical cooperation project with a higher education institution, it will expect the officials and teaching faculties as a project counterpart. Indeed it is the faculties that could plan and implement project activities and make key decisions on the project directions and institutional arrangements. But if it is a university/college where faculty members have to spend much more time in teaching and administrative work compared to research, it may be difficult for the teaching faculties to spend time in the research and development activities in the lab. Conversely, non-teaching staff could spend much time for the project implementation, but they may not be in a position to be proactively committed to the planning and implementation of the project without guidance from their line teaching faculties. The JICA TCP wants more commitment from the counterpart in terms of staff time especially in case long-term Japanese experts are dispatched to the counterpart organization. It is recommended that in the preliminary survey for project assessment, it is necessary to make a thorough investigation on the governance structure of the counterpart organization, behavior principles of the staff in different positions, and their constraints.

5. Performance

(1) During the project preparation in the early stage of the COVID-19 pandemic, the officer in charge of the project at the JICA Headquarters voluntarily hosted a series of online meetings where the project counterparts could learn about the experience of the FabLabs and other types of fabrication

spaces around the world. The speakers were from Jomo Kenyatta University of Agriculture and Technology (Kenya), College of Engineering Pune (India), FabLab Bohol (the Philippines), Field Ready (Nepal), and FabLab Hiratsuka (Kanagawa University, Japan). Most of them were the fabrication space in the college/university campus, and the counterparts could learn from their experience in running the fabrication space as part of the university system as well as taking advice on what they could do before the opening of the FabLab in their campus.

(2) Also, during the project planning and preparation phase, the JICA Bhutan Office used to place an order for customized office furniture, involve the FabLab Bhutan in their delivery of Winter Camp for Highland Schoolchildren in 2019, and consult with the FabLab for the local production of PPE in the early stage of COVID-19 outbreak. These efforts helped the project to plan and implement the collaborative programs quickly in Thimphu while the long-term expert was not allowed to move to the project site.

(3) While the long-term expert was forced to remain in Thimphu, the FabLab Bhutan played a crucial role in planning and implementing the programs for the project. Their greatest contribution was the hosting of the Pre-Fab Academy and Fab Academy from the year-end of 2021 to the first half of 2022, in spite of a series of restrictions on domestic travels and human mobility. In these adverse circumstances, the FabLab Bhutan agreed to assume the Fab Academy node for Bhutan and receive four candidates from CST to the academy. It also hosted a hands-on training on machine operations in January 2023 for the CST students during winter vacation. Unfortunately the FabLab Bhutan was dissolved in the same timing as the inauguration of the FabLab CST. However, their previous contributions to the   growth of the FabLab Bhutan Network.

(4) In addition to the single efforts by the FabLab Bhutan, the global network of FabLabs, fab instructors and Fab Academy participants is worthy of note. FabLab Bhutan could host the Fab Academy 2022 as one and only country node in Bhutan. However, since there was no Bhutanese Fab Academy graduate, it had to invite fab instructors from other countries. The Fab Foundation contacted one instructor from India and two from Japan. They visited Bhutan one after another and gave technical advice and mentoring service to the Fab Academy participants from Bhutan. Sometimes the participants undertook the group work with their peers from other countries. This experience of group works has created a sense of solidarity among the candidates in the same batch and helped the graduates to join in the network and in the forum such as Bali Fab Festival (2022) and FAB23 in Bhutan (2023). In the global FabLab network, a framework for such human resources development and communication has already been built in. The project could take full advantage of this framework to achieve effectiveness and efficiency in the project implementation.

6. Additionality

(1) Many JICA technical cooperation experts and consultants have been dispatched to Bhutan. In addition to them, 30 JICA volunteers posted to government offices, SOEs and schools as of 1st November 2023. This distributed assignment of Japanese human resources is a special feature of the way JICA provides the development cooperation. If those distributed human resources could be successfully connected to the distributed production sites such as FabLab in each of their constituencies, they could facilitate the rapid-prototyping process simultaneously in different parts of the country, testing their ideas as soon as they come up with them. As mentioned in III-1-(2) above, signs of such decentralized collaborations were observed between the volunteers and FabLab CST and they already succeeded in making products that would facilitate their volunteer activities. Also, the FabLab CST invited the volunteers for their skills and knowledge when it hosted a basic tailoring training and a sensitization workshop on body functions for better design of assistive devices. These win-win collaborations were made possible by a long-term JICA expert stationed at FabLab CST who communicated with the other JICA human resources.

(2) In the challenge hosted at FabLab CST, the participating fabbers and community partners made eight prototype assistive devices and the JICA volunteer made a considerable input to the co-design and co-creating process by bringing her perspectives of physiotherapy. The networking of host FabLabs and JICA experts and volunteers cannot be achieved by a single effort of a project. In order to scale up, JICA needs to install a system to connect its human resources to the FabLab network of the country as a whole.

(3) Since its commencement, the project has looked at the information dissemination as a crucial element for bringing global attention to its own constituency, and opened the project Facebook page[2] and YouTube Channel[3] to update on the events. They were handed over to the FabLab CST as a platform for communication with the users. This Facebook page has received 3,113 registered followers as of 13th November 2023. The new knowledge gained through the project was shared in the Project News on the Japanese websites, and there have already been 54 project news posted as of 14th November 2023.

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

1. Prospects to Achieve Overall Goal

(1) The College offers engineering and technology based programmes continuous use of the lab by the students and staff could be achieved. According to the R/D, college is supposed to solve social issues and the lab could facilitate "Solving social issues through digital fabrication" thereby contributing to technical education policy after the project completion. Based on the the record of

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2   https://www.facebook.com/people/FabLab-CST-in-Phuentsholing-Bhutan/100071110512703/
3   https://www.youtube.com/channel/UC7GOgLvM6Rj2mJvuu5IrbAw

the FabLab users until the project completion, in order for digital fabrication to contribute to solving social issues, CST needs to ensure that:

(a)   FabLab users/designers could interact with the potential beneficiary of the solution or "need-knower" in the design process so that the perspectives of the latter could be well reflected in the prototyped solutions; and

(b)   The prototyped solution developed in the design process could be deployed in the society.

For the last 15 months, the project has tried to have the above two mechanisms and hosted the open innovation events on its own. In the post-project phase similar approaches could be coordinated through CST-Tech Incubation Centre and FabLab CST collaboratively undertaking the planning and implementation of the similar co-design events. More startup and technological business idea competitions to be coordinated to achieve the overall goal.

(2)   Based on the experience, students from different programmes visit the lab to fabricate their prototypes for their assignments, mini projects, and technology idea competitions. It has become important to promote documentation platforms and record implementation processes. The faculties have to initiate collaboration with stakeholders, promote final-year and mini project documentation and facilitate the project's contribution to the overall goal.

(3)   While the majority of the CST students already became the FabLab user, there are still very few CST staff and faculties who turned to be a frequent user after the orientation. This is admittedly unaboidable, as the faculties seem to be giving higher priority to education of the students than research of their own. However, the two mechanisms raised in (1) - (a) and (b) above require the sensitization of the teaching faculties who are involved in the policy implementation of technical education. The above two mechanisms cannot be installed so easily by the single efforts of the FabLab. It was learnt that the last-minute rush by the student users to use the machines in the lab was caused by the lack of their understanding about the user rules and regulations. It was also learnt that some students came to the lab when they were forced with assignments using the machines at the lab. Such practice encourages students to visit the lab without any orientation and hands-on sessions on machine operations before. Based on the observations, to avoid overloading of lab staff due to last minute rush and all faculties could take the responsibility to instruct students to follow the user rules and regulations and to complete hands-on sessions on machine operations, to undertake assignments using FabLab.

(4) With regards to the scale-up of the project impact, the following five possible channels for technology diffusion from a community-based FabLab:

(a) Expansion of geographical, sectoral and thematic coverage and deepening of the services in the current constituency: More penetration to Phuentsholing, Chhukha and Samtse, as well as more outreach to the different stakeholders of the community;

(b) Nationwide roll-out of good practices born in FabLab CST: Promotion of assistive technology and integration to STEAM curriculum; and collaboration with youth centres on Pi-top coding and 3D printing;

(c) Deepening of the lab-based R&D: more activities in the areas which CST has comparative advantage, such as assistive technology;

(d) Alignment to the international commitment made by Bhutan: Fab City Global Initiative and the introduction of Precious Plastics machines;

(e) Network maintenance with Global FabLab Network: Relationship with FabLabs in Japan, South Asian Region and FAB23 participants; Networking with the FabLabs which JICA supported in the past; FAB24 (Mexico), FAB25 (Czech), FAB26 (Boston) and FAN6 (Malaysia 2024) and FAB7 (Australia 2026).

(5) Out of the five channels listed in the paragraph (4) above, FabLab CST and the College of Science and Technology as a whole have to fulfill their accountability in the post-project performance for the channels (a), (c) and (d). With their own single capacity, they have to take actions with their existing institutional framework or by the revenues made by the FabLab. In case they need external resources, both financial and technical, to make new investments in the equipment or human resources, the College shall require to search and apply for project grants and research grants. The following are actions to be takenby the College and the FabLab should take;

(a) Host a regional forum and share achievements through makeathons and other prototyping events and technical skill training. Such forum is expected to enhance visibility to wider audience and stakeholders in the community on the use of FabLab to attract more users;

(b) Building on the knowledge and experience in the project period, mainstream the assistive technology by: (i) more deployment of prototype tools in the community; (ii) research and development in the final-year projects by the students; (iii) research and development initiated by the faculties; (iv) integration of assistive technology into the CST curriculum of each department; and (v) development of the national certified curriculum on assistive technology in the Bhutanese context.

(c) Re-use of plastic, aluminum, wood and paper wastes at the lab level and the college campus level, so that they would not discharge wastes beyond their domains and put environmental pressure on the local community. Such experiences to be shared with the other FabLabs, RUB colleges and their surrounding areas.

(6) Even though the FabLab CST and the College of Science and Technology are willing to share their good practices for scaling up across the country, the channel (b) of the paragraph (4) above may not work with their single efforts alone. However they could post their good practices and show their presence through their own web-media and other web platforms listed in the Annex 2-7. Such facilitation shall provide information and disseminate the efforts as knowledge sharing. Although FabLab CST and the College of Science and Technology alone cannot achieve all the results, the FabLab Bhutan Network as a whole could play a pivotal role in the country through network meetings with shared concern. It is also expected that such actions to be taken by JNWSFL. As JICA has requested the government to take up the frequency of the FabLab Bhutan Network meetings as one of the KPIs to monitor the impact of its Development Policy Lending to Bhutan, JICA also needs to see to it that knowledge sharing is promoted for nationwide roll-out of good practices.

(7) Besides the maintenance of the network of FabLabs in Bhutan, the network members could network with the FabLabs and individual fabbers in other countries to consult with those associated labs and individuals in difficult times in the lab. As far as Assistive Technology is concerned, the FabLab CST has made remarkable performance in the Fab Bhutan Challenge in July 2023 and was awarded the "People's Choice Award." It needs to report to the global audience during the FAB24 the progress of the deployment of the prototypes made and other related activities in twelve months after the FAB23. In general, the FabLabs in the developing countries are all facing difficulty in grabbing the opportunities to participate in-person in the fab events outside their own countries to stay connected to the global network. However, if the FabLab CST continues to attract the attention of the global audience as a unique and vibrant place in Bhutan, the interested FabLabs and individual fabbers around the world may choose to travel to Fablab CST on their own expenses for open innovation events. Such information dissemination could be initiated in the single efforts by the project counterpart.

2. Plan of Operation and Implementation Structure of the Bhutanese Side to Achieve Overall Goal

(1) **FabLab CST Operations and Management:** The Lab will be operated under the ECED and supervised by FabLab Manager. The Manager will be assisted by Technician in charge and faculties with Fab Academic certificates and identified Fablab members. The College also has plans to integrate Tech Incubation Centre and FabLab gradually later based on the need. Undergraduate students from first-year and second-year should be trained

(2) FabLab User Guidelines: The developed lab user guidelines and the framework shall be subjected to change in due process based on the requirements upon consultation with all the members. Wherever, necessary protocols and measures shall be developed in addition to the existing framework and guidelines.

(3) Fablab Orientation and Training: All interested staff will be provided training on FabLab usage in order to facilitate students for module assessment, mini project and final year Project related lab use. Such a process is expected to facilitate faculties and students to use the lab.

(4) Organize annual Ideathon, Makathon and Tech Business Idea Competition: Organize Ideathon, Makethon and Tech Business Idea Competition annually for students and community.

(5) Network with FabLabs within Bhutan and other FabLabs: The FabLab CST shall continuously explore opportunities with networks within and outside Bhutan. Learn their experiences of good practices.

(6) Supply of raw materials to the Lab: The College will explore possible options to coordinate the supply of raw materials based on practices adopted by other Fablabs in Bhutan. Possible option is to buy online or purchase directly from the supplier abroad as there is no supplier inside Bhutan. Discussion shall be initiated by the College with other FabLabs in Bhutan on such purchases and if required and if approval is granted the FabLab CST could initiate to supply raw materials to other labs in Bhutan.

(7) Sustainability of the FabLab CST: The existing operational practices and guidelines shall be used subjected to change based on the need in future. If the lab operation fund is limited based on current fee structure the College should be in the position to fund the lab consumable through college operating budget as project works and mini projects.

3. Recommendations for the Bhutanese Side

(1) Long-term Business Sustainability of the FabLab CST: The College of Science and Technology should revise the management structure of the FabLab CST so that it could be sustained in terms of staffing and finance. The measures to ensure the long-term business sustainability include: integration of the Fablab CST and CST-Tech Incubation Centre, outsourcing the operations services to a private entity, outsourcing the operations to the student body for the hours unattended by the CST staff, revision of the operating hours together with the promotion of web-based machine booking. With regards to the grant proposal and partnership-building, CST should sensitize the teaching faculties to play a leading role to involve the FabLab in their teaching and research programs.

(2) Sensitization of the Faculties and Staff: The College of Science and Technology should consider integrating the use of FabLab CST to the performance indicators of the teaching faculties. The use of FabLab could be measured in terms of the number of orientations and hands-on sessions initiated by the teacher, the number of cases the teacher facilitated the interaction between their students and need-knowers for prototyping solutions, and the number of the events hosted by the FabLab CST the teacher has participated.

(3) Procurement of the Equipment and Imported Consumables: Although it may not require immediate action due to the limited accessibility to the fund for investing in the new machines and human resources development, the College of Science and Technology should find the way to quickly procure the equipment and imported consumables. This includes the acceleration of the discussion on the joint procurement, which had been left pending in the FabLab Bhutan Network for so long. This discussion should also involve the Ministry of Education and the Youth Centres working for the promotion of STEAM education.

(4) Information Dissemination: The College of Science and Technology and FabLab CST should keep posting the information of the events they host at the FabLab on their website and social media and other web platforms, so that they could attract the community stakeholders, other FabLabs in the country, and FabLabs and individual fabbers around the world.

(5) FabLab Bhutan Network: The Royal Government of Bhutan, as a recipient of the Development Policy Lending, should monitor the activities of the network and ensure that the FabLab Bhutan Network meeting could be an invaluable platform to promote the STEAM education and socio-economic development of Bhutan. It should consider injecting a seed fund for hosting the in-person network meetings and the "Fab Festival" annually. This could help the RGoB to understand the capacity and concerns of the local FabLabs and reduce the pressures on the JNWSFL for the implementation of too many programs.

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

Proposed monitoring activities after the project are shown below.

(1) E-Health Project: Even though the project is completed, another JICA Technical Cooperation Project for E-Health is coming in for the expert team to collaborate with the College in the prototyping of the wearable devices to collect vital data from the human body. For the research and development of the devices, this project will use the FabLab.

(2) FabLab Bhutan Network Meeting: As a financier of the Development Policy Lending, they have a right to speak for the promotion of the FabLab Bhutan Network. It could request the Royal Government of Bhutan to ensure that the network meetings should be held on a regular basis in such a way for the participants to share good practices and discuss the common issues for collective actions.

(3) FAB24 in Mexico: Because the FabLab CST won the People's Choice Award in the Fab Bhutan Challenge in July 2023, it has the responsibility to report to the audience in the next International FabLab Conference (FAB24) in August 2024 in Mexico. It is also worth considering obtaining infomraion through the JICA Mexico Office on what FabLab CST will present at the FAB 24 conference.

(4) Progress Update from the FabLab Network in Japan: One of the main features of the development cooperation through the local FabLabs is that the labs are interconnected and act as a network, not only locally but also globally. This means that even if there is no direct contact with the FabLab upon the project completion, there are other FabLabs in Japan which are still connected to the FabLabs JICA has supported and keep an eye on the progress of the post-project activities. In the case of the FabLab CST, FabLab Hamamatsu and FabLab Shinagawa are connected. Even in the case of other FabLabs supported in the past, there are many Japanese fabbers who remain connected to them and know what's happening there. It is also possible to monitor the status of the FabLab through this situation.

