Open Innovation and Development

JICA Research Institute

December 2016

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Introduction/Background to the Study Group

Ichiro Tambo (JICA)

As today's information society continues to develop, Information and Communications Technology (ICT)—including mobile phones, smartphones, and the Internet—as well as new production, service, and corporate activities developed by employing such devices as platforms are being applied in manufacturing and a wide range of other industries.

The Industrial Internet and Germany's Industry 4.0 policy are two examples of such applications in the manufacturing industry. Our attention has also been drawn to movements aimed at introducing methods for the development and commercialization of software/network products and services in hardware fields, such as open source designs and hardware that are created based on the open source software approach widely employed in the software/IT industry as well as the Internet of Things (IoT). Furthermore, movements such as the following continue to expand worldwide: fab labs, workshops, or communities that are designed to provide the general public with free access to 3D printers and other digital manufacturing equipment; hackerspaces, which are collaborative workspaces for avid manufacturers; and makerspaces, which are collaborative workspaces that are designed to facilitate the start-up of new businesses. These movements are often generally referred to as the Third Industrial Revolution.

The use of ICT is also rapidly expanding in developing countries as well, mainly in urban areas. Information on cutting-edge developments can be acquired simultaneously from any place on Earth via the Internet or a smartphone. More and more people from developing countries who have studied, worked, or started businesses in developed countries and areas that support innovation, including Silicon Valley in the United States, are working to share the benefits of their experience in their countries of origin. As a result, national borders are disappearing when it comes to innovation.

Against this backdrop, the 2030 Agenda for Sustainable Development was finally adopted at the United Nations (UN) Summit held in September 2015. Under this agenda, the promotion of science and technology innovation (STI) was listed as a specific development target in the following Sustainable Development Goals (SDGs) based on the concept that expanding ICT use, developing global networks of people and organizations, and promoting STI in a wide range of areas (such as pharmaceutical products and energy) will accelerate the advancement of humankind and the development of a knowledge-based society: SDG 8 (economic growth and employment); SDG 9 (infrastructure, industrialization, and innovation); and SDG 17 (implementation methods/partnership). Also, since the publication of the World Bank Report *An East Asian Renaissance* in 2007, the need to produce higher levels of physical and human capital stock, including knowledge and innovation, has often been identified as a policy issue for sustainable growth that will overcome the middle-income trap. In addition, reducing poverty through high-quality economic growth is listed by JICA as the highest priority issue in Japan's Development Cooperation Charter, which was approved in February 2015. JICA needs to develop initiatives to solve this issue.

Today, we are faced with a need to adopt a new approach to economic and social development in developing countries. In short, open innovation focused mainly on software and services is expected to open up new possibilities that would be unattainable under conventional industrial development policies. In particular, Fab Labs (i.e., digital workshops developed for the general public) are a form of open innovation that has attracted attention as a new approach capable of generating "leapfrog" effects in the economies and societies of developing countries. As such, Fab Labs are likely to demonstrate great potential in promoting the development of communities and industries. Open innovation is, of course, not limited to the grassroots levels; it can also occur among companies in the manufacturing and service industries, between companies and users, as well as among industry, academia, and the government.

In the world today, it is no longer possible to meet the expectations of developing countries by simply pursuing development assistance policies for human resource development and technical guidance based on the conventional ideas and experience of Japanese companies. Nowadays, there is an urgent need to focus on open innovation movements at the public and grassroots levels, which are not as yet widely understood but are gradually becoming more commonplace in Japan, as well as to understand the reality of such movements, to learn from the activities of their supporters, to study the development of new innovations, and to develop theories and practices aimed at realizing the potential of these movements.

Based on the above hypothesis, we established a study group in September 2015 to explore the issue of Open Innovation and Development while also focusing on the future of development economics. With the participation of prominent Japanese experts in the field of development economics and innovation, the study group held four sessions up to February 2016 to study problems from a variety of perspectives with the aim of obtaining suggestions concerning the following issues: (1) what impact is open innovation likely to have in the context of development?; (2) based on the answer to question (1), what approaches can JICA undertake to achieve the STI-related SDGs stipulated in the 2030 Agenda for Sustainable Development?; and (3) how can JICA use the context of open innovation to achieve the high-quality economic growth mentioned in the Development Cooperation Charter? This report summarizes the results of these sessions.

Chapter 1: Changes in the International Environment for Development

1-1 Transition from MDGs to SDGs

Koji Yamada (JICA)

At the UN Summit on Sustainable Development that was held in New York in September 2015, the UN member states voted unanimously to adopt the 2030 Agenda for Sustainable Development[1], which defined new development goals that had been examined for more than three years. Building on the Millennium Development Goals (MDGs) that were to be achieved by 2015, the new agenda summarizes the development issues that need to be addressed by all members of the international community by 2030 into 17 goals and 169 targets. These goals and targets are referred to as the Sustainable Development Goals (SDGs).

Prior to the adoption of the SDGs, the international community is said to have identified two general developments. One was the poverty reduction initiative, which was defined in the MDGs, while the other was the sustainable development initiative, which was adopted after the United Nations Environmental Development Conference held in 1992. To pursue the latter initiative, the United Nations Conference on Sustainable Development was held in 2012 in Rio de Janeiro, Brazil (Rio + 20). At this conference, consensus on the adoption of the SDGs as successors to the MDGs was achieved and the process for formulating the SDGs was started based on this consensus.

One serious problem that was raised with regard to the MDGs was that the goals overlooked the issue of widening economic gaps. According to the progress report on MDG initiatives that the UN published in July 2015, although schedules had been arranged effectively to achieve many of the targets, the level of achievement varied from one target to another. The report also pointed out that the poorest and the weakest are still being left behind. The targets regarding gender inequality, economic differences between the poorest and wealthiest households, and the considerable gap between rural and urban areas are unlikely to be achieved, and this issue is a serious point of concern for SDGs, as well. The proportion of the population without access to safe drinking water is only 4% in urban areas, but this figure rises to as high as 16% in rural areas. The proportion of the population without access to toilets also differs considerably between urban areas (18%) and rural areas (50%). Formulated based on the principle of inclusiveness (i.e., ensuring that no one will be left behind), the SDGs include goals aimed at providing education, welfare, water security, food security, and other direct support services that are focused with precision on specific support targets.

Meanwhile, even those who managed to escape poverty thanks to successful efforts to achieve the MDGs over the past 15 years still live in vulnerable conditions where they could find themselves in a

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[1] United Nations General Assembly, 2015. "Transforming Our World: The 2030 Agenda for Sustainable Development," Resolution adopted by the General Assembly. A/RES/70/1. 21 October 2015. http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

predicament in the event of an economic crisis, an accident, a natural disaster, or the outbreak of conflict. Therefore, in consideration of the downside risks that people potentially face, the SDGs also include goals for reducing these risks and enhancing resilience to shocks.

Furthermore, in response to criticism that the MDGs had been discussed behind closed doors by the UN Secretariat, a larger number of UN member states participated in the drafting of the SDGs, with research groups, civil society organizations, and private firms all highlighting priority issues that were important to them. As a result, the SDGs were designed to incorporate the following: the special needs of least developed countries (LDCs), small island developing states (SIDS), landlocked developing countries (LLDCs) and other small nations; the needs of women, people with disabilities, ethnic minorities, immigrants, and other vulnerable people; and considerations for human rights. For this reason, the SDGs include the very large number of development goals and targets described above.

These results provide evidence for the growing vulnerability of the global system as well as the increasing complexity and globalization of development issues. Published by former JICA President Akihiko Tanaka in 2009, *The Post-crisis World* depicts the large-scale transformation that the global system underwent between the late 20th and the early 21st century as a simultaneous increase in the presence of developing countries (power transition) and non-state actors (power diffusion). As global externalities have continued to increase, the impact of issues such as infections and climate change have become more widespread and serious, biodiversity has diminished, resource, energy, and food security risks have intensified, and the threats posed by terrorism and international crime have grown. At the same time, new actors have taken an active part in the building of global governance. Tanaka points out that to overcome development challenges that have continued to grow in complexity, it is necessary to gather all of the knowledge possessed by the diverse range of actors that are involved.

Moreover, according to the results of a trial calculation carried out by the World Bank, a fund of approximately 1 trillion US dollars will be required on an annual basis to achieve the SDGs. However, the annual total amount of ODA is presently only about 135 billion US dollars (as of 2013), an amount that is considered to be completely insufficient.[2] Going forward, there will be a growing need to use ODA as a catalyst for employing domestic resources, utilizing private finance (both domestic and international) and improving development effectiveness by enhancing capacity. The World Bank also emphasizes the importance of building partnerships through promoting the participation of a diverse range of stakeholders (multiple stakeholders), including the private sector, local governments, universities, research institutions and civil society organizations.

The fact that the SDGs aim to achieve all of the goals and targets through partnerships means that they already fulfill the requirement of "openness," which is one aspect of open innovation and the key concept of this study. Moreover, as stated earlier in this document, the SDGs extol the benefits of

[2] World Bank, 2015. "From Billions to Trillions: Transforming Development Finance," Development Committee Discussion Note, April 2, 2015.

being "inclusive," aiming to ensure that no one is left behind. The people targeted in these goals are defined not merely as beneficiaries who need protection, but as important stakeholders who participate in and lead the development processes and take an active part in achieving the SDGs.

So, what about "innovation," the other aspect of open innovation? Innovation is mentioned in the SDGs mainly in the following three contexts.

Firstly, any innovation that directly contributes to the goals and targets of the SDGs—including clean energy, improved agricultural productivity, water treatment technology, and vaccine development—is referred to as "innovation" or "science, technology and innovation" (STI). The SDGs are very ambitious development goals, so they would be difficult to achieve by 2030 if they were viewed merely as an extension of "business as usual."[3] The SDGs are based on high expectations for the development and introduction of innovative approaches and technologies that will radically change conventional solutions to development challenges. Consequently, although using STIs in an effort to achieve individual goals and targets is not explicitly stated as a precondition, it can be implicitly assumed to be one.

In addition, the SDGs were based on the assumption that many such STIs will be created in developed countries that have abundant resources. Such technologies are global public goods that will have a positive impact not only in one country, but in other countries as well. In light of this, the SDGs have been designed to reflect the argument made by developing countries that a mechanism must be introduced to ensure access to STIs so that developing countries can use such technologies at a lower cost (Table 1, Goal 17). However, the view that STIs originate in developed countries is not always consistent with reality. In fact, there have already been many cases in which STIs originating in emerging countries have spread to developed countries as well as other developing countries. Going forward, the number of such cases is likely to continue to increase.[4]

Secondly, innovations are also required to sustain economic growth, which is an important element that provides support for continued efforts to achieve the SDGs. Such innovations aim to increase the added value of industries, promote employment, and facilitate the start-up and economic growth of businesses established by SMEs (Table 1, Goals 8 and 9). These goals do not apply to low-income countries alone. Emerging countries in Asia that have already reached the middle-income threshold by taking advantage of cheap labor and growing exports have been caught in a middle-income trap, where they experience economic stagnation before catching up with developed countries. These countries

[3] Susan Nicolai, Chris Hoy, Tom Berliner and Thomas Aedy (2015), "Projecting Progress: Reaching the SDGs by 2030." Overseas Development Institute (ODI) Flagship Report, September 2015. http://www.developmentprogress.org/publication/projecting-progress-reaching-sdgs-2030

[4] Editorial staff of The Economist (2012), *The World in 2050: The Economist Predicts*, Bungeishunju Ltd., August 2012; Radjou, Navi, Prabhu, Jaideep, Ahuja, and Simone, 2012. *Jugaad Innovation: A Frugal and Flexible Approach to Innovation for the 21st Century.* Random House, India, June 2012; Vijay Govindarajan and Chris Trible (2012), *Reverse Innovation: Create Far from Home, Win Everywhere*, Brilliance Corporation, November 2013.

have high expectations that the promotion of STIs will provide a new way to maintain economic growth.[5] In Japan too, the administrations that were in power during the late 2000s—including the Democratic Party of Japan administration and the Liberal Democratic Party administration led by Shinzo Abe—placed a high priority on growth strategies. Sustained growth targets that are achieved through the promotion of STIs clearly demonstrate the universality of the SDGs in that they apply not only to low-income countries, but also to middle- and high-income countries.

However, to realize innovation in these two contexts, it is also necessary to develop policies and system environments that will enable such innovation. The need to develop policies and systems to promote STIs is already stipulated in Goals 8 and 9. In addition, we must also emphasize the need to develop human resources in a third context. As mentioned mainly in Goal 3, it is necessary not only to develop the skills required to enhance capacity for employment and business start-ups through technical education and vocational training and to expand the range of higher education to include activities such as research and development in engineering, science, and technology, but also to improve the quality of the primary and secondary education system that prepares students for higher education.

Table 1-1: Sustainable Economic Growth and Science and Technology Innovation in the SDGs

Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	
8.1	Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries
8.2	Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value-added and labor-intensive sectors
8.3	Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services
Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	
9.5	Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per one million

[5] Gill, I. and H. Kharas (2007), *An East Asian Renaissance: Ideas for Economic Growth*, Washington, DC, World Bank. In addition, the Fifth Asian Development Forum that was held in Hanoi in September 2014 defined the theme for the forum as follows: "Challenges and Strategies towards Sustainable Growth in Asia." At this forum, it was pointed out that in order to maintain economic growth by avoiding the middle-income trap, it is important to promote innovation through research and development, provide higher education for human resource development in industry, facilitate industry-academia collaborations, meet the vast infrastructure needs, and provide the support required to allow government organizations to play their respective roles in achieving these goals. https://www.jica.go.jp/english/news/field/2014/141017_01.html

	people and public and private research and development spending
9.A	Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing states
9.B	Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities
Goal 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development	
17.6	Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism
17.7	Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favorable terms, including on concessional and preferential terms, as mutually agreed
17.8	Fully operationalize the technology bank and science, technology and innovation capacity-building mechanism for least developed countries by 2017 and enhance the use of enabling technology, in particular ICT

Source: Excerpts from "Transforming Our World: The 2030 Agenda for Sustainable Development" (https://sustainabledevelopment.un.org/post2015/transformingourworld)

1-2 Limitations of Traditional Development Stakeholders

Hideshi Yamashita (JICA)

In the previous section, we focused on innovation in terms of the SDGs defined under the new development agenda. In this section, we focus on and conduct an analysis of aid approaches and stakeholders in the context of development.

1-2-1 Traditional Development Cooperation: ODA Provided by DAC Countries

Traditionally, bilateral aid provided by development aid agencies and multilateral aid provided by the UN and other international organizations played pivotal roles in the pursuit of development, and these forms of aid were available in the form of official development assistance (ODA) from developed countries. Although it became a recipient of aid soon after the end of World War II, Japan has provided aid to developing countries throughout the more than 60 years that have passed since the launch of its ODA program in 1954.

As mentioned in the previous section, the UN plays a leading role in defining development goals and issues. However, the Development Assistance Committee (DAC) of the Organisation for Economic Co-operation and Development (OECD)[6] has been taking the lead in discussions about aid approaches, including in terms of how to harmonize international development assistance schemes and how to improve the development effects by coordinating the efforts of the various different development aid agencies. Through the Paris Declaration (2005), the Accra Agenda for Action (2008), the Busan Partnership Document (2011), and other such agreements, the OECD/DAC has worked to promote initiatives that are aimed at clarifying development goals, particularly those based on ownership by the developing countries. To achieve these development goals, OECD/DAC member states and its partners have promoted greater coordination in the implementation of the activities undertaken by the various development stakeholders to enhance the effectiveness and efficiency of their development cooperation in partnership with the developing countries.

Until the 2000s, ODA was the mainstream approach to development. Accordingly, discussions at the OECD/DAC had been focused mainly on the framework for ODA provided by DAC countries (developed countries). However, with the international community becoming increasingly aware of infectious diseases, climate change, conflicts, and other global issues, funds and development stakeholders outside of the ODA framework have begun to exert greater influence as a result of the growing standing of emerging countries, private foundations, and other non-DAC groups, the

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[6] Made up of the European Union (EU) and 28 of the 34 OECD signatories, the DAC has a total of 29 members. The Development Assistance Group (DAG), which was the precursor to the DAC, was established in January 1960 and the OECD was established in September 1961. Subsequently, the DAG became a committee under the jurisdiction of the OECD and was reorganized to form the Development Assistance Committee (DAC). Japan joined the DAC in 1961.

increasing flow of private funds to developing countries and the expanded roles played by the private sector in development. In consideration of these developments, the Busan Partnership Document (2011) presented new arguments concerning issues such as how to cope with the new assistance structure resulting from the diversification of development challenges and the expanded range of development stakeholders, including emerging countries and private companies. At the most recent OECD DAC High Level Meeting (i.e., the 50th such meeting, which was held in February 2016), participants shared the view that it is necessary to further expand and deepen collaborations with non-DAC countries based on the 2030 Agenda for Sustainable Development and the new reality for development cooperation. In consideration of the diversification of development stakeholders, participants also expressed the view that it is necessary to mobilize the public and private funds and make effective use of them to contribute to the development of developing countries. Going forward, discussions will be held to address more specific issues, including statistics for development funds other than ODA.

Thus, given the growing presence of funds other than ODA and the diverse range of stakeholders involved in development, it is becoming more and more necessary to re-examine the aid cooperation framework that has been developed under the leadership of the OECD/DAC.

1-2-2 Growth of Non-ODA Funds

As described above, recent years have seen global issues gaining public attention, SDGs being adopted for inclusive development, and development funds from emerging countries and private foundations playing more prominent roles alongside the private sector. As a result, the forms of development cooperation that are used have diversified as the types of development stakeholders have continued to diversify. In particular, the growth of development funds, including private ones, and the increasing role of the private sector have been discussed by the OECD/DAC as important themes that are likely to grow in importance in the context of development in the future.

In the following sections, we discuss development forms and aid approaches other than ODA. A variety of development funds other than ODA are available today, such as financial assistance from private financial institutions, direct investment by private companies, and remittances from expatriates. In addition to large-scale loans for infrastructure and other facilities, financial assistance provided by private financial institutions also includes microfinance systems for the poor, such as the microfinancing provided by the Grameen Bank (a microcredit system that provides small amounts of unsecured loans), which was established by Nobel Peace Prize Winner Muhammad Yunus in Bangladesh in 1983. Having attracted global attention as a new form of financial services for the poor, who until then had not been considered as viable candidates for loans, microfinancing is becoming more widespread and expanding in developing countries as an approach to reducing poverty.

The Grameen Bank was designed as a business model for providing loans to the poor. To that end, the bank imposes conditions in exchange for not requiring security for its loans, such as requiring its customers to form mutual aid groups made up of five people. Until then, providing unsecured loans to the poor had been an inconceivable business model for ordinary financial institutions. However, the bank maintained a high repayment rate by forming mutual aid groups to disperse the risk and by offering strong incentives so as to develop unconventional financial services for the poor.

Initially, many people were skeptical about the Grameen Bank due to the high financial risks involved. Nevertheless, the bank managed to maintain a high repayment rate contrary to predictions by using various measures and systems, thereby proving that it offers an effective approach for reducing poverty. Japan's ODA was provided in the form of yen loans as capital for the Grameen Bank, so the bank promoted the use of ODA as well. Since ODA is based on inter-governmental cooperation, it had been difficult to establish direct contact with people living in poverty to provide them with financial assistance. The emergence of the Grameen Bank and other microfinance institutions has made it possible to provide financial services to the poor through loans made to microfinance institutions. Microfinance institutions serve as a means of channeling ODA to the poor and they have great significance in their capacity as entities that help to expand the scope of ODA.

Another reason why the Grameen Bank attracted global attention was that the bank promoted the establishment of businesses by the poor. Essentially, the Grameen Bank program attracted attention as a model for social businesses aimed at solving specific social issues for profit, particularly as it is a Base of the Pyramid (BOP) business model designed specifically to assist the poor.

BOP businesses offer a relatively new approach in that they solve social issues in developing countries (by providing water, daily supplies and services, reducing poverty, etc.) through business ventures. As was the case with the Grameen Bank, many people believe it is difficult to develop successful businesses for the poor. This is probably because they believe in providing business opportunities for the poor in existing markets. In contrast, the feature that is common to the Grameen Bank and other companies that develop BOP businesses is that they provide services that meet the consumption patterns and preferences of the poor (e.g., the selling of products in small packages, usage-based charges, low-price products equipped with core functions, and effective use of existing sales channels and IT). The most important element is the employment of a business design (human-centered service design) that meets the real needs of the BOP. However, given that the BOP market is not yet fully developed, a perfect business model for success is far from being established and there is no guarantee that even large companies will succeed in business. Therefore, it is often said that we need to create, rather than discover, opportunities in the BOP market.[7] The BOP market is, of course, very challenging in terms of the risks and restrictions that are involved. Recent estimates put the BOP

[7] Ted London and Stuart L. Hart, *Next-Generation Business Strategies for the Base of the Pyramid: New Approaches for Building Mutual Value*, Pearson FT Press, 2010.

population at approximately 4 billion people and the BOP market is considered to be a market of the future worth as much as 5 trillion dollars that has enormous potential. Thus, the BOP is not only considered to be a core target in the context of development, but is also beginning to be seen as a market with business potential. These examples demonstrate that the growing presence of social/BOP businesses is attracting public attention as a new trend in the context of development, which conventionally tended to be centered on ODA and NGOs.

The emergence of social/BOP businesses is considered to make a considerable contribution to development in two respects. Firstly, in the conventional development approach, the poor in developing countries were regarded as the target for assistance. In the social/BOP business approach, however, the poor are seen as entities involved in economic activities—such as loan candidates, consumers, producers, or vendors—or as potential new markets. As the method of identifying aid targets changes, the method of approaching them obviously changes as well. These changes in how aid targets are identified are, therefore, likely to have a strong impact on and reframe the conventional development approach, thereby creating mutual interaction between the BOP and service providers in addition to the conventional intervention based on external assistance.

Secondly, as mentioned above, the development approaches and stakeholders have diversified and the business areas have expanded. As the BOP market is attracting public attention and social/BOP businesses are becoming more widespread, an increasing number of companies are gaining access to the market to develop businesses. Originally, many companies carried out activities in developing countries as part of their corporate social responsibility (CSR) and other charitable programs. However, following in the footsteps of Unilever and Nestlé, companies have now started to develop social/BOP businesses. Since these companies engage in ventures that are beneficial to development as their main business lines, they are able to support the introduction of the products, technologies, and business models that they have developed through business into the field of development, which was conventionally reserved for traditional development stakeholders. These developments have made it possible for a wide variety of products and services that had previously been difficult to offer to the poor, including intervention programs and services, to be provided through ODA. As a result, the range of available services was diversified, which was a groundbreaking advance in the context of development.

As mentioned earlier, the BOP market is very new and it offers great business opportunities for not only entrepreneurs but also large companies. Consequently, the market has created a large number of social enterprises—including social entrepreneurs that have started social/BOP businesses—thereby attracting public attention by offering new business models and role models from a business perspective.

In light of this, an increasing number of companies and entrepreneurs who are aiming to create new business models for development programs are participating in BOP businesses and diversifying the range of development stakeholders. The programs developed by these enterprises and the values proclaimed by social entrepreneurs and companies have also helped remove the conventional boundaries between development and business. As a result, the closed space of the development sector seems to be gradually opening up, resulting in an expansion of the business areas for development.

In tandem with the diversification and expansion of the range of development approaches and stakeholders outside the ODA framework, bilateral and multilateral development aid agencies are also working to actively support development cooperation. To that end, they are collaborating with the private sector in pursuing development activities and using various corporate resources and technologies instead of providing conventional unilateral aid through ODA. Consequently, development cooperation projects, often referred to as "public-private partnership programs," have been launched to utilize the technologies, products, and business models developed by the private sector.

The forms of public-private partnership programs vary from one development aid agency to another. In fiscal 2010, JICA also started conducting the Preparatory Survey for BOP Business Promotion with the aim of developing BOP business models in developing countries, drafting business plans, and studying the possibility of JICA entering into partnerships with private companies.[8] JICA conducted this survey based on proposals made by Japanese companies of various sizes that they screened and selected. To date, more than 100 programs have been implemented.

The programs that have been implemented so far include Ajinomoto's project in Ghana to develop and sell KOKO Plus, a dietary supplement designed to improve children's health, and Saraya's project in Uganda to sell alcohol-based hand disinfectant. Such projects have actually contributed to business development in the developing countries. For example, Saraya's alcohol-based hand disinfectant was used to prevent the spread of Ebola hemorrhagic fever in Africa in 2012, and it is starting to be used widely overseas now as well. In addition to health care, JICA also provides support for business incubation to promote the use of corporate products and technologies in a wide range of areas, including agriculture (organic farming, agricultural equipment leasing, etc.), education (e-learning, etc.), and banking (microfinancing, etc.). In fiscal 2012, JICA also launched a project focused on Japanese SMEs to support their overseas business development. In accordance with the policy of using ODA to support Japanese SME's overseas business development as stipulated in the Japan Revitalization Strategy (2013), the Japanese government's growth strategy, and the Infrastructure System Export Strategy (FY 2014 revised edition) (2014), this project carries out surveys and projects using SME products and technologies that are expected to contribute to resolving issues and challenges in developing countries. The project scheme provides three different options: a Partnership Promotion Survey, a Feasibility Survey, or a Verification Survey. As is the case with the above-

[8] See the official JICA website for details.

mentioned Preparatory Survey for BOP Business Promotion, this survey is being conducted based on proposals made by SMEs. Nearly 400 surveys and projects have been implemented to date.

JICA's scheme includes projects in a wide variety of areas, ranging from water treatment (sand filtration, film treatment, water purification agents, etc.) and natural energy technologies (wind power, micro-hydraulic power, photovoltaic power, etc.) to energy-saving measures and advanced waste treatment technologies. In recent years, we have received an increasing number of proposals for the use of ICT. Consequently, we are developing projects using cutting-edge technologies that change simultaneously in developed countries, such as remote medical care, e-learning, and traffic control using GPS.

Surveys and projects such as those described above that are developed based on companies' proposals use technologies and business models that JICA had not adopted until now. In particular, model projects that use ICT are extremely innovative and their achievements are expected to deliver benefits to other JICA projects. As these examples demonstrate, the contributions that private companies' products and technologies make to development cooperation are attracting public attention. Such contributions are creating a trend that enables JICA and other development aid agencies in Japan and overseas to acquire new ideas from both inside and outside of their organizations and to develop new development cooperation projects.

For example, the United Nations High Commissioner for Refugees (UNHCR) is working in collaboration with IKEA[9] to provide solar lanterns and Better Shelters,[10] newly developed temporary housing units, in refugee camps. Also, the United Nations Children's Fund (UNICEF) recently launched the UNICEF Innovation Fund for the purpose of investing in open source technologies, thereby raising 9 million US dollars. UNICEF has already started investing in the following three areas: products for people under the age of 25 that can be used for a wide range of purposes, including learning and social participation; the provision of real-time information that can be used to assist decision making; and infrastructure that improves access to services and information (connectivity, power, costs, sensors, transportation, etc.).

As the above demonstrates, development aid agencies are collaborating with private companies and other organizations more often than ever as development issues become ever more globalized and complex. One of the reasons for this is that more and more traditional development stakeholders have recognized that conventional development methods and existing aid approaches do not provide fundamental solutions to the issues they face. Such recognition is also one of the reasons why,

[9] A Sweden-based company that is the world's largest furniture vendor.
[10] Started by the Housing for All Foundation, which is a nonprofit foundation established by the IKEA Foundation. Based on a demographic design (forms, functionality, quality, sustainability, and low prices), the use of Better Shelters was trialed by 40 refugee families in Iraq and Ethiopia to repeatedly improve its design.

compared to the MDGs, the SDGs set out more inclusive goals and more strongly emphasize the need for the active involvement of the private sector as well as public agencies and the civil sector.

Through the involvement of private companies and other new players, this trend is expected to increase the likelihood of discovering new solutions that differ from conventional ones by complementing and enhancing conventional ODA-centered development projects. Furthermore, looked at from another perspective, this trend may also result in conventional profit-oriented corporate activities being replaced by activities for creating shared value (CSV); in other words, corporate activities that are more focused on social missions. In fact, some private companies are already working directly in developing countries without going through development aid agencies or other such organizations to develop businesses that would conventionally have been supported by development aid agencies in the telecommunications infrastructure sector. For example, business ventures designed to provide free-of-charge Internet access have been undertaken by Google using high-flying balloons in Sri Lanka and by Facebook launching a satellite in Africa. These two companies are, of course, developing such businesses with the aim of increasing their sales by improving overall access to the Internet. Nevertheless, by supporting the development of large-scale basic infrastructure facilities, these private companies are creating unconventional business models (perhaps close to the business models used by railway companies in the past to combine business with urban development).