ANNEX 1: Results of the Project

Annex 1-1: List of Experts Dispatched

Annex 1-2: List of Counterparts

Annex 1-3: List of Trainings Provided

Annex 1-4: List of Events Hosted

Annex 1-5: List of Activities Before Inauguration

Annex 1-6: List of Equipment Provided

Annex 1-7: List of Other Handed-over Equipment (Purchased by the Project Operational Budget)

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

Annex 2-1:   List of the Side-Events Hosted/Coordinated by the Project During the FAB23

Annex 2-2: Business Plan for FabLab CST Phuentsholing

Annex 2-3: "How To User FabLab CST Phuentsholing (for General Users)

Annex 2-4: FabLab CST Payment Policy (February 2023)

Annex 2-5: Standard Operating Procedures (SOPs) for External Entity Collaboration

Annex 2-6: FabLab CST Project User Registration Form

Annex 2-7: List of Web-Based Deliverables

ANNEX 3: PDM (All versions of PDM)

ANNEX

Annex 1: Results of the Project

Annex 1-1:   List of Experts Dispatched

No.	Name	Title / Assignment	Affiliate	From	To	Special Remarks
[Long-Term Expert]						
1	Koji Yamada	Chief Advisor	JICA	17th May 2021	16th Dec. 2023	(17th May 2021 - 26th Apr. 2022) Thimphu (27th Apr. 2022 - 16th Dec. 2023) Phuentsholing
[Short-Term Experts]						
2	Yoichi Kogure	Expert Team Leader/ FabLab Management 2/ Training	JDS	9th January 2022	13th February 2022	3rd JCC meeting/ Information gathering on SOP/ Special lecture (10th-24th Jan.: Quarantine period of COVID-19)
				6th August 2022	30th August 2022	Inauguration of FabLab/ 4th JCC meeting/ FabLab Web site/ LAN configuration (8th-12th Aug.: Assigned to another duty)
				26th January 2023	9th February 2023	5th JCC meeting/ Equipment management system/ Discussion on collaboration with local industry/ Special lecture
				9th November 2023	18th November 2023	Hands-on workshop on TinyML/ 6th JCC meeing/ LAN configuration
3	Tsutomu Ono	Educational Program Development	JDS	11th April 2022	9th June 2022	Integration of FabLab into ECED curriculum. Workshops at CST
				31st January 2023	1st March 2023	Integration of FabLab into ECED curriculum. Workshops at CST
4	Masato Takemura	FabLab Management 1	JDS (FabLab Hamamatsu)	7th July 2022	9th August 2022	Machine Setup and Hands-on Training on Machine Operations
				17th October 2022	22nd October 2022	Network Facilitation at FAB17 (Bali Fab Festival)
				12th February 2023	6th March 2023	Workshops at CST
				12th May 2023	26th May 2023	Support for FAB23 Preparation
				10th July 2023	30th July 2023	Network Facilitation at Fab Bhutan Challenge and FAB23
				4th November 2023	12th November 2023	Workshops at CST
5	Tomoaki Watanabe	Open Innovation	JDS	20th June 2022	9th July 2022	Visit potential places for collaboration with FabLab (22nd-26th Jun.: Quarantine period of COVID-19)
				18th November 2022	3rd December 2022	Visit potential places for collaboration with FabLab
				14th July 2023	28th July 2023	Support for Fab Bhutan Challenge and FAB23 events

No.	Name	Title / Assignment	Affiliate	From	To	Special Remarks
6	Akihiro Inada	Equipment 2	JDS	20th June 2022	9th July 2022	Acceptance and inspection of equipment and its placement (22nd-26th Jun.: Quarantine period of COVID-19)
7	Mai Kaneshiro	Support for holding FabLab meetings, etc./ Business coordination	JDS	29th January 2023	8th February 2023	Checked the operational statsu of provided equipment, and its parts and supplies. Assisted in the preparation of equipment management procedure manuals. Supported for holding 3rd JCC meeting.
				20th July 2023	30th July 2023	Participated to Fab23 to support.
8	Sonoko Hayashi	Assistive Technology	FabLab Shinagawa	2nd March 2023	13th March 2023	* Participated to the Fab Bhutan Challenge from 17th to 21st July 2023 under the separate funding arrangement by the JICA New Business Idea Pitch
9	Naoki Hamanaka	Assistive Technology	FabLab Shinagawa	2nd March 2023	13th March 2023	* Participated to the Fab Bhutan Challenge from 17th to 21st July 2023 under the separate funding arrangement by the JICA New Business Idea Pitch

Annex 1-2:   List of Counterparts

No.	Name	Title	Responsibilities in the Project	Contribution to the Project		Special Note
				From	To	
1	Cheki Dorji, Dr.	President, CST	Project Director	Dec. 2020	Dec. 2023	
2	Karma Kelzang Eudon, Ms.	Lecturer, ECE Manager, FabLab CST	Project Manager	Dec. 2020	Dec. 2023	Coordinator for Fab Bhutan Challenge FAB23 (2023), EMPOWER (Chennai, 2023)
3	Tenzin Dorji, Mr.	Lab Technician, ECE	Fab Academy Graduate	Dec. 2020	Dec. 2023	Fab Acadmy graduate in 2022 FAB17 (Bali 2022), Fab Bhutan Challenge (2023), FAB23 (2023), EMPOWER (Chennai, 2023)
4	Kamal Kumar Chapagai, Mr.	Head of Department, ECE	Fab Academy Graduate	Dec. 2020	Dec. 2023	Fab Academy graduate in 2022 FAB17 (Bali 2022), Fab Bhutan Challenge (2023), FAB23 (2023)
5	Dechen Lhamo, Ms.	Programme Leader, ECE	Member	Dec. 2020	Dec. 2023	Appointed for the Training in Japan in 2022
6	Sonam Deki, Ms.	Research Officer, DRIL	Fab Academy Graduate	Dec. 2020	Dec. 2023	Fab Academy graduate in 2022 FAB17 (Bali 2022), Fab Bhutan Challenge (2023), FAB23 (2023)
7	Tshewang Lhamo, Ms.	Lab Technician, ECE	Member	Dec. 2020	Dec. 2023	Participated in the Training in Japan in 2022
8	Tashi Dr.	Dean AA, ECE	Member	Dec. 2020	Dec. 2023	Participated in the Training in Japan in 2022
9	Namgay Tenzin, Mr.	Lecturer, EE	Member	Dec. 2020	Dec. 2023	Participated in the Training in Japan in 2022
10	Sumitra Ghalley, Ms.	Lecturer, Architecture	Member	Dec. 2020	Dec. 2023	Participated in the Training in Japan in 2022
11	Sangay Penjor, Mr.	Lecturer, Architecture	Fab Academy Graduate	Dec. 2020	Jun. 2023	Fab Academy graduate in 2022 FAB17 (Bali 2022) Left CST in June 2023 for study abroad
12	Kinley Wangdi, Mr.	Lab Technician, ECE	Member	Dec. 2020	May 2023	Participated in the Training in Japan in 2022 Left CST in May 2023
13	Yangchen Dolkar, Ms.	Lab Technician, ECE	Member	Dec. 2020	May 2023	Participated in the Training in Japan in 2022 Left CST in May 2023
14	Karma Yangdon, Ms.	Lecturer	Member	Aug. 2022	Jun. 2023	Appointed for the Training in Japan in 2022 Left CST in June 2023
15	Pema Namgyel Ghaley, Mr.	General Secretary, Association of Bhutanese Industries	Member	Jun. 2022	Dec. 2023	Participated in the Training in Japan in 2022
16	Ugyen, Mr.	Urban Planner, Phuentsholing Thromde	Member	Jun. 2022	Dec. 2023	Participated in the Training in Japan in 2022
17	Tshewang Tobgay, Mr.	Lab Technician, ITD	Member	Jul. 2023	Dec. 2023	
18	Kuenzang Thinley, Mr.	Lecturer, ECE	Member	Jul. 2023	Dec. 2023	

No.	Name	Title	Responsibilities in the Project	Contribution to the Project		Special Note
				From	To	
19	Duk Bahadur, Mr.	Lecturer, ECE	Member	Jul. 2023	Dec. 2023	
20	Shankar Raj Giri, Mr.	Lecturer, ECE	Member	Jul. 2023	Dec. 2023	
21	Karma Norbu, Mr.	Lecturer, ECE	Member	Jul. 2023	Dec. 2023	
22	Ringhen Wangmo, Ms.	Lecturer, ECE	Member	Jul. 2023	Dec. 2023	
23	Kazuhiro Muramatsu, Dr.	Lecturer, ECE	Member	Jul. 2023	Dec. 2023	
24	Pema Zangmo, Ms.	Lecturer, ECE	Member	Jul. 2023	Dec. 2023	

Annex 1-3:　List of Trainings Provided

No.	Date	Venue	Name of the Training	Target	No. of Participants
1	11/24/2021	FabLab Mandala	Pre Fab Academy (-12/12)	Fab Academy Candidates	12
2	1/26/2022	FabLab Mandala	Fab Academy (July 2022)	CST Staff	4
3	8/28/2022	Japan	Knowledge Co-creation Program in Japan	CST Staff	8
4	8/31/2022	FabLab CST	Orientation	CST Students	15
5	9/1/2022	FabLab CST	Orientation	CST Students	8
6	9/1/2022	FabLab CST	Orientation	CST Students	10
7	9/2/2022	FabLab CST	Orientation	CST Students	11
8	9/2/2022	FabLab CST	Orientation	CST Students	10
9	9/3/2022	FabLab CST	Orientation	CST Students	9
10	9/3/2022	FabLab CST	Orientation	CST Students	11
11	9/3/2022	FabLab CST	Hands-on Training on Machine Operations	CST Staff	10
12	9/5/2022	FabLab CST	Orientation	CST Students	7
13	9/5/2022	FabLab CST	Orientation	CST Students	4
14	9/6/2022	FabLab CST	Orientation	CST Students	9
15	9/6/2022	FabLab CST	Orientation	CST Students	9
16	9/7/2022	FabLab CST	Orientation	CST Students	8
17	9/7/2022	FabLab CST	Hands-on Training on Prusa 3D Printer	CST Students	5
18	9/8/2022	FabLab CST	Orientation	CST Students	8
19	9/8/2022	FabLab CST	Orientation	CST Students	10
20	9/8/2022	FabLab CST	Hands-on Training on Lasercutter	CST Students	5
21	9/9/2022	FabLab CST	Hands-on Training on Prusa 3D Printer	CST Students	5
22	9/9/2022	FabLab CST	Orientation	CST Students	6
23	9/9/2022	FabLab CST	Orientation	CST Students	7
24	9/10/2022	FabLab CST	Orientation	CST Students	7
25	9/10/2022	FabLab CST	Orientation	CST Students	13
26	9/10/2022	FabLab CST	Hands-on Training on Machine Operations	CST Staff	7
27	9/12/2022	FabLab CST	Orientation	CST Students	10
28	9/12/2022	FabLab CST	Orientation	CST Students	6
29	9/12/2022	FabLab CST	Hands-on Training on Lasercutter	CST Students	5
30	9/13/2022	FabLab CST	Orientation	CST Students	10
31	9/13/2022	FabLab CST	Orientation	CST Students	10
32	9/13/2022	FabLab CST	Hands-on Training on Prusa 3D Printer	CST Students	3
33	9/14/2022	FabLab CST	Orientation	CST Students	4
34	9/14/2022	FabLab CST	Orientation	CST Students	12
35	9/15/2022	FabLab CST	Orientation	CST Students	9
36	9/16/2022	FabLab CST	Orientation	CST Students	8
37	9/17/2022	FabLab CST	Orientation	CST Students	10
38	9/18/2022	FabLab CST	Orientation	CST Students	7
39	9/19/2022	FabLab CST	Orientation	CST Students	8
40	9/19/2022	FabLab CST	Orientation	CST Students	18
41	9/20/2022	FabLab CST	Orientation	CST Students	8
42	9/20/2022	FabLab CST	Orientation	CST Students	8
43	9/21/2022	FabLab CST	Orientation	CST Students	9
44	9/21/2022	FabLab CST	Orientation	CST Students	9
45	9/22/2022	FabLab CST	Orientation	CST Students	10
46	9/22/2022	FabLab CST	Orientation	CST Students	7
47	9/24/2022	FabLab CST	Hands-on Training on Prusa 3D Printer	CST Students	8
48	9/24/2022	FabLab CST	Orientation	CST Students	11
49	10/1/2022	FabLab CST	Hands-on Training on Lasercutter	CST Students	8
50	10/1/2022	FabLab CST	Orientation	Makeathon Participants	21

No.	Date	Venue	Name of the Training	Target	No. of Participants
51	10/3/2022	FabLab CST	Orientation	CST Students	7
52	10/4/2022	FabLab CST	Orientation	CST Students	8
53	10/6/2022	FabLab CST	Orientation	CST Students	6
54	10/7/2022	FabLab CST	Orientation	CST Students	5
55	10/7/2022	FabLab CST	Orientation	CST Students	12
56	10/11/2022	FabLab CST	Orientation	CST Students	10
57	10/11/2022	FabLab CST	Hands-on Training on Lasercutter	CST Students	3
58	10/12/2022	FabLab CST	Orientation	CST Students	5
59	10/14/2022	FabLab CST	Hands-on Training on Prusa 3D Printer	CST Students	4
60	10/14/2022	FabLab CST	Orientation	CST Students	2
61	10/15/2022	FabLab CST	2D Design for Makeathon with CorelDRAW	Makeathon Participants	15
62	10/15/2022	FabLab CST	3D Design for Makeathon with Tinkercad	Makeathon Participants	14
63	10/18/2022	FabLab CST	Hands-on Training on Lasercutter	CST Students	1
64	10/21/2022	FabLab CST	Orientation	CST Students	3
65	10/29/2022	FabLab CST	Orientation	General Users	5
66	11/4/2022	FabLab CST	Orientation	CST Students	5
67	11/30/2022	FabLab CST	Orientation	ABI Members	25
68	12/13/2023	FabLab CST	Fusion360	Interns/OJTs	7
69	12/13/2022	FabLab CST	MESH IoT Block	Interns/OJTs	7
70	12/14/2023	FabLab CST	Adobe Illustrator	Interns/OJTs	7
71	12/15/2022	Gedu	Basic Tailoring Training	Interns/OJTs	7
72	12/19/2022	FabLab CST	Basic Tailoring Workshop with Ms. Mutsuko Yamanaka, JOCV (- 12/24)	CST Staff	45
73	12/31/2022	FabLab CST	Orientation	Phuentsholing Thromde Staff	15
74	2/10/2023	FabLab CST	Orientation	CST Students	10
75	2/11/2023	FabLab CST	Introduction to M5Stack Unit V2 (- 2/12)	CST Students	10
76	2/15/2023	FabLab CST	Upcycling Aluminum Cans with Electric Melting Furnace	CST Staff	5
77	2/16/2023	FabLab CST	How to Link 3D Printing and Casting and Molding	CST Staff	5
78	2/17/2023	FabLab CST	Fusion360	CST Students	3
79	2/18/2023	FabLab CST	Introduction to Raspberry Pi Pico W (- 2/19)	CST Students	20
80	2/20/2023	FabLab CST	Hands-on Training on Lasercutter	CST Students	2
81	2/21/2023	FabLab CST	Hands-on Training on Prusa 3D Printer	CST Students	4
82	2/22/2023	FabLab CST	Metal Molding Workshop with Lasercutter	CST Students	10
83	2/22/2023	FabLab CST	Introduction to Google Colaboratory (- 2/23)	CST Students	19
84	2/23/2023	FabLab CST	Metal Casting Workshop	CST Students	9
85	2/24/2023	FabLab CST	Screen Printing with the Design Cut-outs	CST Staff	4
86	2/24/2023	FabLab CST	Orientation	CST Students	13
87	2/24/2023	FabLab CST	Fusion360	CST Students	19
88	2/25/2023	FabLab CST	Digital Textile Design Using 3D CAD	CST Staff	5
89	2/27/2023	FabLab CST	Hands-on Training on Lasercutter	CST Students	10
90	2/28/2023	FabLab CST	Jewelry and Accessories Workshop	CST Students	8
91	3/1/2023	FabLab CST	Hands-on Training on Prusa 3D Printer	CST Students	6
92	3/3/2023	FabLab CST	Orientation	CST Students	1
93	3/3/2023	FabLab CST	Fusion360	CST Students	20
94	3/5/2023	FabLab CST	3D Scanning Workshop	CST Students	10
95	3/5/2023	FabLab CST	3D Printing Workshop on Filament Choice and Post-Print Treatment	CST Students	24

No.	Date	Venue	Name of the Training	Target	No. of Participants
96	3/10/2023	FabLab CST	Fusion360	CST Students	20
97	3/17/2023	FabLab CST	Fusion360	CST Students	8
98	3/30/2023	FabLab CST	Orientation	CST Students	14
99	4/4/2023	FabLab CST	Basic Tailoring Training	CST Students	8
100	4/5/2023	FabLab CST	Basic Tailoring Training	CST Students	6
101	4/6/2023	FabLab CST	Basic Tailoring Training	CST Students	10
102	4/7/2023	FabLab CST	Basic Tailoring Training	CST Students	6
103	4/10/2023	FabLab CST	Basic Tailoring Training	CST Students	7
104	4/11/2023	FabLab CST	Basic Tailoring Training	CST Students	7
105	4/12/2023	FabLab CST	Basic Tailoring Training	CST Students	5
106	4/21/2023	FabLab CST	Fusion360	CST Students	3
107	4/22/2023	FabLab CST	Orientation for Arura Academy of Health Sciences	AAHS Students	16
108	4/28/2023	FabLab CST	Fusion360	CST Students	21
109		FabLab CST	Hands-on Training on CNC for Architecture Final-Year Students	CST Students	14
110	5/1/2023	FabLab CST	Hands-on Training on Lasercutter	CST Students	13
111		FabLab CST	Hands-on Training on PCB Milling for 3ICE Students	CST Students	21
112	5/6/2023	FabLab CST	Orientation on Project User Registration Form	CST Students	9
113	5/12/2023	FabLab CST	Fusion360	CST Students	2
114	5/20/2023	FabLab CST	Aluminum Sand-molding Workshop	CST Staff and Students	11
115	5/22/2023	FabLab CST	Hands-on Training on Prusa 3D Printer for Architecture Final-Year Students	CST Students	15
116	5/26/2023	FabLab CST	Orientation on Project User Registration Form	CST Students	15
117	6/1/2023	Gedu	Advanced Tailoring Training	CST Staff and Students	12
118	8/2/2023	FabLab CST	Orientation (1-Architecture)	CST Students	22
119	8/2/2023	FabLab CST	Orientation (1-IT)	CST Students	43
120	8/2/2023	FabLab CST	Orientation (1-EG)	CST Students	25
121	8/3/2023	FabLab CST	Orientation (1-EE)	CST Students	41
122	8/3/2023	FabLab CST	Orientation (1-Civil)	CST Students	56
123	8/4/2023	FabLab CST	Orientation (1-ECE)	CST Students	29
124	8/4/2023	FabLab CST	Orientation (1-ICE)	CST Students	23
125	8/5/2023	FabLab CST	Orientation (1-Mechanical)	CST Students	20
126	8/7/2023	FabLab CST	Orientation (1-WRE)	CST Students	26
127	8/7/2023	FabLab CST	Orientation	CST Students	5
128	8/7/2023	FabLab CST	Orientation	CST Students	12
129	8/11/2023	FabLab CST	Hands-on Training on Prusa 3D Printer	CST Students	4
130	8/12/2023	FabLab CST	Orientation	CST Students	7
131	8/13/2023	FabLab CST	Tinkercad	CST Students	15
132	8/14/2023	FabLab CST	ECE Faculty Fab Training (- Onwards)	CST Staff	7
133	8/18/2023	FabLab CST	Hands-on Training on Prusa 3D Printer	CST Students	6
134	8/19/2023	FabLab CST	Orientation for Arura Academy of Health Sciences (-8/20)	AAHS Students	120
135	8/24/2023	FabLab CST	Tinkercad	CST Students	8
136	8/25/2023	FabLab CST	Hands-on Training on Prusa 3D Printer	CST Students	3
137	8/26/2023	FabLab CST	Orientation for New CST Staff and Hands-on Training	CST Staff	4
138	8/30/2023	FabLab CST	Hands-on Training on Lasercutter	CST Students	10
139	8/31/2023	FabLab CST	Tinkercad	CST Students	2

No.	Date	Venue	Name of the Training	Target	No. of Participants
140	9/1/2023	FabLab CST	pi-top Bootcamp for Engineering College Students (- 9/2)	CST Students	37
141	9/7/2023	FabLab CST	Fusion360	CST Students	7
142	9/9/2023	FabLab CST	Tinkercad	CST Students	5
143	9/15/2023	FabLab CST	Hands-on Training on Lasercutter	CST Students	10
144	9/16/2023	FabLab CST	Hands-on Training on Lasercutter	CST Students	9
145	10/7/2023	FabLab CST	TinyML Bootcamp for Engineering College Students (- 10/8)	CST Students	24
146	10/23/2023	FabLab CST	Hands-on Training on Creality CR30 (- 10/25)	CST Students	19
147	11/2/2023	FabLab CST	Low-Cost Assistive Technology Workshop Using Local Materials (- 11/4)	CST Staff and Students	18
148	11/7/2023	FabLab CST	Workshop on Woodworking Safety	CST Staff and Students	9
149	11/9/2023	FabLab CST	Workshop for Video Production on Safety Awareness	CST Staff and Students	3
150	11/11/2023	FabLab CST	TinyML Quick Start Hands-on with Wio Terminal and Codecraft	CST Students	15
151	11/13/2023	Gedu	Training on Sewing Machine Repair and Maintenance (- 11/22)	General Users	20
152	12/8/2023	FabLab CST	Sensitization Workshop to Understand Disabilities with PT and OT from JNWNRH (-12/9)	CST Students	12

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Annex 1-4:   List of Events Hosted

No.	Date	Venue	Name of the Events	Target	Collaborators
1	8/25/2022	FabLab CST	Inauguration	General	
2	8/31/2022	FabLab CST	Orientation for Phuentsholing Middle Secondary School	School Teachers	
3	8/31/2022	Online	Supplementary Session for STEM Teachers on 3D Modeling	School Teachers	
4	9/2/2022	FabLab CST	Orientation for Phuentsholing Youth-Friendly Integrated Service Centre	Youth Centre Staff and Volunteers	
5	9/17/2022	FabLab CST	Orientation for Phuentsholing Middle Scondary School	School Students	
6	10/1/2022	FabLab CST	First Makeathon (- 10/22)	General	CST-Tech Incubation Centre
7	10/17/2022	Bali	Bali Fab Fest (FAB17)		
8	10/17/2022	Online	Online Training on 3D Printing for Youth Centres (- 10/19)	Youth Centre Staff	Dept. of Youth and Sports
9	10/21/2022	Online	Orientation for New JICA Volunteers	JICA Volunteers	JICA Bhutan Office
10	10/29/2022	FabLab CST	Users' Forum "FIRST Global Challenge Report"	General	
11	11/5/2022	FabLab CST	Users' Forum "Wood Altar Experience with ShopBot"	General	
12	11/12/2022	FabLab CST	Users' Forum "Bali Fab Fest Report"	General	
13	11/10/2022	FabLab CST	Orientation for Sonamgang Middle Secondary School	School Students	
14	11/24/2022	FabLab CST	Orientation for Arura Academy of Health Sciences (- 11/25)	AAHS Students	Arura Academy
15	11/25/2022	FabLab CST	Users' Forum "Open Innovation and Role of Learning"	General	
16	11/28/2022	FabLab CST	Ideathon "Fab for the Lab"	CST Students and Lab Technicians (33)	
17	11/29/2022	FabLab CST	Orientation for Phuentsholing Higher Secondary School	School Students	
18	11/30/2022	FabLab CST	Orientation for Association of Bhutanese Industries	ABI Members	ABI
19	12/1/2022	FabLab CST	Interns and OJTs (- 1/27)	CST Students	
20	12/17/2022	Phuentsholing	National Day Exhibition at Phuentsholing Central Park	General	Phuentsholing Thromde
21	12/19/2022	FabLab CST	Basic Tailoring Workshop with Ms. Mutsuko Yamanaka, JOCV (- 12/24)	CST Staff	JOCV (Yamanaka) Karma Stitch House
22	12/26/2022	FabLab CST	MESH IoT Block Workshop for Local Schoolchildren (-12/29)	Local Children (25)	
23	12/31/2022	FabLab CST	Orientation for Phuentsholing Thromde	Thromde Officials	Phuentsholing Thromde
24	1/4/2023	FabLab CST	Micro:bit Workshop for Local Schoolchildren (- 1/6)	Local Children (6)	
25	1/9/2023	FabLab CST	Tinkercad Workshop for Local Schoollchildren (- 1/10)	Local Children (6)	
26	1/12/2023	FabLab CST	Lasercutting Workshop for Local Schoolchildren (- 1/13)	Local Children (6)	
27	1/12/2023	Phuentsholing	3D Printing Workshop for Winter Youth Engagement Program (- 1/13)	Local Children	Phuentsholing Youth Centre
28	1/14/2023	FabLab CST	"Hack the KeyTouch" Workshop	Local Children (5)	
29	1/27/2023	Online	Online Meetup with FabLab Shinagawa	General	FabLab Shinagawa

No.	Date	Venue	Name of the Events	Target	Collaborators
30	2/4/2023	FabLab CST	Users' Forum "Astronomy and Fab" & "OJT Experience at JNWSFL and FabLab CST"	General	JDS
31	2/18/2023	Training Hall	Ideathon for E-Health Prototyping	CST Students	JICA Bhutan Office
32	2/25/2023	FabLab CST	Users' Forum "Prototyping Can Compactor in Makeathon"	General	
33	2/26/2023	Phuentsholing	3D Scanning Workshop at Phuentsholing Youth Centre	Local Children	Phuentsholing Youth Centre
34	3/4/2023	Phuentsholing	Bhutan Stroke Foundation Awareness Program at CST and Phuentsholing Hospital	CST Students Hospital Staff	Bhutan Stroke Foundation
35	3/6/2023	FabLab CST	Mini-Makeathon "Let's Make Something Small But Useful"	CST Students (15)	Local SEN Schools
36	4/4/2023	Online	Online Meetup with MakeFashion EDU	General	SteamHead
37	4/15/2023	MPH	CST College Fashion Show	CST Students	CST NDLD Club
38	4/22/2023	FabLab CST	Special Orientation for Arura Academy of Health Sciences	AAHS Students (16)	Arura Academy
39	4/29/2023	FabLab CST	Users' Forum "Mokan Joka System"	General	
40	5/5/2023	MPH	Zorig Day Prototype Exhibition	CST Students	CST Student Council
41	5/6/2023	FabLab CST	Design Thinking Workshop for Wearable Devices	CST Students AAHS Students	JICA Bhutan Office Arura Academy
42	5/6/2023	FabLab CST	Users' Forum "Review of College Fashion Show"	General	
43	5/23/2023	FabLab CST	Support for Phuentsholing Rigsar Higher Secondary School for Prototyping for National Innovation Challenge	School Students (5)	
44	5/29/2023	MPH	Final Presentation for 10th Annual Green Tech Challenge	CST Students	Tarayana Foundation
45	6/15/2023	FabLab CST	Prototype Furniture Presentation by Final-Year Architecture Students	CST Students	
46	6/19/2023	FabLab CST	Summer Internship (- 7/15)	CST Students	
47	7/3/2023	Phuentsholing	3D Printing Workshop for Summer Youth Engagement Programme	Local Children	Phuentsholing Youth Centre
48	7/3/2023	FabLab CST	Prototyping for Fab Student Challenge (- 7/5, Samtse HSS, Yoeseltshe HSS)	School Students	JNWSFL
49	7/11/2023	FabLab CST	Workshop for the Revival of Fab2.0 Machines in Bhutan (- 7/14)	FabLab Staff	Choego FabLab
50	7/17/2023	FabLab CST	Prototyping for Fab Bhutan Challenge "Aluminum Waste, Gracefully Braced" (- 7/21)	SEN Schools Challenge-takers	Local SEN Schools
51	7/23/2023	Thimphu	FAB23 (- 7/28)	General	JNWSFL
52	8/12/2023	FabLab CST	Users' Forum "Debriefing of FAB23 Conference"	General	
53	8/19/2023	FabLab CST	Orientation for Arura Academy of Health Sciences (- 8/20)	AAHS Students (120)	Arura Academy
54	8/23/2023	FabLab CST	Orientation for Phuentsholing Rigsar Higher Secondary School Entrepreneurship Club	School Students	
55	8/25/2023	Online	Orientation for New JICA Volunteers	JICA Volunteers	JICA Bhutan Office
56	8/26/2023	FabLab CST	Users' Forum "Replicating FAB23 Workshop Locally"	General	
57	9/1/2023	FabLab CST	pi-top Bootcamp for Engineering College Students (- 9/2)	CST Students (37)	
58	9/7/2023	FabLab CST	"Come Join Me" Project (LED Sign Box) (- 9/11)	CST Students	

No.	Date	Venue	Name of the Events	Target	Collaborators
59	9/28/2023	Online	Online Meetup with FabLab Nepal	General	FabLab Nepal
60	9/30/2023	FabLab CST	Users' Forum "Debrieging of Fab Camp Challenge at FabLab Jogja"	General	
61	10/2/2023	Kathmandu	Staff Visit to FabLab Nepal		FabLab Nepal
62	10/5/2023	Chennai	EMPOWER2023 Conference and Other Site Visits in Chennai (- 10/9)		
63	10/7/2023	FabLab CST	TinyML Bootcamp for Engineering College Students (- 10/8)	CST Students	
64	10/8/2023	Phuentsholing	pi-top Workshop for Local Youths (10/15, 11/5, 11/12)	School Students	Phuentsholing Youth Centre
65	10/14/2023	FabLab CST	Makeathon for Highway Market Outlet (- 10/23)	CST Students	Chukha Dzongkhag CST-Tech Incubation Centre
66	10/26/2023	FabLab CST	FabLab Bhutan Network Meeting (- 10/27)	FabLabs	
67	11/2/2023	FabLab CST	Low-Cost Assistive Technology Workshop Using Local Materials (- 11/4)	CST Students	Travancore Rehab
68	11/2/2023	FabLab CST	2nd Presentation on the Prototypes for Highway Market Outlet	Chukha Dzongkhag	Chukha Dzongkhag
69	11/5/2023	FabLab CST	"Come Join Me" Project (Assistive Devices for Local Tailor in Kamji) (- 11/17)	CST Students	Chukha Dzongkhag
70	11/11/2023	FabLab CST	"Come Join Me" Project (Teaching/Learning Tool for SEN Schoolchildren) (- 11/20)	CST Students	
71	11/11/2023	FabLab CST	TinyML Quick Start Hands-on with Wio Terminal and Codecraft	CST Students	JDS
72	11/13/2023	Gedu	Training on Sewing Machine Repair and Maintenance (- 11/22)	General	Chukha Dzongkhag
73	11/24/2023	Online	Orientation for New JICA Volunteers	JICA Volunteers	JICA Bhutan Office
74	12/5/2023	FabLab CST	Interns and OJTs (- 1/27)	CST Students	
75	12/8/2023	FabLab CST	Sensitization Workshop on Rehabilitation by a JICA Volunteer and JNWNRH	CST Students	JOCV (Tanabe)

Annex 1-5: List of Activities Before Inauguration

No.	Date	Venue	Name of the Events	Target	Collaborators
1	6/21/2021	Thimphu	Support to DSP Digital Fabrication Skill Training 1st Batch (- 6/23)	Desuups (14)	FabLab Bhutan (Host)
2	6/28/2021	Thimphu	Support to DSP Digital Fabrication Skill Training 2nd Batch (- 7/8)	Desuups (14)	FabLab Bhutan (Host)
3	7/12/2021	Thimphu	3D Modeling Workshop (Introductory)	CST Staff & Students (3)	JICA Bhutan Office
4	7/13/2021	Thimphu	3D Modeling Workshop (Introductory)	CST Staff & Students (8)	JICA Bhutan Office
5	7/17/2021	Thimphu	Study Tour to FabLab Bhutan	CST Students (5)	FabLab Bhutan
6	7/19/2021	Thimphu	3D Modeling Workshop (Introductory)	CST Students (2)	JICA Bhutan Office
7	7/26/2021	Thimphu	Support to 3D Modeling Session in the Summer Youth Engagement Program at Thimphu YFISC	School Students	FabLab Bhutan
8	7/31/2021	Thimphu	Saturday 3D Modeling Workshop	CST Students (4)	JICA Bhutan Office
9	8/7/2021	Thimphu	Saturday 3D Modeling Workshop	CST Students (4)	JICA Bhutan Office
10	8/9/2021	Online	Online Meetup Session Series (I): FabLabs in Japan	General	JDS
11	8/14/2021	Thimphu	Saturday 3D Modeling Workshop	CST Students (3)	JICA Bhutan Office
12	8/14/2021	Thimphu	3D Modeling Workshop (Introductory)	CST Students (5)	JICA Bhutan Office
13	8/19/2021	Thimphu	Meeting with Disabled People's Organizations (ABS, Draktsho, DPOB, BSF) at JICA Bhutan Office	DPOs	Bhutan Stroke Foundation
14	8/21/2021	Thimphu	Saturday 3D Modeling Workshop	CST Students (3)	JICA Bhutan Office
15	8/21/2021	Thimphu	3D Modeling Workshop (Introductory)	CST Students (6)	JICA Bhutan Office
16	9/4/2021	Thimphu	Saturday 3D Modeling Workshop	CST Students (3)	JICA Bhutan Office
17	9/4/2021	Thimphu	3D Modeling Workshop (Introductory)	CST Students (5)	JICA Bhutan Office
18	9/6/2021	Online	Online Meetup Session Series (II): FabLab Kamakura & FabLab Shinagawa	General	JDS
19	9/11/2021	Thimphu	Saturday 3D Modeling Workshop	CST Students (3)	JICA Bhutan Office
20	9/11/2021	Thimphu	3D Modeling Workshop (Introductory)	CST Students (8)	JICA Bhutan Office
21	9/14/2021	Thimphu	Orientation for New JICA Volunteers at FabLab Bhutan	JICA Volunteers (5)	JICA Bhutan Office
22	9/15/2021	Online	JNEC Guest Lecture	JNEC Staff & Students	
23	9/15/2021	Online	Fusion360 Tutorial (9/22, 9/29, 10/6, 10/10)	General (1)	
24	9/18/2021	Thimphu	Saturday 3D Modeling Workshop	CST Students (2)	JICA Bhutan Office
25	9/24/2021	Online	2nd JCC Meeting		
26	9/25/2021	Thimphu	Saturday 3D Modeling Workshop	CST Students (2)	JICA Bhutan Office
27	9/26/2021	Online	FAB17 National Coordination Meeting		FabLab Bhutan
28	10/2/2021	Thimphu	Saturday 3D Modeling Workshop	CST Students (3)	JICA Bhutan Office
29	10/4/2021	Thimphu	3D Modeling Workshop (Introductory) for Bhutan Stroke Foundation at JICA Bhutan Office	BSF Staff (4)	Bhutan Stroke Foundation
30	10/4/2021	Online	Online Meetup Session Series (III): FabLab Minato-Mirai and FabLab Nagano	General	JDS