As a result, the range of activities undertaken by private companies in the development business is steadily expanding and this trend is likely to continue to grow in the future. To promote development, it is necessary to use advanced products, technologies, and business models created by private companies that will contribute to the resolution of issues in developing countries. How we go about identifying recent trends and making effective use of these corporate assets in starting businesses based on innovative and effective development ideas that would have been impossible to achieve using conventional development approaches will become even more important going forward, especially in Japan as it has seen a decline in the number of its ODA programs.

Finally, let's take a look at some trends in developing countries. Since the late 2000s, the development of ICT—especially those used in mobile phones—has had a considerable impact in a variety of areas, including the telecommunications industry in developing countries. Unlike in Japan, SIM-card mobile phones and prepaid mobile phones are commonly used in developing countries. Thanks to the inexpensive initial investment and usage-based telephone rates, these mobile phones are available for low prices there. Since the functions of mobile phones are highly extendable, they can be used even in African villages without electricity and their use is continuing to expand exponentially in developing countries.

As mobile phones do not require large-scale infrastructure facilities or high initial investment and they enable users to obtain and provide information at any time, their use is said to have changed the behavior patterns of the poor. For example, farmers who used to have no access to market information and had to sell their products at greatly reduced prices to brokers are now able to negotiate the sale of their products at appropriate prices since they can access market information via mobile phone. Similarly, health workers who used to have to submit paper-based public health reports to higher authorities every week are now able to submit them via mobile phone, thereby improving operational efficiency. As these examples demonstrate, mobile phones have had an enormous impact on development as well.

In addition to improvements made through the use of telecommunication functions, new services are also being developed through the use of mobile phones as basic devices. A typical example of this is M-Pesa, a financial services package that provides, among other things, money transfer services and small-amount settlement services that were developed in Kenya and other countries. Financial services such as money transfers via mobile phone, micro loans, small-amount settlements, and money withdrawals were originally launched in 2007 in Kenya. Having subsequently expanded into areas other than East Africa, such as the Republic of South Africa and even Eastern Europe, these services are now used in Kenya by approximately one third of its population (approximately 13 million people). This proves that enabling services—such as small-amount transfers, settlements, and loans—to be carried out via mobile phone contributes to improved access to financial services.

Of particular interest is the fact that some services that have not yet been realized in Japan were developed first in Africa. In particular, it is extremely thought provoking that, contrary to the generally held notion that developing countries follow in the footsteps of developed countries, a non-linearly developed business program that was created first in Africa has spread to developed countries.

Another interesting point is that, as was the case with Google and Facebook, two of the world's leading companies, M-Pesa also originated from ideas developed by students. Compared to providing services with the help of hardware or manpower, the use of ICT reduces the initial development costs and the risks involved. This will most likely make it easier for students and venture firms to start businesses in developing countries. Thus, the widespread use of mobile phones in Africa as a result of greater access to the Internet has enabled innovative business models to be created anywhere in the world, both in developing countries and developed countries.

Businesses that use IT as a substitute for existing services, such as M-Pesa, and businesses that form part of the "sharing" economy, such as Uber and Airbnb, are likely to serve as low-cost, low-risk business models that are relatively easy to develop and are capable of generating considerable market demand in developing countries.

As the above indicates, companies in developing countries are striving to create new business models on their own, thereby establishing a new trend in development. We believe that this trend is extremely important for the future development of developing countries. Going forward, we may need to work together to consider how we can enable companies in developing countries to create business models that will be able to resolve issues in their own countries.

Development aid agencies have been working to create systems and policies that will provide a framework for government systems and to develop and improve socioeconomic infrastructure and social services (i.e., by developing human resources for such services). Such approaches will continue to have considerable significance. To reduce poverty, however, it is essential that we create a more direct service design for the poor. In light of this, providing services on a business basis will better help to develop approaches that will meet actual needs.

To provide services for the poor, development aid agencies will be required to fulfill the mission of studying how to leverage the innovative ideas and business models of private companies.

We believe that, in order to expand the business areas in development and employ a diverse range of approaches to resolve complex global issues in developing countries, it is necessary to involve a variety of actors and resources and to shift toward creating new value (i.e., establishing ecosystems) by benefitting from their respective strengths.

Chapter 2: Open Innovation and Fab Labs

2-1 Manufacturing Redefined

Yuji Shinohara (JICA)

As mentioned in the previous chapter, manufacturing and design have undergone a major transformation in the context of globalization and open innovation. This section describes how manufacturing is defined in this world.

To consider the definition and history of manufacturing itself, we would need to cover various discussions going back to ancient times, so here—for the sake of convenience—we define manufacturing as being literally the act of making things. Since the dawn of human existence, manufacturing has offered us a way to expand the functions of things and we have made a wide variety of tools from ancient times to the present day, while changing the materials we have used from soil to stones and then to metals. P. F. Drucker describes manufacturing innovation in his book *Post-Capitalist Society* as follows:

> They brought together, codified and published [in the 1700s] the téchne[11], the craft mystery, as it had been developed over millennia. These are the essentials of what we have come to call the 'Industrial Revolution', i.e. the transformation by technology of society and civilization worldwide.

In other words, technologies and techniques that had previously been carried out by humans were delegated to machines, codified and visualized. It is clear that this change was a primary factor in the advent of the Industrial Revolution. At that time, however, codified techniques were disclosed only to closed professional communities (i.e., skilled persons, manufacturers, companies, etc.). As the concept of open innovation demonstrates, we now live in an era in which codified knowledge and techniques are disclosed to an unspecified number of people. In this era, it is necessary to divide the manufacturing process into multiple stages and make it more transparent. However, if we divide the manufacturing process up into more detailed steps, how can we understand it? Although there is room for discussion, the process can essentially be broken down into the elements described below.

Although a well-established theory is not yet available, the manufacturing process can be broadly divided into six elements: Planning → Design → Funding → Manufacturing → Sale → Verification. Even if you decided to manufacture something yourself as a kind of DIY[12] project, you

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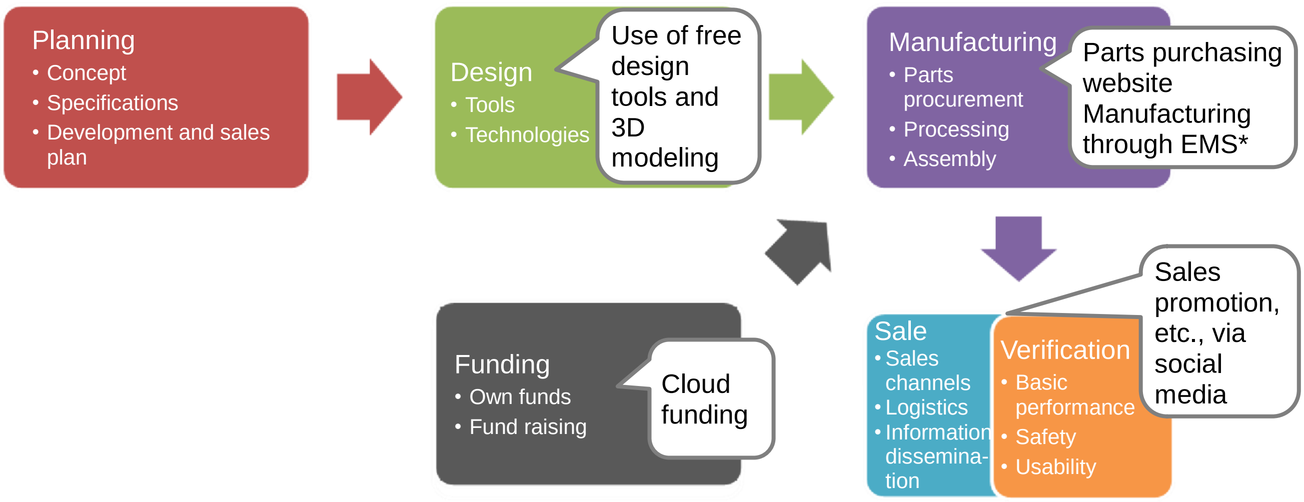
[11] "Téchne" is the Greek word for "techniques." Socrates discussed the meaning of this word by contrasting it with knowledge. Knowledge promotes moral and psychological growth and has a high degree of universality, but it has no utility. Techniques, however, are related acts that are carried out to create utility and handed down in a closed manner.

[12] DIY is an acronym for "do-it-yourself," which refers to the act of manufacturing something by procuring the necessary materials, designing it, and making it yourself.

would still require the necessary equipment, funding, and design technologies. Not only that, you would require a lot of resources and technologies to bring it to market, including in terms of marketing and communication with customers. Due to this complex process, conventional thinking has held that manufacturing is not something that can be done by a single person and the division of labor among more than a certain number of organizations is essential. However, since the advent of open source in the field of ICT, many cases have been observed in which the entire manufacturing process has been controlled at an individual level. For example, Keita Yagi—a sole trader who, as CEO of Bsize Inc., is involved in the manufacture of home electronics—has won the Good Design Award, one of the Japanese manufacturing industry's most prestigious awards. Open source has made it possible for him to engage in manufacturing on his own as a sole trader (see Figure 2-1).



* Abbreviation for electronics manufacturing services. This applies to companies specializing in the contract manufacturing of electronic equipment.

Figure 2-1: Basic Stages of the Manufacturing Process

Source: Prepared by the author

OSVehicle[13] is a company that has gained recognition as an innovative presence in the manufacturing industry. It has developed a four-seater car that can be assembled by anyone in just one hour. In fact, some people have been able to use the company's innovative process to make their own cars for approximately 500,000 yen.

Now that individuals can make whatever they want by leveraging open-source hardware and software, worldwide manufacturing know-how and achievements can be shared in real time (if language

13 https://www.osvehicle.com/company/

differences are not taken into account). There are, of course, some technologies that cannot be shared due to intellectual property rights, patents and other forms of incentives for innovation, but the scope of open source is rapidly expanding around the world. The above-mentioned examples can be seen as signs of a shift from conventional software-focused innovation to hardware-related innovation.

Following the work of Herbert Marshall McLuhan, it has been said that spatial and temporal restrictions will be eliminated by ICT. Since the invention of 3D printers, laser cutters, and other creative tools, the relationship between data and hardware has become ever closer and McLuhan's message has started to influence people in a practical sense. These technologies allow manufacturers to design more things for the individual person, family, or community, regardless of personal or technical requirements. Such innovation will give rise to a fundamental change in the existing division and flow of labor. Furthermore, this redefined concept of manufacturing will change regional societies considerably in terms of not only software but also hardware.

So, what kind of social system should we look to create in this era? The following section considers how Fab Labs, innovation, and ecosystems will be built.

2-2 Case Study on Building Fab Labs and Innovation Ecosystems

Koji Yamada (JICA)

In parallel with the process of establishing the Sustainable Development Goals (SDGs), Western think tanks and economic publications have released a series of reports predicting what will happen toward the middle of this century. The UK's *Economist* magazine predicts that the coming decades will see the greatest revolution in the manufacturing industry since the advent of the era of mass production. The magazine states that as the use of 3D printing (an additive manufacturing technology) becomes more widespread in the manufacturing industry, small manufacturers in extremely remote locations will be able to provide services on the global market. Ordinary people will be able to *print* their own unique products that they have designed by themselves without having to buy ready-made products.[14] The *Global Strategic Trends* paper published by the UK's Ministry of Defence also provided forecasts for the period up to 2045. The paper described the impact of 3D printing on the manufacturing industry as follows:

> 3-D printing enables on-demand production, allowing items to be created quickly when an order is placed, rather than large amounts of costly stock having to be held in readiness for prolonged periods. With more decentralised production, products could be designed and printed for local consumption, potentially reducing reliance on expensive imports and requiring less industrial infrastructure than conventional manufacturing. It is also likely that personal use of 3-D printers will increase rapidly, allowing for unprecedented levels of mass customisation and even the 'democratisation' of manufacturing, as consumers and entrepreneurs begin to print their own products. By 2045, additive manufacturing systems could be a common feature in the home and be capable of producing a wide range of outputs —food, clothing, and even complex devices with mechanical and electronic components.[15]

On the other hand, to create innovation at the grassroots level, people interested in manufacturing can meet in workspaces such as Fab Labs or makerspaces and collaborate using machine tools.

Fab labs are citizen workspaces that are equipped with a variety of digital machine tools, such as 3D printers and laser cutters, with the goal of allowing people *to make almost anything*. Available not only in developed countries such as Japan and the US, but also in developing countries such as Ghana and India, Fab Labs offer free access to all citizens. They allow users to use machine tools, to download open-source data to make things, to receive advice from or collaborate with fabricators around the world through online or video conference systems during the fabrication process, and to share the

[14] Editorial staff of The *Economist* (2012), *The World in 2050: The Economist Predicts*, Bungeishunju Ltd., August 2012, p. 303.
[15] Ministry of Defence, 2014. *Global Strategic Trends—Out to 2045*, Fifth Edition, United Kingdom, June 2014, p. 68.

finished works globally. Fab labs exist at more than 600 locations in 50 countries worldwide, and they are expected to expand tremendously going forward, mainly in developed countries.

The advantages of Fab Labs are as follows: they reduce the initial investment risk by allowing small and medium-sized entrepreneurs to carry out prototyping inexpensively; they enable an appropriate number of different products (customization) to be produced using local materials based on local needs; they facilitate the creation of a recycling-oriented society through the recycling of local waste materials; they contribute to the realization of a low-carbon society by replacing product transportation with data transmission and the manufacture of appropriate quantities of the product locally; and they facilitate the creation of forums for local residents to interact with each other through manufacturing.

With regard to the relationship between Fab Labs and sustainable development, the *World Annual Report* that the UN publishes in June every year has already referred to the potential for Fab Labs to contribute to economic growth and promote employment.

> In the context of renewed debate around innovation, an interesting perspective comes from exploring the role of community-based digital fabrication facilities that enable the development and production of custom-made things which are not accessible by conventional industrial scale technologies. Such tools have the potential to democratize access to technology and permit communities to participate in creating their own technological tools.[16]

JICA has already supported the establishment of a Fab Lab in the Philippines. FabLab Bohol was established in May 2014 at the Bohol Island State University (BISU) by a JICA volunteer specializing in industrial design called Yutaka Tokushima (member of the first dispatch of Japan Overseas Cooperation Volunteers [JOCV] for FY 2012). At the same time, JICA invited around 200 digital creators from eight Asian countries to the 1st FabLab Asia Network Conference (FAN1). Held with the aim of creating a regional "co-creation platform" to solve problems through the power of open innovation, FAN1 won the 2014 Good Design Award (sponsored by the Japan Institute of Design Promotion) under the category of "Activities/solutions for public, social contribution activities" in October 2014.[17] Since Tokushima, JICA has continued to dispatch new volunteers to FabLab Bohol to support its activities in Bohol.

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[16] United Nations Department of Economic and Social Affairs (UN DESA), 2015. *Global Sustainable Development Report: 2015 Edition*, Advance Unedited Version, June 2015, p. 137.
https://sustainabledevelopment.un.org/content/documents/1758GSDR%202015%20Advance%20Unedited%20Version.pdf
In addition, refer to the following website as a briefing note on the report. Ivana Gadjanski, 2015. "Fabrication laboratories – Fab Labs – tools for sustainable development," Brief for GSDR 2015.
https://sustainabledevelopment.un.org/content/documents/640994-Gadjanski-Fablabs.pdf

[17] For details on JICA's support for Fab Labs in the Philippines, refer to the following articles.
-"Fab labs to change development models in developing countries" (October 4, 2013)
https://www.jica.go.jp/topics/news/2013/20131004_01.html

At FabLab Bohol, beneficiaries familiar with the local context are expected to get involved in product development and generate low-cost innovations that conform to local requirements. As FabLab users who are close to the beneficiaries take the initiative in product development, the innovations created there can be described as being locally based.

For example, a local dairy product association produced a mold for water buffalo soap at FabLab Bohol through the Advancing Philippine Competitiveness (COMPETE) Project, which is run by the United States Agency for International Development (USAID) for small and medium-sized enterprises. Similarly, a BISU graduate who used FabLab Bohol while in school went on to become a young female entrepreneur involved in the local manufacture and sale of chocolate after graduation.[18] As these examples demonstrate, FabLab Bohol has been used locally in many different ways, such as to add high value to existing products, develop new products, and start up new businesses. Also, a German volunteer who was assigned to the Bohol Office of the Department of Trade and Industries (DTI) created racks for displaying local products and a logo for Bohol specialties by making use of FabLab Bohol. These racks were placed in local hotels, where they helped to promote the sale of local products to tourists visiting the island. In this sense, FabLab Bohol provides a forum for local-level aid coordination.

According to the interview that I conducted in Bohol, few people feel that the innovations created at FabLab Bohol contribute directly to poverty reduction and sustainable development. Instead, many stakeholders envision a road map for creating self-employment in the region in the form of start-ups, which will eventually lead to regional economic growth. However, if we look at the products and works made at the lab, it is apparent that FabLab functions not just as a place for creating employment, but as a workspace for creating innovations that contribute directly to the resolution of local environmental and social problems. For example, as part of its efforts to cooperate in the reconstruction work conducted in the aftermath of the large-scale earthquake that struck the region in 2013, JICA used FabLab's machine tools to quickly rebuild an infant care center that had collapsed. In addition, after the earthquake, local university students started working with residents of the disaster-stricken area to earn an income by making and selling coin purses with a unique design that were made from local coconut shells. Currently, locally procured waste plastics are being reused and

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-"FabLab Asia Network Conference hosted by JICA volunteers wins Good Design Award" (October 2, 2014) https://www.jica.go.jp/topics/news/2014/20141002_01.html

-Yutaka Tokushima (2015), "Economic Development using an Enabling Environment for Contextualized Innovation: The Case of the 'Poverty Reduction Project by Building-up the Innovation Environment Using FabLab,' Bohol Province, The Philippines," JICA Research Institute, July 26, 2015. http://jica-ri.jica.go.jp/publication/assets/Tokushima_paper_JP.pdf

[18] This entrepreneur is scheduled to travel to Washington in September 2016 at the invitation of USAID to make a presentation on her experience of starting a business.

processed to make plastic plates by using a heat press machine that was independently manufactured at FabLab Bohol, after which these plates are used to produce other products.[19]

Since FabLab Bohol is situated on the university campus, it is frequently used as a site for providing science, technology, engineering, and mathematics (STEM) education to not only students of the university but also students of neighboring high schools. As mentioned above, some young people have learnt to use machine tools through STEM education and then remained in the local community after graduation to start up a new business using FabLab. On the other hand, many users started out by completing something that they wanted to make through a one-on-one relationship with a lab staff member. It will still take time for FabLab to become a collaborative community in which users can share their ideas and discuss their problems and ideas with each other.

Although Fab Labs allow people *to make almost anything*, some citizens feel at a loss and don't know what to do when confronted by machine tools as they can appear difficult to operate at first. To convert one-time users into long-term users and create a sense of a collaborative community, it is therefore necessary to devise a way for such citizens to receive a helping hand from lab staff and previous users who already have knowledge of making things. One way of doing this may be to hold workshops and events that require a slightly higher level of expertise, such as hackathons and make-a-thons, so as to provide a forum for interaction between individual creators from different makerspaces and workshops. According to my field survey, FabLab Bohol invited citizens to participate in a Fab Summer workshop that was being held to address the themes of 3D modeling, Arduino basics, and 2D modeling. At this workshop, they were able to gain some experience of how to operate machine tools and make products. As a side event to the annual Sandugo Trade Expo, the DTI-Bohol office also holds Maker Fest[20] at movie theaters and shopping malls in collaboration with the local tourism office. At Maker Fest, visitors get to experience making things by participating in competitions[21], with awards being presented for outstanding works.

However, FabLab Bohol is currently confronted by a problem in that a single lab cannot fully meet the needs of local micro-, small and medium-sized entrepreneurs who, having taken advantage of the opportunity to increase their income through their initial use of the lab, now want to manufacture more product lots. It has also been pointed out that since FabLab Bohol is located on a university campus, it is difficult for off-campus business operators to access it. I conducted some on-site interviews and the results indicate that users want Fab Labs to be located closer to them, not on a university campus. Machine tools are still expensive for an individual to purchase, so if there were other facilities that would allow them to use machine tools, they would definitely be willing to pay usage fees. These are

[19] Other activities conducted at FabLab Bohol include an international collaboration project between FabLab Kannai and Keio University that was started to develop super low-cost prosthesis limbs for developing countries. This project has been adopted as a "Frontier Makers Development Project" by Japan's Ministry of Economy, Trade and Industry.

[20] http://makerfest2015.weebly.com/maker-fest.html

[21] http://makerfest2015.weebly.com/bhli2i-competition.html

new local needs that have arisen as part of the next step following the establishment of the first FabLab facility.

The concept of Fab Labs originated in the US, and most of the machine tools installed in these labs are made in the US or Japan. However, since incorporating Fab Labs into local communities helps to promote the creation of a variety of innovations by local citizens, they can be positioned as a component of the ecosystem or as a tool kit that enables open innovation through user participation. Since the establishment of a Fab Lab in Bohol, significant progress has been made in the creation of the subsequent local innovation ecosystem, as described in this chapter. Rather than being static, this ecosystem demonstrates ever-changing dynamism.

Having been impressed by the local impact of FabLab Bohol, the Philippine government plans to establish Fab Labs at eleven other locations throughout the country by 2017. As FabLab Bohol is well known in the Philippines, there is a movement to follow the example of Bohol and establish the Fab Labs on university campuses. As this demonstrates, Fab Labs are becoming a government-backed nationwide movement in the Philippines, but this movement is still in the "one Fab Lab per city" stage. At present, Bohol remains the only place in the country where more new Fab Labs are needed as a result of a deepening of the local innovation ecosystem.

Building a local innovation ecosystem is an effective approach for implementing SDGs that are focused on initiatives at the sub-national level. To scale-up these initiatives, it is necessary to clearly demonstrate how they contribute to the realization of the SDGs. However, as the Tokushima paper included in this report indicates, each Fab Lab has different characteristics based on the background and history of its establishment, its locational conditions, and the composition of its users. Given this, it is difficult to generalize and indicate which SDG targets Fab Labs will be able to address at the regional level.

The details provided above with regard to the FabLab Bohol of the Philippines can be broadly summarized as shown in Table 2-1. This Fab Lab is able to make a direct contribution to many of the region's targets, such as nurturing micro-, small and medium-sized entrepreneurs, promoting local industries and fostering the human resources required for science and technology innovation. At the same time, it is also necessary to continue monitoring what is made at the Fab Lab in order to ascertain the targets that are achieved through the contributions made by the Fab Lab's region-specific innovations. Several items have been listed as indirect contributions, but the Fab Lab seems to have the potential to make a wider range of contributions.

Table 2-1: Contributions Made by FabLab Bohol to the Realization of the SDGs and the Impact of the SDGs on FabLab Bohol

Goals and targets of SDGs		Direct contribution by FabLab	Indirect contribution by FabLab	Impact on FabLab
Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.				
4.3	By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university.			✓
4.4	By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship.	✓		
4.5	By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations.	✓		
Goal 5. Achieve gender equality and empower all women and girls.				
5.b	Enhance the use of enabling technology, in particular ICT, to promote the empowerment of women.	✓		✓
Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.				
8.1	Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries.		✓	
8.2	Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labor-intensive sectors.		✓	
8.3	Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services.	✓		✓
8.6	By 2020, substantially reduce the proportion of youth not in employment, education or training.		✓	
8.9	By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products.	✓		✓
Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.				
9.4	By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.		✓	
9.b	Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities.			✓
Goal 10. Reduce inequality within and among countries.				
10.1	By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average.		✓	
10.2	By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status.		✓	
Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable.				

Goals and targets of SDGs		Direct contribution by FabLab	Indirect contribution by FabLab	Impact on FabLab
11.3	By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries.		✓	
11.6	By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.		✓	
11.7	By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.	✓		
11.c	Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials.			✓
Goal 12. Ensure sustainable consumption and production patterns.				
12.5	By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.	✓		
12.8	By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.		✓	✓
12.a	Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production.			✓
12.b	Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products.			✓
Goal 17. Strengthen the means of implementation and revitalize the global partnership for sustainable development.				
17.6	Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation. (The rest is omitted.)			✓
17.7	Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favorable terms, including on concessional and preferential terms, as mutually agreed.	✓		✓
17.16	Enhance the global partnership for sustainable development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the sustainable development goals in all countries, in particular developing countries.	✓	✓	✓
17.17	Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships.	✓	✓	✓

Note: Given the correlation between targets, efforts aimed at achieving multiple targets may have had a positive impact on the development of the environment at FabLab Bohol and its surrounding ecosystem. Given this, items that may have had an impact on the FabLab are also included here.

Source: "Transforming our World: the 2030 Agenda for Sustainable Development" https://sustainabledevelopment.un.org/post2015/transformingourworld

2-3 Maker Movement and Developments in the Context of Open Innovation

Izumi Aizu (Tama University)

2-3-1 Advent of New Manufacturing

In recent years, a new form of manufacturing using digital machine tools such as 3D printers has been spreading across the world.

Having originated in the US and Europe, this trend has since spread and grown widely from East Asian countries (e.g., Japan, Korea, Taiwan, Hong Kong, and China) to other Asian countries (e.g., Indonesia, Singapore, Thailand and India) and then on to African and Latin American countries.

Early initiatives, such as the maker movement and Fab Labs, focused mainly on hobbies and personal interests. More recently, however, a series of new innovations have appeared centered on the IT sector, entrepreneurial movements, and large-scale initiatives that aim to change the means of production and distribution in the manufacturing industry, such as the IoT, Germany's Industry 4.0 and the Industrial Internet. With each of these new innovations influencing one another, this has led to a major new trend.

In this section, we focus on the maker movement in the context of open innovation, and consider its significance and potential in terms of future aid for developing countries.

Firstly, let's take a look at some of the factors that have enabled these new forms of manufacturing to appear.

2-3-2 Evolution of Digital Machine Tools: Enabling Individuals to Perform Material Processing

The first factor that has facilitated the emergence of new forms of manufacturing is the evolution of digital machine tools. Computerized numerical control (CNC) machine tools—such as lathes, milling machines and other machine tools controlled by computers—have been widely used since the 1970s and their use has spread to the manufacturing industry. 3D printers are actually not a particularly new technology for stakeholders in the manufacturing sector.

Since the 2000s, however, the prices and sizes of not only 3D printers but also laser cutters, milling machines, 3D scanners, and other digital machine tools have been significantly lowered, and the significance of which was beyond expectations of experts. As a result, ordinary people with the necessary knowledge and motivation found that they had access to machines that in the past only specialized companies with a strong enough capital base would be able to use—this development brought about a change similar to the one that occurred when personal computers began to replace large computers.

This development was not brought about only by hardware miniaturization and cost reductions. Computer-controlled machines are controlled by software, so the introduction of software that is as easy to use as a word processor lead to a sizable expansion in the base of users. The conventional world in which high skills, intuition and experiences were what mattered has transitioned (although only in part) into a world in which users are able to run simulations and correct mistakes on a screen as many times as they like.

Simple 3D software is relatively easy to learn, and it allows users to output models created on a screen from a 3D printer. The availability of laser cutters that can cut paper, wood, plastic, and other materials into free forms makes it easy for users to plan and design a variety of works. Computerized sewing machines also make it easy for users to create works.

The digitization of machine tools such as these has made it possible for even elderly people, women, and children with limited physical strength to create works that are of comparable quality to those made by skilled workers. Even if they fail at the beginning, they can try as many times as they like by modifying the data. This is extremely similar to the world of digital music, where users are able to compose and play original songs even if they cannot play musical instruments. Neil Gershenfeld, a professor at the Massachusetts Institute of Technology (MIT) and a pioneer of the Fab Labs movement, refers to this as the third digital revolution.

> The first digital revolution occurred in the field of communications when it became possible to conduct highly reliable communications using low-reliability systems (the Internet). The second digital revolution took place in computing when it became possible to conduct highly reliable computations using low-reliability systems. The third digital revolution was brought about by the development of digital fabrication, which allows anyone to make anything by enabling them to correct errors in material structures.[22]

In the fields of communications and computing, digital technology led to the establishment of a field called "information processing," which has made it possible for us to manipulate and process data consisting of bits. This development has led to major innovations in our lifestyles, society as a whole, and industry. Similarly, the third digital revolution that is currently underway has led to the establishment of a field called "material processing," which has made it possible for us to manipulate and process materials at the atomic level. In a broad sense, this means that we are able to manipulate and process the structures and construction of materials. As material processing can now be undertaken by individuals, manufacturing is becoming popularized and democratized.

2-3-3 Emergence of "Makers" and the Formation of Communities through Networks

[22] https://fabcross.jp/topics/event_report/20160302_sww2016_03.html

The second factor that has facilitated the emergence of new forms of manufacturing is the fact that users of digital machine tools have connected through the Internet and grown together by forming communities. This development has made data sharing and know-how exchanges possible and promoted mutual learning, which in turn has led to the spread of more advanced works and technologies.

A notable example of such users is "makers."[23] Such users have given rise to the "maker movement," a trend in which the social interaction and movement of people who enjoy manufacturing as a hobby has expanded globally.

Launched in the US in 2004, the magazine *Make:* serves as a driving force for the promotion of this movement and it regularly holds Maker Faire events around the world, each of which attracts tens or hundreds of thousands of people. Maker Faire is registered as a trademark, and certain requirements need to be met for an event to be held under this name. Maker Faire events—which are held in many countries around the world, including Japan—are currently run by an organization that is independent of the magazine publisher.

Many of the people who attend Maker Faire events enjoy hobbies and DIY and they exhibit a wide variety of things. These include not only technical works created by digital machine tools, but also handicrafts and foods created using traditional tools and techniques, furniture crafts, and science teaching materials and games for children. In a sense, these events are a bit like festivals.

Of the various Maker Faire events held across the globe in 2015, the one that attracted the largest number of participants was the one held in Shenzhen, China, which attracted more than 190,000 people. This was nearly double the number of people who attended the World Maker Fair when it was held in the US (New York).

These Maker Faire events have opened up a new world that arose as a result of the digital machining trend based on the DIY culture widely adopted in Western society. Although digital technology has been a major engine for the evolution and growth of this development, it is not necessarily the sole cause.

2-3-4 New Maker-led Industrial Revolution

Some makers have presented works that incorporate new ideas and, having been encouraged by the positive reviews they received, they have gone on to successfully launch new businesses.

Written by Chris Anderson and published in 2012, the book *Makers* attracted attention for its claim that makers will not just continue enjoying manufacturing as a hobby, but actually lead the way in the

[23] In Japanese, people who are engaged in this new movement are often referred to as "makers" to distinguish them from traditional manufacturing companies that are referred to as "manufacturers."

New (21st Century) *Industrial Revolution.* Having a good understanding of the claim that Anderson makes in *Makers*, Mr. Hiroo Yamagata had the following to say in his review of the book.

> It pains me to say it, but the author's claim is both honest and correct…it details a story centered on 3D printers and CNC. Furthermore, while O'Reilly's books about makers traditionally tend to focus on actual manufacturing, one characteristic of this book is that it positions 3D printers and CNC as a means of new business creation and entrepreneurship. The book's subtitle—*The New Industrial Revolution*—is derived from this concept. Far from simply advocating the maker movement, the author actually started up a company that supplies parts for radio-controlled airplanes based on this method. I think that's very impressive. I guess there's a limit to how much soldering you can do on your own. From his descriptions of real feelings, though, we can clearly see that the author is not just adopting a pose—he has continued to adopt a hands-on approach.[24]

Chris Anderson served for a long time as a journalist and the editor-in-chief for the magazine *Wired*, which focuses on issues related to the Internet-centric digital industry and culture. In his books *The Long Tail: Why the Future of Business Is Selling Less of More* and *Free: The Future of a Radical Price*, he clearly states that Internet businesses, such as Amazon, will help develop a market and industrial economy that is completely different from the traditional one of today.

Anderson gathered information and wrote about new movements from an outside perspective not only in his capacity as a journalist, but because he was genuinely fascinated by the possibilities offered by this world of new digital manufacturing and he actually launched his own air vehicle (drone) business. He claimed that desktop digital machine tools combined with open innovation would create a huge range of new products, such as open-source hardware, and that this would eventually lead to the formation of new industries. As his claim was based on his own experience, it was convincing and readers identified with it.

2-3-5 Makers and Hackers Merge: Transitioning from Software to Hardware

In addition to Chris Anderson, engineers and managers who had until then been active in the software and Internet industries have also become fascinated by the world of hardware and launched their own businesses by joining the maker movement by taking advantage of their own digital technologies. This development originated largely in Silicon Valley.

Nick Woodman, the founder of GoPro, is a good example of this. As a surfer, he noticed that video cameras suitable for filming surfing experiences had yet to be developed, so he started up his own business and made a success of it. Through the success of GoPro, he established a groundbreaking

[24] Extract from the "Keizai no Torisetsu" blog written by Hiroo Yamagata (October 19, 2012) http://cruel.hatenablog.com/entry/20121019/1350614569

product genre called "action cameras." At that time, existing video camera manufacturers, such as Sony and JVC, were still bound to the premise that they should supply products only if they were suited to mass production and the mass market, so the commercialization of a product based on an outstanding unique idea was beyond their expectations.

Elon Musk, the founder of the electric car manufacturer Tesla Motors, has also adopted a Silicon Valley-style management approach focused mainly on software to take on the challenges presented in the hardware world of the automobile industry. It is well known that Apple's iPhone helped to undermine the market dominance exerted by the hardware-oriented products of existing cellphone manufacturers by focusing on software and Internet-oriented ideas.

Hiroshi Menjo is a Japanese venture capitalist based in Silicon Valley who has been proactively reporting on these industry trends while engaging in the investment business and consulting services for over 20 years. In January 2015, he began releasing a series of reports entitled *The IoT Industrial Revolution: Reports from Silicon Valley* on Diamond Inc.'s online business site with the aim of analyzing and reporting on industry trends in detail. Here, we introduce a slightly long excerpt from the first article of this series: *Apple's Great Success Opened the Door to the IoT Industrial Revolution.*

> The first attempts to integrate hardware and software services like the IoT took place a long time ago. So, why has the IoT suddenly become a hot topic recently?
>
> In short, this is because the software community has begun to pay attention to hardware. In the venture capital world of Silicon Valley, it is said that "hardware is the next software." This means that the evolution of the technology paradigm that we have experienced in software so far will also affect hardware. As a result, the software companies and human resources of Silicon Valley that have swept the world have begun to consider expanding their business areas by incorporating hardware. There is no doubt that this trend has been inspired by the great success enjoyed by Apple, but the underlying cause is the dramatic evolution of software/IT and hardware.
>
> (1) Following the increased use of smartphones and cloud services, the added value of such products can be shared between hardware and software.
>
> (2) Due to a further advancement of Moore's Law, the costs of sophisticated electronic components and modules have fallen dramatically. This development has reduced start-up risks considerably by facilitating the fabless development of hardware. (First articulated in a research paper by Gordon Moore, a co-founder of Intel, "Moore's Law" is a theory that predicts that the number of transistors on a semiconductor chip will double at regular intervals.)

(3) With the cost of storing data having fallen dramatically, users can now store all kinds of data and this has resulted in big data analysis becoming a reality.

(4) Communication between databases and applications on networks and individual devices has become much faster and cheaper, thereby making real-time connections between hardware and the cloud feasible.

(5) Software applications can be developed much more cheaply and faster than ever before and supplied to the market at ultra-high speed, and this has resulted in an explosive increase in the range of products and services that can flexibly meet market needs.

(6) With hardware becoming more open source and modularized, even people in the software industry with little hardware knowledge or reconciliation know-how can handle hardware.

An IoT platform can be launched by people in the software and IT fields who are skilled at the overall design of value provision solutions, and this can serve as the driving force for new hardware. It is no coincidence that Google, an IT company, established Google X in 2010 and then started developing automatic driving vehicles and Google Glass (a device shaped like glasses that displays information).[25]

In the US, communities of software development experts called "hackers" have existed since around the 1950s. Working mainly in Boston (where MIT is located) and Silicon Valley, these people formed their own culture and communities, led the personal computer revolution and drove the information revolution. In a broad sense, it can be said that Steven Wozniak and Steve Jobs, who developed Apple, and Bill Gates, who founded Microsoft, were brought up in the hacker culture.[26]

Hackers set up meeting places—called "hackerspaces"—where they could proactively carry out their work. In recent years, some hackerspaces have installed and shared digital machine tools that can be used for hardware manufacturing, which has further led to new developments. There are also similar facilities called "makerspaces," one of which is TechShop, a membership-based commercial workshop that was launched by collecting second-hand professional machine tools. Launched on the West Coast of the United States, TechShop services are scheduled to be launched in Japan soon in partnership with Fujitsu Ltd.

In Silicon Valley, people often say that they are tired of software and networks and that real-world products are more fun. Many of the people who have launched new businesses in the field of hardware manufacturing originally achieved success in the software and network industries.

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[25] http://diamond.jp/articles/-/65064?page=2
[26] The original hacker culture is detailed in Steven Levy's book *HACKERS* (Kogakusha, Ltd., 1987).

One example of this is Bill Woodcock, a well-known player in the Internet industry who has set up ISPs and data centers. When I met him at the Internet Governance Forum in Brazil in the fall of 2015, he said that he had started a track manufacturing business as he had gotten tired of the Internet world.

I also met one of the founders of Airbnb at the World Internet Conference in China, but he had already left Airbnb by then. He, too, said that he wanted to work in a more real-world environment because he had gotten bored with the Internet business.

Both of these people wanted to advance into "real space" (i.e., the real world) and find fresh value in creating things, moving them and then providing them to society, rather than being confined to a computer screen, the Internet, or cyberspace.

The same trend exists in Japan. For example, a leading player in the Japanese Internet industry called Osamu Ogasawara invested 1 billion yen in the launch of a manufacturing space called DMM.make in Akihabara and co-founded Sakura Internet, which is centered on data centers, in 1996. In his book entitled *Makers Evolution: The Real Winners Are Determined by the IoT* (published in the fall of 2015), he said the following.

> Everyone in the Internet industry will get angry if I say this, but it's not much fun. I got bored with the Internet industry as it's focused only on intrusive social media platforms, the collection of service fees, and competing for advertising revenues—it's no different to the mass media of the past. Having spent time searching for an alternative, I finally ended up in manufacturing, which connects people as well as things.[27]

I'm sure there are quite a few people who share such feelings.

2-3-6 Fab Labs Have Their Roots in a University

Fab labs, which are a global network of local labs that are open to the public, were launched by Professor Neil Gershenfeld of the Center for Bits and Atoms (CBA), which was established at MIT in 2001. Initially developed for the purpose of research-related outreach activities, Fab Labs have expanded in a way that those involved could never have expected.

It all started when Gershenfeld set up a course of weekly practical lecture classes that would run for 14 weeks and provide students with a place where they could learn practical skills in a variety of different areas, including electronic circuit design, woodworking, and software under the theme of "How to Make (Almost) Anything." Students from all over the world attended in numbers that were greater than he had expected, and he was surprised by the high quality of their work, creativity, and learning motivation.

[27] Osamu Ogasawara, *Makers Evolution: The Real Winners Are Determined by the IoT* (NHK Publishing, Inc., 2015)

To reach out to people overseas who cannot attend MIT and provide a solution to the digital divide, Fab Labs were established at five locations around the world, including India in 2002, thanks to funding from the US National Science Foundation (NSF).

In the 10 years since then, Fab Labs have been established in 560 locations all over the world to form a global network that serves as a major promoter of new forms of manufacturing using digital machine tools. Many of these Fab Labs are located in developing countries, such as India and various Asian, African, and Latin American countries. Japan now has 15 Fab Labs.

Figure 2-2: Fab Labs around the World

Source: Fablabs.io website (https://www.fablabs.io/map)

2-3-7 Diverse Situations of Makers (Partial)

The activities carried out by makers and "fabbers" (i.e., people who implement digital fabrication) are quite diverse and multifaceted, so a uniform definition for them cannot be produced. The places in which makers and fabbers carry out their activities are also given a wide variety of names based on the founder's philosophy or direction of activities, such as "manufacturing space," "XX workshop," "XX studio," and "XX factory."

Furthermore, there are a variety of organizational types, including the following: corporate-type organizations that are run using revenue from membership and usage fees; organizations affiliated with universities, high schools, and other educational institutions; organizations that receive subsidies from local governments; and non-profit shared community workshops. However, regardless of the type of organization, it is not easy to establish and maintain a sustainable management system using only the income raised from user fees.

Meanwhile, there is a high affinity between these manufacturing spaces and the shared spaces—such as co-working offices and share offices—that have been appearing in increasing numbers in a variety of places. It is common for co-working and manufacturing spaces to avoid the high rents charged in city centers by occupying vacant lots at waterfront sites, which are home to many factories and warehouses. Many of these sites have cafes that serve simple meals and drinks. Basically, co-working and manufacturing spaces are located in areas where many people come together under the concept of sharing digital machines tools and instruments.[28]

2-3-8 Business Development: Hardware Start-ups

Many Fab Labs are operated for relatively non-profit purposes related to public services, education and research. However, some makers pursue their activities not just as hobbies or for research and education, but with the active aim of achieving commercial success as start-ups by commercializing their ideas and technologies. Generally referred to as "hardware start-ups," such makers are expanding rapidly, particularly in Silicon Valley in the US and Shenzhen in China.

Silicon Valley has long had a mechanism, or ecosystem, for supporting start-ups. The majority of companies that have achieved success as start-ups in Silicon Valley, including semiconductor, computer, and Internet businesses, have benefited from such environments and resources.

Various forms of individual and organizational investors, such as venture capitalists, angels, and accelerators, solicit and screen prospective projects. To ensure the eventual recovery of their investments, they not only make investments, but also get involved in and provide guidance on strategy formulation, technology development, human resource coordination, funding, market development, and other requirements for running a successful business.

In recent years, this approach has also been applied to the hardware start-up world. In particular, with Silicon Valley having accumulated advanced investment and management know-how and Shenzhen enjoying a concentration of design and manufacturing resources for all of the stages from prototyping through to mass production, exchanges between these two areas have been deepening. As a result of collaborations between Silicon Valley and Shenzhen, both of which function as advanced ecosystems, a concentration of start-ups and talents is occurring around the world.

Apple's iPhones and Google's Android devices are typical examples of the outcome of cooperation and synergy between the Silicon Valley and Shenzhen ecosystems.

Details about the ecology of makers and start-ups and the actual situations of the ecosystems of Shenzhen and other cities can be found in the book *Makers' Ecosystem* (Impress R&D, 2016) published by Masakazu Takasu, a resident of Singapore who was invited to act as a lecturer for this

[28] An example of this type of co-working space in Japan is FabLab Kitakagaya, which is located in Osaka City's waterfront area.

research workshop, and the NicoNico Gijyutsu-Bu (Technical Department) of the Shenzhen High Tour by Makers.

2-3-9 Openness

As you may know, the "Free and Open Source" movement has been widely promoted in the world of software. The concept behind open source is to realize better technologies and products based on the wisdom and contributions of many individuals by widely sharing manufacturing processes and the resultant works across society while respecting the creators' rights to their technologies and products. The "free" aspect of this movement is not much emphasized in Japan and the US, but in European countries such as France, the terms "free" and "open" are often used in combination. This indicates strong opposition to the money-making approach adopted by US-style companies using open source, with European countries claiming that "free" means "free of charge."

Needless to say, open source does not advocate abandoning or neglecting copyrights and intellectual property rights. An advantage of open source is that, by publicly sharing product structures and manufacturing methods while respecting the rights and privileges of the creators, it makes it possible to take advantage of the wisdom of more people, speed up the cycle of technological progress, and quickly provide products and services in response to different environments and requests.

In terms of the time and effort that is required from development through to completion, the required materials, and the creation methods, there is, of course, a significant difference between software products that can be implemented and run only with computer code and tangible hardware products consisting of physical structures and components. It is not possible to apply the open-source approach used for software directly to the world of hardware.

In regard to this point, the above-mentioned Mr. Takasu has said that the maker movement is made up of various aspects and that people understand it in their own way, but essentially it means that the open-source approach of the software world has been brought into the world of hardware. He further commented as follows.

> Since free, open-source development tools have become the mainstream, the world of software and web development has changed significantly. What impact will this change to software development have? Large-scale software that in the past could only have been developed using considerable capital and a large number of people can now be created by individuals or groups of individuals.
>
> For example, the initial versions of products such as Dropbox, Evernote, and Twitter were developed by 5 to 10 people. In other words, it is now possible for software that can be used by people all over the world to be created by a group of individuals equal in number and

> power to a rock band. If they can get a product on the market before they run out of funds from their parents and/or acquaintances, they can start up a business.
>
> Making software is not necessarily easy, but it is now possible thanks to open source. If about five people come together and work intensively for six months to develop a product, they can create one with a certain level of quality. The number of such start-ups has grown tremendously, especially in the US. A culture has now been established in which investors will, in return for a certain number of shares in the start-up, support entrepreneurs who aim to develop new products based on outstanding ideas by paying their living expenses for six months.
>
> It is important to understand that the maker movement is a hardware version of what happened in the software world.[29]

This understanding of the maker movement is important.

Many makers and fabbers place great emphasis on "openness." The Fab Charter defines Fab Labs as laboratories that offer "open access to individuals" and demands compliance with its provisions. Given this, Fab Lab facilities are required to be open to the public free of charge. It is recommended that the production processes for works be recorded and publicly shared to the degree possible while ensuring the legal rights of the creators.

There are, of course, few people who possess all of the requisite technologies and skills in every field. As a result, we have seen a culture naturally evolved in which makers help each other by teaching what they are good at and acquiring knowledge to overcome their weaknesses. They can maximize the advantages by sharing knowledge and skills with each other, and this is the very basis for the sharing economy.

If people withdraw into their offices, the open sharing of knowledge and technologies will not occur. In particular, when tangible items that have a physical structure are to be created, effective sharing is impossible over the Internet alone. Open, shared physical spaces that are equipped with machine tools and allow individuals to share manufacturing processes are necessary and effective.

In Silicon Valley, the number of shared offices and co-working spaces has increased sharply since around 2010, and a number of software and Internet start-ups have emerged. Examples of recent successes include the car-sharing service Uber and the private lodging service Airbnb.

It is also efficient for hardware start-up companies to use hackerspaces, and other similar workspaces where digital machine tools are installed, during the prototyping stage.

[29] Comments made by Mr. Takasu in his presentation at the Open Innovation and Development workshop hosted by the JICA Research Institute (November 24, 2015).

2-3-10 Shigeru Kobayashi Identifies the Three Elements of the Innovation Chain

A leading expert in the promotion of open innovation and open-source hardware in Japan, Professor Shigeru Kobayashi of the Institute of Advanced Media Arts and Sciences (IAMAS; situated in Ogaki, Gifu Prefecture) is very knowledgeable about the global movements occurring in places such as Shenzhen.

He stated the following in his keynote speech at MakerCon Tokyo 2015, which was held in November 2015.[30]

> In the 21st century, some of the elements necessary to bring about innovation have been developed. These include the following: "open-source hardware," for which the design data is made publicly available; "digital fabrication devices," such as 3D printers and CNC; and human resources called "makers." At present, it is said that multiplying these three elements sets off a chain reaction of innovation.

2-3-11 Open-Source Hardware

The "open-source hardware" trend—which involves applying the essence of the open-source development and commercialization method that is widely used in the software field to hardware products—has now spread beyond Silicon Valley.

By making the products themselves open source, we can attract more users and develop platform-centric businesses rather than pursuing the mass production and sale of individual products.

The following section describes some typical products and platforms as concrete examples of open-source hardware.

2-3-12 Customizable 3D Printers

3D printers may have attracted attention as a symbol of digital manufacturing and given rise to excessive expectations, but originally they were long used as a prototyping tool in the manufacturing industry. In recent years, however, 3D printers have become widely available because, following the expiry of some key patents, a large number of low-priced products were commercialized and the basic software was provided as open source.

In particular, with the method for making 3D printers having been disclosed, machines that can "self-replicate" by making copies of themselves were released and attracted support from many people. This is a typical example of open-source hardware.

[30] http://makezine.jp/blog/2015/12/makercon2015_report_keynote.html

The most notable example of open-source hardware is the RepRap project, which was launched at the University of Bath, UK, by Dr. Adrian Bowyer in 2005. It allowed an international community to be formed for the creation of a variety of products and works. The official website for this project provides the following explanation.[31]

> RepRap takes the form of a free desktop 3D printer capable of printing plastic objects. Since many parts of RepRap are made from plastic and RepRap prints those parts, RepRap self-replicates by making a kit of itself—a kit that anyone can assemble given time and materials.

There are many models of 3D printers that have been derived from RepRap.

2-3-13 OSVehicle

Founded by Mr. Tin Hang Liu, a Chinese national from Torino, Italy, OSVehicle is a company that develops and supplies open-source vehicle manufacturing platforms.[32]

When I attended FAB10, which was held in Barcelona in 2014, what left me most impressed during the week-long series of events was Tin Hang Liu and his project. I immediately invited him to Japan, and he visited in his capacity as a presenter at the ICT Summit hosted by Nihon Keizai Shimbun one year later in June 2015. Following that, I invited him back to Japan to act as a workshop leader at the Beppu Bay Conference that was held in Oita in December 2015.

OSVehicle's vision is to democratize car manufacturing, and they are working to provide open-source platforms that drive innovation. Rather than facilitating the mass-production of standard products by makers, OSVehicle aims to enable anyone to locally create customized vehicles that will meet their needs at a low cost.

Figure 2-3: Tin Hang Liu, Founder of OSVehicle

Source: Prepared by the author

Mr. Liu worked for 10 years at the studio of Giorgio Giugiaro, a world-class car designer based in Torino. However, he eventually left the studio once he began to feel the limits of the conservative

31 http://reprap.org/wiki/RepRap
32 https://www.osvehicle.com/

automobile industry in which a new product is launched only once every few years. After that, he lived for a while in Silicon Valley, where—having been inspired by the potential of social media marketing and open-source hardware—he started up a business based on his vision of providing an open-source vehicle platform available to everyone.

According to Mr. Liu: "The mobility sector is stalling globally. The global automobile industry cannot resolve issues concerning environmental destruction and economic efficiency (oligopolistic economy) or social issues (bankruptcy and unemployment). By introducing the Silicon Valley and open-source approaches, vehicle manufacturing can be democratized. Tesla is pioneering this approach, which is based on sharing distributed production systems and collaborating with developing countries."

OSVehicle's vision is clearly illustrated in two videos posted on its website. Unlike in conventional production methods, this B2B approach involves operators close to the users building and installing car bodies that meet the latter's needs on chasses provided by OSVehicle, which makes it possible to develop customized vehicles locally. The chassis kit can be assembled in one hour.

I met the OSVehicle team at the venue for FAB10, the international Fab Lab conference held in Barcelona in 2014. I happened to attend their workshop, which did not just address the physical creation of vehicles. Instead, each participant team examined the entire process involved in the car manufacturing and sales business by covering all of the relevant stages—such as product concept, competitive analysis, marketing, finance, and needs definition—and then presenting the work developed. The business start-up process as a whole is a form of work. I felt newly inspired by the workshop, which shared the challenges and experiences of OSVehicle to a wide audience. Since then I have continued to interact with Mr. Liu, the company's founder.

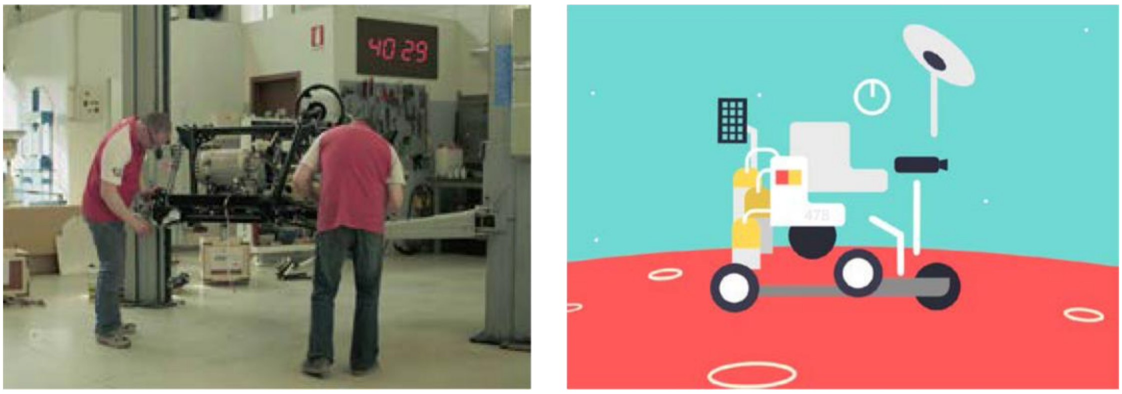

Figure 2-4: Concept Video for OSVehicle

Source: vimeo (https://vimeo.com/113110682)

OSVehicle is establishing relationships with a number of global partners. Initially, it chose 10 projects to promote partnerships with these companies, which include a UK military equipment manufacturer, a Chinese electric car manufacturer, a French regional industry promotion association, and some Silicon Valley venture capitalists.

The UK military equipment manufacturer envisages having organizations such as the United Nations Peacekeeping Force and Doctors Without Borders as its clients. With OSVehicle, they would be able to deliver up to 16 vehicle kits at a time by a large helicopter. Vehicles delivered in kit form are ready for assembly on site, which allows peacekeeping activities, such as the conducting of patrols and the provision of medical services, to be carried using vehicles even in conflict zones that are surrounded by armed guerrillas. As the service also offers the use of electric cars with solar panels, the client would not need to worry about ensuring gasoline supply lines. Similarly, even on islands or in mountainous areas where bridges and roads have been destroyed in a disaster, vehicle kits carried by air can be assembled on site to facilitate disaster relief operations.

Figure 2-5: Up to 16 Assembly Kits Can Be Delivered by a Single Helicopter

Source: Prepared by the author

OSVehicle provides the chasses and other key vehicle manufacturing components as part of a "platform" for meeting and responding to the diverse range of needs and ideas of its B2B partners. In other words, this approach applies the basic software business model (i.e., providing an OS and leaving the creation of applications to developers who look at things from the users' perspective) to the hardware industry.

In particular, OSVehicle is striving to create new markets in developing countries, which until now had no choice but to import completed vehicles. It is doing this by working to establish the niche market of electric cars as their main target and stimulating the motivation of the many entrepreneurs aiming to enter a new market.

2-3-14 WikiHouse

It is now possible to apply open source to housing development, as well. WikiHouse, which was originally launched in the UK, is a typical open-source project. Having been established as a nonprofit foundation, it has announced that it will complete its first prototype in 2017 and then enter into full operation in 2018. On its website, WikiHouse describes its purpose as follows.

> Our purpose is to advance and coordinate the third industrial revolution in housing by developing open tools, shared infrastructure and open standards from which all benefit.[33]

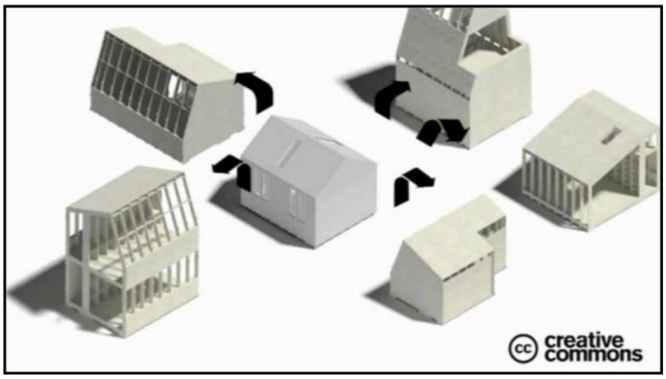

Figure 2-6: WikiHouse

Source: Prepared by the author

WikiHouse shares its designs publicly. With little need for special tools, these designs can be easily assembled using a laser cutter or a milling machine.