No.	Date	Venue	Name of the Events	Target	Collaborators
31	10/9/2021	Thimphu	Saturday 3D Modeling Workshop	CST Students (4)	JICA Bhutan Office
32	10/11/2021	Thimphu	3D Modeling Workshop (Introductory) for Draktsho at JICA Bhutan Office	Draktsho Staff (3)	Draktsho
33	10/23/2021	Thimphu	3D Modeling Workshop (Introductory)	CST Students (6)	JICA Bhutan Office
34	10/26/2021	Thimphu	Visit to Yangchengatshel SEN School and Changangkha SEN School	SEN Teachers	Ministry of Education
35	11/1/2021	Online	Online Meetup Session Series (IV): Kyoto Ultra Factory & FabLab Sendai	General	JDS
36	11/5/2021	Thimphu	3D Modeling Workshop (Introductory) for Selwa (Queen's Project) at JICA Bhutan Office	Selwa Staff (4)	Selwa
37	11/8/2021	Thimphu	Study Tour to Super FabLab	CST Students (5)	Super FabLab
38	11/12/2021	Thimphu	3D Modeling Workshop (Introductory) for BSF at BSF Office	BSF Staff (5)	Bhutan Stroke Foundation
39	11/13/2021	Thimphu	Saturday 3D Modeling Workshop	CST Students (4)	JICA Bhutan Office
40	11/13/2021	Thimphu	3D Modeling Workshop (Introductory)	CST Students (4)	JICA Bhutan Office
41	11/15/2021	Punakha	Visit to Kuruthang Youth Centre and Phuntshothang School	School Teachers	
42	11/20/2021	Thimphu	3D Modeling Workshop (Introductory)	General (4)	JICA Bhutan Office
43	11/20/2021	Thimphu	3D Modeling Workshop (Introductory)	CST Students (4)	JICA Bhutan Office
44	11/24/2021	Thimphu	Pre Fab Academy (- 12/12) with Suhas Labade	Fab Academy Candidates	FabLab Mandala
45	11/27/2021	Thimphu	3D Modeling Workshop (Introductory)	CST Students (1)	JICA Bhutan Office
46	11/29/2021	Online	Online Meetup Session Series (V): FabLab Saga & FabLab Oita	General	JDS
47	12/4/2021	Thimphu	Saturday 3D Modeling Workshop	CST Students (3)	JICA Bhutan Office
48	12/4/2021	Thimphu	3D Modeling Workshop (Introductory)	CST Students (4)	JICA Bhutan Office
49	12/6/2021	Thimphu	3D Modeling Workshop (Introductory) for SEN Teachers at Changangkha Middle Secondary School	SEN Teachers (10)	Ministry of Education
50	12/27/2021	Online	Online Meetup Session Series (VI): Kyoto Sangyo Univ. & FabCafe Kyoto	General	JDS
51	12/28/2021	Thimphu	Orientation for New JICA Volunteers at FabLab Mandala	JICA Volunteers (5)	JICA Bhutan Office
52	1/7/2022	Thimphu	Micro:bit Workshop	CST Students (18)	JICA Bhutan Office
53	1/10/2022	Thimphu	Hands-on Training on Digital Fabrication Tools for CST Students (- 1/14)	CST Students (20)	FabLab Mandala
54	1/15/2022	Thimphu	Micro:bit Workshop	CST Students (17)	JICA Bhutan Office
55	1/18/2022	Online	Online Meetup 2.0 (I): Mr. Yutaka Tokushima, Instalimb	General	
56	1/21/2022	Online	3rd JCC Meeting		
57	1/26/2022	Online	Fab Academy (- July 2022)	CST Staff (4)	
58	2/9/2022	Online	Special Lecture by Mr. Yoichi Kogure	CST Students	JDS
59	2/19/2022	Thimphu	Micro:bit Workshop	CST Students (5)	JICA Bhutan Office
60	2/28/2022	Online	FabLab CST Logo Selection Meeting		
61	3/12/2022	Online	Tinkercad Training for Kids (I) & (II)	Children (73)	FabLab Mandala
62	3/14/2022	Online	JICA Chair Lecture "Japanese Local Development"	RUB College Staff & Students	JICA Bhutan Office

No.	Date	Venue	Name of the Events	Target	Collaborators
63	3/19/2022	Online	Tinkercad Training for KIds (III) & (VI)	Children (50)	FabLab Mandala
64	3/26/2022	Thimphu	Tinkercad Follow-Up Workshop for Kids at FabLab Mandala	Children (3)	FabLab Mandala
65	4/15/2022	Online	Online Roundtable Meeting on the Progress of Fab Academy, Updated by the Fab Academy Participants from CST	JICA Staff	
66	4/17/2022		JICA Expert Shifts to Phuentsholing		
67	5/8/2022	IT Bldg.	MESH IoT Block Workshop (I) & (II)	CST Students (15)	JDS
68	5/9/2022	IT Bldg.	MESH IoT Block Workshop (III) (- 5/10)	CST Students (4)	JDS
69	5/14/2022	IT Bldg.	Tinkercad Training for Kids Living in the CST Campus	Children (11)	
70	5/15/2022	IT Bldg.	MESH IoT Block Workshop (IV)	CST Students (4)	JDS
71	5/21/2022	IT Bldg.	Tinkercad Training for Kids Living in the CST Campus	Children (11)	
72	5/23/2022	ADM Bldg.	Introduction of MESH and M5Stack to ECE Faculty (- 5/27)	CST Staff (8)	JDS
73	5/28/2022	IT Bldg.	Tinkercad Training for Kids Living in the CST Campus	Children (12)	
74	5/30/2022	Thimphu	Orientation for New JICA Volunteers at FabLab Mandala	JICA Volunteers (5)	JICA Bhutan Office
75	6/2/2022	Thimphu	3D Modeling Workshop (Introductory) for KGUMSB-JICA Project Staff at KGUMSB	KGUMSB Staff (7)	JICA Medical Education TCP
76	6/3/2022	Online	Online Meetup 2.0 (II): Mr. Yoshisuke Kuramoto, Tama Fab Space Lab.	General	
77	6/4/2022	Thimphu	Inauguration of JNWSFL		
78	6/4/2022	IT Bldg.	M5 Stack Workshop (I) & (II) (- 6/5)	CST Students (12)	JDS
79	6/6/2022	Paro	Visit to Agriculture Machinery Centre		JDS
80	6/19/2022	IT Bldg.	MESH IoT Block Workshop (V)	CST Students (6)	CST Student Council
81	6/29/2022	Samtse	Visit to JK Furniture, Samtse College of Education with Prof. Watanabe		JDS
82	6/30/2022	Phuentsholing	Visit to Local Tailor, P'ling MSS, Zimdra, BBPL, Arura Academy, etc. with Prof. Watanabe (- 7/4)		JDS
83	7/6/2022	Thimphu	Visit to Tarayana Foundation, Bhutan Stroke Foundation, Startup Center, YiGA Chocolate with Prof. Watanabe (- 7/7)		JDS
84	7/23/2022	Online	Training of STEM Teachers of Little Dragon Primary School (7/23 & 7/30)	School Teachers	Little Dragon PS
85	8/6/2022	IT Bldg.	Hands-on Training on 2D/3D Modeling and Machine Operations for Participants to the Training in Japan (8/6 & 8/13)	CST Staff (9)	
86	8/21/2022	Phuentsholing	3D Modeling Workshop (Introductory) for Children at People's Project for Youth	Children (10)	People's Project for Youth

Annex 1-6:   List of Equipment Provided

Category	No.	Name	Model	Qty
Large Machine	1	Laser cutter	Trotec Speedy 300	1
	2	CNC	Shopbottools 96x48x8	1
	3	Small type CNC	MDX50	1
	4	3D printer (FFD)	Prusa I3 MK3S	3
	5	3D printer (SLA)	Prusa SL1S	1
	6	Desctop cutter	GS-24	1
Electronic work related	7	Soldering Iron (Station type)	FX888D-01SV	1
	8	Hot air gun	LCD Soldering Station / Hot air gun IC	1
	9	Stand type magnifying glass	Gynx Magnifying Lamp	1
	10	Automatic vacuum pick-up tool	FR301-81	1
	11	Remover fume	FA-400	1
	12	Consumable parts for electric	Solder, remover, flux, etc.	1
Woodworking tools	13	Sliding circular saw	Makita 190mm Round Saw LS0717FL	1
	14	Hand trimmer	RT50DZ	1
	15	Orbital sander	BO180DRF	1
	16	Jigsaw	MSJ401	1
	17	Circular saw	Makita 255mm Circular Saw 2711	1
	18	Impact driver	TD171DRGX(6.0Ah)	1
	19	Electric drill	DF480DRGX(6.0Ah)	1
	20	Belt sander	RYOBI Belt sander BDS-1010	1
	21	Hand tools	Saws, chisels, hammers, files, sharpeners, etc.	1
	22	Consumable parts	Various sandpaper (3 years worth), circular saw replacement blades, scroll saw replacement blades, etc.	1
Light metal work tools	23	Light welder	i-MIGO 140 SIG-140	1
	24	Hand grinder	GA402DRF	1
	25	Band saw machine	PB183DZ	1
	26	Double-headed grinder	Makita	1
	27	Hand tools	Hacksaw, Metal file, etc.	1
	28	Consumable parts	Various (3 years worth)	1
Others	29	Dust collector	Makita	2
	30	Vacuum cleaner	CL281FDFCW(3.0Ah)	2
	31	Ventilation fan	CF300DZ	2
	32	3D scanner	EinScan Pro HD	1
	33	Straight stitch sewing machine	Juki DDL-7000AS-7	1
	34	Overlocker	Juki MO-6816	1
	35	Embroidery sewing machine	Tajima SAI	1
PC	36	Notebook PC with discrete GPU	Dell G3 15	5
Server	37	Server PC for Intranet system	HPE ProLiant MicroServer Gen10 Plus	1
	38	LCD Display	HP 17" Square Monitor 5RD64AA#ABJ	1
Wireless LAN	39	Wireless LAN Router	TP-Link AX6000	1
Storage	40	Network Attached Storage	Netgear ReadyNAS 422	1
LAN switch	41	Network L3 Switch	Netgear GS108T	1
Wide area IoT	42	LoRaWAN Gateway	Netvox WAPS-232N	1
UPS	43	UPS (Uninterruptible Power Supply)	APC UPS 1500VA Smart-UPS with SmartConnect	2
Transformer	44	Power supply transformer	STX-312P	3
Software, Online service	45	Digital design software package	Adobe CC Complete (3 years subscription)	3
	46	3D Modeling software	Autodesk Fusion 360 (3 years subscription)	3
	47	Hosting service	Hotinger Cloud Professional	3
	48	Streaming services	Vimeo Pro (3 years subscription)	1

Annex 1-7:   List of Other Handed-over Equipment (Purchased by the Project Operational Budget)

S. N.	Items		Qty.	Date of Delivery	Place of Use
	Category	Model			
1	3D Printer	UP mini ES	1	17/5/2021	FabLab CST
2	Programmable Computing Device	Pi-Top IV	1	17/5/2021	FabLab CST
3	3D Scanner	Shining 3D EinScan-SE	1	17/5/2021	FabLab CST
4	Gimbal Video Camera	DJI Picket 2	1	17/5/2021	FabLab CST
5	Laptop Computer	Dell Latitude 3310	1	6/10/2021	FabLab CST
6	Projector	EPSON EB-E01	1	14/2/2022	FabLab CST
7	iPad	iPad 9th Generation	2	3/6/2022	FabLab CST
8	CCTV System	SAT DOME Bullet	1	14/10/2022	FabLab CST
9	LCD Monitor	Samsung Crystal	1	4/11/2022	FabLab CST
10	Table Planer	Makita	1	15/3/2023	FabLab CST
11	Bench Drill	Makita	1	30/3/2023	FabLab CST
12	Welding Machine	Makita	1	30/3/2023	FabLab CST
13	Cordless Circular Saw	Makita	1	30/3/2023	FabLab CST
14	Video Camcorder	Sony HDR-CX405 9.2 HD Handy Cam	1	10/16/2023	FabLab CST
15	Desktop PC	Vostro 3020 SFF	5	10/31/2023	FabLab CST
16	Sewing Machine	Jack F5	2	11/2/2023	FabLab CST
17	3D Printer	Creality Ender-3 V3 SE	2	11/24/2023	FabLab CST
18	Combi Planer	J-1019	1	12/7/2023	FabLab CST

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

Annex 2-1: List of the Side-Events Hosted/Coordinated by the Project During the FAB23

S.N.	Date	Type of Event	Title	Applicant	Delivery	Remarks
1	10:00-14:00 Sun. 23rd July (FabFest)	Exhibition	Experience 3D Printing Assistive Devices	Hidenori Matsuo, JICA New Business Idea Pitch	JICA New Business Idea Pitch FabLab Shinagawa Bhutan Stroke Foundation FabLab CST	Venue: Clock Tower Square
2	11:00-14:00 Sun. 23rd July (FabFest)	Exhibition	E-Health Prototypes	Kamar Kr. Chapagai, CST Sonam Deki, CST	GovTech Agency Ministry of Health JICA Bhutan Office CST	Venue: Clock Tower Square
3	10:00-17:00 Tue. 25th July	Hands-on	Expereience 3D Printing Assistive Devices	Koji Yamada, CST-JICA FabLab Project	FabLab CST JICA New Business Idea Pitch Bhutan Stroke Foundation FabLab Shinagawa	Venue: Bhutan Stroke Foundation Declined as an official side-event.
4	10:00-11:00 Wed. 26th July	Fab Sympo.	Fab Lab Bhutan Network Panel	JNWSFL	Koji Yamada, FabLab CST CNR Bio-FabLab TTTIC FabLab, DGI FabLab	
5	15:00-19:00 Wed. 26th July	Hands-on	Making Machine that Makes Happiness (Making Prayer Wheel)	Masato Takemura, CST-JICA FabLab Project	FabLab Hamamatsu	
6	16:00-17:00 Thu. 27th July	Short Talk	Inclusive Makathon in Bhutan and Future Perspectives	Sonoko Hayashi, FabLab Shinagawa	FabLab Shinagawa JICA New Business Idea Pitch	
7	15:00-16:00 Thu. 27th July	Panel	"One Year of FabLab CST Phuentsholing as Community Lab"	Koji Yamada, CST-JICA FabLab Project	Atsushi Yamanaka (JICA HQs), Dr. Cheki Dorji (President CST), Karma Kelzang Eudon (FabLab CST) Tenzin Dorji (FabLab CST) Karma Wangda Phuntsho (CST Alumni) Nanda Kr. Gurung (Ex FabLab Bhutan)	
8	10:00-13:00 Fri. 28th July	Hands-on	Let's Make Something Small But Meaningful (II) - 3D Modeling of Assistive Tools for Persons with Disabilities	Koji Yamada, CST-JICA FabLab Project	FabLab CST JICA New Business Idea Pitch Bhutan Stroke Foundation FabLab Shinagawa	Need-knowers from Draktsho Vocational Training Centre for Special Child and Youth
9	13:00-14:00 Fri. 28th July	Panel	"FabLabs and Development Partners - Case of Japanese Development Cooperation"	Koji Yamada, CST-JICA FabLab Project	Tomoyuki Yamada (JICA Bhutan Office) Atsushi Yamanaka (JICA HQs) Shuhei Aoki (JKUAT, Kenya) Prasetya Kurniawan (UGM, Indonesia) Mutsuko Yamanaka (Draktsho, Bhutan) Koji Yamada (CST-JICA Project)	