2-3-15 Arduino

Created in Torino, Italy, Arduino is a typical electronics prototyping platform that is also popular and used by many people in Japan. Wikipedia describes Arduino as indicated below.[34]

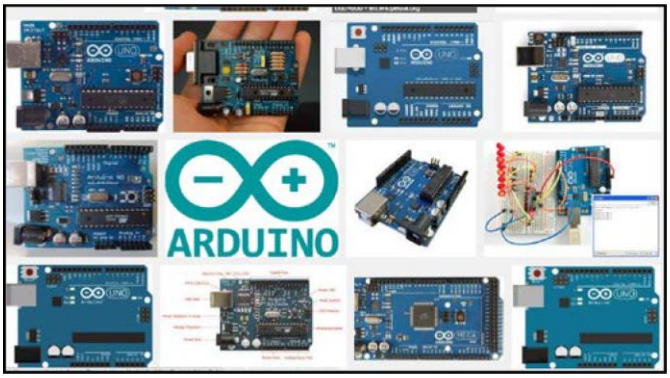

Figure 2-7: Arduino Products

Source: Prepared by the author

> Arduino is a single-board microcontroller that is designed to be used in the development of stand-alone interactive devices that can be controlled using software (e.g., Adobe Flash,

[33] http://www.wikihouse.cc/partners/

[34] https://en.wikipedia.org/wiki/Arduino

> Processing, Max/MSP, Pure Data, or SuperCollider) on a host computer. Open-source hardware EAGLE files containing hardware design information are publicly available free of charge. Arduino boards are available for purchase in pre-assembled from or as do-it-yourself kits. Arduino is highly regarded by some on the basis that it has helped to spread the concept of open-source hardware.
>
> The Arduino project was started in 2005 in Italy with the aim of producing prototyping systems that were cheaper than the other robotic manufacturing control devices for students that were then available. The design group succeeded in developing a platform that is far cheaper and easier to use than many competing products. Arduino had sold more than 50,000 boards by October 2008, about 150,000 boards by February 2011, and about 700,000 boards by 2013 (figures for official products only; sales to date of unofficial clones are estimated to equal or exceed these figures).
>
> Along with the IoT trend, Arduino has attracted considerable attention for its use as a sensor device since 2010.

Many manufacturers of electronic parts and hardware around the world—including Makeblock and Seeed Studio, both of which are described later in this section—have released Arduino-compatible products. As this demonstrates, Arduino has established its presence in the market for electronic components as the de facto standard platform, so it is no longer just a single product or brand. Arduino offers not only hardware, but also open-source software for controlling its functions that is available for free download.

Both OSVehicle and Arduino are based in Torino, and their stakeholders interact with each other. OSVehicle is said to be influenced by Arduino in a positive sense.

2-3-16 Makeblock

Based in Shenzhen, China, Shenzhen Maker Works Technology Co., Ltd. (Makeblock) is attracting attention as a typical hardware start-up. The company, which has over 120 employees, develops and sells Makeblock products, and it has achieved steady growth over the past three years since its establishment in 2012.

As the extract from the company's website indicates, the basic concept behind Makeblock is the provision of an Arduino-compatible open-source robot building platform. Makeblock allows users to make the robot they want by combining various parts. Makeblock products are sold in the US and on other international markets. In Japan, they are sold through a tie-up with Switch Science, Inc.

> Makeblock is an open-source Arduino robot building platform to turn ideas into success. No matter what your ideas are, Makeblock provides various mechanical parts, electronic

modules and software to make them possible, such as beams, plates, connectors, motors, brackets, sensors, drivers and controllers, etc.

(Source: Makeblock's website)

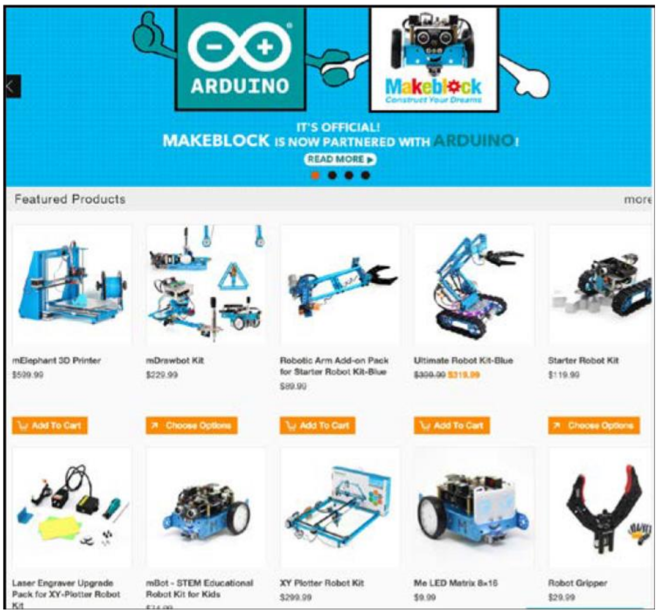

Figure 2-8: Makeblock Products

Source: Prepared by the author

In June 2015, I went on the Nico-Nico Chosa-Bu Shenzhen Tour organized by Mr. Masakazu Takasu. In the tour, I visited Shenzhen Maker Works Technology (Makeblock), where I had the chance to talk with Jasen Wang, its founder. Born in 1985, he was 30 years old at the time. He majored in aeronautical engineering at the Northwestern Polytechnic University in the US. Makeblock set up an extremely interesting booth at the World Maker Faire held in New York in September. At the booth, which was located near Seeed Studio's booth, more than ten employees were available to provide demonstrations and explanations.

One notable fact about Makeblock is that it holds competitions for enthusiastic users so that it can solicit interesting works and then sell any outstanding works directly as kits. The outstanding ideas provided by these users are sold as kits and shared by more users, thereby leading to further development. As a result, the company's collections spread and its user base grows, which creates a win-win relationship. This is one positive outcome obtained from providing such a platform.

Recently, the company officially announced that it is entering into a partnership with Arduino. With one powerful platform further developing through a tie-up with another one, this too can be described as "open innovation."

2-3-17 Measures of National Governments

Currently, a number of governments around the world are actively promoting open innovation and the maker movement. In fact, the White House hosted the White House Maker Faire in 2014, and President Obama mentioned 3D printing and the maker movement in one of his State of the Union addresses in the context of restoring the manufacturing industry. Science, technology, engineering, art, and math (STEAM) education has also been promoted.

However, due to factors such as the President's relationship with Congress, these measures have not necessarily been promoted with large budgets. When I met Tom Kalil, the Deputy Director for the Office of Technology Policy at the White House, in September 2015, he said, "Since Congress does not approve budgets, we are promoting activities in a grassroots style. NetDay, an early-stage Internet promotion measure, also made use of grassroots efforts."

In France, four ministers and the then-Prime Minister Jean-Marc Ayrault visited a Fab Lab in Paris in February 2013. After that visit, they incorporated the establishment of Fab Labs in their subsequent regional development measures, but the budget size was still extremely limited.

2-3-18 Chinese Government: Innovation Policy Focused on Makers

In fact, it is probably China that is doing the most to try and promote the maker movement, which is taking place mainly in Shenzhen.

Li Keqiang, Premier of the State Council of the People's Republic of China, visited a makerspace in Shenzhen on January 4, 2015. Based on this visit, he announced at the end of January a policy aimed at promoting the construction of new innovation platforms, as described below.

> 至於創客 (Maker) 一詞，今年李克強之政府工作報告也首次出現，並指出：
> 大力調整產業結構。著力培育新的增長點，促進服務業加快發展，支持發展移動互聯網、集成電路、高端裝備制造、新能源汽車等戰略性新興產業，互聯網金融異軍突起，電子商務、物流快遞等新業態快速成長，眾多"創客"脫穎而出，文化創意產業蓬勃發展。同時，繼續化解過剩產能，鋼鐵、水泥等 15 個重點行業淘汰落后產能年度任務如期完成。加強霧霾治理，淘汰黃標車和老舊車指標超額完成。
> 關於創客納入中國大陸政府工作計畫的背景是這樣的：
>
> 2015 年 1 月 4 日，正在深圳考察的國務院總理李克強來到柴火創客空間，體驗各位年輕"創客"的創意產品。總理現場評價說："創客充分展示了大眾創業、萬眾創新的活力。這種活力和創造，將會成為中國經濟未來增長的不熄引擎。"
> 2015 年 1 月底，李克強總理主持召開國務院常務會議，確定支持發展"眾創空間"的政策措施，為創業創新搭建新平臺。"創客"是在創新驅動發展的大潮中，湧現出的一批真正從個人興趣出發、不以盈利為目標、努力把各種創意轉變為現實的年輕人。
> "創新、創業、創客與眾創空間"已成為中國大陸經濟與產業結構轉型之雙引擎，而由

政府引導之政策也將影響中國大陸整體創新與創業環境。中國大陸整體政策與民間版的創業基金，如何影響台灣整體創新與創業環境值得進一步觀察[35]

Reference translation produced using Google Translate:
As for the term "Maker," this year, Li Keqiang's government work report also appeared for the first time, and pointed out:

Vigorously adjust the industrial structure. Focus on cultivating new growth points, promote the rapid development of services to support the development of mobile Internet, integrated circuits, high-end equipment manufacturing, new energy vehicles and other strategic emerging industries, the Internet financial emergence, e-commerce, logistics and other new forms of rapid growth, "Created" come to the fore, cultural and creative industries flourish. At the same time, continue to resolve the excess capacity, steel, cement and other 15 key industries to eliminate backward production capacity of the annual task completed on schedule. Strengthen the haze control, out of the yellow standard car and old car indicators exceeded.

The background for the inclusion of a fan into the Chinese government's work program is this:
January 4, 2015, is in Shenzhen to visit the Premier of the State Council Li Keqiang came to the firewood space, to experience the young "founding" creative products. "The vitality and creation will become the future of China's economic growth," said the prime minister's on-site evaluation.

At the end of January 2015, Premier Li Keqiang presided over the State Council executive meeting to determine the support of the development of "public space" policy measures for entrepreneurship innovation to build a new platform. "Innovation" is in the tide of innovation-driven development, the emergence of a number of really from the personal interest, not to profit as the goal, and strive to transform the various ideas into reality young people.
"Innovation, entrepreneurship, a passenger and a public space" has become China's economic and industrial structure of the dual engine, and the government-led policy will also affect the overall innovation and entrepreneurial environment in mainland China. China's overall policy and private version of the venture fund, how to affect Taiwan's overall innovation and entrepreneurial environment worthy of further observation.

When I mentioned this to a reporter from the Yomiuri Shimbun at the World Internet Conference held in December in Wuzhen, China, he said, "Recently, Premier Li Keqiang talks about makerspaces and innovation a lot." This is supported by the fact that such movements were active both at home and

[35] http://iknow.stpi.narl.org.tw/post/Read.aspx?PostID=10828

abroad. It has been reported that, on his visit to Korea in November, Premier Li Keqiang said, "I want to create a creators' facility for Chinese and Korean youth in southern China."

It has been announced that the international Fab Lab conference FAB12 will be held in Shenzhen in 2016. It is well known that, in the background, the Chinese government pursued an aggressive campaign and offered funding to secure the hosting of the conference.

2-3-19 Innovation in Shenzhen Led by Seeed

Underpinning the Chinese government's promotion of its maker policy is the active development of makerspaces centered on Seeed Studio in Shenzhen.

Founded in 2008 by former Intel employee Eric Pan, Seeed Studio has been drawing attention for its unique business model under the vision of "Maker for Makers." The company has adopted a slogan of "From 0 to 10,000" to reflect its central mission of supporting hardware start-ups (and the individuals who aim to launch these start-ups). Seeed Studio provides the support that each individual requires by categorizing them as follows: "Dreamer = 0" for those who have an idea for a new product in mind but have never actually translated the idea into a tangible form; "0.1" for those who have created only a prototype; and "Veteran Maker = 1" for those who have created one product. Seeed Studio helps these individuals with the manufacturing and sale of products in quantities from 1,000 to 10,000.

Normally, when a business is started by a single person or a small number of people, they must do everything themselves through their own effort, including product development, funding, prototyping, mass production, design and marketing. No matter how good the idea is, they have a tough road to walk until the product actually goes into mass production and generates profits.

Figure 2-9: From 0 to 10,000

Source: Prepared by the author

A business that provides software or Internet services can be commercialized while incurring only limited costs, such as personnel expenses and cloud usage fees. In the development of hardware, however, prototyping, sample preparation and other such tasks incur material costs, outsourcing costs and the like, which are several times larger than the costs of starting up a software or Internet business.

However, Seeed shares this cost burden with its customers. There are not many factories that will accept orders from newly established companies that have no experience, but Seeed has a manufacturing base in Shenzhen named the Agile Manufacturing Center, which actively undertakes small-lot, low-cost manufacturing to quickly respond to orders from small-scale customers.

This type of service is quite rare, and the center receives orders from all over the world, including Silicon Valley. When I was in France recently, I met an entrepreneur based in Germany and the UK who develops small navigational devices for bicycles. He too said that he is considering placing orders with Seeed. Details of the development of Seeed's services are provided in the book *Makers' Ecosystem* mentioned above.

2-3-20 Significance of Open Innovation in Development

What is the significance of the open innovation activities promoted by makers and Fab Labs in terms of the economic and social development of developing countries?

First of all, the products and services that society requires can be designed and developed in accordance with the reality of the situation in developing countries. This does not mean, of course, that there has never been such products or services before. However, in many cases, such products are produced based on traditional manufacturing methods and technologies, and only a few have been made using digital technologies.

For example, Fab Labs in India have developed an ultrasonic dog repulsion machine. They have also developed a foot-operated power generator that makes use of a bicycle in places where the supply of power is poor. In response to the request of a junior high school student, a Fab Lab in Afghanistan has developed a Wi-Fi system that has wooden antennas with the aim of making the Internet available throughout the village. This subsequently spread to the global Fab Lab network as the open-source "FabFi," and a Kenyan Fab Lab has reportedly improved the FabFi system.[36]

[36] https://en.wikipedia.org/wiki/FabFi

Makers in Kenya are working on projects for the development of low-cost medical equipment in cooperation with local Fab Labs, universities, and hospitals.[37]

On the JICA website, Fab Labs are described as having the following potential.

> Production of water purifiers and toilets (health and sanitation), teaching materials (education field), micro hydropower generators (electric power field), recycled plastic products (environmental field), environmental measurement equipment (agricultural field), and prosthetic legs and hands (medical field).[38]

Reflecting the local circumstances and conditions, Fab Labs can develop these products much more cheaply than similar products could be developed and manufactured in developed countries. Products that meet local performance needs can only be realized through local-based efforts and ideas.

At the same time, though, some technologies and ideas have been introduced and combined in an optimal way through global networks, without any distinction between developed or developing countries. This is a key feature of open innovation.

In Kenya, a service called M-PESA, which allows small-scale money transfers to be made via mobile phone, has spread rapidly as it can be easily used by the poor. Apparently, the amount settled using this system is equivalent to more than half of the country's GDP. Rather than open innovation, this is actually a good example of what is known as "river innovation," but it has significant implications as an example of an expanding service that reflects the reality of developing countries.[39]

(1) Producing Blocks Instead of Bricks in Nepal

The large-scale earthquake that struck Nepal in 2015 caused a great deal of damage because many buildings had been built using traditional low-cost bricks that had poor earthquake resistance.[40] Most of these bricks were dried and fired in factories near Kathmandu so as to allow for their mass production and then transported on trucks to steep mountainous areas over a long period of time.

In response to this situation, the Tono Magokoro Net (an NPO also known as the Tono City Disaster Relief Network) entered the mountain village of Jorongge to support their reconstruction efforts with a focus on the use of cement blocks as the construction material. With this in mind, they started a project to teach local people how to make cement blocks so that the housing reconstruction materials could be produced and made available at a low cost. By producing blocks using locally procured materials, they were able to produce high-quality items at a low cost without incurring any transportation costs. Furthermore, they were able to establish a business by selling blocks to neighboring villages, which

[37] http://innovationsformnch.org/uploads/publications/2013_Project_Brief_Maker.pdf
[38] http://www.jica.go.jp/topics/news/2013/20131004_01.html
[39] http://www.safaricom.co.ke/personal/m-pesa, http://gaiax-socialmedialab.jp/line/384
[40] http://www.bo-sai.co.jp/nepal2.html

promotes the local economy.[41] This demonstrates the effectiveness of the open innovation methodology.

(2) Development of Makerspaces in Disaster-Affected Areas

Based on a similar idea, an international NPO headquartered in the US called Communitere has fully introduced the activities and ideas of the maker movement and open innovation into disaster reconstruction.

It all started when Communitere built a workspace to provide various tools and equipment with the aim of supporting community-based reconstruction efforts when the 2010 Haiti earthquake struck. As these tools included digital machine tools such as 3D printers, the workspace was used as a "makerspace" and the stakeholders were surprised by its effectiveness. In 2013, Communitere carried out its work by establishing a more fully developed makerspace in the city of Tacloban in the Philippines after it was struck by a typhoon. It created a co-working space equipped with 3D printers and other machine tools as well as a high-speed Internet connection in order to support community-based, bottom-up reconstruction efforts.

In the wake of the Nepal earthquake of 2015, Communitere set up a maker facility in Kathmandu, which Nepali youths used to proactively participate in the reconstruction efforts.

In both cases, the support activities were carried out based on the needs and ideas of the local people affected by the disaster, not the ideas of outside supporters. Basically, the local people were able to undertake the reconstruction efforts on their own with supporters assisting these efforts from the outside.[42]

2-3-21 Potential of "Local Production for Local Consumption" in Hardware Fields

In the modern industrial society of today, the central business model is designed to realize efficient mass production by concentrating the production bases in areas that are advantageous in terms of personnel expenses and other such factors, the mass transportation of finished products using large-scale transportation networks, and the mass sale of products in large markets. Using large quantities of crude oil and large-scale logistics networks (e.g., large-scale railway and highway networks), maritime and air transportation systems have developed in line with mass production and sales to support the global economy, primarily in developed countries.

However, in light of the development of autonomous decentralized information networks like the Internet and the advancement of global information sharing, these types of models for the mass

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[41] Content based on a conversation between Kazuhiko Tada (a director of Tono Magokoro Net) and the author (March 1, 2016).

[42] http://communitere.org/; Content based on a presentation by Sam Bloch (the founder of Communitere) and his conversation with the author at the World Maker Faire in New York in September 2015.

production, transportation, and sale of products are not necessarily optimal in terms of efficiency anymore.

Open innovation by makers and the like can now be achieved through information sharing via digital networks, and this has opened up the potential for the adoption of a new model that facilitates the manufacture, sale, and use of only necessary products in necessary quantities in relatively small-scale regional economic zones that are set up as bases within the local communities in which people live. This can be referred to as local production for local consumption in hardware fields.

The above makes it possible for small-scale production to attain the same level of cost efficiency as mass production has. An autonomous decentralized model for ensuring the appropriate amount of production is becoming a reality, which will help eliminate inefficient distribution and wasteful inventory and avoid transportation costs. New forms of manufacturing that use digital machine tools are considered highly suitable for autonomous distributed production activities. By planning and developing products at locations situated close to where they are to be used, it is possible to manufacture products that are better suited to actual needs.

For example, if they are used as is, many of the industrial products that have been developed and produced for developed countries' markets (e.g., those for automobiles and home appliances) are often not well suited to the needs of developing countries due to differences in their economic standards and social infrastructure, such as roads, electricity and housing conditions. However, it had been considered difficult for developing countries to independently develop and produce products that require advanced technologies.

With regard to this point, though, the existence of open-source hardware platforms and the deployment of the Fab Labs and makerspaces described in this report strongly suggest that developing countries may be able to develop and produce a certain quality of products, as long as people with the necessary motivation and skills exist.

This is, of course, still just a hypothesis, but it is believed that these movements strongly suggest the possibility of a new direction for promoting development economics going forward and guiding initiatives will be required to realize this.

2-4 Contextualized Innovation

Yutaka Tokushima (Keio University)

2-4-1 Open-Source Movement in Hardware

Previously limited mainly to the software industry, the open-source movement[43] has become prominent in the physical real world—i.e., hardware—since around the latter half of 2000. This open-source movement in hardware has empowered people to produce a variety of "forked" products, and these open-source products have contributed as a form of open innovation to the resolution of local issues not only in developed countries, but also in developing countries.

So, what turn of events led to a boom for the open-source movement in hardware? One answer to this question may be the substantial reduction in the price of digital fabrication machines, such as 3D printers, CNC milling machines, and laser cutters. About 10 years ago, 3D printers sold for more than 10 million yen—even inexpensive ones cost several million yen. However, over the past ten years or so, their prices have fallen sharply and affordable 3D printers can be purchased for less than 100,000 yen at general consumer electronics stores.

Until the late 1990s, digital fabrication machines such as 3D printers were just one of the difficult-to-handle technical manufacturing devices used by major manufacturing companies to produce prototypes. Users of these tools were mainly limited to expert engineers and designers, so the market size for them was relatively small. Since around 2000, however, rapid prototyping using digital fabrication machines has—in parallel with the trend of shorter product development cycles, the development of computer technologies, and the subsequent spread of 3D CAD software—become widespread in the manufacturing industry and expanded the market for such machines. As this market expansion gradually promoted market competition, prices were driven down in the latter half of the 2000s to the point where they were affordable to individuals, and when the tipping point (threshold) expressed by Gladwell (2000)[44] was exceeded, there was a dramatic increase in the use of such machines. At present, the lowest price for a 3D printer (which is a typical digital fabrication machine) is approximately 20,000 yen (Figure 2-10), while a laser cutter or a CNC milling machine costs approximately 50,000 yen. This means that the prices have fallen into a price range that is acceptable to individuals, although there are still functional differences.

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[43] This movement involves the disclosing of source code to provide design information for the development of software through collaborations with an unspecified number of developers via the Internet. Typical examples of open-source software include the free operating system Linux and the free office software OpenOffice.
[44] Malcolm Gladwell (2014), *The Tipping Point: How Little Things Can Make a Big Difference*, Little Brown, United States.

Figure 2-10: Anycubic 3D Printer (US$169 as of March 15, 2016)[45]
Source: Prepared by the author

The reduction in the price of digital fabrication machines has made it possible for individuals to download a wide variety of digital data (e.g., three-dimensional CAD data and electronic circuit creation data) via the Internet and create works in the physical world by outputting the data to 3D printers or using other such means. Such changes to the environment for individual product fabrication have led to a rapid expansion in recreational product fabrication as well as citizen-level product fabrication—neither of which are necessarily conducted with the aim of making a profit—for themselves, close acquaintances, or their communities. Such not-for-profit creative activities have promoted and expanded a type of co-fabrication that is conducted through mutual cooperation by disclosing and sharing design data via the Internet, which in turn has given rise to and expanded the open-source movement in hardware. This can be said to have followed broadly the same trend as the emergence and expansion of the open-source movement in software, where lower prices and the spread of computers enabled the development of not-for-profit software, which in turn led to the creation of many open-source software products, such as Linux.

2-4-2 Open Source Community

In recent years, open source-based fabrication networks, such as Fab Labs equipped with digital fabrication machines, have captured the public's attention in the context of ODA and development of developing countries. These networks can be understood as being citizen communities created by the open-source movements in both software and hardware. In terms of software, there are some open-

[45] http://it.aliexpress.com/item/ANYCUBIC-Kossel-Delta-3D-Printer-Kit-Kossel-Pulley-Delta-3D-Printer-Version-DIY-Kit-with-J/32575447034.html?spm=2114.010208.3.1.xqn5Am&ws_ab_test=searchweb201556_1,searchweb201602_4_505_506_503_504_301_10034_10020_502_10001_10002_10017_10010_10005_10006_10011_10003_10021_10004_10022_10009_10008_10018_10019,searchweb201603_1&btsid=f49e884c-e11a-4479-8086-6e9c98fac1d5

source communities that develop specific software, such as the Linux community for open-source OS development and the OpenOffice.org community for developing open-source office software, but there are also local open-source communities that are actively engaged in working to resolve local issues, such as those named "Code for XXX (city name)." In terms of hardware, there are open-source communities such as the WikiHouse community for building open-source houses and the OSVehicle community for developing open-source vehicles, as well as locally rooted fabrication communities, such as Fab Labs, that aim to resolve local issues.

Most open-source communities in software do not have any facilities or equipment because the software itself is not a physical entity. Software development does not require the use of any particular physical space or facilities because it can be developed collaboratively via communication over the Internet through the disclosure of design information, such as source code. Hardware, on the other hand, is a physical entity and its development involves the conducting of physical work, such as material processing and assembly. Given this, hardware development requires the use of physical spaces and processing equipment. For this reason, hardware open-source communities usually have their own specific facilities and equipment (Figure 2-11).

Communities that are rooted in specific regions, such as Fab Labs, are collectively referred to as "makerspaces," which are facilities and other workspaces where makers (i.e., individuals and creators carrying out product development in small teams) can collaborate. There are a variety of different types of makerspaces, including large-scale ones with global networks (e.g., Fab Labs) and small-scale closed ones for a single region or company. As makerspaces are basically communities, they naturally have their own characteristics. According to Troxler (2011)[46], TechShop is actually a commercial environment rather than a space for collaborative production, while hackerspaces can even be considered anti-market. Troxler also said that Fab Labs guarantee open access as a common property and that they also recommend business activities that go beyond the labs to grow further. As Fab Labs may promote local economic activities while maximizing the number of beneficiaries by guaranteeing open access to citizens in the form of public property, they can be said to be the most compatible and familiar of all the many different types of makerspaces in terms of ODA and development.

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[46] Peter Troxler, "Libraries of the Peer Production Era," *Open Design Now: Why Design Cannot Remain Exclusive*, O'Reilly

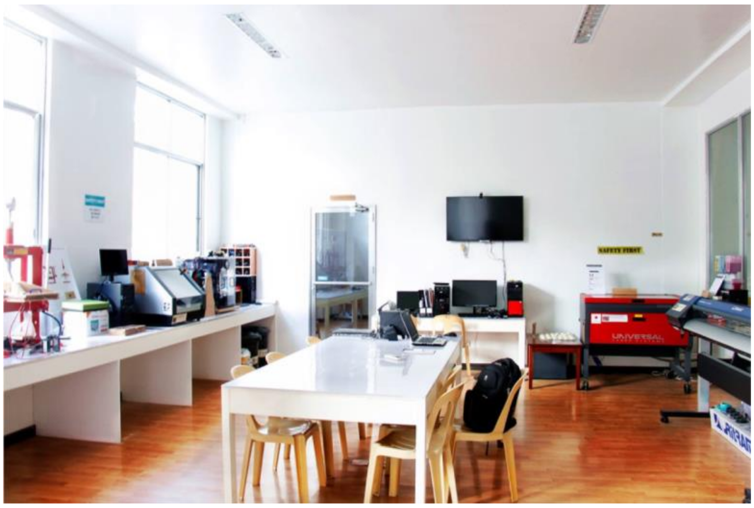

Figure 2-11: Inside FabLab Bohol (Philippines), an Open Source Community

Source: Prepared by the author

2-4-3 Open Hardware Innovation in Developing Countries

In this section, we look at specific examples of what kind of open innovations have been created by makerspaces and how these differ from the science and technology innovations (STIs) of the past. FabLab Bohol, where I currently serve as a director, has developed an ultra-compact heat press machine for the recycling of plastic by utilizing Arduino (an open-source microcomputer board) and other components. Using this machine, it is possible for waste plastics (polyethylene [PE] plastic shopping bags and food packages) that, because they cannot be incinerated, recycled or resold domestically, have just been left as mountains of garbage to be recycled into sheets and other materials. Technically speaking, this type of device is not particularly new, but commercial versions of such products are very expensive, costing approximately two to three million yen. FabLab Bohol has reduced the price of the heat press machine to about 100,000 yen by limiting its functions to the minimum necessary to meet local needs and using only locally available materials. At this price level, it is possible to install recycling machines throughout the area within walking distance of the residents. If such a recycling system is realized, it will be a groundbreaking solution to the problem of the increase in carbon dioxide generated by garbage collection vehicles being larger than the reduction achieved by recycling.

Figure 2-12: Ultra-Compact Heat Press Machine for Recycling Plastic

Source: Prepared by the author

Similarly, a 3D-printed prosthetic leg fabrication solution (Figure 2-13) was jointly developed by FabLab Bohol and Yokohama City's FabLab Kannai by using technical information from the open source community RepRap, and its practical use is now being promoted by SHC Design Co., Ltd. Prosthetic legs used to cost several million yen, but this solution can create an environment in which they can be manufactured and sold for a price of approximately 250,000 yen. FabLab Pabal, which is located in the countryside of India, has developed a milk ingredient analyzer made from one microcontroller, several sensors, and a few other electronic parts. Costing only a few hundred yen, this device can be used for the analysis of fat, a task that until now could only be carried out using an instrument that costs more than one million yen.[47]

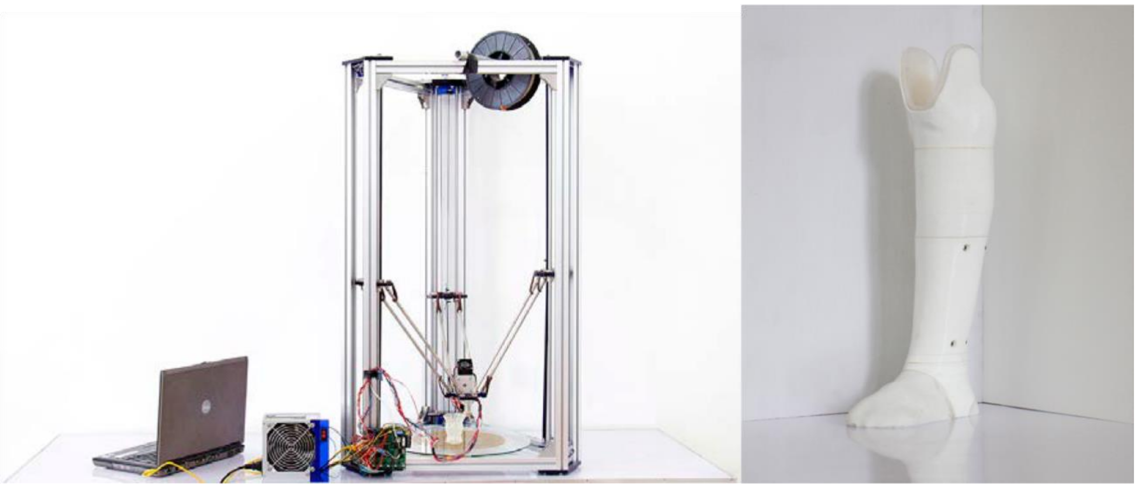

Figure 2-13: 3D-Printed Prosthetic Leg Fabrication Solution (left) and 3D-Printed Prosthetic Leg (right)

Source: Prepared by the author

[47] Neil Gershenfeld (2007), *Fab: The Coming Revolution on Your Desktop—From Personal Computers to Personal Fabrication*, ReadHowYouWant Ltd.

How could such a cost reduction be achieved? One possible answer to this question is the change in design and production methods that has taken place due to the use of digital fabrication machines and open-source hardware. In the conventional product manufacture and development methods that were used before digital fabrication machines and open-source hardware became widely accepted, the parts, materials, and equipment that were used were selected based on the assumption of mass production and mass consumption. For example, the unit cost of the plastic housing used for home electronics and mobile phones ranges from a few tens of yen to a few hundred yen, but it can only be produced after a special die that costs several million yen has been manufactured. Similarly, the unit price of a semiconductor IC or LSI that is used in original electronic circuits ranges from a few yen to few tens of yen, but the design usually costs between several million yen and more than 10 million yen. The initial cost of the dies and the semiconductor design is divided by the number of products to be manufactured and added to the product unit price. As a result, small-lot production using a conventional method and process naturally leads to higher product unit prices. In contrast, using a 3D printer as a digital fabrication machine makes it possible to produce as many plastic housings as you need without having to manufacture a die. Products made using a 3D printer are inferior to those manufactured using a die in terms of unit cost and quality, but they have an overwhelming price advantage due to the fact that there is no initial cost for small-lot production. In addition, the open-source hardware Arduino and other microcontrollers enable users to design original electronic circuits using a single circuit without having to design semiconductors. As the above examples demonstrate, the use of digital fabrication machines and open-source hardware has helped lower the initial cost—which used to be as much as several million to tens of million yen—thereby reducing the total cost for small-lot production.

The small-lot production of high-performance products had been virtually impossible due to the high development and initial costs involved, but the use of digital fabrication machines and open-source hardware has made this possible. Following this innovative change in manufacturing, developing countries that had been unable to earn a profit from mass production are now rapidly establishing makerspaces to resolve problems that are unique to their local areas by using the previously unavailable option of small-lot production. As mentioned in the previous section, the number of Fab Labs has risen to 600 over the past several years, and according to a World Bank report the number of tech hubs in Africa has risen to 171 (WDR 2016)[48].

2-4-4 Contextualized Innovation

As indicated above, it is only recently that an environment that will allow the design and development of high-performance products in the rural areas of developing countries has begun to be established. It is also only recently that the innovative products mentioned above—such as the heat press machine,

[48] World Bank (2015) "World Development Report 2016," Makers for Development Booklet, http://www.worldbank.org/en/publication/wdr2016

the 3D prosthetic leg fabrication solution, and the milk ingredient analyzer—that were developed in the rural areas of developing countries have started to be released. Until this change took place, innovation clusters had been monopolized by a limited number of big cities because inter-regional competition had become more severe in the globalized economy. Furthermore, innovation-led economic development had long been regarded as a tool available only to those situated in the big cities of developed countries. In other regions, such as the rural areas of developing countries, innovations had never been fully utilized for economic development. Florida (2005)[49] states that the creative class (i.e., the social class with the potential to create innovations) has been concentrated in a few big cities. If innovation is a driver of economic development but it is not available in the rural areas of developing countries, this poses a significant challenge to international development cooperation that cannot be overlooked in light of the mission of international development cooperation.

So, is innovation limited only to certain big cities in developed countries or can it take place in other regions as well? This question has arisen partly due to the ambiguity inherent in the word "innovation." Although the word can be interpreted in many ways, I will adopt the following wide-ranging view of innovation proposed by Landry (1995)[50] in the context of international development cooperation: the discovery, through the implementation of inventions, of new or improved approaches or know-how related to all of the processes involved in an economic system, from management through to the production and sales systems. Innovation does not have to apply solely to products and services or to acts of development that can be widely accepted in the markets of multiple developed countries, but it must contribute to improving the lives of local stakeholders and enhancing the local economy.

Under the above definition of innovation, the products developed in the rural areas of developing countries as described above—such as the heat press machine, the 3D prosthetic leg fabrication solution, and the milk ingredient analyzer—can clearly be regarded as innovations. This leads to the conclusion that innovations can now be created even in developing countries because small-lot production has been made possible in advanced product development by the availability of digital fabrication machines and open-source hardware.

Given that, rather than being limited to certain big cities, innovation can actually take place even in the rural areas of developing countries, we need to turn our attention to the considerable advantages this offers in the sense that innovation can directly enhance the local economy in close contact with the local community. However, Kazuhiko Toyama (2014)[51] warns that, in the modern era, the expansion of the global supply chain and the horizontal division of labor makes it difficult to achieve vertical

49 Richard Florida (2005), *Cities and the Creative Class*, Routledge
50 Charles Landry (1995), *The Creative City*, Routledge
51 Kazuhiko Toyama (2014), *Naze Rokaru Keizai kara Nihon wa Yomigaeru no ka: G to L no Keizai Seicho Senryaku* ("Why Japan Will Come Back from Local Economies: The G and L Economic Growth Strategy" [provisional translation]), PHP Shinsho

connectivity between large global enterprises and local small and medium-sized enterprises. As a result, the local economies, which consist of public transport, health and welfare organizations, restaurants, community infrastructure, product distribution entities, and so on, no longer receive as much of a trickle-down growth dividend from the global economy where large enterprises carry out their economic activities. If the global and local economies are divided, the conventional means of pursuing industrial development—by increasing exports through the establishment of large-scale plantations, encouraging global companies to set up factories through the establishment of special economic zones, and proceeding with offshore software outsourcing and development—will be unable to deliver development effects to local economies that are closely tied to their local communities even if the country's GDP increases. This means that we will be unable to deliver the development effects to the local poor who should be the beneficiaries.

If we consider economic development from the viewpoint of poverty alleviation being a central mission of international development cooperation, the development targets should be the organizations and individuals that provide public transport, health and welfare services, restaurants, community infrastructure, and product distribution services for specific local markets that are closely related to the lives of local residents and account for the majority of the local economy. If innovation is not limited to certain big cities and it can be created even in the rural areas of developing countries, we will require context-based innovation that is capable of breaking through and improving certain situations for specific people who constitute the local economy. I define such innovation as being contextualized innovation. It can be said that products such as the heat press machine, the 3D prosthetic leg fabrication solution, and the milk ingredient analyzer mentioned above are the outcome of contextualized innovations that can break through and improve certain situations that are specific to the individual local community.

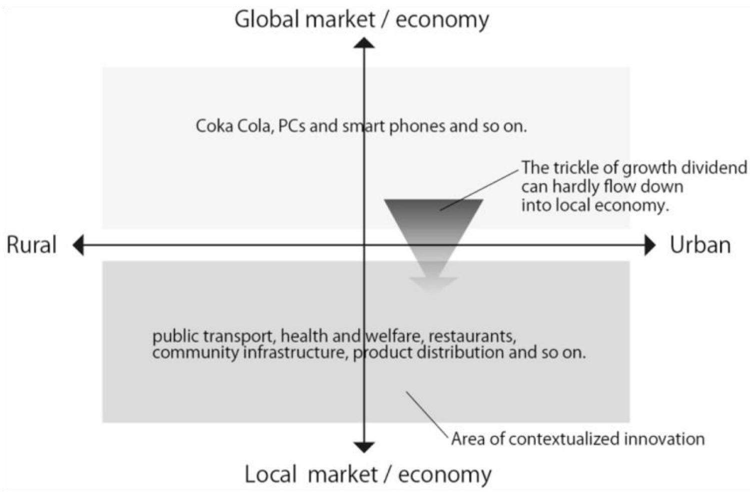

Figure 2-14: Conceptual Diagram of Contextualized Innovation

Source: Prepared by the author

In developing countries, it is extremely difficult to transform average-performing local human resources into world-class innovators who can create innovations that will be competitive on the global market. It is even more difficult to increase the number of innovators to form a creative class in a particular local community and build an environment that will promote the continuous creation of world-class innovations. However, contextualized innovation allows local actors to find solutions to their immediate problems. If local actors pursue contextualized innovation, they do not have to be champions who are able to compete and survive in the global economy and it becomes easier for them to create innovations, thereby making it easier to promote development. If innovators who are capable of creating such innovations can be developed, there is an increased likelihood of local innovators living in the disadvantaged rural areas of developing countries receiving training. A year and a half has passed since FabLab Bohol was established in the Philippines, and there are now 30 to 40 people who have successfully started businesses based on contextualized innovations. These people work hard on their own innovation creation activities while proactively sharing their knowledge with each other through study sessions and other such activities. They refer to themselves as the Technology and Innovation Community (Figure 2-15).

Figure 2-15: Group Photo at a Study Session of the Technology and Innovation Community, a Community for Users of FabLab Bohol

Source: Prepared by the author

2-4-5 Sustainability and Business Models for Fab Labs

Although the prices of digital fabrication machines have fallen rapidly in recent years, it is not easy for an individual to personally acquire the wide variety of equipment and tools required for fabrication and the space necessary to carry out the processing and assembly work using such equipment and tools. All you require to participate in open-source software activities is a computer, so the obstacles to participating in open-source hardware activities are still relatively high in comparison. Makerspaces such as fab labs play a key role in overcoming these obstacles by facilitating the lending of equipment, tools and workspaces to individuals who wish to participate in open-source activities. In short, without makerspaces like Fab Labs, only the middle or upper classes would have enough money to participate in open-source hardware activities. In the rural areas of developing countries, the middle or upper classes are usually in the minority. Therefore, in order to solve local problems by creating contextualized innovations through the use of open-source hardware or communities, Fab Labs and other such makerspaces need to be established.

Next, let's consider how much it costs to provide the rural areas of developing countries with a Fab Lab or another type of makerspace. The previous section mentions that 1 billion yen was invested in DMM.make in Akihabara, a typical makerspace in Tokyo, while approximately 150 million yen was invested in just the facilities alone for TechShop San Jose, a typical makerspace in Silicon Valley. There is no upper limit to the budgets for makerspaces. However, if it is acceptable for just the minimum requirements to be met, it is possible to build a small-scale makerspace with a total investment of approximately two million yen, with one million being spent on the facility itself and the rest being spent to cover the costs of renovating the space, purchasing furniture such as desks and chairs, and having wiring work carried out (Figure 2-16). The types and quality of products that can be fabricated using low-cost equipment are limited of course, so it is best to acquire a diverse range of sophisticated equipment. For example, labs equipped with only small-scale equipment may face limits in terms of being able to participate in large open-source projects, such as building a full-scale house. However, to create contextualized innovations to overcome local problems, it is not always necessary to have a diverse range of sophisticated tools and equipment and a large workspace. The heat press machine, the 3D prosthetic leg fabrication solution, and the milk ingredient analyzer mentioned earlier are examples of contextualized innovations that, with a little ingenuity, can be fully developed even in a small-scale makerspace. In addition, it is not very often that small-scale makerspaces are unable to participate in a global community. For example, Fab Lab communities refer to low-cost labs as Mini-FabLabs or 10K-FabLabs (i.e., Fab Labs that can be created for just 10 thousand dollars) and welcome their participation in the global Fab Lab community.[52]

[52] miniFABLAB, "miniFABLAB: How to Make Almost Any Small Thing," http://www.minifablab.nl/.

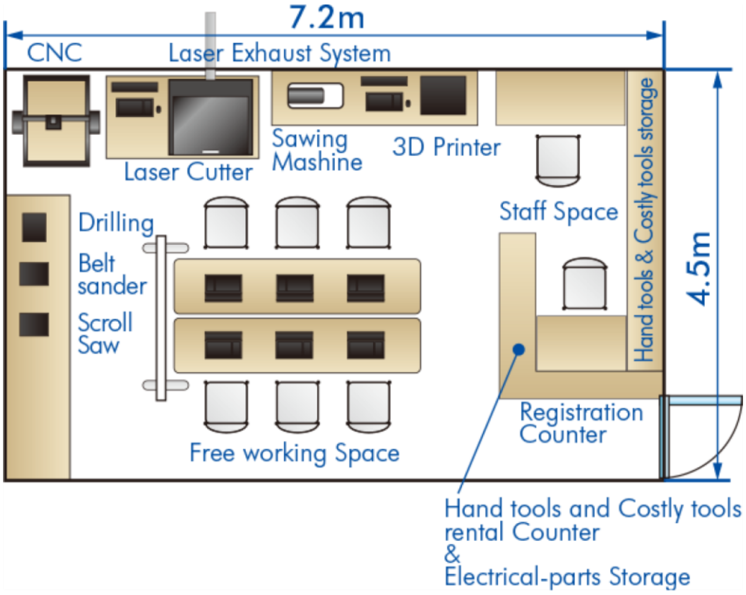

Figure 2-16: Example of a Small-Scale Makerspace
(Typical Layout of a Mini-FabLab)
Source: Prepared by the author

When considering the sustainability of these makerspaces, we need to take into account not only the initial cost of preparing the equipment and workspace, but also the basic revenue-expenditure model for considering the operating balance as well as the running costs, such as personnel expenses. According to the analysis results of an interview survey conducted by Keio University at four Fab Labs in Japan and some Fab Labs in rural areas of Indonesia and India[53], there are roughly four types of revenue-expenditure models for Fab Labs: technology access center, training provider, service bureau, and incubation hub.

A "technology access center" type lab earns revenue mainly from charges paid by the lab users, such as usage fees or membership fees. This type of lab does not require very high-performance equipment and only one or two people are needed to operate it. This helps to minimize both the initial costs and the running costs, thereby ensuring a relatively low risk for start-ups. However, in order to maintain a favorable revenue/expenditure balance, equipment and human resources need to be allocated to increase the number of accesses by users, which means that it is difficult for this type of Fab Lab to manage large-scale development projects involving novel innovations. Although this type of Fab Lab can serve a large number of beneficiaries, its effects tend to be limited to the provision of opportunities and education, and it is difficult for it to contribute greatly to the resolution of problems specific to the local context.

A "training provider" type lab earns revenue mainly from the charges that its users pay to access education and workshop content that is unique to the lab. More than three people are usually needed to

[53] Tomoaki Watanabe and Yutaka Tokushima, "Business Model Typology for Fab Labs: Examining the Sustainability Question with Asian Labs," ICDF 2016.

operate this type of lab to ensure that there are sufficient resources to devise and improve the content and to prepare daily workshops. It is necessary to have talented staff who can develop advanced content, provide high-quality education and conduct workshops worth the prices charged as well as a large workspace in which the workshops can be held. As a result, both the initial costs and the running costs are higher than those of a technology access center. However, since this type of Fab Lab provides precious and unique content, the profits are greater than those of a technology access center. Furthermore, since it is possible to pass on advanced technologies to users, the degree of certainty involved in creating open innovations that will contribute to the resolution of problems specific to the local context is higher than that for a technology access center.

A "service bureau" type lab is one in which the staff themselves develop products using the lab's equipment under contracts with local companies who are trying to promote their businesses or local administrative organs that are attempting to resolve local problems through innovation. Its revenues come mainly from the development commission fees it charges. These types of labs must be staffed by engineers and designers with advanced knowledge and skills who are capable of developing advanced-level products that users are unable to develop themselves. To maintain the revenue/expenditure balance, it is advisable for the lab to get involved in as many different development projects as possible, and a variety of high-performance tools and equipment must be prepared. Accordingly, both the initial costs and the running costs are higher than those of the previous two types of labs. To secure the human and equipment resources needed for commissioned development projects, user access needs to be limited, which results in a smaller number of beneficiaries. However, since this type of lab provides advanced services, it makes larger profits than the previous two types of labs and the degree of certainty involved in creating innovative products that will contribute to the resolution of local problems is fairly high. Given this, the effects of development will also be greater than is the case for the previous two types of labs.

An "incubation hub" type lab provides business support for entrepreneurial users who want to create businesses by using the lab to develop innovative products and corporate users who want to improve their existing businesses dramatically. It is advisable to provide technological support as well as the comprehensive support and mentoring that is necessary for businesses such as finance, marketing, and management. This type of lab creates a large number of social entrepreneurs and social enterprises, thereby helping to resolve problems specific to the local context while simultaneously improving the local economy, which is expected to produce substantial development effects. At present, however, there is no billing model available that generates commission when lab users establish successful businesses. Without grants and financial support from administrative agencies and foundations, it is difficult for this type of lab to achieve a balance between profits and the high costs incurred for advanced equipment and human resources. The ideal revenue model for motivating both the users and the labs would be one in which the labs can be operated using revenue derived from the commission generated when lab users establish successful businesses.

In the entrepreneurial environment found in developed countries, a type of model that corresponds to the above-mentioned commission-based revenue would be seed funding, which involves angel investors and venture capitalists making up-front investments in entrepreneurs, and the accompanying mentoring support. Well known due to a number of successful cases in Silicon Valley, this model serves as an engine for promoting successful business start-ups by creating win-win relationships between entrepreneurs and investors. However, given that the eventual aim of this model is the establishment of initial public offerings (IPOs) or buyouts, it is difficult to adopt with a view to supporting social entrepreneurs in rural areas, particular those in developing countries. In order to operate an "incubation hub" type lab in the type of environment found in developing countries, it is necessary to operate it as a form of public property and to take no account of the revenue/expenditure balance of the lab alone. Alternatively, it will be necessary to develop and establish a new financing model that can be applied in developing countries.

If developed, such a financing/funding model for new developing countries could eliminate a significant fault that exists in the entrepreneurial environment in developing countries in that there is virtually no seed funding to support local entrepreneurs who intend to start a business through innovation. This fault can be said to be a development issue that needs to be quickly eliminated at a global level in relation to Target 1.4 of the SDGs, as described below.

> By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance.

Of the four revenue models mentioned above, the technology access centers require minimal skills and initial investment for their establishment and they can be set up easily, but the profits are small. Service bureaus and incubation hubs require high-level skills and a lot of investment, but they produce higher profits in return (Figure 2-17). Several Fab Labs started out as technology access centers before gradually upgrading their skills and equipment and increasing their profits to become training providers or service bureaus.

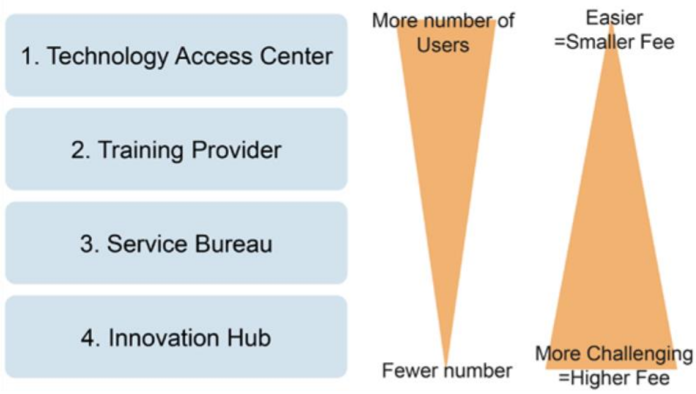

Figure 2-17: Relationship between Access Numbers and Revenue in the Four Revenue-Expenditure Models
Source: Prepared by the author

If the operation type shifts to one of high profitability, the number of users who can access the lab tends to fall, as mentioned above. While the lab's profits increase, infrequent users who have accessed the lab on occasion may lose their place. Sometimes, however, this problem can be solved by the establishment of a new lab in the relevant region. The new lab accepts infrequent users while the older lab provides access to highly skilled heavy users, thereby enabling the two labs to coexist while catering to different types of users. In this case, the new lab does not need to explain to residents of the area what a Fab Lab is and the hurdle to starting up is lowered by the fact that users are acquired relatively easily. The older of the two labs can also acquire mid-level users who wish to go on to a higher level after gaining literacy at the new lab, thereby building a win-win relationship between the new lab and the older one. When a lab in a particular region changes its operating style due to it having grown, a second lab and even a third lab may appear. This leads to improved technical capacities in relation to open innovation and the number of beneficiaries in the region. In fact, the number of labs in Kanagawa Prefecture, which is where Japan's first Fab Lab was established in 2011, has been increasing in an almost ideal manner. There are currently five labs operating in the prefecture. Cases like this, where the effects of development increase with the passing of time, are the most desirable form of support in international development cooperation.

2-4-6 Long Tail Model and Hardware Development

The long tail model presented by Chris Anderson (2006)[54] is a new business model for the Web 2.0 era of using the Internet. This is also well known as the business model adopted by Amazon and

[54] Chris Anderson (2006) *The Long Tail: Why the Future of Business is Selling Less of More*, Hyperion, United States.

Netflix. More precisely, the long tail model is a business model in which you can generate sufficient sales from the bottom 80% of customers or products (i.e., the "tail"), which is completely different from the conventional concept of securing 80% of total revenue from just the top 20% (i.e., the "head") of your customers or products (Figure 2-18). New distributors and sellers, such as Amazon, have made considerable profits from the tail by stocking and selling a variety of products regardless of their sales volume using the new Internet-based sales channel. This sales channel eliminated restrictions associated with conventional over-the-counter sales, such as there being a limit to the amount of shelf space that can be used to showcase products and costs greatly exceeding sales in the event of many products on the shelf being left unsold (cold-selling products), thereby resulting in a no-profit situation. This groundbreaking innovation facilitated the distribution of niche products and small quantity products that meet more specific individual needs or special local needs that the market had failed to meet.

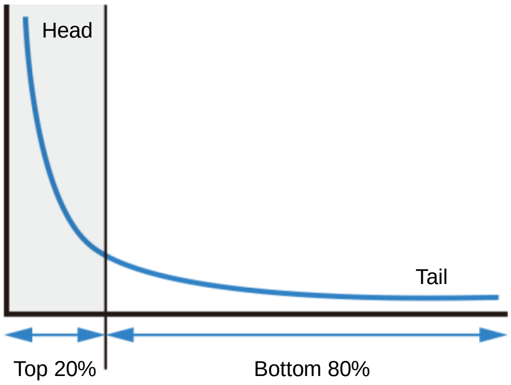

Figure 2-18: Conceptual Diagram of the Long Tail Model

Source: Anderson (2006)

On the other hand, this worldwide increase in the number of Fab Labs and other types of makerspaces has resulted in the release of many products from around the world, which in turn has contributed to the resolution of various region-specific problems. As mentioned above, the products required in developing countries are usually produced through high-mix low-volume production. Based on conventional wisdom, it has long been understood that these types of low-volume products are unlikely to be released on the market. However, this understanding has been gradually overturned following the emergence of the long tail model. In light of the fact that the new Internet-based sales channel has expanded and that the deployment of ICT infrastructure has progressed in developing countries, an environment has been rapidly developed in which high-mix low-volume products that have been produced in developing countries can be distributed on the market and sufficient profits can be made to expand the business.

In the electronics devices and appliances industry, although popular high-volume products that are mass-produced by large companies retain their market shares, many low-volume products that meet more niche needs have been released on the market through Internet sales. Many of these low-volume niche products are manufactured by individuals or small and medium-sized companies to meet personal and preferential needs by using open-source hardware such as Arduino or the small single-board computer Raspberry Pi. The 3D printer market is a typical example of this. Popular 3D printers are mass-produced by established players that occupy the largest share (head) of the market, such as Stratasys, 3D Systems, and MakerBot. The market has also been flooded with original 3D printers that have been developed by individuals or small and medium-sized companies using an open-source motherboard for 3D printers. These tail products account for a large proportion of the market.

2-4-7 Open-Source Hardware: A Solution for Problems in Developing Countries

Needless to say, a variety of the products that comprise the tail part of the hardware market are technically underpinned by open-source hardware. In most cases, open-source hardware integrates specific difficult-to-handle functions into packages or devices. In other words, open-source hardware makes it easy to handle functions that would need to be designed from scratch if they were not offered as part of a package. Functions that would otherwise be difficult to develop and implement are easily available by using packages or devices. Using open-source hardware lowers the hurdle to product development, encourages new creators to enter the market, and expands the open source community, thereby leading to a wider range of variations being created by a variety of actors.

For example, OSVehicle's open-source hardware for cars is an easy-to-understand business model. Designing a car from scratch might seem to be a daunting challenge for anyone, but if you use part of the open-source base frame that is provided and sold as a package and design only the part that you want to modify (e.g. by designing only the exterior and the interior as you like), the hurdle is lowered significantly. Lowering the hurdle to development encourages the entry of new creators and companies who have wanted to fabricate their own original cars and enter the car business. With this expansion of the open source community, OSVehicle can boost its customer base and sales of its base car frame.

When we consider open innovation in the context of development aid, it is important to note that if the hurdles to product development can be lowered through the use of open-source hardware, creators and companies will enter their relevant fields and new markets will be created (in the tail of the long tail). JICA has identified many items as development challenges for developing countries, and the SDGs detail challenges in the form of 17 targets and 169 goals. When attempting to use open innovation to overcome these unresolved challenges, a new approach with great potential could be to make key solution products available to the public as open-source packages or devices. If open-source hardware communities that are focused on areas of challenge can be created and expanded, it may be possible to address these challenges rapidly and simultaneously across the world, while also developing new markets in relevant areas by attracting new creators and companies.

For example, as a measure to combat AIDS and tuberculosis in accordance with Target 3.3 of the SDGs ("By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases"), open-source hardware can be used to develop products to improve medication adherence, such as a pill case or a medicine calendar, as an instance of the Internet of Things (IoT). If a basic package for equipping a pill case or a medicine calendar with a medication reminder function that can be linked to mobile phones can be developed at an ultra-low cost and released as open source, we will see many small businesses emerge in the rural areas of developing countries around the world with the aim of providing products such as pill cases that send a text or makes a call to your mobile phone to remind you to take your medication. Citizen movements promoting the use of such products would soon multiply, which would contribute greatly to suppressing the onset of AIDS simultaneously across the world as well as promoting DOTS for successful tuberculosis control.

In addition to the above, there will be other basic open-source packages that can be provided at extremely low costs, such as ones for developing a water quality inspection device or for developing a clinical thermometer that can be powered by solar cells or AA batteries. The development of the latter product would provide a solution to a problem faced by developing countries in that button batteries for electronic thermometers are hard to acquire and clinical mercury thermometers can be easily damaged on bumpy roads. In this sense, open-source hardware has limitless potential in terms of providing innovative approaches for overcoming complex unresolved problems in developing countries.

Given these possibilities, open-source hardware will not only help to resolve problems in developing countries, but also bring in profits for the providers of the basic open-source packages. This may turn out to be an ideal form of international development cooperation in which developed countries, such as Japan, and developing countries can create a win-win relationship. In fact, in Africa, local Fab Labs based in Kenya are actually working jointly with organizations from developed countries on a project to develop open-source medical equipment that is required for the provision of neonatal medical care with the aim of implementing development cooperation using this model.[55]

Viewed globally, Japan is a technology-oriented nation that possesses some of the world's top-level technologies in many fields of basic technologies, such as those for highly advanced sensors, measuring instruments, and manufacturing equipment. Furthermore, it has a foundation that facilitates the production of many open-source hardware products that could be used to solve problems in developing countries. To explore the possibility of using open innovation for international development cooperation, it is very important that we consider how best to match the excellent basic technical capabilities of Japanese companies to the international development challenges that are faced and transform them into open-source hardware. To this end, we need to consider this both from the perspective of using Japanese technologies to overcome international development challenges and

[55] FabLab Nairobi (2014), "Maker Movement for MNCH: Saving Lives Through Locally Designed Equipment," http://innovationsformnch.org/finding-what-works/technology-as-a-tool-for-health-worker-retention

from that of providing Japanese companies with substantial profits and promoting a new, ideal form of international development cooperation.