GOVERNANCE AND OPERATION

GUIDELINES OF FABLAB CST
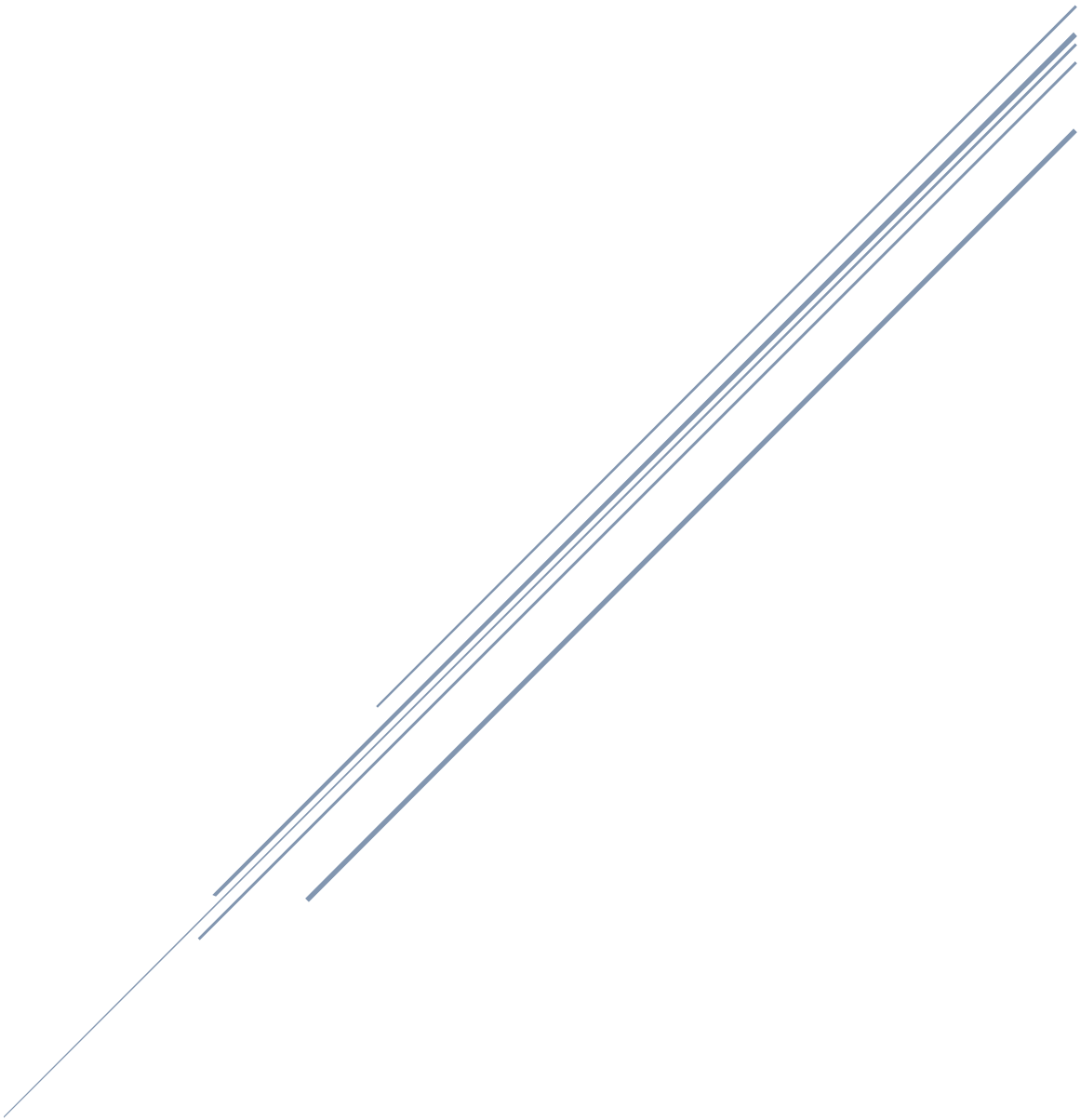
1. Vision

A FabLab that continuously innovates and solves local problems for the community through engagement and interactions.

2. Mission

To solve problems through technology based solutions
To provide opportunity for hands-on skill to community
To collaborate and interact among various stakeholders
To encourage open innovation to solve social and economic problems

3. Core Values

The Core Values of CST FabLab are;

- **Solution-based**: We believe in finding solutions, solving problems with solutions addressing the real problems or needs of the community and industries.

- **Prototyping**: We **believe** the FabLab should be a place nearby makers undergo repeated iteration to make their prototypes.

- **Co-creation**: We believe the FabLab should create a platform for co-working, where makers could design and make things together with the users, or need-knowers.

- **Empowerment**: We strive to teach and learn from others so that everyone could be technologically literate and would be able to fabricate things on their own.

- **Share**: We shall encourage makers to document the making process and share their ideas with proper documentation for others.

4. Strategy

- As the first FabLab attached to an engineering college in the country, we shall have the advantage of developing technology-based solutions for the community.

- As the FabLab located near the country's industrial hub, we can significantly contribute by providing solutions to industry.

- Take advantage of the students, faculty members, and staff to solve community problems on shared resources, thereby enhancing human resources development.

- Network with the global, Asia and Bhutan FabLab to develop human resources and share learning experiences.

5. Target and Key Performance Indicators

Based on the requirement of the FabLab CST the following are the annual KPI and their targets;

5.1 Establish a FabLab of global standard located under the Electronics and Communication Engineering Department (ECED) with the following;

5.1.1 Sustainable Business Plan, Rules and Regulations for the Operation and Management of the FabLab developed.

5.1.2 The content of the modules for practical work from the curriculum to be integrated with FabLab.

5.2 Collaboration and interaction of interdisciplinary lab-based research within CST to be enhanced through FabLab by producing at least 5 number of prototypes.

5.3 CST collaborating with other colleges, public and private institutions to solve social and economic problems of the country using FabLab by proposing at least 6 number of practical ideas to the ministries or companies by the students.

5.4 FabLab functions as a platform for open innovation for individuals/citizens and schools to work on their own needs and enhance their skills by developing customized products that address social and economic problems with at least 10 of users (user/visitors) for FabLab visited by other organizations/schools.

6. Management Structure

The Management of the FabLab will comprise of the following;

- The FabLab will be operated under the Board of Directors comprising of senior faculties, HoD ECE, entrepreneurs, senior civil servants and private individuals.

- The head of the College will serve as the Director of the FabLab.

- The day to day activities of the FabLab will be managed by a Manager appointed by the Board of Directors from the ECE faculty.

- The Technical Committee shall consist of the Fab Academy graduates, passionate users, senior faculties and PL of the ECE programme. The committee will meet periodically as proposed by Manager to plan activities,

discuss the management issues, policy direction, response to inquiries from external entities, and other issues concerning the management.

- The daily operation of the FabLab will be ensured by inducting one dedicated staff on full time, supported by JICA expert till December 2023 and one part-time student/staff.
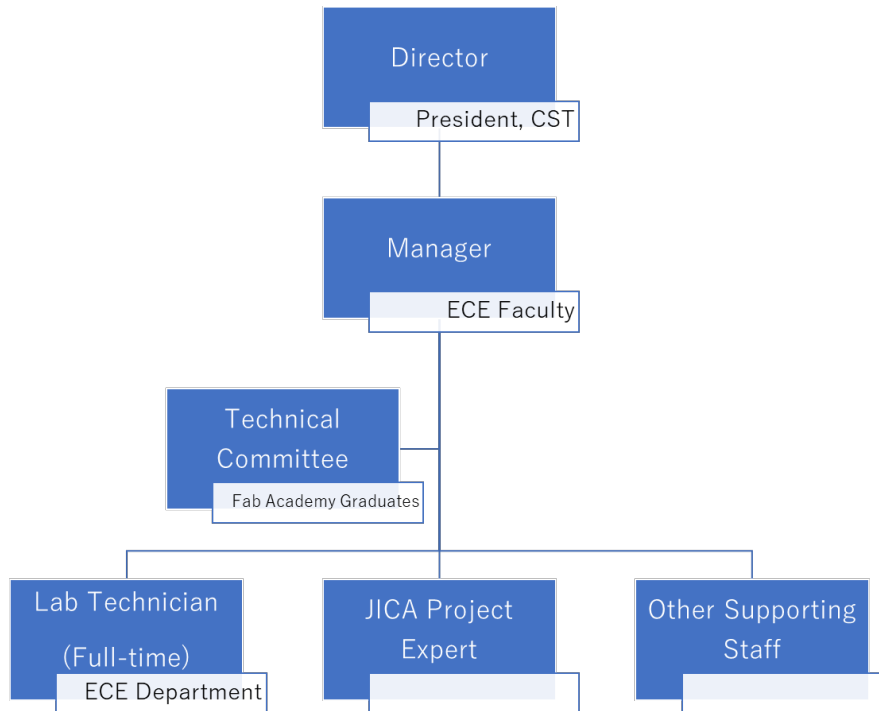
- The student volunteers will be selected based on the instruction workshop requirements to assist in-campus, inter-campus or other community outreach program events.

7. Stakeholders

The FabLab CST is expected to serve the following four major stakeholders;

7.1 **CST Students and Staff**: The primary user of the FabLab to be staff and students of the CST. It could be used as their classes and as their workshop for making prototypes. The faculty members could also use the Lab facility for their R&D activities.

7.2 **RUB Colleges**: The other constituent Colleges of RUB could use the FabLab for rapid prototyping works on their ideas and promote innovations. CST Fablab could share experience and expertise to develop new FabLabs in the other RUB colleges.

7.3   **Schools**: The school children and teachers could use the FabLab for fabricating their products for their project and hands-on related education and innovation to encourage STEM related activities.

7.4   **Communities:** The local Public/Private Entities and entrepreneurs could use the FabLab to develop new things or learn new skills, prototyping, product process development, to provide solution to the economic/social/environmental problems of the community.

8.   Operational Framework

8.1   Registration of users and Hands-on Training:

8.1.1   All users shall complete the user registration and attend the guided tour of the FabLab. The users shall be informed on the issues described in the user rules and Fab Charter (For detail refer to User Rules and Regulations for the Users).

8.1.2   Users shall take a hands-on training on machine to be used as pre-requisite for using the machine. (For detail refer to User Rules and Regulations for the Users).

8.1.3   All users can make reservations for the exclusive usage of the machine on the Lab website. Those users wishing to work on their projects in the co-working space should also make a reservation in the Lab website to determine the availability of the Lab spaces.

8.1.4   The in-campus users wishing to use the co-working space and machine of the Lab could use anytime during operating hours based on the availability of the Lab.

8.1.5   The users wishing to use the Lab facility exclusively for tutorial or practical sessions or other programs, shall make reservations on the Lab website.

8.2   User Fee

The cost of operations and maintenance of the FabLab to be made sustainable as far as possible through the following initiatives;

8.2.1   All training initiated by FabLab CST will be free.

8.2.2   For other use nominal fee shall be charged for machine usage, material usage as below;

8.3   Raw materials:

8.3.1   All users are encouraged to bring their own materials and electronics parts for their use.

8.3.2   The Lab will provide materials to users on payment basis as per the fee structure and guidelines as published on the web sites.

8.3.3   The materials for hands-on training for machine operations shall be provided by the Lab.

8.4   Special Program by Users:

8.4.1   It is expected that some users will approach the FabLab with a request to undertake specific Prototyping works. For such works the FabLab will appoint the focal person among its technical committee members and prepare the partnership agreement including cost-sharing measures to cover the expenses to be incurred. It is mandatory for the external group members to be part of the project team and follow the Do-It-Yourself (DIY) principle set by the global Fab Charter. The members should register their membership and take all the steps required to operate the machines they need. However, the machine usage and material cost should be covered by the prototyping project budget.

8.4.2   All school and college outreach programmes besides the free workshops and trainings initiated by the FabLab to be funded by school and colleges to cover the expenses incurred to hosting the event without having to register as a user. However all members are required to undertake steps required to operate the machines supported by CST volunteers.

8.4.3   As far as possible FabLab shall not undertake production on contract to maintain the principle and require the orderer to register as user and be engaged in the production process him/herself. Only in special cases, orders could be accepted based on the decision of the Manager.

8.4.4   If there are any other cases not in any of the above categories indicated from (i) to (iii), the Manager shall decide on how to respond and proceed (with consultation to technical committee members-suggested by SPenjor).

5

8.5 Operation Hours

10:00 – 19:00 (Monday to Saturday)

The FabLab will remain open from 10-19:00 from Monday to Saturday and it could remain open on Sunday and holidays in case there is any special program or on request by the users.

12.15-14:15-Lunch break:

To ensure continuous operation of FabLab, it will remain open even during lunch break. Staff will work on a rotational basis between 12:15-14:15 to ensure continuous attention to Lab during operating hours.

Extra Opening Hours:

The closing time of the FabLab shall be extended depending upon the machine operation time with close monitoring of the experts.

Special Closure:

The closure of FabLab due to special events should be announced well in advance on the Lab website.

Open Day:

All saturday shall be kept as Consultation day for users and technical committee members. At all times at least one FabAcademy graduate shall be available for the day.

9. Risk Management

The Director shall periodically assess the risk concerning the operation of the FabLab CST in consultation with the Manager and the Technical Committee members and take the risk mitigation measures. The following are the risks identified;

9.1 Operational Risks

9.1.1 **Prolonged implementation of the special programs**: All the special programs, no matter whether they are brought in by the external entities or initiated by in-campus users will be subjected to the monitoring by the Technical Committee members.

9.1.2 **Staff turnover**: To prevent immediate loss of staff from FabLab through quitting, all fabacademy graduates should remain in the FabLab CST

fraternity for one year. All technical committee members shall also serve for atleast one year and tender their resignation to the Manager.

9.1.3 User Satisfaction: User satisfaction shall be ensured through service and product delivery by monitoring product designs process continuously by technical committee members and Manager.

9.1.4 Information Security: All design and data related to FabLab will be protected with confidentiality and only upon the consent of the maker and designer will be shared. The external threat will be prevented with an appropriate firewall system on the College server.

9.2 Disaster Risks

9.2.1 Occupational Safety and Health: All the safety measures to ensure safe operations of the machines will be installed and displayed with periodical review by the Technical Committee. The Lab shall be equipped with the first aid kit and the SOP for critical injury. The users shall be sensitized on Safety Rules and precautions in terms of wall posters, leaflets and website posts.

9.2.2 Fire Safety: The Lab to be equipped by installing fire extinguishers and fire alarms wherever required.

9.2.3 Power Backup: All the machines to be connected to UPS (Unlimited Power Supply).

9.2.4 Thefts and Damages: To put in place measures to mitigate the risk of thefts of small parts and supplies and damages on the machines. Access control system to be installed to record the individuals and proper inventory system on spares and consumables shall be maintained and periodically be reviewed.

9.2.5 Natural Disaster: To ensure continuity of the operation during an emergency situation, the Manager shall assess the vulnerability of the Lab and recommend to the Director for measures to enhance the resilience of the facility.

9.3 Legal Risks

9.3.1 Creative Commons Licenses: In order to promote the creative reuse of the works done by others, a platform will be created to apply appropriate licenses for innovations from the Lab. In case of any major violation of innovations in terms of copyright law, the Director will take appropriate measures, including the cancellation of the user registration.

9.3.2 **Product Liability**: Due consideration to the product liability will be provided to the maker by involving the users from the initial stage of the design process to minimize the risk.

9.3.3 **Intellectual Property**: The design and process innovation developed from FabLab CST shall be protected and sold however an inventor chooses. However opportunities for other individual member users to use and learn from the innovation will be facilitated.

9.3.4 **Misuse of the Facility**: Log book on the use of each machine will be maintained to prevent proper use of machines and to maintain the ambience of the lab. These books shall be periodically supervised by the Manager and Director.

9.4 **Financial Risks**

Financial Sustainability: The FabLab CST is one of the laboratories under the College of Science and Technology. While it is the responsibility of the College for subsidizing the FabLab for the usage for the college programs, the Lab itself should also endeavor to ensure its own financial sustainability.

10. Finance and Accounting

The FabLab CST shall be subjected to two accounting practices based on the actual source of funding support. For funds received through CST-JICA FabLab Project till December 2023. It shall cover part of administrative expenses and operational expenses as below;

✓ Purchase of consumables and necessities;
✓ Expenses for the activities initiated by the Project;
✓ Expenses for the activities undertaken by the JICA experts.

10.1 **Budget and Disbursement Decision**: The budget requests shall be made in the beginning of the Japanese fiscal year in April with proper budget estimates and submitted to the JICA Bhutan office for approval. The release of the budget will be done quarterly as per the agreement with the JICA Bhutan office. All the expenses made from JICA project budget shall be verified and approved by the Project Coordinator, JICA expert and all expenditures shall be subjected to JICA's accounting rules.

10.2 **For funding support shared by the College**

Upon the launching of the FabLab CST, the following expenses shall be integrated to College Development Fund with different budget head as below;

8

- ✓ Staff cost;
- ✓ Utility cost;
- ✓ Expenses and revenues from the student users for their final-year projects;
- ✓ Expenses and revenues of the Special Programs;
- ✓ Expenses on membership and the machine and material usage by the external users.

10.2.1 **Budgeting and Disbursement Decision**: All the revenue generated from the FabLab CST will be booked under respective activity of the FabLab budget in the College Development Fund Account. The expenditure shall be subjected to procurement norms of the college. The Manager shall keep the revenue-expenditure record for each program for record and reporting requirements.