JICA is actively engaged in activities aimed at incorporating Japan's technological assets into international development cooperation, while benefiting Japanese companies through the use of public-private partnership schemes. I sincerely hope that JICA will incorporate new ideas and the essence of open innovation into international development cooperation and take a leading role in pioneering new international development cooperation trends by taking advantage of its extensive experience.

Chapter 3: Impact of Open Innovation on Development

3-1 Economic Analysis of Fab Labs: Suggestions for Development Assistance

Tatsuo Tanaka (Keio University)

In this report, I will try to provide an economic analysis of Fab Labs. Equipped with a series of machine tools (e.g., 3D printers and laser cutters) connected via the Internet, Fab Labs are laboratories where users can carry out development and production activities while exchanging ideas each other. As Fab Lab users can share data freely in today's connected world, ideas travel around the globe without restriction and this can be expected to lead to unprecedented technical innovations. Users can create objects wherever they may be as long as they have the necessary data. Given this, problems associated with the location of production can almost be ignored.[56] Since the production facilities are shared from the beginning, the producers do not need to have their own facilities or a labor force. One thing we should consider, though, is that although Fab Labs are still relatively small in scale at present, what will happen if they grow bigger? In this section, we consider how Fab Labs can be understood as a business model and their implications for development assistance.

3-1-1 Business Model

Let's start by considering what the situation would be like if Fab Labs were commonly available to all. If every convenience store in every town had a 3D printer, you would be able to manufacture simple products at a convenience store near your house as long as you had the necessary data. To manufacture bigger products or ones requiring special materials, you would be able to use a makerspace or a workshop situated near to a major terminal railway station.

In a situation like this, no labor would be required and capital equipment could be shared. The capital equipment usage fee divided by the number of products would be extremely low. The cost to produce an additional unit of product (i.e., the marginal cost), which would be only a material cost, would be low and constant. There would be almost no divergence between the average cost and the marginal cost for consumers.[57] Figure 3-1 illustrates this situation.

[56] It should be noted, though, that Fab Labs may still face locational problems, such as whether they are located within walking distance of the users and, if they are not, how much it will cost to deliver the fabricated items from remote locations. However, they do not face locational problems related to the production factors inherent in traditional product manufacturing, such as the availability of capital and labor, which are basic components of economics, and the regional bias of the manufacturing technologies to be used.

[57] How the cost to developers (i.e., the development costs or sunk costs) could be recovered would remain a problem. This will be discussed later.

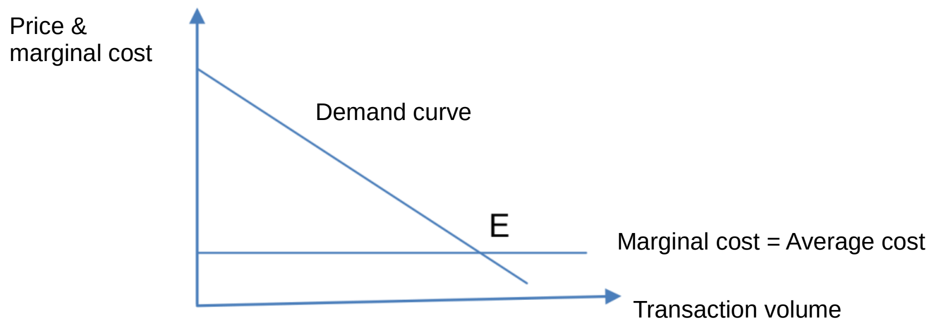

Figure 3-1: Relationship between Transaction Volume and Price/Marginal Cost in a Situation Where Fab Labs Are Commonly Available

Source: Prepared by the author

If the marginal cost is constant, several types of business models can be considered. The typical four types are as described below.

(1) Reputation Model

In Figure 3-1, a competitive equilibrium is achieved at point E, where the producer surplus reaches zero. This model applies to cases in which the manufacturing data of a 3D printer is immediately shared over the network. This model also includes cases in which the data can be easily reconstructed from finished products. As the developer's profit is zero, the development costs cannot be recovered and there is no monetary incentive to develop products. However, a certain number of developers will want to develop products just to gain a favorable reputation. Open-source software products, such as Linux, have been made in a way that is close to this reputation model. Fab labs have been started on a voluntary basis in many countries, and these Fab Labs are, by nature, highly compatible with the reputation model.

(2) Product Differentiation Model (Customization Model)

Differentiated (customized) products are provided to meet differing consumer needs. Customizing products results in the generation of monopoly power, which allows prices to be set higher than the marginal costs, thereby leading to profit. The development of prosthetic legs at Fab Labs is a typical example of this model. As the fabrication of prosthetic legs requires the use of customized data that is specific to the individual user, competition with other developers seldom occurs. Since development fees are paid for the design and fabrication, developers can make a profit.

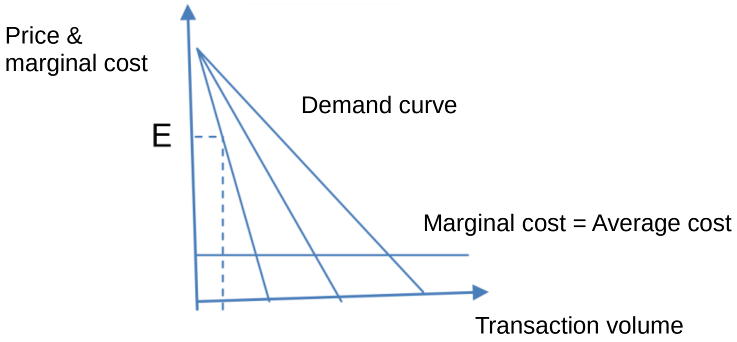

Figure 3-2: Product Differentiation Model

Source: Prepared by the author

Because the users themselves can process products at Fab Labs, it is extremely easy for them to create products that have been customized to their own needs. In general, factories are optimized to produce large quantities of the same goods so they are not suited to handling extreme product differentiation. Fab labs are advantageous in that they make it easy to provide the ultimate in customization on an individual basis.

(3) Rent Model

This model creates profits by securing monopoly power through the use of intellectual property or special materials. These profits are made by protecting the design data as intellectual property or using special 3D-printer materials that can only be supplied by specific companies.

A basic tenet of economic theory is that intellectual property provides an incentive if the marginal cost is zero. Bottleneck strategies that involve the use of special materials, such as the printer-ink strategy, are often carried out. However, intellectual property requires institutional protection and special materials are not necessarily always available.

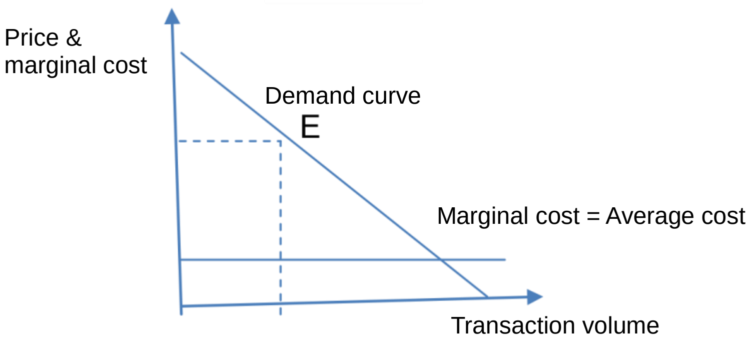

Figure 3-3: Rent Model

Source: Prepared by the author

(4) Freemium Model

This model generates revenue by providing a high volume of the product to a wide range of people at marginal-cost prices, while also providing special differentiated products or services to consumers who are committed fans of the product. Freemium is a method that is frequently used in digital services, such as the Nico-Nico video sharing website (paid membership), LINE instant messaging service (online store for purchasing stickers), and social games (in-game purchases of random items). The freemium model differs from the rent model in that there are many users who use the product at the marginal-cost price. The challenge posed by this model is how to create differentiated products and services to be offered to consumers who are committed fans of the product. For example, possible ways in which such differentiation can be created include considerate after-sales services and specially designed products that cannot be manufactured by a 3D printer.

If the freemium model succeeds, it generates substantial profits and considerable consumer benefits. The total social surplus is maximized. However, in order for this model to succeed, there needs to be a certain number of consumers who, as committed fans of the product, are able to pay a lot of money for the differentiated products designed for them.

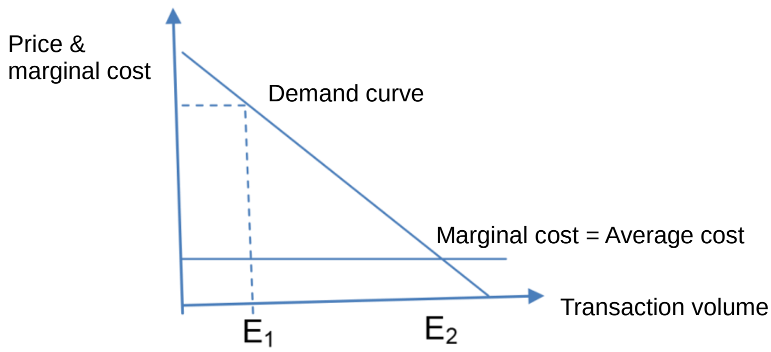

Figure 3-4: Freemium Model

Source: Prepared by the author

3-1-2 Innovation Model

The models described above can also be adopted by large companies. If companies such as Siemens, GM, or Japan's Shimadzu Corporation were to set up several hundred Fab Labs, have their development teams develop product data and then create products at these Fab Labs, they could adopt any one of business models (1) to (4) above. In other words, what I have written about so far deals not so much with Fab Labs, but with 3D printers and networks that fall within the scope of Germany's Industry 4.0.

The true value of Fab Labs does not lie in the models described above. Fab labs help to dramatically reduce the costs involved in entering the development and manufacturing business, thereby opening the way for numerous engineers. Since Fab Labs are connected by a network, ideas and knowledge can be widely shared and development is accelerated. In other words, accelerated innovation is the biggest advantage of Fab Labs.

As Figure 3-5 illustrates, joining a Fab Lab enables independent individuals and individuals who have until now interacted only within the framework of their companies to start exchanging information, become inspired, and receive incentives to create innovative products or services. The Fab Lab provides a place—or a platform—for many individuals to collaborate.

This type of development, in which large numbers of individuals participate in a development platform for promoting innovation outside of their companies, can be regarded as open innovation. Open innovation is a concept that has been inspired by the success of Silicon Valley and Linux. Unlike innovation that is completed within closed organizations like traditional companies, open innovation is a type of innovation that is accelerated through mutual interaction with the outside world at various levels.

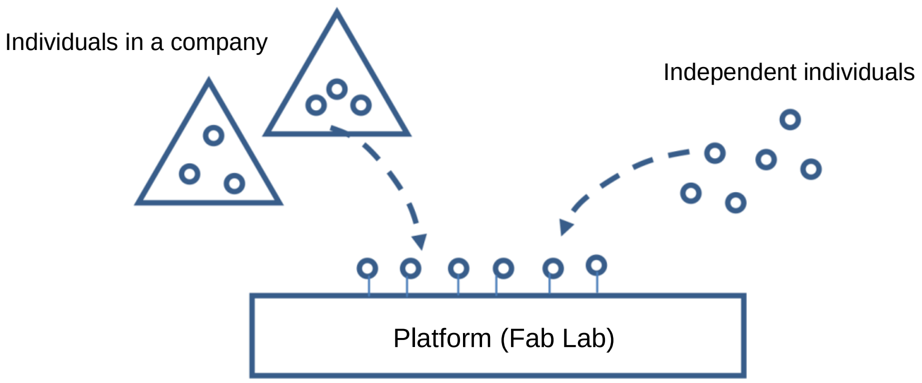

Figure 3-5: Fab Lab Innovation

Source: Prepared by the author

As indicated on the left side of Figure 3-5, the term "open" can be used with regard to individuals working for a company in the sense that it implies they open up the "shell" of the company. However, as indicated on the right side of the figure, it does not really apply to independent individuals who do not work for a company because there is no "shell" for them to open in this case. This is close to the situation that exists in developing countries. Personally, I feel it may be more appropriate to call this "networked innovation" or "collaborative innovation," but in the absence of a more suitable established term, I refer to it as "open innovation" as this is the most commonly used expression at present.

As the figures in section 3-1-1 show, accelerated innovation can be understood to be an expansion of demand (or the creation of the market itself). If the demand curve is described based on the aforementioned figures, it shifts considerably to the right (Figure 3-6). The innovation model can be combined with any of business models (1) to (4) to further increase the profit opportunities. For example, since it often takes time for an innovation to become widespread, one possible approach would be to make sufficient profit before the innovation becomes widely used (i.e., before it is imitated).

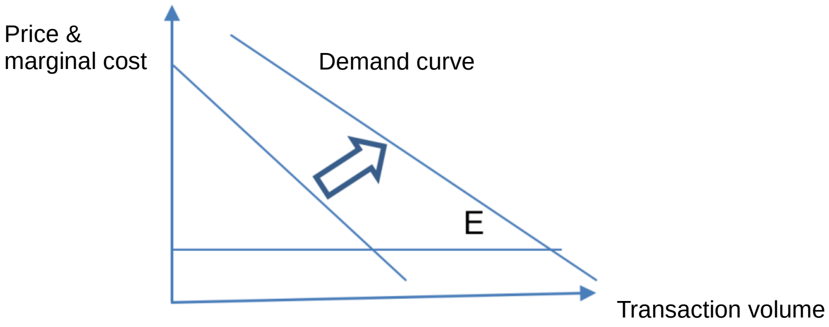

Figure 3-6: Effects of Innovation

Source: Prepared by the author

The acceleration of innovation in Fab Labs can be broken down into two categories: venture businesses and educational effects.

(1) Venture Business

At Fab Labs, large numbers of individuals share information while competing with each other, and carry out numerous attempts to create new innovations. Most of these attempts prove to be relatively unsuccessful so they end up disappearing, but some attempts result in new products that generate considerable value. This "high birth and death rate" development mechanism has also been observed in Silicon Valley, so it is appropriate to call such developers venture businesses. Since Fab Labs serve as platforms for venture businesses, they are referred to as the "Silicon Valley" of the manufacturing industry.

(2) Educational Effects and the Human Resource Development Mechanism

Fab labs have a human resource development mechanism that helps produce outstanding human resources, but not all of them go on to start their own businesses. Suppose all high schools and universities had Fab Labs—if those students who like manufacturing worked seriously on manufacturing while sharing their experiences with each other, the educational benefits would be immeasurable. Furthermore, if the engineers who trained there went on to play an active role as a company employee, society as a whole would benefit. Business people working for companies can also get intellectually inspired or inspire others by using Fab Labs in their leisure time.

3-1-3 Relationship with Development Assistance

In this section, we discuss the pros and cons of adopting Fab Labs as a development assistance target. One option would be to establish dozens of Fab Labs in developing countries by providing the necessary financial assistance. The amount of assistance required for 3D printers and networking equipment would not be especially large. Firstly, we discuss whether Fab Labs offer an efficient (effective) means of pursuing economic development in developing countries, and then we consider whether it is necessary to provide development assistance for them.

(1) Efficiency of Fab Labs as a Development Assistance Target

Here, the term "efficiency" is used in the sense of "cost effectiveness"; that is, the benefits of economic growth relative to investment. In this regard, the provision of development assistance to Fab Labs could, if they prove successful, deliver considerable benefits.

The first reason for this is that Fab Labs make it possible to fabricate products even without skilled labor and capital equipment. Even if developing countries have individuals with outstanding ideas or techniques, developed countries have abundant capital and skilled labor so they have the advantage in terms of being able to transform such ideas or techniques into reality in the manufacturing industry. This uneven distribution of production factors is one reason why talented Indians and Chinese have often started their businesses in the US rather than in their own countries. However, capital equipment is now available at Fab Labs around the world and skilled labor is embodied in the data. The fact that, as mentioned above, Fab Labs do not face locational problems means that businesses can start up without having to worry about their location. Although they cannot gain a competitive advantage by using the inexpensive labor that is available in developing countries, they have no concerns about obstacles such as a shortage of capital or skilled labor. If things go well, talented individuals in developing countries may be able to sell their ideas and products globally.

The second reason is that there is believed to be substantial demand for local customization—or "localized demand"—in developing countries. Developing countries have a wider range of lifestyles than developed countries do, so product requirements vary from region to region. For example, even the shape of a bucket may be suited to a certain region. Fab labs are ideal for customized production, and they allow people in developing countries to customize and produce products that will meet demands specific to that region. Conventional factories have no choice but to mass produce products, and their distance from the place of consumption means that localization can prove difficult due to a lack of information. Since Fab Labs are in close contact with their local communities, they can create localized products that meet local needs. Stable businesses will be established if local people can make products that will cater to local tastes.

(2) Need for Development Assistance

One criticism that is sometimes raised is that if the cost effectiveness is high, the work can just as easily be done by the private sector. To provide development assistance, we need to set out the reasons why this cannot be done by the private sector.

The first reason why this cannot be done by the private sector is the high risk involved. I mentioned in (1) above that the cost effectiveness is high, but this is true only if the Fab Lab is successful. There is no certainty that a Fab Lab will produce successful companies. Even if 10 Fab Labs were established and many businesses launched, it is quite possible that only one of them will succeed. If one lab achieves great success and generates an added value that exceeds the total setup costs of the 10 labs, the establishment of these labs will pay off for the country. However, the risk of setting up a Fab Lab is too great for it to pay off for a private company.

The second reason is external factors. Even if a Fab Lab produces successful companies, the margin will be absorbed by consumers or the successful companies' profits, which means that only a small part of the margin will be returned to the founder of the Fab Lab. Therefore, even if the Fab Lab proves to be socially successful, its founder may end up in the red. Because Fab Labs promote education and human resource development, they are expected to help produce outstanding human resources. However, the benefits of this human resource development will be dispersed throughout society without providing a return for the founder of the Fab Lab. In other words, the benefits that arise from the establishment of a Fab Lab will flow outside the lab through an excessive number of users and human resource development. Because of these external factors, it is necessary to implement development projects even if they will make a loss. This is where the significance of development assistance lies.

3-2 Economic Issues in Open Innovation

Toshiya Jitsuzumi (Kyushu University)

In this report, we discuss various economic issues pertaining to open innovation.

3-2-1 Scope of Adoption for Open Innovation

Even when new technologies or new production processes are introduced, it is rare for them to replace conventional technologies and processes completely. Instead, they first begin to be used as part of the conventional process and are then introduced in a progressively wider range of applications, thereby gradually improving the resource allocation efficiency of the entire market. As suggested by the concept behind the expression "the right person in the right place," it is necessary to make a reasonable judgment by comparing the advantages and disadvantages presented by open innovation and traditional innovation. For example, if a linear technological development pathway should be pursued to address a technical problem and the accumulated production experience can make a positive contribution to this, the most efficient course of action is to adopt a traditional innovation process because it excels in the allocation of large amounts of resources to pre-determined targets. If, on the other hand, there are multiple technical solutions that can be used to address a problem and this problem requires flexible thinking that is not bound by past experience, the most efficient course of action is to use an open-innovation approach. With the open innovation approach, we can pursue multiple possibilities simultaneously with the expectation that market dynamism will determine the most efficient solution.

If we assume that the value of solving a technical problem (i.e., the value of an innovation) is constant and that the marginal cost of the technological development process increases as the scope of the application expands, the scope to be covered by each of the processes is derived from the intersection point of their marginal cost curves (Figure 3-7) in a graph where the horizontal axis represents the nature of the technical problem. In this framework, the increasing adoption of open innovation can be interpreted as a direct result of reducing the marginal cost of the open innovation process through improvements to the Internet infrastructure, the advancement of devices, and the evolution of AI.

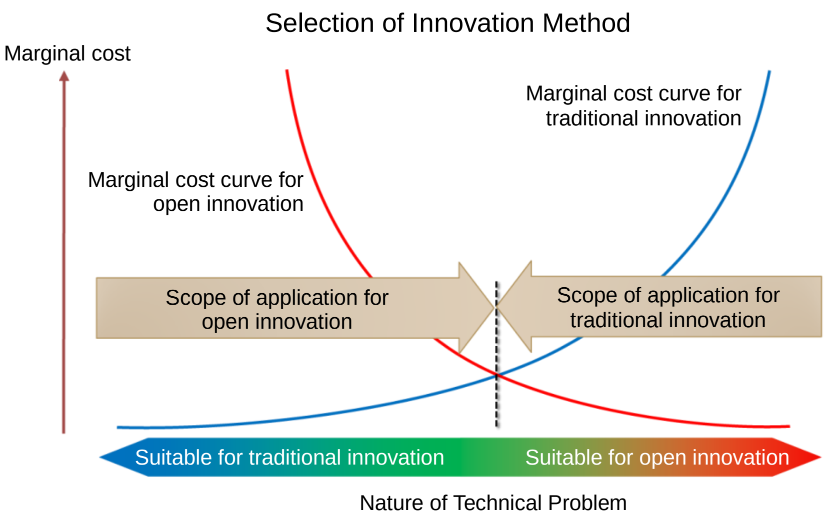

Figure 3-7: Selection of Innovation Method

Source: Prepared by the author

We also need to take into consideration the fact that the technical progress that has expanded the scope of application for open innovation can contribute to improving the efficiency of the traditional innovation process as well. This optimal demarcation point needs to be continuously reviewed in accordance with technological progress as well as changes in terms of the challenges that the innovation process faces. When conducting such reviews, we also need to take into account the possibility of costs being reduced through the sharing of related know-how among players (this concept relates to Marshall's externality).

3-2-2 Evaluation of Support Measures for Disseminating New Technologies

Developing a new technology is, on its own, not enough to generate sufficient benefits for society. In order for a new technology to demonstrate its potential, the technology needs to be integrated into the supply process and the resultant new value needs to be fully incorporated into the ecosystems (which include consumers as key stakeholders). For this reason, it takes time to evaluate the performance of the various support measures taken for that purpose. The same applies to open innovation, and it is necessary to avoid making a hasty judgment and instead take a long-term view to determine whether or not the administrative resources used for the support measures have produced the desired effects.

(1) Supply Side

For a new technology or innovation to be effective on the supply side, the related peripheral arrangements need to be fully completed (Jitsuzumi [2005], etc.). As reported in existing literature (van Nievelt [1999], etc.), the successful introduction of IT requires the restructuring of business models. David (1990) points out that in order for the electricity revolution to have a significant impact on an entire economy, it was necessary to restructure plant equipment, which took approximately 40 years. The production of new products and services (i.e., product innovation) beyond efficiency improvements for existing processes (process innovation) or the creation of a new industry through the adoption of a new technology takes place at a later stage, when the potential value of the technological development has been fully realized.

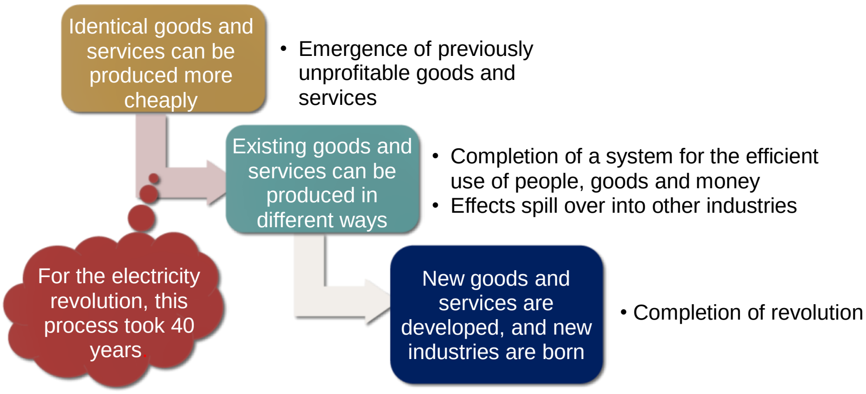

Figure 3-8: Technology Spillover Process

Source: Prepared by the author

The rapid development of ICT, as represented by Moore's Law (which is an empirical rule), and improvements to the average literacy of consumers are expected to accelerate the process described above. However, it is still unlikely that the effects of new technologies will be revealed immediately.

The likelihood of new technologies being adopted by for-profit companies depends on the magnitude of the technology's future benefits (more precisely, expectations for its future benefits). Since forecasts about the future in the face of rapid technological advancements and market changes are subject to considerable uncertainty, the incentives for risk-averse players to adopt new technologies always tend to fall below the optimal level for such players. This phenomenon is greatly affected by the "sentiment" shared across the market, which is depicted in the "hype cycle" concept developed by the research company Gartner. According to this concept, in order for a new technology to take hold and deliver steady efficiency improvements, it must go through a time-consuming process that involves a rapid initial expansion followed by a waning of the expectation "bubble."

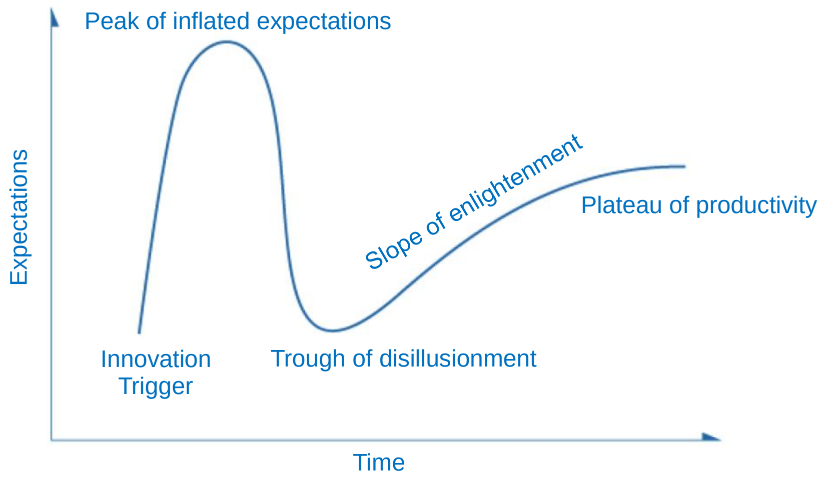

Figure 3-9: Hype Cycle

Source: Gartner website

(http://www.gartner.com/technology/research/methodologies/hype-cycle.jsp)

(2) Demand Side

According to Rogers' diffusion theory (2003), new goods and services are diffused as follows: first to the innovators (the advanced users group that is expected to account for approximately 2.5% of the entire market); then to the early adopters (13.5%), the early majority (34.0%), and the late majority (34.0%); and finally to the laggards (16.0%). It has been pointed out by Moore (2014) that there is a chasm, at the diffusion level of 16%, that must be bridged before the early majority is reached (Figure 3-10) and that a high cost (time) is incurred to cross it. In fact, many goods and services fail to cross the chasm, leaving their developers with no choice but to remain as niche players. In particular, for goods and services that are influenced by demand-side economies of scale (also known as "network effects"), crossing the chasm is considered to be synonymous with reaching the point of critical mass where demand becomes sustainable. This means, then, that a failure to cross the chasm will lead directly to withdrawal from the market. In summary, dramatic success at the beginning of diffusion does not necessarily guarantee continued success, so a hasty evaluation of support measures can give rise to many problems.