10.3 Financing

10.3.1 It is expected that Special Programs offered to the external stakeholders such as local governments, industries, entrepreneurs, educational institutions, development partners and Civil Society Organizations would provide external funding. To generate such, fund collaboration and activities are to be coordinated and offered.

10.3.2 All the final year projects using the FabLab shall be subject to fee. The FabLab management meeting to be held periodically to review strategy and improve approaches for funding mechanisms.

10.3.3 In case of proposals for prototyping projects by staff and students in the Lab other than academic related works, FabLab will jointly initiate for external funding sources.

11. Procurement and Inventory Management

11.1 Inventory Management

11.1.1 **List of Equipment**: After the handing over of equipment from JICA to FaLab CST. The Lab will make a comprehensive list of machines in accordance with the existing asset management practices of the College with regular updates with addition or cancellation of equipment.

11.1.2 **Stock of Spare Parts**: FabLab CST to maintain an inventory of spare parts of all the machine to avoid disruptions due to lack of spare parts. All spare parts to be under strict custody and only be authorized by the Manager. The inventory list to be periodically reviewed by the Technical Committee and the

Manager will place an order for the purchase based on the recommendations by the Committee.

11.1.3 Electronic Parts and Sizes: All the inventory of electronic parts and other supplies even to the academic programs of the College shall be facilitated through FabLab CST. The stock to be reviewed periodically and the release to be made with approval from the Manager. Consumption and requirement of materials of more demand to be stocked based on the need and demand.

11.2 Procurement

11.2.1 Local Suppliers: FabLab CST to work closely with local suppliers to develop the maker eco-system. The Lab shall endeavor to identify potential local suppliers to respond to the inquiries and shall facilitate them by providing list of possible distributors of items from other countries.

11.2.2 Joint Purchase: Lab could collaborate with other local makerspaces to scale up the demand for parts and supplies and enhance the business sustainability for the local suppliers.

11.2.3 Procurement Decision: All procurement decisions to be made by the Lab Manager after the consultation with the Management Committee members. The purchase of the small equipment, tools, electronic parts and other supplies shall be financed through CST-JICA FabLab Project during the project implementation period.

12. Facility Management

12.1 Co-Working Space

12.1.1 Space and Furniture: To secure the space and furniture for the users to co-work with others inside the Lab. Users could come to the Lab even without specific ideas on the things to make and use the co-working space as the space for meeting or any other joint work.

12.1.2 Lab-based Events: Co-working space could be used as the venue for the Lab-hosted events, such as workshops, enlightenment talks, hackathon/makathons, and school outreach programs. When the Lab is reserved for academic programs, the co-working space is the venue for the tutorial and practical sessions.

12.1.3 Office Equipment and Amenities: To facilitate the co-working practices among the users, arrangements for free wifi access and other amenities shall be provided.

12.2 Universal Access

The access to any users will be facilitated to FabLab CST through periodically review and strategizing with actions. To access the Lab an access route from the drop-off point to the Lab, and improvement on the physical infrastructure to ensure easier access to the Lab building shall be provided for all.

To record the user data and transparency, a system will be developed wherein all the users will be provided with access cards. For user cards, Manager and Technical Committee members shall be provided with their own cards, however, other users shall be provided with a guest card registered against their name facilitated by the fablab website. (By SPenjor)

12.3 Fire Safety

12.3.1 Fire Prevention Assistant Supervisor: The Fire Prevention Supervisor will be identified and nominated. He/she is responsible for the safety and security measures against fire accidents by reviewing the fire safety measures and recommends to the management on the additional measures to minimize the fire risks, including the fire drills.

12.3.2 Fire Extinguishers: The Lab equipment prone to fire risk shall be provided with fire extinguishers.

12.3.3 Fire Alarms: Fire alarms shall be installed either through the purchase of the product or through the prototyping project by the in-campus users.

12.3.4 Access Control: The Access Control System to record the inventories of the Lab visitors shall be available for the lab either fabricated by prototyping work in the Lab.

12.4 Regular Clean-up

12.4.1 Machine Users: All users who use the specific machines shall clean up the table and floor around the machines after use and before they leave the Lab.

12.4.2 Daily Clean-up: The users and Lab staff who remain until the close of the day shall clean up the tables and floor and check the conditions of the machines and unplug all the electrical connections from the power points in accordance with the check list set forth by the management.

12.4.3 Cleaning Equipment: The Lab shall be equipped with cleaning equipment, such as brooms, mops, dust cloths and cleaners, ready for regular clean-up practices.

12.4.4 Eating and Drinking: Except drinking water at the co-working desk, eating and drinking is not allowed anywhere inside the Lab.

12.4.5 Waste Management: All means and measures to reduce waste by prototyping the systems for upcycling plastic, paper, sawdust and other wood wastes will be practiced in the Lab. Waste management of the Lab is aligned to the rules and regulations of the College. And both the users and the Lab staff must abide by them.

13. Program Management

This section mainly refers to the management of the Special Programs offered to external agencies and the programs initiated by the in-campus users. It could also apply to the individual users.

13.1 Definition

Special Programs refers to Programme initiated by FabLab CST to the external entities or by the in-campus users. If the proposals are brought by the external entities, the FabLab CST shall consult with the Technical Committee and College Management and respond accordingly. The special program could be broadly be categorized as;

13.1.1 Prototyping Projects: They are projects about prototyping the things or the whole systems which could be deployed to address the issues and challenges that the community and stakeholders face.

13.1.2 School Outreach Programs: **They** are the activities for promotion of STEM education and for the enhancement of the capacity of the schools and the students.

13.1.3 Contracted Production: They are production activities undertaken by FabLab for production.

13.1.4 Others: Any other activities which the management of the FabLab CST deem appropriate to undertake.

13.2 Focal Person

The focal person is the representative of the program from the College side and is responsible for the preparation for the partnership agreement, oversight on the whole program life cycle, documentation and reporting, and the revenue and expenditures concerning the implementation of the program.

13.2.1 In case the Special Programs are proposed to the FabLab CST by the external entities, the Lab will consult with the College so that the college could appoint a faculty member as focal person for that particular program.

13.2.2 The focal person could consider involving student-users of the FabLab CST in the implementation of the program. The student-users to be selected from the rosters and to plan the activities to avoid overloading any particular student. The selection process is decided by the consultation between the focal person and the Lab.

13.3 Partnership Agreement

Once we agree on the terms and conditions with the external entity, the focal person shall prepare the Partnership Agreement which defines the objective, implementation period, deliverables, responsibilities of the two parties, cost-share arrangements, etc.

13.4 Implementation and Monitoring

13.4.1 Co-Design: The design and the prototyping works to be joint work with external entities and the FabLab CST. Each partner should also appoint a focal person committed to the design and prototyping process together with his/her counterparts in the College.

13.4.2 Diversity: For the student-users in the Special Programs, the team shall consist of diversity in terms of gender, school grades, departments and other expertise.

13.4.3 Documentation: Each team or users shall document the product design and process for open-source to ensure for the others to use and learn from it. For the requirement of intellectual property rights of the product, some documents could be maintained confidentiality.

13.4.4 Monitoring: All the special programs, no matter whether they are brought in by the external entities or initiated by the in-campus users, are subject to the monitoring by the Technical Committee.

13.5 Capacity Development

13.5.1 Training/Workshops: In addition to the hands-on skill training on the machine operations and design, other training and workshops on ideation, design thinking, project management shall be made available based on the availability of resource persons in the College.

13.5.2 **Enlightening Talks**: Besides the training and workshops talk sessions by inviting special guests from different backgrounds, to stimulate the thinking of the participants by inviting special guests in the Lab.

13.5.3 **Show & Tell**: As part of sharing practices, the users shall be require to show and tell their stories of product design and process to other users in the round-table talks at the Lab.

14. Communication Management

For Contact Information the FabLab CST shall have its own mobile number and email ID (fablabinfo.cst@rub.edu.bt). It shall be displayed for contact information on the web page and the Facebook page. One elected member from the Technical Committee shall be assigned to take the calls and read the incoming emails.

14.1 Web Media

The FabLab CST shall have its own web pages and Facebook page as below;

14.1.1 **Web Pages**: The web pages shall have a comprehensive view on the FabLab CST. The College shall appoint a focal person responsible for the development and update of the web page. Students shall be encouraged to participate to edit and update the pages on a voluntary basis. The web pages shall cover the following information:

- ✓ General information about the FabLab CST (vision, mission, core values, organogram, staff profile, instructor profile, etc.)
- ✓ Information for the Users (Fab Charter, user registration, notifications, calendar, reservation for machines and for the whole Lab facility, rules and regulations, etc.): For web-based reservation, user login is required.
- ✓ News (event information, event reports, etc.)
- ✓ Past and Ongoing Activities (descriptions of the Special Programs, products developed, information about the development process as well as design data)
- ✓ Contact information.

14.1.2 **Facebook Page**: The Facebook page shall feature the events from FabLab CST and shall share the news and information for its users. The page will be supervised by the focal person appointed by the College to update web pages. Students will be encouraged to volunteer as editorial board members

and to update the page as often as possible. The Facebook page shall cover the following information:

✓ Notifications to the users;
✓ News (event information, event reports, featured activities, etc.);
✓ Other featured stories of the users;
✓ Other useful information shared from other sources.

14.1.3 fablabs.io: The FabLab CST shall be registered on the fablabs.io after the launch as one of the FabLabs in Bhutan with updated information on a regular basis.

14.1.4 Other Social Media: FabLab CST will use WhatsApp and Telegram group chats for inquiries by the users.

14.2 Events and Media Coverage

14.2.1 Intra-College Events: The FabLab CST shall provide the venue for the special events, such as Business Idea Competition and Startup Weekends, hosted by the College to reach out to the wider audience inside the College. It shall also initiate a platform for students, faculty members and staff to pitch their ideas and collect feedback.

14.2.2 Inter-College Events: The Lab shall provide the venue for the inter-college event sponsored by the RUB or other entities as part of the effort to reach out to a much wider audience.

14.2.3 SOP for Hosting Events: The Standard Operating Procedure (SOP) shall be made available separately for hosting or co-hosting the events with external entities such as RUB colleges, foreign universities, other FabLabs, local public entities and private entities.

14.2.4 Relationships with National News Media: For awareness, events from the Lab will be shared through national newspaper and TV broadcasting service to inform the larger audiences across the whole country.

14.2.5 Visibility in Other Constituencies: The FabLab CST shall participate in seminars/workshops/conferences hosted by other constituent FabLabs for better recognition and FabLab network in Bhutan.

14.2.6 Collaboration with Other FabLabs: The FabLab CST shall work closely with other FabLabs in Bhutan and proactively participate in the programs and events initiated by the global FabLab network members to enhance networks with the global Fab community.

15. Quality Assurance

15.1 **Products by Individual Users**: Each user shall set his/her own quality standard on his/her final product for personal use. For deployment of business or society, he/she shall go through test requirements for prototypes before the final product is deployed. The FabLab CST shall sensitize the individual users on the quality assurance issues through the consultations and the capacity building programs.

15.2 **Products from Special Programs**: Any product developed by external entities or by the in-campus user shall maintain standard product design and fabrication process to achieve quality.

16. Review of the Governance and Operation Guidelines

These governance and operation guidelines shall be subjected to the periodical reviews with the support from the Joint Coordination Committee (JCC) of the CST-JICA FabLab Project till December 2023. The review framework after the project shall be finalized in the JCC meetings.

Attachment: FabLab CST Calendar of Events

Year 2022

| | xlh Sat | College Event | Events at Fab Lab CST | |
			Weekday Events	Weekend Events
Aug	1		Lab Setup	Hands-on skill training for Project Counterparts I
	2		Preparation for Inauguration	Hands-on skill training for Project Counterparts II
	3		Orientation for Faculty Members led by the Fab Academy Graduates	Lab Management Test
	4	Business Idea Competition (21st Aug) Term Test I (Students)	4th JCC Meeting (24th) inauguration (25th) Preparation for Maker Faire Tokyo	Lab Management Test
Sep	1		Training in Japan (28th Aug - 16th Sep): Orientation for Students	Hands-on skill training for Faculty Members I
	2		Training in Japan (28th Aug - 16th Sep); Orientation for Students:	Hands-on skill training for Faculty Members II
	3		Orientation for Students	Hands-on skill training for students
	4	College Foundation Day (26th Sep) Term Test II (Stud ents)	Orientation for Students	Hands-on skill training for students
Oct	1		Orientation for Students Fab Academy Promotion Seminar	Hands-on skill training for students
	2		Orientation for Students	Hands-on skill training for students
	3		FAB17 (10th - 24th Oct) Makathon in collaboration with Tech Incubation Centre	Markathon in collaboration with Tech Incubation Centre
	4		FAB17 (10th - 24th Oct)	Open day for external users
	5		Consultation with KGUMSB (TBC)	
Nov	1			
	2	Semester Exam		
	3	Semester Exam		
	4	Semester Exam		
Dec	1		Budget Execution Review	
	2			
	3	National Day (17th Dec)		
	4	Winter Vacation starts.	Mini Maker Faire Phuentsholing?	Mini Maker Faire Phuentshoting?
	5			

Year 2023

Month	xth Sat	College Events	Events at Fab Lab CST	
			Weekday Events	Weekend Events
Jan	1			
	2			
	3		Outreach Program	Outreach Program
	4		Outreach Program Fab Academy 2023 starts.	Outreach Program
Feb	1	Reporting to College		
	2	Reporting of Students		
	3			
	4	Royal Flower Exhibition in Phuentsholing? (Exhibition?)	Any contribution to Flower Exhibition? Data Science Program Delivery by Musashino University Students	Any contribution to Flower Exhibition?
Mar	1			
	2			
	3	Term TestI (Stuents)		
	4			
Apr	1			
	2			
	3	Fashion Show		
	4			
	5	Zorig Day (27th Apr) Term Test II (Students)		
May	1	Teachers' Day Celebration (2nd May)		
	2			
	3			
	4	Final Semester Exam (Students)		
Jun	1	Final Semester Exam (Students) Release of the Results of the Annual CST Challenge by Tarayana Foundation (4th Jun)		
	2	Exhibition of Final-Year Projects (start) Final Semester Exam (Students)		
	3			
	4	Graduation Day	Fab Academy 2023 ends.	
Jul	1	Summer Break starts.		
	2	Summer Break ends.		
	3	Students report Staff report.		
	4			
	5	Exhibition of Final-Year Projects (end)		
Aug	1			
	2		FAB18	FAB18
	3			
	4	Term TestI (Stuents)		
Sep	1			
	2			
	3			
	4			
	5	Term Test II (Students) College Foundation Day (26th Sept.)		
Oct	1		Fab Academy Promotion Seminar	
	2			
	3			
	4			
Nov	1			
	2	Semester Exam		
	3	Semester Exam		
	4	Semester Exam	JICA Project Final Seminar (Thimphu/ P'ling)	
Dec	1		Budget Execution Review	
	2		Mini Maker Faire Phuentsholing?	Mini Maker Faire Phuentsholing?
	3	National Day (17th)		
	4	Winter Break starts		
	5			

18

The Fab Charter

What is a FabLab?
   FabLabs are a global network of local labs, enabling invention by providing access to tools for digital fabrication

What's in a FabLab?
   FabLabs share an evolving inventory of core capabilities to make (almost) anything, allowing people and projects to be shared

What does the FabLab network provide?
   Operational, educational, technical, financial, and logistical assistance beyond what's available within one lab

Who can use a FabLab?
   FabLabs are available as a community resource, offering open access for individuals as well as scheduled access for programs

What are your responsibilities?
   safety: not hurting people or machines
   operations: assisting with cleaning, maintaining, and improving the lab
   knowledge: contributing to documentation and instruction

Who owns FabLab inventions?
   Designs and processes developed in FabLabs can be protected and sold however an inventor chooses, but should remain available for individuals to use and learn from

How can businesses use a FabLab?
   Commercial activities can be prototyped and incubated in a FabLab, but they must not conflict with other uses, they should grow beyond rather than within the lab, and they are expected to benefit the inventors, labs, and networks that contribute to their success

October 20, 2012

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https://fab.cba.mit.edu/about/charter/

<h1 style="text-align:center">How to use FabLab CST Phuentsholing (for general users)</h1>

For the first time users.

You need 2 steps before using FabLab CST Phuentsholing (See detailed explanation later in this document).

1. User Registration
2. Introduction to FabLab and its facilities (Video)

For users already registered and viewed the introduction video

1. Join the training on how to use each equipment (for beginners of that equipment)
2. Check availability of equipment / Reserve the use of equipment
3. Come to the FabLab and check in at the front desk
4. Optionally ask for technical advice from staff at the FabLab
5. Use the equipment
6. Clean the equipment and its environment that you used
7. Check out the FabLab when you leave

Open hours

10:00 – 19:00 from Monday to Saturday
Closed on Sunday and on national holidays
There may be occasional close and special events when the FabLab is used exclusively for the events, so please check at our Web site before coming to the FabLab.

Detailed reference on the usage of FabLab CST

1. User Registration

You need to register as a user of the FabLab before you can use it.
There are two ways to register you as a user: at FabLab office and through online registration.
If you plan to register at the office, please come to our office during the open hours. You need to fill in the forms about your name, telephone number, e-mail address (if any). You need to bring your ID for the verification.
If you plan to register online, please visit the Web site (https://xxxxxxxxx) for the registration. You are requested to fill in the forms about your name, telephone number, e-mail address (all are required). After online registration, you need to bring your ID for the first time you come to the FabLab for the verification.
Registered users can login to our Web site and can make reservation for the use of FabLab facilities. Users will also receive occasional news regarding the FabLab including upcoming events at the FabLab.

<div style="text-align:center">2</div>

2. Introduction to FabLab and its facilities (Video)

The first time users are requested to watch the introduction video of the FabLab (around 15 minutes) that covers basic topics required for using the FabLab such as the brief history of the FabLab establishment, facility and layout of the FabLab, and available equipment with their target use in the FabLab.

3. Join the training on how to use each equipment

If you plan to use an equipment in the FabLab but you have never used that equipment before, you need to participate in the training on how to use the equipment. Depending on the required knowledge and skill for using the equipment, the training would take time from several hours to several days. Below is the list of available training sessions for using each equipment.

Table-1: List of training sessions for using particular equipment in FabLab CST

Equipment	Content of training session	Duration

4. Check availability of equipment / Reserve the use of equipment

You can check the availability of particular equipment from our Web site. The Web site shows a calendar indicating the availability / reservation status of all equipment in the FabLab (except for small equipment / tools that you can use any time if available).

https://fablab.cst.edu.bt/#!/machines

Figure-1: Screen image of equipment availability / reservation site

You can also check the availability of equipment when you come to the FabLab and ask to our staffs.

5. Come to the FabLab and check in at the front desk

Every time you come to the FabLab, you are requested to check in at our front desk. During the check in, you can ask our staff for availability of equipment and facilities.

6. Optionally ask for technical advice from staff at the FabLab

If you need assistance on how to use equipment or need advice from the FabLab staff, you can ask them when the staffs are in the FabLab.

7. Use the equipment

After you have checked in the FabLab, you can use the equipment according to your reservation or upon its availability if no reservation is made.

8. Clean the equipment and its environment that you used

After you finished using any equipment, you must clean the equipment and its environment. This is a very important ethics of FabLab usage. Guides for how to do the cleaning are always available near the equipment, or you can ask our staff in case you cannot find the guide.

9. Check out the FabLab when you leave

When you leave the FabLab, you are requested to check out at our front desk. This is required to ensure that you have finished using the FabLab. Even if you need to leave the FabLab temporarily for a short period and will come back again, you must tell our staff at front desk for your leave.

5

Safety Rules at FabLab CST Phuentsholing

All users who enter and work in the FabLab must comply with our safety rules.

Compliance

- Any user who does not or refuse to comply with our safety rules will be asked to leave immediately.
- If users are found to violate the FabLab safety rules many times or to compromise FabLab and user safety, their access to the FabLab may be revoked.

Duty of Care

Upon entering the FabLab all users, staff and visitors are bound by a Duty of Care. This means that each person must take responsibility for the health and safety of him/herself and of other users who may be affected by his/her actions while in the FabLab. Staff and visitors must:

- not place themselves or other persons at risk of injury.
- observe all instructions and safety guidelines issued by FabLab staff.
- observe all workshop rules.
- be aware of Emergency and Occupational Health & Safety Procedures.
- use equipment in a safe manner and follow all safe operating procedures on signage and in machine guidelines.
- assist in the maintenance and cleaning of the laboratory and machines.
- report any incidents to FabLab staff.

Workshop Rules

All areas in the FabLab share the basic rules listed below which must be adhered to, as well as specific rules for individual machines.

1. Ask

If there is something you don't know or understand ask one of the staff or other users

2. Instructions must be observed

All instructions, written or verbal, issued by staff must be observed

3. Safety guidelines

All safety guidelines must be adhered to. Please refer to the instruction manuals or the easy-to-use guides available.

6

4. Machinery always operated in safe manner

Equipment and machinery are to be operated in a safe manner and in accordance with the procedures demonstrated by staff. Activities involving equipment / machinery supplied by users must be cleared first with workshop staff.

5. Personal protective equipment

Personal protective equipment (PPE) and other specialized safety equipment is to be worn as indicated on wall signage and specified in standard operating procedures. The FabLab has a variety of PPE for FabLab members to use.

6. Clothing

Appropriate clothing to the area and task is to be worn at all times - for instance, jewelry or loose-fitting clothing is not to be worn in proximity to operational machinery, and beards and long hair are to be rigorously contained when operating machinery or power tools.

7. No food and drinks

Food and drink are not to be consumed in the FabLab.

8. Materials

Please notify and check with staff if you are bringing your own materials to work on in the FabLab before using.

9. No external tools

Users cannot bring their own power tools. If you need to use machines that are not in the workshop, check with the staff first.

10. Personal belongings

- Store your personal belongings in the designated areas on the shelves or under the benches.
- Never place your bag or clothes near the power equipment or near emergency exit.
- If you leave anything behind in the designated areas, label it with your name, contact details, the date you left it and the date you will collect.

11. Standard Operating Procedures (SOP)

Standard Operating Procedures (SOP) should be strictly adhered to when operating each piece of equipment or machinery. Please see the manufacturer guidelines or use the easy-to-use guides available.

12. Clean up after use

Users should clean up and put things away after use as they may become safety hazards. It is the responsibility of workshop users to keep the area clean and tidy.

- Clean up dusts and unused parts into bin nearby.
- Keep areas around machines and walkways clear.
- Don't block or obscure emergency evacuation routes and exits.
- Return any tools/equipment you have finished using back in its allocated space.
- If a tool/equipment is broken, blunt, damaged or unsafe to use it is your responsibility to inform staff. Do not return or put away damaged tools/equipment without informing staff, as the next user could be seriously hurt or injured. The same rules apply when you break or damage the tool/equipment.

FabLab CST Payment Policy

February 2023

Introduction

FabLab CST is a self-sustaining digital fabrication lab that was established with the funding support form JICA. The lab houses a number of machines starting from 3D printers to CNC machines. Since the lab is supposed to be self-sustained, there are payments for the utilization of the lab space and the machines.

Payment Modality

The fee structure for the lab utilization is based on the type of user.

Users	Registration fee	Monthly package for unlimited usage	Daily usage fee	Material fee	Machine fee
General/ Short term user	Nu. 500	n/a	Nu. 500	applicable	applicable
start up/ long term user	n/a	Nu. 5,000	n/a	applicable	n/a
students	n/a	n/a	n/a	applicable	applicable

Machine Usage Fees

The usage fees vary based on the different machines.

Machine	Payment per hour	time extension payment	Remarks
3D printer	100/hr	50 per additional hr	
Vinyl cutter	500/hr	300 per additional hr	
Big CNC machine	1000/hr	500 per additional hr	
Embroidery Machine	500/hr	300 per additional hr	no material fee applicable
Sewing Machine + Overlocking	800/hr	200 per additional hr	no material fee applicable
Small CNC(MDX)	800/hr	400 per additional hr	*Subject to Change
Wood workshop ()	600/hr	500 per additional hr	
Laser Cutter	500/hr	300 per additional hour	
SLA 3D printer	300/hr	120 per additional hour	

Material Usage Fee

Although users should bring the materials they want to use, some materials are not available in the local market and the purchase in the international market usually takes much time to get them delivered. Therefore, we keep in stock some materials and users could consume them on a fee basis.

1

Materials fee can be changed with the change in the cost of raw materials from the market. It is calculated based on the amount charged to purchase. It may even include the taxes that have to be borne. Addition and subtraction of materials in the list are expected with respect to the availability of it.

As of January 2023, the rates are as follows:

Machine	Material (Types)	Approx Size (unit)	Price (NU)
3D printer (FFD)	PLA	1g	2
	SLA	1ml	9.5
Laser	Plywood (4mm)	61 x 61 cm (¼)	300
	Plywood (8mm)	4 x 8 ft.	320
	Acrylic board		
Vinyl	Vinyl Sheet (any color)	10cm*61cm	200
Big CNC	Plywood (8mm)	4 * 8 feet	As per market

Other Payments

There are other costs that could be involved as per the user requirements.

	payment per hour	Remarks
Design Fee	1000/hr	500/hr for every additional hour beyond 6 hrs
Instruction Fee	800/hr as per CST Resource personal rate, 2018	400/hr for every additional hour beyond 6 hrs

Services

1. **Training**
2. **Workshop**
3. **Production**

Training Fees

FabLab CST will also provide training based on the requirements and the fees for the training will include the following;

1. Staff expense (Trainer and administrative)
2. Material Cost
3. Refreshment
4. Course Package (Based on type of machine, user and time)

An addition of 20% overhead to be charged.

2

Production Services

When there is an order requested by a community member for production of items of more than one in quantity with no personnel from the community to process the request, the work will have to be processed by FabLab member(s).

The instruction fee rate collected for the work will be disbursed as follows:

(Instruction Fee rate * Number of hours) ÷ (Number of members)

Note: The number of hours is the extra hours taken to complete the production during the off hours of FabLab CST.

If the request is a mass production of items of more than 50 in number then an addition of 20% overhead is to be charged.

Standard Operating Procedures (SOPs) for Collaboration with External Entities

September 2023

FabLab CST Phuentsholing

1 Introduction

This SOP outlines the process for initiating and implementing collaboration activities between FabLab CST Phuentsholing and external entities, including local educational institutions (primary schools, secondary schools, vocational schools, universities, etc.), local industries (private companies especially CSIs, industrial estates, industrial organizations, etc.), local public service providers (Phuentsholing thromde, youth centres, etc.) and other official entities (development partners, CSOs, central government offices and research institutes, etc.).

2 Scope

This SOP applies to all FabLab staff members involved in establishing and maintaining partnerships and collaborations with external entities.

3 Objectives

This SOP covers the collaboration with external entities that has one or more objectives of the following categories.

1) Prototyping solutions to the socio-economic problems in its constituency.
2) Enlightening and/or empowering of local people.
3) Facilitating and promoting entrepreneurship of local people.
4) Enhancing education and/or training of local people by means of digital fabrication.
5) Implementing the sponsored activities in line with the policies and guidelines set by the sponsors.

Activities with other objectives, especially profit-oriented commercial activities that do not fit in the above categories (such as making prototypes or undertaking mass production ordered by private enterprises) should not be covered by this SOP and should be treated as normal paid use of FabLab.

4 Procecures I. Initiate Contact

4.1 Collaboration Proposed by External Organizations

1) External organization expresses an intent of collaboration directly to FabLab CST or to the faculty of the College of Science and Technology.
2) FabLab CST requests for an introduction letter from the external organization to the Manager, FabLab CST or an email to fablabinfo.cst@rub.edu.bt. The introduction letter/email should clearly state the purpose, potential benefits, and the kind of collaboration that it is proposing with FabLab CST.
3) If it is the CST faculty that receives an introduction letter from the external organization, he/she should share it with the Manager, FabLab CST.

1

4.2 Collaboration Proposed by FabLab CST

1) FabLab CST identifies potential partner organizations that could benefit from using FabLab resources.

2) FabLab CST prepares an introduction letter in the name of the Manager, FabLab CST, or email from fablabinfo.cst@rub.edu.bt, clearly stating the purpose, potential benefits, and the kind of collaboration that FabLab CST is proposing. It sends the introduction letter/email to the head of the organization or the person responsible for managing such partnerships.

3) Then wait for their response and be prepared to answer any questions or provide further information as required.

5 Procedure II. Preparation of the Kick-off Meeting

5.1 Collaboration Proposed by External Organizations

1) Once the interest of both sides has been confirmed, FabLab CST arranges a kick-off meeting between the representatives of the partner organization. In case a faculty member of the College is appointed as a focal point by the management for the communication with the external organization, he/she must arrange a similar meeting inviting the Manager or his/her deputy of the FabLab CST to the meeting.

2) The external organization or the focal point in the College may prepare an agenda for the meeting covering the following topics:
   • Introduction of both parties;
   • Purpose, objectives, and target group of the collaboration;
   • Potential outcomes of the collaboration;
   • Define the role for the FabLab CST to play in the whole picture of the collaboration between the external organization and the College of Science and Technology; and
   • Facility tour in the FabLab CST (if not done before yet).

   Also, the following topics should also be included in the meeting agenda:
   • Rough schedule of implementing the collaboration;
   • Materials to be used from the stock inventory of the FabLab, and the necessity to purchase the specific materials and components for that particular purpose;
   • Marketing and public relations of the collaboration to be taken. Task distribution between the College and FabLab CST;
   • Cost sharing and external source of budget (if any) of the collaboration. To what extent the cost incurred to FabLab CST could be recovered by the external source of funding;
   • Cost recovery procedure; and

2

- Persons in charge of both sides and implementing structure.

3) Be sure to share the meeting invitation and agenda with the attendees in advance. In case the College appoints a focal point in the CST faculty, he/she shall undertake this responsibility, but FabLab CST should double-check the participants.

5.2 Collaboration Proposed by FabLab CST

1) Once the interest of both sides has been confirmed, FabLab CST arranges a kick-off meeting between the representatives of the partner organization.

2) Prepare an agenda for the meeting, focusing on the following topics. Even if the meeting is called by the other focal point in the College, these topics should also be covered:
   - Introduction of both parties;
   - Purpose, objectives, and target group of the collaboration;
   - Potential outcomes of the collaboration; and
   - Facility tour in the FabLab CST (if not done before yet).

   Also, the following topics should also be included in the meeting agenda:
   - Rough schedule of implementing the collaboration;
   - Materials to be used from the stock inventory of the FabLab, and the necessity to purchase the specific materials and components for that particular purpose;
   - Marketing and public relations of the collaboration to be taken;
   - Cost sharing and external source of budget (if any) of the collaboration. To what extent the cost incurred to FabLab CST could be recovered by the external source of funding;
   - Cost recovery procedure; and
   - Persons in charge of both sides and implementing structure.

3) FabLab CST sends the meeting invitation and agenda to the attendees in advance.

6 Procedure III. The Kick-off Meeting

6.1 Collaboration Proposed by External Organization

1) FabLab CST reconfirms the attendees one day before the kick-off meeting.

2) All parties discuss the topics prepared in the agenda listed in Section 5.1 above. Following topics may also be discussed according to the nature of the collaboration.
   - Potential risks and their preventive measures or possible solutions;
   - Needs for outsourcing some portion of preparation / implementation to the third parties; and
   - Required permissions from RUB, relevant agencies, local government, etc.

3

3) Either the CST focal point or FabLab CST documents the minutes and note all the points discussed and decisions made after the meeting, and sends it to all the attendees for review and confirmation.

4) In case the external organization wants FabLab CST to waive its right to claim the fees incurred to the resource usage by the external organization itself or the users associated with the proposed collaboration, both parties exchange the letters or emails about the agreement.

6.2 Collaboration Proposed by FabLab CST

1) FabLab CST reconfirms the external organization one day before the kick-off meeting.

2) Both parties discuss the topics prepared in the agenda listed in Section 5.2 above. Following topics may also be discussed according to the nature of the collaboration.
   - Potential risks and their preventive measures or possible solutions;
   - Needs for outsourcing some portion of preparation / implementation to the third parties; and
   - Required permissions from RUB, relevant agencies, local government, etc.

3) If the meeting is just between the external organization and the FabLab CST, the latter documents the minutes and note all the points discussed and decisions made after the meeting, and sends it to the other party for review and confirmation.

7 Procedure IV. General Preparation of the Collaboration

1) Get necessary permissions (if any) from RUB, relevant agencies, local government, etc.
2) Secure the required budget and sponsors (if any).
3) Purchase required materials and consumables if not available in the stock.
4) Hold meetings for updating the progress of preparation and for discussing the solutions for raised issues (if any).
5) Document the process of preparation with issues and solutions, for the future reference and sharing.

8 Procedure V. Specific preparation and implementation of the collaboration

Depending on the nature of collaboration, prepare and implement the collaboration as follows.

8.1 Prototyping at FabLab CST

This section describes the general procedures when the FabLab CST receives the user for prototyping in his/her preparation for the collaboration event with the external organization

that requires showcasing of his/her prototype. In case the collaboration incurs undertaking of prototyping by the FabLab CST staff, the following procedures will also apply:

1) The participant fills out the "FabLab CST User Project Registration Form" and describes the overall project description and the components he/she wants to make in the FabLab. If it is about undertaking of prototyping by the FabLab staff, FabLab CST fills out the same Project Registration Form.

2) The User Project Registration Form is submitted to the FabLab CST management team and kept in their office together with the Activity Log Sheet.

3) When the user decides the date and time of their prototyping in the FabLab, he/she first makes online booking of the machines he/she wants to use on the FabLab CST website (https://fablab.cst.edu.bt/). In case he/she is not a member of the FabLab CST yet, he/she signs up for the membership on the same website.

4) When the user comes to the FabLab for prototyping, he/she first contacts the office and picks up his/her Activity Log Sheet.