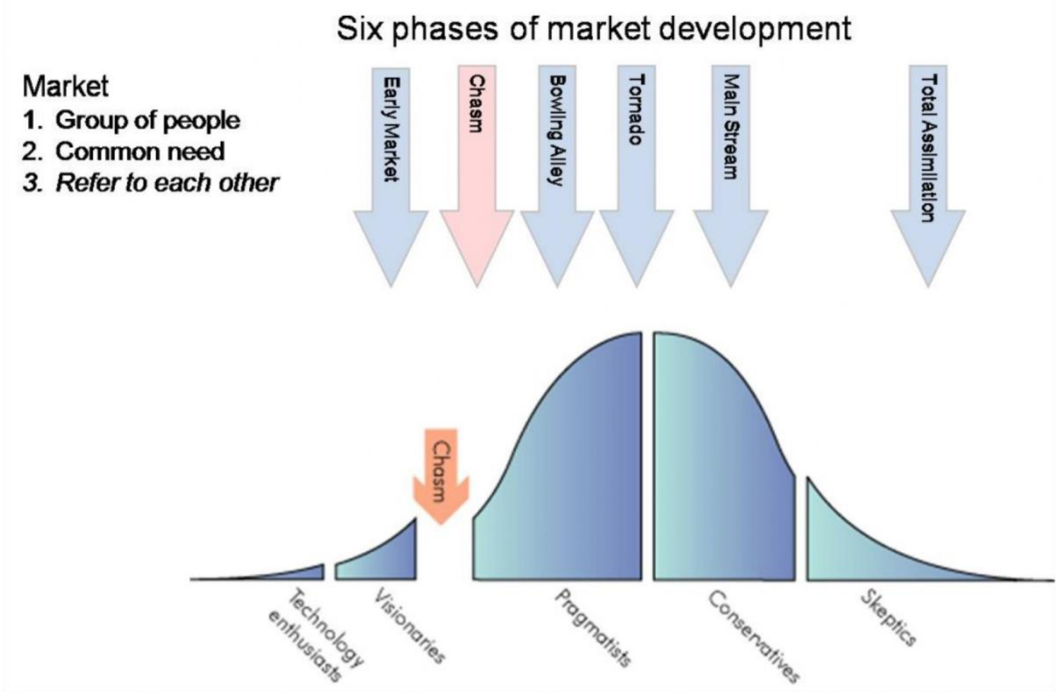

Figure 3-10: Six Phases of Market Development and the Chasm

Source: http://www.idgotomarket.com/2010/07/early-adopters/

3-2-3 Network Effects and Their Consequences

Open innovation is expected to produce a virtuous cycle in which countless innovators create new products through collaborative work, some of which are fortunate enough to attract end users and gain a sufficient market share to surpass the break-even point, which in turn generates resources for more innovations. This means that the "place" where open innovation occurs serves as a platform for connecting innovators and end users, while indirect network effects occur between the innovators and the end users. In other words, open innovation can be described as having the nature of a two-sided market (Figure 3-11).

In a two-sided market, a platform increases its appeal by attracting more innovators and end users, enjoys economies of scale on the demand side, and eventually gain market monopoly power (a "winner-takes-all" situation). The platform operator can monetize its position by charging the innovators and end users platform usage fees in consideration of the network effects that they each enjoy. This scenario is repeated each time the market environment and technical prerequisites change. In other words, platform operators repeatedly engage in competition every time the environment changes so as to gain a monopolistic position.

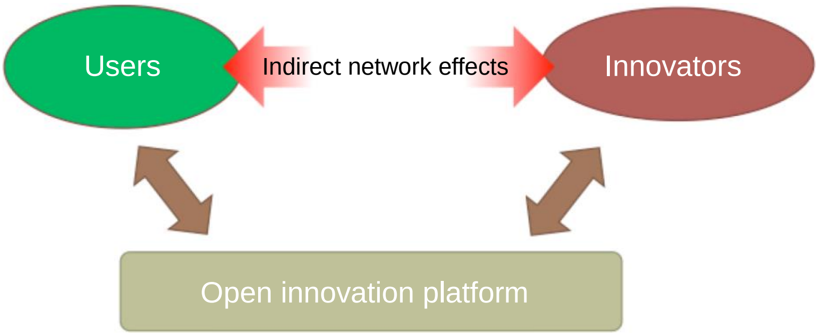

Figure 3-11: Open Innovation as a Platform

Source: Prepared by the author

Traditional financial systems cannot be expected to provide players who can offer little or no assets as collateral with the funds necessary to carry out projects with an extremely low probability of success but an extremely high potential return. This field of investment needs support from "venture capital" funds. A prerequisite for the venture capital funding mechanism to function adequately is that the platform operator must be able to continuously accumulate a sufficient number of projects to form an investment portfolio. To this end, efforts must be made to connect locally established open-innovation platforms to develop a global innovation portfolio. Furthermore, to attract funding on preferable terms, it is necessary to improve the probability of success for each project, and the building of a network of innovation platforms to facilitate the sharing of global best practices has considerable benefits in this respect.

3-2-4 Methods of Implementing Support Measures

When policy support measures are implemented in the field of open innovation, the most problematic issue is that "information asymmetry" lessens the effectiveness of the support measures. As the form of open innovation changes rapidly in accordance with Moore's Law, Gilder's Law, and Metcalfe's Law, we cannot expect the administrative agency to be able to effectively keep up with these rapid changes and design the necessary regulations and support frameworks. There are concerns that market efficiency may actually be diminished if inadequate regulations and support measures are enforced. Therefore, from the perspective of focusing on resource allocation efficiency, it is desirable that the competition dynamism be utilized as much as possible and that support measures be exercised only when a serious market failure[58] is anticipated. Possible causes of market failures include external diseconomies, dynamic externalities, dysfunction in the capital markets, and subadditivity of the cost function (which amounts to a natural monopoly). Even if a market failure is certain to occur, it is important to understand that daring to abandon a market failure can prove to be an efficient solution depending on the results of a comparison between the policy intervention costs and the potential benefits.

[58] In this context, the term "market failure" is used in its narrowest sense to indicate a situation in which the efficiency criteria have not been met. Market failure in the broad sense also includes a situation in which the fairness criteria have not been met.

Owing to the network effect, the platform value increases in proportion to the number of innovators and end users (i.e., the installed base) that use it. Because of the size of the installed base that has been cultivated to date, it is possible that the life of inferior-quality goods and services may be prolonged and that the introduction of higher quality goods and services onto the market may be hindered (this is known as "excess inertia"). The dissemination of information through market transactions can resolve such deficiencies in the long run by eventually replacing inferior goods and services with higher quality ones. However, if such a remedial process incurs significant costs, the government is justified in promoting the higher quality goods and services by, for example, setting a technical standard. It is, of course, necessary to give sufficient consideration to the possibility that such a government intervention may give rise to other types of inefficiency.

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3-3 Diversifying Development Issues and Open Innovation

Yoshiro Masuda (JICA)

At this workshop, we discussed and studied development implications based on various global open innovation trends, such as Fab Labs and the IoT. In this report, however, I would like to consider the effectiveness of using open innovation to drive development from the viewpoint of conventional development cooperation.

3-3-1 Development Cooperation and Innovation

In traditional development cooperation, solutions to individual development challenges are provided through infrastructure development (hardware), human resource development (software) or a combination of the two. They support the introduction of mechanisms designed to sustain and further expand the outcomes of cooperation projects with the aim of supporting the economic and social development of the relevant developing country.

The purpose of carrying out individual development cooperation projects is to help bridge the gap between the current situation and the desired situation for developing countries. The resultant outcome of such cooperation is the introduction of new facilities, equipment, and mechanisms in the target countries. For example, Japan has assisted in the introduction of the Maternal and Child Health (MCH) Handbook as a new product and service in various countries around the world, such as ASEAN countries (e.g., Indonesia and Viet Nam) as well as Palestine, Kenya, and the Dominican Republic. This initiative has contributed to the achievement of the MDGs due to its considerable impact on the way maternal and child health care is carried out in each of these countries[59]. This type of innovation falls under the category of "new goods" according to the definition used by Joseph Schumpeter[60].

In this sense, the type of innovation required by developing countries is not to create completely new things that do not yet exist in the world (which is consistent with the original meaning of the term "innovation"), but to incorporate technologies and mechanisms that are widely used in developed countries and adapt them to their social and economic environments.

Projects in developing countries are subject to a greater degree of uncertainty than those in developed countries are, and unexpected events (including successes and failures) tend to occur. The challenge faced in developing countries is the gap between the current situation and the desired situation, and the

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[59] July 2008 edition of monthly JICA, "Maternal and Child Health Care: Protecting Precious Lives," http://www.jica.go.jp/publication/monthly/0807/01.html.

[60] In his book *The Theory of Economic Development*, Schumpeter (1883–1950) identified the following five types of innovations: (1) the production of new goods (products and services); (2) the introduction of new production methods; (3) the development of new sales channels and markets; (4) the acquisition of new supply sources for raw materials or half-products; and (5) the realization of new organizations.

needs there are enormous. The industrial structure of developing countries has changed dramatically beyond the time axis experienced by developed countries. Furthermore, the population structure of developing countries tends to be similar to the population pyramid of post-war Japan, with the population consisting of a large number of young people and a small number of elderly people. With the development of ICT, it has become easier for people in developing countries to access information around the world through TV and the Internet. Given this, their perception of development is also changing[61]. In the current era, new knowledge is no longer restricted to developed countries, as it is widely shared and utilized in developing countries, as well. This is consistent with the "seven sources of innovative opportunity" proposed by Peter F. Drucker. If the risk of failure in innovation is high in developed countries, it is even higher in developing countries. Nonetheless, many innovations have been created to date through development cooperation in developing countries[62].

3-3-2 Development Cooperation and Open Environment

In traditional development cooperation projects, experts from developed donor countries strive to help overcome the challenges that developing countries face by proposing solutions to problems that cannot be solved only by the human resources of the target country. Particularly for the types of technical cooperation projects that Japan tends to engage in, Japanese experts do not propose solutions unilaterally. Instead, they consider the issues and implement countermeasures together with their counterparts in the recipient country with the aim of ensuring that the latter can improve its capacity on its own based on the concept of capacity development.

In technical cooperation projects, technology transfers are generally carried out by experts using innovative ideas generated by bringing together knowledge from their specialized fields according to the local situation. However, technologies brought in from outside will not take root locally unless they are accepted by the local people, even if they have been customized to suit the local environment. In light of this, experts from developed countries and their counterparts in developing countries have undertaken a diverse range of collaborative efforts in open environments—including hands-on workshops and projects with community participation—and these have produced a variety of ideas.

JICA also carries out issue-specific training programs in which trainees invited from multiple countries use Japanese case studies for reference as they work to create ideas that will help to resolve the issues their respective countries face. Based on the outcomes of these programs, each trainee formulates an action plan and submits proposals to the relevant organizations after returning to his/her home country. Through the JICA Alumni Associations that have been established in each country, a variety of new ideas are generated and put into practice as a result of exchanges among people who,

[61] Many countries demand investment rather than aid.
[62] 5S, Kaizen, the One Village One Product (OVOP) Project, dissemination and promotion of New Rice for Africa (NERICA), etc. However, not all projects have delivered the outcomes that were initially expected.

although they hold different positions, have a shared experience of having spent time in Japan (through training programs in Japan), thereby helping to resolve problems in their respective countries.

In this way, development cooperation is carried out through collaboration among a diverse range of human resources that have not only diverse attributes but also diverse opinions. It can be said that an environment and culture that respects and accepts different opinions has already been fostered in development cooperation projects.

3-3-3 Development Cooperation and Open Innovation

Open innovation in the manufacturing industry can be defined as a paradigm that assumes that firms can create new value by organically combining internal ideas and external ideas (Chesbrough). If this is simply applied to the context of development cooperation, open innovation in development cooperation can be defined as a paradigm that assumes that developing countries can create new value by organically combining internal and external ideas. Until now, the "external" role has mainly been played by donors and NGOs from developed countries. However, due to stagnant economies in developed countries and economic growth in developing countries, private enterprises have also become a major force in development cooperation. In addition, an increased awareness of concepts such as corporate social responsibility (CSR), BOP business, and creating shared value (CSV) management has persuaded private enterprises to introduce goods and services that address social problems.

In present-day Africa, young entrepreneurs—referred to as the "Cheetah Generation"—are rapidly finding solutions to social problems through business ventures by regarding social needs as business opportunities[63]. The driving force behind this is the African diaspora, who are people who have their roots in Africa but were educated and gained their business experience in developed countries. There have been many cases in which members of the African diaspora have returned to their home countries and made a successful contribution to resolving social problems and promoting economic growth there by utilizing their personal connections and financial resources. Furthermore, as reported in *Design with the Other 90%: Cities*[64], even slum dwellers are devising and creating innovations for their own survival. Meanwhile, new products are being created every day in Shenzhen, China. Consideration does need to be given to copyright and other issues related to imitation in the manufacturing industry, but many of the techniques that are applied in the field of development cooperation—particularly in technical cooperation—are highly public in nature, so they can be considered examples of how imitation can give birth to innovation.

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[63] "The Cheetah Generation: Changing Africa," *NHK Close Up Gendai*, aired Monday, May 10, 2010, http://www.nhk.or.jp/gendai/kiroku/detail_2885.html.
[64] Cynthia E. Smith, *Design with the Other 90%: Cities*, Cooper Hewitt, Smithsonian Design Museum, 2011.

The world would also lose out if the outstanding ideas developed by the rapidly increasing human resources in developing countries were to remain untapped. It is not always clear who has come up with these ideas, but due to the widespread use of the Internet, mechanisms for sharing ideas around the world are being established while Fab Labs and other such hubs provide the tools and equipment required to turn these ideas into reality. Simply by developing human resources and preparing an environment to make full use of them, we can increase the possibility of previously inconceivable innovations being created, as demonstrated by the case studies introduced in this workshop.

In the field of development, comprehensive cross-sectoral problem-solving programs have become increasingly important, which represents a shift away from conventional sector-led individual problem-solving projects. In light of this, it is necessary to transform closed project environments, such as those of certain business sectors or specific countries, into more open ones so as to seek ideas through cross-sectoral or cross-regional programs.

These basic ideas will become open platforms, but they will be accepted as delivering value only after they have been improved according to the environment of the individual users (or, in the context of development cooperation, individual countries). For example, the MCH Handbook was introduced as a platform that provides certain basic features that are required in many countries (e.g., portability and ease with which details concerning matters such as the mother's wellbeing and the child's health and growth can be recorded) and then modified to take into account the local context, including the relevant country's health system[65]. JICA continues to invite stakeholders from various countries around the world to attend training programs in Japan so that the best practices and challenges in both Japan and the attendees' respective countries can be shared. In the country-specific training sessions, case studies and challenges are shared among the domestic stakeholders, and support continues to be provided to help disseminate and improve the MCH Handbook. JICA also serves as a facilitator of the MCH Handbook platform by, for example, holding international conferences on the MCH Handbook for high-level stakeholders.

In the field of disaster prevention, JICA has implemented a number of cooperation projects, taking full advantage of Japan's experience in overcoming the damage caused by natural disasters. At the same time, there have been cases where the outcomes of cooperation efforts carried out in developing countries have been utilized in disaster mitigation in Japan. For example, the outcome of a cooperative venture that was launched in 1985 to promote erosion control around Mt. Merapi in Indonesia was actually utilized in the construction of an erosion control dam and a training wall at the Fugen-dake peak on Mt. Unzen in Nagasaki Prefecture[66]. As this suggests, we are beginning to see examples of

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[65] See the following link for an overview of the MCH Handbook used in Palestine. http://www.jica.go.jp/project/palestine/001/news/ku57pq00000m92u8-att/20121105_01.pdf

[66] *JICA's World Special Edition*, April 2012, "ODA Today: Considering Domestic and International Challenges in an Integrated Manner to Pursue Japan's Revival and World Development," http://www.jica.go.jp/publication/j-world/1204special/pdf/04.pdf.
September 14, 2012, "JICA President Akihiko Tanaka Visits Indonesia: Sharing Experiences and Lessons Learnt from Disasters with the Rest of the World," http://www.jica.go.jp/topics/news/2012/20120914_01.html.

reverse innovation, in which the experience gained through cooperative ventures in developing countries is utilized in Japan.

3-3-4 Diversifying Development Challenges as Sources of Innovation

The probability of innovations being successful is as low as three in one thousand—or perhaps even three in ten thousand—but their impact is considerable. As JICA provides support through public funds, the projects that it supports are, in principle, not allowed to fail. However, since the number of actors involved in development cooperation has increased, the developing countries do not want to pursue only the conventional means of development assistance. Instead, they want to nurture industries and human resources that will help enable them to quickly catch up with developed countries through innovation. JICA needs to continue to carefully identify which challenges need to be addressed with traditional aid methods and which ones need to be addressed through open innovation. Particularly for challenges that need to be addressed through open innovation, it may be necessary to consider the impact of the entire program as an indicator, not just the success or failure of individual projects.

Just as innovations in developed countries trigger innovations in developing countries, the reverse is also true. This results in a spiraling increase in innovations. Given this, it is necessary for development assistance, which is a form of public investment using public funds, to develop the necessary human resources and provide suitable opportunities.

The role of development assistance will eventually end and be withdrawn from developing countries, but business enterprises will, under the concept of going concern, take root in their economies in various ways, continue to create jobs and employment, and continue to provide products and services that are recognized as having value by their citizens.

To achieve a true sense of sustainable growth and continue to demonstrate their significance in a peaceful and stable world, developing countries will need to achieve true development by leveraging their unique competitive advantages. For that to happen, the solutions that developing countries develop to address the challenges that they face will need to be ones that only they are able to carry out under their own environment. In this process, the assistance provided by developed countries serves only as a catalyst. Issues that a country cannot deal with on its own can be resolved by incorporating innovation outcomes produced outside of the country, but the value of such innovations will be recognized by the country's citizens only after they have been adapted to its environment. Enterprises from developed countries will get involved if they can see value in doing so, but each country needs to address any social needs that do not directly produce any economic value on their own. This is exactly the concept of capacity development that JICA has been aiming to achieve for many years.

The idea of capacity development has gradually expanded, having started at the level of individual capacity development before progressing to the level of organizational and social innovation. Innovations reflect the desires of the individual innovator, and such desires lead to social innovation only through the establishment of an organizational infrastructure that can nurture these desires and turn them into reality. Given this, it will become increasingly important to encourage counterparts and experts with creative ideas to participate in JICA projects. Development cooperation projects that promote the creation of platforms for connecting innovators (i.e., experts and counterparts) and users (i.e., citizens in developing countries) contribute to the resolution of development challenges that are diversifying and cannot be addressed through traditional development cooperation. The open-innovation approach can be a key resource in proposing solutions to such challenges.

The diaspora of developing countries are playing a leading role in the establishment of various new businesses that seem to be unrelated to donor support and creating social innovations in their respective countries. In fact, the impact of this nearly exceeds that of donor support. Unless donors change their approach to development, they will no longer be relied upon by developing countries. Rather than seeking to create innovations themselves, development aid agencies need to function as institutions that create opportunities for the cultivation of human resources who will work to resolve development challenges in developing countries through innovation. It is the development aid agencies who can identify people who will try to innovate and take risks in the pursuit of innovative ideas. An obsession with ensuring that all projects are successful means that development aid agencies are limited to projects that are almost certain to succeed. It is now time for them to recognize their essential role as catalysts for development assistance and taking risks that private companies cannot.

No innovation seed is guaranteed to succeed. "Learning-by-doing" is the only approach that can be adopted in developing countries. It has become increasingly apparent through this workshop that the open-innovation approach can help resolve complex and diverse development challenges that cannot be addressed through innovation under a traditional approach to development cooperation. Going forward, it is necessary to clarify the effectiveness of development cooperation by accumulating case studies.

Chapter 4: Using Open Innovation in Development Projects

Tomoyuki Naito (JICA)

In this chapter, we study the following questions by using a four-step approach based on the points made in the previous chapters: with new value being created daily on numerous occasions through open-innovation platforms such as Fab Labs, what significance does such value have for JICA—the agency tasked with carrying out the Japanese government's ODA programs—when it implements development assistance projects and what specific conditions does it need to consider when implementing such projects?

In step 1, we present some past case studies on how JICA and other development aid agencies have used open innovation in the context of development. In step 2, we examine the appropriateness of using open innovation based on these case studies and study—with a specific focus on Fab Labs—the significance of using open innovation in JICA projects. In step 3, we study the cost-effectiveness of implementing Fab Lab projects as ODA programs, as well as options for JICA project schemes. In step 4, based on recent arguments, we discuss copyright, one of the most important points to bear in mind when applying open innovation to development.

4-1 Case Study on the Use of Open Innovation in Development

4-1-1 The World Bank and Open Innovation

Quite a few organizations around the world that support economic growth and poverty reduction in developing countries actively incorporate open-innovation approaches into their development assistance projects. Open innovation is innovation that combines the technologies, ideas, and services owned by various organizations—including companies (both the innovator's own and others), universities, and social entrepreneurs—with the aim of developing innovative business models and research achievements as well as new products and services. As past project assessments and historical facts indicate, the accumulation of small-scale innovations created through issue-focused JICA training, as described in the previous section, and through individual projects carried out by agencies in different countries provides part of the foundation that supports economic growth and poverty reduction in countries around the world.

The World Bank Group, an organization commonly referred to as the World Bank that represents the interests of international development banks, has been very proactively involved in providing developing countries with the most innovative support ever by making full use of open environments, especially since Jim Yong Kim was appointed as the bank's 12th president in July 2012. Held in Tokyo in October 2012, the first annual meeting to be held since his appointment saw President Kim proudly declare his intention to create a new identity for the World Bank, speaking in front of government representatives from 181 member states and the representatives of various other stakeholders and related international organizations, he said the following: "We must grow from being a 'knowledge' bank to being a 'solutions' bank. To support our clients in applying evidence-based, non-ideological solutions to development challenges."[67]

Until then, the World Bank had provided analytical advisory services under the Technical Assistance (TA) category in order to reinforce its sovereign financing operations, which is its most important line of business, to ensure that the funds it loans out are used effectively by the borrowing countries in accordance with the agreed-upon plan. In the 1980s, the World Bank came under severe criticism from around the world for the failure of some of its structural adjustment loans. Responding to this criticism, then President James D. Wolfensohn made what is known as the "Knowledge Bank" declaration in 1996. Since then, in place of its conventional loan-centered policy, the World Bank has adopted a policy of proactively providing clients (i.e., borrowing countries) with the analytical advisory services and intellectual know-how (referred to as "knowledge" by the World Bank) required for lending.

Thanks in part to the World Bank's powerful support tools, an average annual GDP growth rate of more than 5% has been achieved over the past ten years in approximately 50 developing countries that have a combined population of over 4 billion. This growth has helped to reduce poverty at an unprecedented pace, thereby enabling the original MDG target of halving the 1990 poverty rate by 2015 to be achieved five years earlier than expected. Meanwhile, according to Thomas Piketty, the contemporary world is returning to a form of patrimonial capitalism, where inherited wealth dominates the bulk of the economy. The power of the wealthy grows, creating a shift toward oligarchy. Also, future economic growth rates are generally predicted to be low, so the tendency for returns on capital (r) to exceed the economic growth rate (g), a trend that has continued since the 1970s, is likely to persist going forward.[68] If that proves to be the case, wealth inequalities will remain unless effective measures are taken, and the World Bank will have to face up to the dilemma that its ideal of eliminating poverty from the world may never be realized.

Meanwhile, development issues in various countries around the world are becoming more diverse year after year. As a result, it is now more necessary than ever before to create sustainable, affluent societies that are more sympathetic toward the weak. Therefore, all development stakeholders are faced with a need to provide new solutions that will help to realize some, or all, of these ideals for countries facing development issues. In other words, stakeholders are confronted with the following reality: the range of outcomes that can be achieved by conventional approaches is already quite limited and such approaches may gradually lose their effectiveness in addressing multi-dimensional development issues that continue to diversify from one year to the next.

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[67] Speech by President Jim Yong Kim at the World Bank Annual Meeting.
http://www.worldbank.org/en/news/speech/2012/10/12/remarks-world-bank-group-president-jim-yong-kim-annual-meeting-plenary-session

[68] Thomas Piketty, *Capital in the Twenty-First Century*, Harvard University Press, March 2014.

The "solutions bank" that the World Bank strives to become is aimed at helping it to learn and develop solution-finding processes in cooperation with its partner organizations (the UN, the IMF, regional development banks, bilateral aid agencies, civil society organizations, foundations, research institutions, the private sector, etc.), its clients (recipient countries), and the local communities.

More specifically, the solution bank approach is aimed at identifying a diverse range of solutions more quickly and more efficiently by connecting many stakeholders throughout the world and by promoting knowledge exchanges outside of the conventional organizational framework. It assumes the use of the Internet and other ICT that minimize physical and temporal restrictions. In addition, the World Bank will be required to create and provide open environments as much as possible. A solution bank is also more focused on delivering outcomes than conventional banks are. In an era where resources are limited and the world is confronted with enormous challenges, delivery is required by both the donors (i.e., the aid agencies) and the clients (i.e., the recipient countries). Many clients have access to more funds today than they did in the past. However, all countries face challenges in terms of delivery, including with regard to the planning, implementation, and presentation of outcomes. For example, even if governments adopt powerful anti-corruption bills, hardly anything changes in reality. This constitutes a delivery failure. Similarly, large-scale government investment in elementary education does not necessarily guarantee that all children receive a good education or that they actually go to school. This, too, constitutes a delivery failure. The World Bank believes that systematically using and applying the lessons learned from such experiences is of great importance and that, as a solution bank, it needs to be open to learning from both its successes and failures.

At the spring general meeting held in April 2015, the World Bank announced the launch of its Global Delivery Initiative (GDI) as one of its specific initiatives for implementing delivery as mentioned above.[69] The GDI is implemented through a collaboration involving more than 30 institutions and organizations, including the following: the World Bank, China's Ministry of Finance, the Korean Development Institute (KDI), the German Corporation for International Cooperation (GIZ), the European Union (EU), the Bill & Melinda Gates Foundation, the Inter-American Development Bank (IDB), and Harvard University. Going forward, the plan for this initiative is to collect case studies on development successes and failures from around the world under the World Bank's leadership and then summarize and document them where possible so that they can be openly shared worldwide by various means through the use of ICT.

Monitoring how the GDI is implemented will have the implications listed below. These will be of great importance when studying the relationship between open environments in development and innovation generated through the provision of useful information; in other words, open innovation.

[69] *Global Delivery Initiative*. http://www.worldbank.org/reference/GDI/

Firstly, case studies on the types of issues that international aid agencies face due to their being isolated from each other for a variety of reasons, including language differences, are to be publicly released on a single platform in the same format. As a result, a reference library on development projects that can be shared worldwide will be created through a joint project. This is equivalent to open source software being developed through a joint project on an unprecedented scale. No organization other than the World Bank would be capable of exercising the global convening power required to carry out a development project of this type.

Secondly, the GDI provides a framework that allows not only public aid agencies, but also research institutes and foundations throughout the world and even the private sector to participate freely. To handle specific development issues, the World Bank has promoted the development of Communities of Practice (CoPs) as a system designed to gather experts from around the world in a virtual environment. However, a CoP often ends up being a restricted network led by experts on specific issues, such as researchers and aid agency officials, which is substantially different from the open platform that the GDI aims to create.

Given the above, can initiatives like the GDI be considered the best open-innovation solutions in development and are the secondary effects that this platform may generate capable of creating true innovation? The answer is both yes and no.

Officials and researchers from various agencies and organizations document case studies on internationally standardized forms so that they can be uploaded on a GDI platform for use by developing countries. Furthermore, if individual participants perform their functions according to the initiative's strategy, we will see the creation, as mentioned above, of an unprecedented reference system that facilitates the global sharing of information on development projects. As a result, it may be possible, based on studies of similar cases in the past, to achieve the improved delivery that is being targeted by the World Bank and to reduce wealth inequalities. Above all, an enormously diverse range of stakeholders from around the world all working together on a single platform will provide invaluable opportunities in the course of implementing the GDI, and this is extremely significant in terms of sharing diversity. In particular, if we can effectively combine the GDI with the SDGs that have been shared worldwide through the UN, there is a possibility that unconventional, liberated ways of thinking—in other words, innovations—may arise in the open environment in the course of carrying out work using a platform that provides diversity. In the explanation about the means of implementation required to achieve one of the SDGs (Goal 17: "Strengthen the means of implementation and revitalize the global partnership for sustainable development"), it is stated that a mechanism will be established to promote the development of technologies. As part of such a mechanism, an online platform will be constructed to map the existing STI-related mechanisms and programs of the UN and other organizations and to provide a gateway to such information and services.[70] In this sense, therefore, the answer to the above question is yes.

Meanwhile, a joint operation such as the GDI that requires the involvement of a wide range of stakeholders on a semi-mandatory basis has an inherent risk in that the creation of an enormous database may itself become the purpose of the operation. The initiative's short-term goal will be to collect as many case studies on worldwide development as possible in a unified format. As this work continues, however, the interested parties are left on their own to achieve the initiative's intended purpose, which is to distinguish between different issues so as to identify their solutions and work steadily with clients to effectively resolve the issues based on studies of similar cases (i.e. to deliver the desired outcome). As a result, the GDI may become a platform that merely provides knowledge without breaking the cycle of delivery failure, thereby ending up as an operation that wastes enormous amounts of human, physical, and temporal resources to simply create a massive database. In regard to this point, Owen Barder, Senior Fellow of the Center for Global Development, has already warned that the GDI will not succeed (in delivering on complex development issues) unless efforts are repeatedly made to apply solutions. The World Bank's Chief Economist, Jeffrey Lewis, has also expressed concern that if the GDI continues to expand, it may become difficult to maintain the brand in terms of quality management.[71]

It will take several years before we can assess the success or failure of the GDI. However, we believe that in order to provide innovative solutions in an open environment in the context of development, simply creating an official platform such as the GDI will not be enough to ensure the complete elimination of rigidity. Above all, it is obvious that, under the leadership of public agencies, it will not be easy to promote the following: agile selection of solutions, which is one of the most important benefits of open innovation; optimization through trial and error; and free exchange of ideas.