5) Every time the user finishes the work of the day, he/she fills out the Activity Log Sheet, recording the time of machine usage and the consumption of the materials stocked at FabLab. Once it is filled out, the user gets the verification by the FabLab staff and returns the Sheet to the FabLab office.

6) Once all the prototyping works are completed, the user reports to the FabLab staff. FabLab staff calculates the machine and material usage, prepares the invoice and hands it to the user.

7) The user submits the invoice to the external organization together with the other invoices for settlement. If it is about undertaking of prototyping by the FabLab staff, FabLab CST submits the invoice directly to the external organization.

8) The external organization deposits the invoiced amount to the user or directly to the FabLab CST. In case the user receives the deposit, he/she further deposits the invoiced amount to the FabLab CST by him/herself.

9) FabLab CST reconciles all the deposits/debits with the bank statement periodically and writes in the deposit book.

10) The user completes the documentation of his/her project on the Project Gallery of the FabLab CST website or other documentation platform and informs FabLab CST of the completion of his/her project.

8.2   Talk Events / Seminars / Symposiums

This section describes the procedures for organizing events such as: (i) stand-alone talk events/seminars/symposiums, including Online Meetups and FabLab CST Users Forum; (ii) final selection of prototypes in the week-long or month-long prototyping competition in

5

collaboration with the external organization; (iii) orientation for the visitors to FabLab CST; (iv) FabLab staff visit to orientation/demonstration/exhibition in other places:

1) Discuss and agree on the success criteria and its metrics of the event. The metrics should be collected by feedback form (described later) of the event.

2) Secure venue for the event.
   - Secure and reserve the venue for the event. If the venue is outside of FabLab CST, compare potential venues with their available time slots and costs, then decide the venue by agreement of both parties.
   - Get permission to use the venue if required.
   - Make necessary arrangement for pre-payment of the venue if required.

3) Contact speakers and presenters, including chief guest and guests of honor.
   - Elaborate potential speakers, presenters, and guests of the event and contact them for their consent and availability.
   - Communicate with speakers and presenters for the content of their speech / presentation. Confirm any need for additional equipment or material to be used, then make necessary arrangement for them.
   - It is desirable to obtain their speech content / presentation material prior to the event. Make printed copies if it is necessary to distribute them to the participants of the event.

4) Call for volunteers to help organizing the event (if necessary).

5) Prepare event time schedule by coordinating with speakers and presenters.

6) Prepare and execute the marketing and promotion of the event.
   - Design a marketing plan including target audience, core message to deliver, marketing methods, etc.
   - Implement the marketing and promotion using available channels and medias including social media advertising, email campaigns, posters, newspapers, and website announcements.

7) Preparation of the venue layout and logistics
   - Plan the layout of the venue including exhibitions, hands-on showcases, demonstrations, posters, etc.
   - Prepare for registration forms if necessary. Online registration form is suitable for capturing potential list of attendees. Also prepare for paper registration form to be used at venue.
   - Prepare feedback forms if necessary. Online feedback form (with QR code shown at the venue) and / or paper feedback form (questionnaire) should be

6

prepared. The form should contain metrics to be measured for the success of the event (such as subjective satisfaction level 1-5 of the visitors, etc.).

- Arrange all logistics, such as transportation, accommodation for guest speakers, signboard for the location of venue (room), etc.

8) Prepare backup and contingency plans for potential issues, such as a change in venue or cancellation of a guest speaker / presenter.

9) Event Implementation
- Before starting the event, all staffs should gather and have a briefing session on the confirmation of schedule and responsibilities.
- Manage registration of guests and visitors.
- Implement the event as per the plan.

8.3 Workshops and Trainings

This section describes the procedures for organizing events such as: (i) stand-alone workshops and trainings at FabLab CST or any other place upon the request by the external organizaiton; and (ii) capacity building as part of the week-long or month-long prototyping competition in collaboration with the external organization:

1) Design the workshop / training by discussion of both parties.
- Identify target group that would benefit most from the workshop / training.
- Determine time-schedule, participant prerequisites, equipment and materials to be used, and expected outcomes (products, achievements, etc.).
- Design the content of the workshop / training (lectures, hands-on practices, mini-projects, etc.)
- Determine how to evaluate the achievement (by some metrics or by evaluation of products created by the participants, etc.). For trainings, set a goal and target skill level after the training, and determine the measurable evaluation method such as examination or score-based product assessment.

2) Assign trainers of the workshop / training such as the followings.
- Staffs of FabLab CST.
- Invited trainers from other FabLabs and relevant institutions.
- Also call for volunteers to help organizing the workshop / training (if necessary).

3) Develop training materials such as the followings.
- Textbook, presentations, hands-on practices, sample products, and other instructional materials that align with the objectives of the workshop / training.
- Prepare for the certificate to be given to successful participants of the workshop / training.

7

4) Secure venue, equipment, and materials for the workshop / training.
   - Reserve necessary venue and equipment of the FabLab.
   - In case the venue is not in FabLab CST, make necessary reservation or arrangement to secure the venue including budgetary allocation.
   - Test all necessary equipment in the FabLab and arrange them for easy access during the workshop / training.

5) Send reminders to participants regarding date, time, location, and any prerequisites.

6) Prepare venue by setting up the equipment, seating arrangement, and other necessary materials such as attendance sheet.

7) Conduct the workshop / training
   - Registration and Introduction: Register attendees and provide an introductory session if necessary.
   - Carry out the workshop / training as planned, ensuring safety protocols are followed.
   - Offer individual assistance as needed, making sure each participant gains practical experience.

9 Procedure VI. Post-Collaboration Activities

1) Evaluation: Collect feedback from attendees and evaluate the collaboration's success based on predefined metrics.
2) Appreciation: Send thank you notes or certificates of appreciation to speakers, sponsors, volunteers, and attendees.
3) Certificate of Participation: Prepare the certificate of participation to participants in case it deems necessary.
4) Reporting: Prepare a report of the collaboration, including the achievement of goals, attendee feedback, and financial details.
5) Documentation: Document and publish the event online for future reference including photos, videos, written summaries, lessons learned, etc.
6) Information sharing: Share the documentation and other useful outcomes of the collaboration with other FabLabs in the world.
7) Networking: Keep communication open with the partner organization for potential future collaborations.

10 Amendments

The SOP should be reviewed annually or whenever significant changes occur in the process or legal requirements. All amendments should be approved by the Director of FabLab CST Phuentsholing and communicated to all relevant staff.

Annex 2-6:   FabLab CST Project User Registration Form

FabLab CST Project User Registration Form

User Name (Team Representative)		ID. No.	
Contact Email ID		Mobile	
Department/Workplace/ Organization			
Purpose of the Use (Project Description)			
Expected Period of FabLab Usage	From / / To / / (weeks)		
Machines Expected to Use			
Budget Arrangement	☐ Funded by the Department/Workplace/Organization _____ ☐ Self-Funding		
Measures to Share Your Experience with Others (Check at least one box.)	☐ Google Documents ☐ Project Gallery on FabLab CST Website ☐ Other Platform_____		
Verification by the Supervisor	Name: (signature) Date: / /		

I went through and fully agreed on the principles as a responsible fabber described in the Fab Charter and hereby agreed to follow the terms and conditions on the use of FabLab CST.

Signature: _____

Date: /   /

[For Internal Use]

Project Closing	Date: / / Confirmed by:
Payment	Date: / / Confirmed by:

Annex 2-7:   List of Web-Based Deliverables

S.N.	Type of Media	Title	URL Link	Target	Remarks
1	SNS	FabLab CST Phuentsholing Facebook	https://www.facebook.com/p/FabLab-CST-in-Phuentsholing-Bhutan-100071110512703/	Users, General Bhutanese Citizens, Global FabLab Community, Development Partners	Est. July 2021 3,120 followers (as of 30th November 2023)
2	SNS	YouTube Channel	https://www.youtube.com/@fablabcst-ue8em	Users, General Bhutanese Citizens, Global FabLab Community, Development Partners	Est. November 2023 17 followers (as of 30th November 2023)
3	Web-site	FabLab CST Phuentsholing Web-site	https://fablab.cst.edu.bt/	Users, Global FabLab Community	(i) Membership Registration (ii) Web-based reservation of machines and rooms (iii) Web-based reservation of training and other events (iv) Documentation Platform "Project Gallery"
4	Web -site	JICA Project Website (in Japanese)	https://www.jica.go.jp/Resource/project/bhutan/012/index.html https://www.jica.go.jp/oda/project/1900281/index.html	JICA/JOCVs, General Japanese Citizens, FabLabs in Japan, Other JICA Projects	Est. December 2021 55 project news uploaded (as of 30th November 2023)
5	Other Web Platform	fablabs.io	https://www.fablabs.io/labs/fablabcst	Global FabLab Community	Web-platform for all the FabLabs in the world are supposed to upload their profiles.
6	Other Web Platform	NayKap Gokab (Platform for Grassroot Innovation)	https://naykapgokab.bt/	Grassroot Innovators, Funders/Fundseekers, Solution Seekers/Providers	Launched by UNDP in May 2023 FabLab CST was one of the first four local solutions posted on the platform.

Project Design Matrix

Project Title: Project for Promotion of Technology Education and Diffusion through Digital Fabrication Laboratory (Fab-Lab)　　Version 1.0

Implementing Agency: College of Science and Technology (CST), Rinchending, Phuentsholing, Bhutan　　Dated October 3, 2019

Target Group: Students and Faculties of the CST and Other Colleges of Royal University of Bhutan

Period of Project: 36 months (from the date of 1st JICA expert dispatched.)

Project Site: CST at Phuentsholing

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal					
Solving social issues through digital fabrication by incorporating skill based educational programme in Bhutan	Solving social issues through digital fabrication is featured as a subject of technical education policy	Record of CST			
Project Purpose					
Develop new educational models and innovation that links technological capacity to the needs of the society and industries by establishing the digital fabrication laboratory at CST	Sustainable business plan, rules and regulations for the operation and management of the Fab Lab is developed.	Project Report	Budget for CST and FabLab does not decrease dramatically.		
Outputs					
1. A global Standard FabLab as a digital fabrication technology base under the Electronics and Communication Engineering Department (ECED) at CST.	1. Sustainable business plan, rules and regulations for the operation and management of the FabLab is developed. 2. The lab based work is integrated into the ECED curriculum	Project Report	Trained personnel do not resign, or are transferred to frequently.		
2. Collaboration and interaction of interdisciplinary lab-based research within CST is enhanced through FabLab.	XX number of prototypes developed by in collaboration with other department	Project Report			
3. CST collaborates with other colleges, public and private institutions to address social and economic problems of the country using FabLab as a platform.	XX number of practical ideas are proposed to the ministries or companies by the students	Project Report			
4. FabLab functions in CST provide the platform for open innovation for individuals/citizens and schools to work on own needs, enhance their own skills and develop customized products that address their social and economic problems.	XX of users (user/visitors) for FabLab visited by other organizations/schools	Project Report			

Activities	Inputs		Important Assumption
	The Japanese Side	The Jordan Side	
[Output 1]	1. Dispatch of Japanese experts. 　a. Chief Advisor/ Project Administrative Coordinator 　b. Designer and developer of FabLab; 　c. Training on digital fabrication 　d. Curriculum development 　e. Private Sector/Incubation 2. Equipment (Necessary equipment and spare parts for setting up the FabLab) 3. Training for Counterpart Personnel (in Japan or 3rd country) 4. Local cost for the activity of Japanese Experts.	1. Assignment/ allocation of Counterpart personnel (s) 2. Office space for the project experts 3. Space and necessary furniture for FabLab 4. Provision of use of related equipment (software and hardware)	
1-1. Make the institutional arrangements for ECED to be a department responsible for operation and management of the FabLab.			
1-2. Train human resources to be instructors of the new FabLab.			
1-3. Develop a sustainable business plan for the FabLab.			
1-4. Develop rules and regulations for the operation and management of the FabLab.			
1-5. Construct and develop interior of the FabLab.			**Pre-Conditions**
1-6. Procure required equipment and spare parts for FabLab.			1. The CST provides a dedicated space for setting up the FabLab within the campus.
1-7. Integrate the FabLab into the ECED curriculum.			
[Output 2]			
2-1. Provide training on digital fabrication for the other faculties and students.			
2-2. Facilitate the production of the prototypes and equipment for the other existing laboratories.			
2-3. Organize events to promote the inter-department collaboration of faculty members and students.			
[Output 3]			
3-1. Develop standard operation procedure (SOP) to create an enabling environment with other colleges and institutions.			
3-2. Enhance the students' exposure visites to the sites where the relevant technologies aren skills are applied.			
3-3. Organize forum to promote the collaboration with other colleges and institutions.			
3-4. Support students to conduct sub-projects with other colleges or institutions using FabLab.			<Issues and countermeasures>
[Output 4]			
4-1. Develop rules and regulations, including fee structures, for the use of the FabLab by citizens.			
4-2. Receive citizens as FabLab users and provide the trainings/workshops for them.			
4-3. Facilitate interactions between FabLab users to create new ideas for innovations.			
4-4. Develop school outreach programme to invite schools for science and technology demonstrations and experiments.			

Project Design Matrix

Project Title: Project for Promotion of Technology Education and Diffusion through Digital Fabrication Laboratory (Fab-Lab)   Version 2.0

Implementing Agency: College of Science and Technology (CST), Rinchending, Phuentsholing, Bhutan   Dated July 18, 2022

Target Group: Students and Faculties of the CST and Other Colleges of Royal University of Bhutan

Period of Project: From December 18, 2020, to December 17, 2023

Project Site: CST at Phuentsholing   Model Site:

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal					
Solving social issues through digital fabrication by incorporating skill based educational programme in Bhutan	Solving social issues through digital fabrication is featured as a subject of technical education policy	Record of CST			
Project Purpose					
Develop new educational models and innovation that links technological capacity to the needs of the society and industries by establishing the digital fabrication laboratory at CST	Sustainable business plan, rules and regulations for the operation and management of the Fab Lab is implemented in CST.	Project Report	Budget for CST and FabLab does not decrease dramatically.		
Outputs					
1. A global Standard FabLab as a digital fabrication technology base under the Electronics and Communication Engineering Department (ECED) at CST.	1. Sustainable business plan, rules and regulations for the operation and management of the FabLab is developed. 2. The lab-based work is integrated into the ECED curriculum.	Project Report	Trained personnel do not resign, or are transferred to frequently.		
2. Collaboration and interaction of interdisciplinary lab-based research within CST is enhanced through FabLab.	5 number of prototypes developed by in collaboration with other departments.	Project Report			
3. CST collaborates with other colleges, public and private institutions to address social and economic problems of the country using FabLab as a platform.	6 number of practical ideas are proposed to the ministries or companies by the students.	Project Report			
4. FabLab functions in CST provide the platform for open innovation for individuals/citizens and schools to work on own needs, enhance their own skills and develop customized products that address their social and economic problems.	10 of users (user/visitors) for FabLab visited by other organizations/schools.	Project Report			

Activities	Inputs		Important Assumption
	The Japanese Side	The Jordan Side	

[Output 1]
 1-1. Make the institutional arrangements for ECED to be a department responsible for operation and management of the FabLab.
 1-2. Train human resources to be instructors of the new FabLab.
 1-3. Develop a sustainable business plan for the FabLab.
 1-4. Develop rules and regulations for the operation and management of the FabLab.
 1-5. Construct and develop interior of the FabLab.
 1-6. Procure required equipment and spare parts for FabLab.
 1-7. Integrate the FabLab into the ECED curriculum.
 [Output 2]
 2-1. Provide training on digital fabrication for the other faculties and students.
 2-2. Facilitate the production of the prototypes and equipment for the other existing laboratories.
 2-3. Organize events to promote the inter-department collaboration of faculty members and students.
 [Output 3]
 3-1. Develop standard operation procedure (SOP) to create an enabling environment with other colleges and institutions.
 3-2. Enhance the students' exposure visites to the sites where the relevant technologies aren skills are applied.
 3-3. Organize forum to promote the collaboration with other colleges and institutions.
 3-4. Support students to conduct sub-projects with other colleges or institutions using FabLab.
 [Output 4]
 4-1. Develop rules and regulations, including fee structures, for the use of the FabLab by citizens.
 4-2. Receive citizens as FabLab users and provide the trainings/workshops for them.
 4-3. Facilitate interactions between FabLab users to create new ideas for innovations.
 4-4. Develop school outreach programme to invite schools for science and technology demonstrations and experiments.
	1. Dispatch of Japanese experts.
	   a. Chief Advisor/ Project Administrative Coordinator
	   b. Designer and developer of FabLab;
	   c. Training on digital fabrication
	   d. Curriculum development
	   e. Private Sector/Incubation
	 2. Equipment (Necessary equipment and spare parts for setting up the FabLab)
	 3. Training for Counterpart Personnel (in Japan or 3rd country)
	 4. Local cost for the activity of Japanese Experts.
		1. Assignment/ allocation of Counterpart personnel
		 2. Office space for the project experts
		 3. Space and necessary furniture for FabLab
		 4. Provision of use of related equipment (software and hardware)
			Pre-Conditions
			 1. The CST provides a dedicated space for setting up the FabLab within the campus.
			
			 \<Issues and countermeasures\>

A-65