4-1-2 kLab and Fab Labs in Rwanda

In projects managed by JICA, unique initiatives that fall under the category of open innovation began to be implemented in Rwanda, a landlocked country in Africa, several years ago.

Since 2010, JICA has been dispatching ICT policy formulation advisors (under its individual expert project) to the Rwandan government on an ongoing basis. The project's initial aim was to support the formulation of the National Information and Communication Infrastructure (NICI) Plan and to monitor its subsequent implementation. However, as part of efforts to facilitate its implementation, the project's scope of operations has expanded in recent years to include promoting the activities of the ICT Chamber of the Private Sector Foundation, which supports the ICT industry in cooperation with the

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[70] "Transforming Our World: the 2030 Agenda for Sustainable Development": https://sustainabledevelopment.un.org/post2015/transformingourworld.
[71] *Inside Jim Kim's 'Science of Delivery'*: https://www.devex.com/news/inside-jim-kim-s-science-of-delivery-86096.

government. To that end, JICA provided financial and operational support for the establishment of the Knowledge Laboratory (kLab) in 2012. Located in Kigali, the capital of Rwanda, the kLab was originally established as an incubation center in accordance with the country's policy of building an ICT-based nation. This government policy was developed to meet an urgent need to gain comparative advantages by using all available knowledge to achieve economic growth in Rwanda, which is a small landlocked country in East Africa that is poor in resources and at a disadvantage in terms of logistical costs. Its aim was to provide the younger generations in particular with official support in exchanging innovative ideas by leveraging ICT to start new businesses. The Ministry of Youth and ICT provides support for the kLab, but it is the ICT Chamber that actually manages it. In an effort to assist the Rwandan government, JICA helped to establish the kLab by dispatching the policy support advisors mentioned above. With Rwanda having achieved remarkable economic growth compared to the rest of Africa, the kLab is not only highly regarded domestically, but it is also visited by development stakeholders from around the world due to its success. A Fab Lab was scheduled to be established in adjacent space in 2016 with the aim of introducing a more effective means of commercializing the innovative ideas created at the kLab, which is an open incubation environment. Work to establish this facility was underway as of March 2016. This Fab Lab too is being established with the help of the policy formulation advisor mentioned earlier. However, it has been confirmed that the Rwandan government also has a high sense of ownership with regard to the Fab Lab. As an innovative system designed to help achieve the Rwandan vision of building an ICT-based nation, the Fab Lab is beginning to attract global attention and, in addition to the financial support provided by JICA, other organizations (e.g., the Massachusetts Institute of Technology) are offering to donate lab equipment free of charge.

4-1-3 Innovation Lab and Rapid Pro at UNICEF

To help UNICEF Next Generation—a group created within UNICEF USA, one of UNICEF's largest field offices—achieve UNICEF's mission of providing equal opportunities in various forms to children around the world, UNICEF is starting to conduct innovative new support programs in addition to traditional support projects.

UNICEF Next Generation is a group composed of young experts from various fields who are in their 20s and 30s and share a commitment to supporting the activities required to achieve UNICEF's mission. Between 2009 and 2013, this group took advantage of various opportunities to raise more than 3.5 million US dollars with the aim of creating a fund that can be used to provide subsidies for nine projects being developed worldwide by UNICEF. In 2013, the group raised more than 500,000 US dollars to help establish three innovation labs in East Asia, and they also provided funds for the Project to Enhance a child-friendly justice system in Viet Nam.[72] Moreover, at Active Talk, an

[72] *UNICEF Annual Report 2013*, p. 33: https://www.unicef.org/publications/files/UNICEF_Annual_Report_2013_web_26_June_2014.pdf.

international symposium that was held 38 times in various locations around the world in 2014, UNICEF organized a discussion session that was attended by online participants as well as young people, innovators, experts, and opinion leaders to discuss innovations that have the potential to offer greater opportunities for children suffering the greatest hardship. The innovations proposed in this session included the following: inexpensive toys designed to teach science to children living in remote, poor, or rural areas; the Solar Suitcase, a photovoltaic power generation kit that can help midwives assist with births at night; and a malaria-testing Android application that can be used by pregnant women as it does not require blood samples to be taken.

In the same year, UNICEF also developed an open-source data platform called "Rapid Pro," which is designed to facilitate the sharing of information among governments, international development aid agencies, and local communities. Rapid Pro is an application store that quickly and fairly distributes information among participants. One smartphone application that uses Rapid Pro is U-Report, which is a tool that enables young people to connect directly with governments and services via their mobile phones. Having grown from 300,000 at the beginning of 2014 to 500,000 by the end of the year, the number of U-Report users continues to increase. The application is currently used in approximately 12 countries. With the help of the types of mobile connections that are widely used by the young generation today, it helps young people share opinions and interests directly with their peers and community leaders. At the same time, the application is also designed to provide a wide range of stakeholders with real-time information and services as well as an open environment so as to allow innovative ideas and approaches to be created spontaneously across various barriers.[73]

The activities carried out by UNICEF and JICA in Rwanda have a number of characteristics in common. First of all, their aid agencies offer advice and funding to help develop an open environment with a priority on providing systems that will enable a wide variety of stakeholders to come together in this environment through the use of ICT. At the same time, however, these agencies avoid presenting a direct analysis of the actual issues confronting the developing countries and the solutions required to address these issues. The reason why they avoid doing this is to allow a wide range of participating stakeholders, including the developing countries themselves, to find their own solutions to these issues through discussions, thereby enabling innovative ideas to be spontaneously created. In other words, in order to focus on providing support for the development of a common platform, aid agencies provide "seed money" as subsidies, but they then transfer authority to the users in an effort to maximize the benefits of networking and to use the wisdom of a wide range of interested parties and stakeholders to find solutions to the relevant issues. This provides a model in which aid agencies remain in the background so as to help create innovative solutions that will surpass their past successes.

[73] *UNICEF Annual Report 2014*, pp. 45-6: https://www.unicef.org/publications/files/UNICEF_Annual_Report_2014_Web_07June15.pdf.

It is easy to criticize such strategies on the grounds that they are merely financial cooperation programs for distributing standardized equipment, that they lack mechanisms for promoting ownership by the beneficiaries and the durability of programs and that they provide assistance by using precious tax revenue based on an irresponsible hands-off policy that is extremely poorly organized. Such criticisms assess the appropriateness of a project's implementation in a negative light by focusing on its low immediate output. Criticism is most likely to arise in the absence of a shared understanding of the various social benefits (outcomes) that the presence of Fab Labs brings in their capacity as innovation platforms. Paradoxically, to avoid such naive criticisms, it is essential to provide clear explanations based on a thorough understanding of the potential outcomes and their benefits, thereby helping to ensure that this understanding is shared effectively and efficiently. In the next section, we examine how to explain the significance of implementing projects—i.e., their appropriateness—and their possible outcomes.

4-2 Significance of Using Open Innovation in JICA Projects

In Section 3-1 ("Economic Analysis of Fab Labs: Suggestions for Development Assistance"), it was suggested that although the benefits resulting from the establishment of a Fab Lab are spent on compensating for the excessive number of Fab Lab users as well as on developing human resources, the significance of providing development assistance lies in this externality that is inherent to the structure of Fab Labs. In other words, rather than the benefits generated by the new Fab Lab system being returned to the Fab Labs themselves, they are enjoyed by various Fab Lab-related users in a broad sense. One of the sources of benefits is the advantages that result from a networking environment that connects everyone around the world via video conferencing systems and other such media. These advantages can be regarded as platform effects. Being connected with Fab Lab devices and functions that are fixed in specific places makes it possible for users to enjoy the benefits of participating in an expanding network by using these devices and functions as gateways.

Similar effects are produced by incubation facilities in which local governments and other organizations provide office space at low prices to citizens aiming to start new businesses. However, Fab Lab users do not necessarily intend to start a new business. Their common purpose is a desire to resolve and eliminate frequently encountered issues and to meet needs through a form of manufacturing that is carried out by leveraging the platform effects and utilizing the roughly standardized, packaged space through the use of common methods of manufacturing for business and non-business purposes.

For users then, the platforms provided by Fab Labs, which are connected throughout the world via the Internet and video conferencing systems, serve as workspaces that enable them to efficiently realize their creations by borrowing knowledge from others as necessary. What is done with the objects created in these workspaces is left to the discretion of the users themselves without any interference from the Fab Labs. In this sense, Fab Labs also serve as incubation spaces. As long as an understanding of the various public benefits generated through the physically secured facilities and functions of the Fab Labs is shared by the various people involved in creating the objects, establishing Fab Labs and providing the support necessary to ensure their durability through ODA or other public assistance programs is, given their social significance, equivalent to creating public assets. In short, Fab Labs have a rationality that is similar to that of local community centers that are built and managed by local governments. In fact, Fab Labs, which exist in various forms around the world, have a very strong affinity with local governments, as the activities of existing Fab Labs clearly demonstrate.

However, the decisive functional difference between local community centers and Fab Labs is whether or not networking environments—including advanced digital devices—are available. This difference leads us to believe that Fab Labs have, from the beginning, had conditions that facilitate the creation of a wider range of multi-faceted, value-added products compared to rational investment in local community centers.

In fact, Fab Labs can (in theory) be differentiated from other facilities based on their capability to produce heavily customized, one-of-a-kind products that have the same quality anywhere throughout the world. This capability is made possible through the utilization of networking environments that establish worldwide connections and the availability of roughly standardized (packaged) devices, such as 3D printers and laser cutters. Thanks to these technologies, an innovative sandal design that has been created at a Fab Lab in Kamakura, Japan, for example, can be shared as 3D data by a Fab Lab in Ethiopia that is connected to Japan via the Internet. As a result, sandals with exactly the same design as that created in Kamakura can be manufactured at the Ethiopian Fab Lab using Ethiopian leather to be exported for sale in Japan. There are already many cases like this. Fab labs established in developing countries have the potential to provide one-of-a-kind, customized products for markets in developed countries. This is an example of reverse innovation, which is contrary to the conventional direction of marketing. One disadvantage of Fab Labs is, of course, that it is difficult to use them to mass-produce products. However, heavily customized, one-of-a-kind products are, by definition, not mass-produced products.

According to Mitsuhiro Seki (2016), the Japanese manufacturing industry has, over the past quarter of a century, been unable to adequately meet the needs of today's multi-dimensional era, which is characterized by the following factors: the developing economies of Southeast Asia and China; the maturing of domestic markets; the increasing trend of population decline, fertility decline and population aging; and the establishment of basic standards for IT and the environment. However, there have been signs of change following the occurrence of various large-scale events in recent years (e.g., the collapse of Lehman Brothers in 2008 and the Great East Japan Earthquake in 2011). A shift toward providing and sharing development opportunities and gathering collective wisdom in search of new possibilities (open innovation) is considered to be one such sign.[74] In the markets of developed countries, values have diversified as markets have matured, with demand shifting from mass-produced products to one-of-a-kind products in various situations. In response to the needs of these changing times, we can now envisage how Fab Labs in developing countries can mutually collaborate with the help of network technologies by using digital fabrication technologies that do not require any craftwork skills. What synergetic effects will result from such collaborations? There is no doubt that these effects will differ from the ones that we would traditionally expect to see, and they can serve as examples of innovations on the supply side, which flexibly responds to diverse demands.

To produce such effects, it is important to examine how we support the establishment of Fab Labs through the use of ODA programs based on the above-mentioned concept of public assets. By setting appropriate conditions, we may be able to confirm the appropriateness of assistance programs, which help to create an environment that enables developing countries to directly connect to the markets of developed countries, thereby providing what are known as "enabling environments."

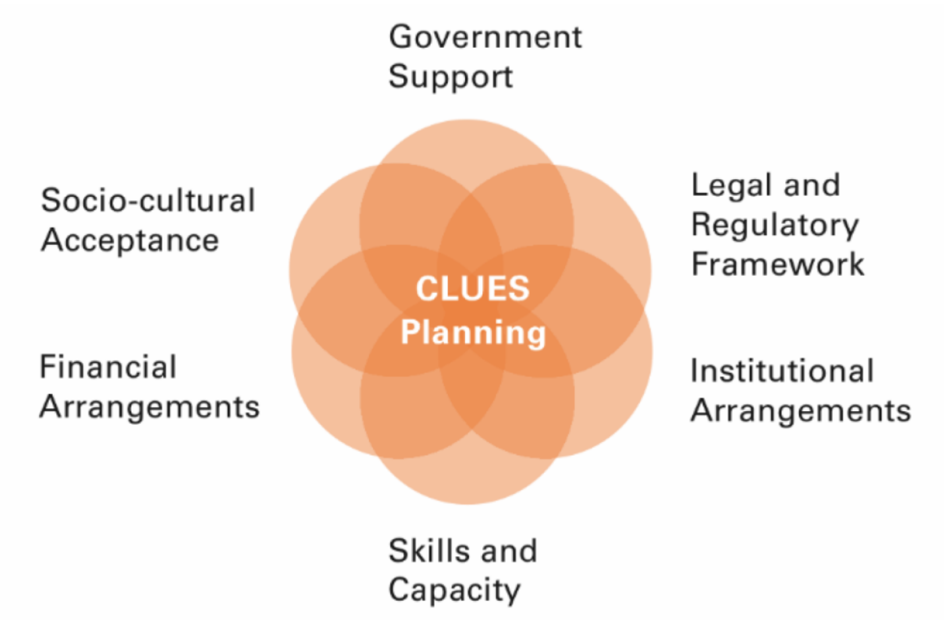

Figure 4-1: Six Elements of Enabling Environments

Source: http://www.sswm.info/content/community-led-urban-environmental-sanitation-clues

Note: CLUES is an acronym for Community-Led Urban Environmental Sanitation

As shown in Figure 4-1, in order to examine the enabling environments and resolve social issues (in this example, urban environmental sanitation), it is necessary to consider six mutually related elements as the conditions for producing a sustainable and effective change. Proposed by the World Bank in

[74] Mitsuhiro Seki, "Conditions for the Continued Existence of Small and Medium-sized Manufacturers: Efforts to Grow as Small Global Companies," Nihon Keizai Shimbun (Economics Class), February 18, 2016.

2003[75], these concepts are used in a variety of situations today.

For example, when a Fab Lab is developed with public funds with the aim of resolving a development issue in a particular country, the ODA falls under the categories of "Government Support" and "Financial Arrangements." It is important to note, though, that these elements alone will not resolve the issue or allow enabling environments to produce genuine effects. Enabling environments produce effects only if the "Legal and Regulatory Framework" and the "Institutional Arrangements" elements that support the environments have been created and the necessary "Skills and Capacity" and "Socio-Cultural Acceptance" elements have been developed and mutually coordinated.

Therefore, to verify whether the establishment of a Fab Lab, which can be regarded as a public asset, is actually appropriate as an ODA project, it is important to consider how prepared the recipient country is in terms of these elements or whether they have laid the groundwork required to develop and coordinate these elements. Furthermore, ODA is available to support all of the relevant elements and, to help stabilize the macro economy in the recipient country, we may be able to create enabling environments as a means of resolving development issues that are causing bottlenecks. Therefore, if we accept the idea of using a Fab Lab as one of the components of enabling environments, we may be able to better understand the need to provide the supplementary assistance required to support the necessary peripheral elements for the Fab Lab. The crucial development issues in this context are new issues that can be addressed only by a non-conventional approach. The entirely different approach that is needed to resolve these issues is the one mentioned earlier that is designed to enable developing countries to directly connect to the markets of other countries almost as if they were leapfrogging from one to the next.

4-3 Cost-effectiveness of Fab Labs and Implementation Schemes

As explained in the previous sections, establishing a Fab Lab as a means of creating value through open innovation provides Fab Lab users with two major advantages. Firstly, they are able to create equivalent products in countries around the world through the use of cutting-edge designs and technologies by making the most of the network that connects Fab Labs worldwide via video conferencing systems and other such media. Secondly, they are able to take up the challenge of creating products based on state-of-the-art development and processing technologies by making effective use of packaged materials and equipment that cannot be obtained on an individual level.

If it is necessary to establish a Fab Lab in a developing country, making the most of the first advantage (i.e., the one gained by utilizing the network that connects Fab Labs worldwide) will completely eliminate the need to pay customs duty and the time required to physically import products. Furthermore, detailed corrections and repairs can also be made in close proximity by the users

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[75] "Enabling Environments for Civic Engagement in PRSP Countries," World Bank, March 2003. http://siteresources.worldbank.org/INTPCENG/214578-1116506912206/21061533/sdn82.pdf

themselves. Accordingly, the total cost advantage will be enormous. A good example of this is the prosthetic leg project carried out by Tokushima (2015) in the Philippines.[76]

In this report, a developing country is defined as being a low-income country that, with a nominal per-capita GDP of 5,000 US dollars or less, is ranked roughly 100th in the world or lower for nominal per-capita GDP. As an example, the nominal per-capita GDP of ASEAN countries are shown in Table 4-1.

Since developing countries are defined in this report as being those ranked 100th or lower, the ASEAN countries listed in Table 4-1 that meet this definition are Indonesia and the countries below that. If we generalize based on their respective levels of industrialization, the six countries that fall under this category due to their nominal per-capita GDP being less than 5,000 US dollars have not yet developed sufficiently advanced technologies to be able to export products. Even Thailand, a country with a nominal per-capita GDP in excess of 5,000 US dollars (94th among the 187 ranked countries), has not yet developed competitive scientific technologies that are able to generate foreign currency through exports, despite the fact that its vehicle assembly technologies have made it famous as the "Asian Detroit." In recent years, however, Thailand has gradually accumulated technologies that have been transferred from developed countries through direct foreign investment during past periods of economic growth, thereby becoming able to develop and sell Thai brand smartphones and other products. As a result, Thailand, which has simultaneously been investing in higher education as well as science and technology, has now reached a level of development at which it is capable of pursuing technological development on its own.

Table 4-1: Nominal Per-capita GDP of 10 ASEAN Countries

Ref.	Country	Nominal per-capita GDP (US dollars)	Ranking (among 187 ranked countries)
1	Singapore	56,286	9
2	Brunei	41,460	24
3	Malaysia	11,049	65
4	Thailand	5,896	94
5	Indonesia	3,524	120
6	Philippines	2,862	130
7	Viet Nam	2,051	135
8	Laos	1,693	142
9	Myanmar	1,227	156
10	Cambodia	1,080	160

Source: Prepared by the author based on the "World Economic Outlook Database" (October 2015 version) produced by the International Monetary Fund (IMF).

[76] "Super Low Cost Prosthetic Leg Using 3D Scan and Print Technology in the Philippines" (YouTube video): https://www.youtube.com/watch?v=LBy2fWxcnbk.

Meanwhile, countries with nominal per-capita GDP of 5,000 US dollars or less have not yet reached the level of Thailand or Malaysia. Therefore, if we establish and manage Fab Labs equipped with packaged standard devices in these developing countries in the same way as we do in developed countries, leveraging the positive effects of open innovation—i.e., publicly released product data that is protected under Creative Common licenses (CC licenses; explained later) in combination with networking environments—will theoretically enable Fab Labs to produce products that, on the face of it, have the same value as those produced in Thailand, Malaysia or any other developed countries. This will greatly enhance cost-effectiveness, thereby making it possible for the resulting supplementary profits to be used for other investments. Consequently, such developments will most likely contribute to the relative expansion of economies. These considerations lead us to believe that the establishment of Fab Labs produces greater cost-effectiveness in countries with lower incomes. The outcomes are also likely to provide greater leverage for such countries to enjoy development benefits in the form of "leapfrog" effects.

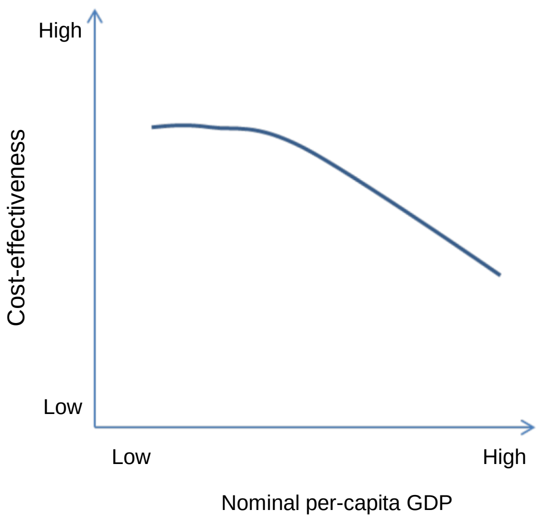

Figure 4-2: Relationship between the Cost-effectiveness of Establishing Fab Labs and Nominal Per-capita GDP
Source: Prepared by the author

Figure 4-2 shows the relationship between the two factors based on the above hypothesis.

As stated in the previous section, however, in order to establish Fab Labs for the purpose of creating enabling environments, it is necessary to fulfill certain conditions (see Figure 4-1). Therefore, in countries where these conditions have already developed to a certain degree, cost-effectiveness is estimated to be high, but in countries that struggle to fulfill these conditions, it is necessary to make investments and provide support in order to develop the relevant conditions. Thus, as shown in Figure 4-2, a certain level of nominal per-capita GDP (indicated on the horizontal axis) is required to meet the minimum standard. In countries that have a nominal per-capita GDP below this level, the cost-effectiveness is reduced.

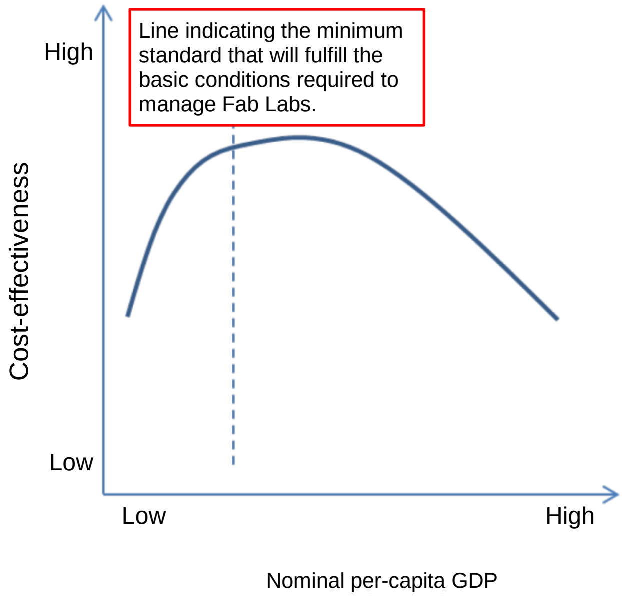

Figure 4-3: Relationship between the Cost-effectiveness of Establishing Fab Labs and Nominal Per-capita GDP (with the minimum standard line)
Source: Prepared by the author

It is not easy to define the standard line shown in Figure 4-3. As mentioned in Section 4-1-2, for example, Rwanda is currently developing Fab Labs that are expected to have a certain level of cost-effectiveness. This leads us to believe that Rwanda's 2014 nominal per-capita GDP of 712 US dollars (171st among 187 countries) can serve as a standard, although such an assumption will naturally need to be corroborated in the future. In other words, only a little fewer than 20 countries have a nominal per-capita GDP that is lower than that of Rwanda. Therefore, there is good reason to consider establishing Fab Labs to create enabling environments in many countries around the world. All ASEAN countries—including Cambodia, which has the lowest income—are included as targets and the lower the nominal per-capita GDP is, the greater the development effects are expected to be.

Meanwhile, we also need to consider what patterns can be used for the applicable implementation schemes when establish Fab Labs in a JICA ODA project.

There are a wide range of JICA ODA projects, but those that can be implemented to achieve its organizational missions in accordance with the stipulations of the Act on the Japan International Cooperation Agency fall under one of the following project categories.

Table 4-2: Categories for ODA Projects Implemented by JICA

1	Technical cooperation for developing countries (accepting trainees, dispatching experts, providing equipment and materials, establishing and managing technical cooperation centers, and conducting basic surveys regarding development plans)
2	Loan assistance (ODA loans and overseas investment and loans)
3	Grant aid (excluding programs implemented independently by the Ministry of Foreign Affairs)
4	Promotion of citizens' cooperation activities
5	Support for expatriates and Japanese immigrants
6	Development and provision of human resources for technical cooperation
7	Surveys and research
8	Stockpiling and provision of equipment and supplies for emergency relief
9	Dispatching of Japan Disaster Relief Teams

Source: Prepared by the author based in information from JICA's official website.

As Yutaka Tokushima explained in Chapter 2, the direct initial investment costs involved in establishing a Fab Lab vary considerably from millions of yen to hundreds of millions of yen, depending on the design and size of the Fab Lab. In this section, we assume that we are establishing entry-level Fab Labs for the first time in the targeted developing country at a cost of several million yen per lab. Meanwhile, we will examine the forms of these Fab Labs based on the four basic models presented by Tokushima: technology access center, training provider, service bureau, and incubation hub[77]. More specifically, we will follow a scenario in which the developing country chooses to establish Fab Labs as a means of resolving a pressing development issue. The four basic balance models mentioned above naturally depend on the socio-economic conditions, including human resources, of the relevant country and the area in which the Fab Labs are to be established. Therefore, to provide a standard for determining which one of the four models should be chosen, it is necessary to evaluate in advance the six elements of enabling environments, as described in Section 4-2.

However, if we exclude the two elements that are indispensable for implementing ODA programs (i.e., "Government Support" and "Socio-cultural Acceptance"), the remaining four of the six elements (i.e., "Financial Arrangements," "Legal and Regulatory Framework," "Institutional Arrangements," and "Skills and Capacity") are actually lacking or do not exist in many developing countries around the world. At present, we have no other choice but to start examining how to establish Fab Labs under these conditions. Therefore, to ensure sustainable development after a project has been terminated (which is the highest priority when JICA projects carried out using ODA funds are assessed), business

[77] For details, see "2-4: Contextualized Innovation" (written by Yutaka Tokushima) in Chapter 2 of this report.

schemes that support the enhancement of these four elements are, along with the establishment of Fab Labs, the most sought-after options in many developing countries. These considerations lead us to believe that providing technical cooperation and promoting citizens' cooperation activities (citizen participation projects) are the most appropriate scheme options under the present conditions.

Meanwhile, in cases where the recipient countries can make most of the preparations in regard to the six elements, the establishment of "service bureau" and "incubation hub" type Fab Labs, which Tokushima describes as being highly profitable models, also deserve consideration. In such cases, the facilities and equipment are likely to require high specifications and large sizes relative to the basic profit structure so as to ensure that lab services can be provided from the beginning. Accordingly, the initial investment per Fab Lab may range from several tens of millions to even hundreds of millions of yen, in which case grant aid may—if we assume the existence of favorable conditions in which the six elements have all been prepared in advance—naturally be added as an option instead of technical cooperation.

The various regions and centers around the world to which JICA has provided ODA support, including financial and technical cooperation, include some places in which the Fab Labs will be able to complement existing functions and create synergy either immediately or in the future. Japan Centers for Human Resources Development ("Japan Centers") are typical examples of this. They were conceived to serve in countries transitioning to a market economy as hubs for personalized assistance programs as well as to train business personnel and build human networks with Japan. Ten Japan Centers have been established since 2000 in a total of nine countries located in East, Central, and Southeast Asia. They provide support for a variety of programs, including the development of human resources for business and the building of networks between local management personnel and Japanese companies. As such, these centers provide extremely appropriate environments for Fab Labs to perform their unique functions, including network connections and platform effects, especially for those who have links to Japan.

Meanwhile, if we consider this from a slightly different perspective, a useful approach may be, for example, to design Fab Labs not as permanent institutions, but as time-limited centers that for a limited amount of time develop and manufacture goods that are in short supply. More specifically, Fab Labs can be seen as an input element in the provision of emergency relief for regions affected by large-scale natural disasters, such as major earthquakes and severe typhoon damage. Such an approach makes it possible for the creation of time-limited centers to provide affected regions with packaged digital devices from Fab Labs as part of the equipment and supplies stockpiled for emergency relief. Alternatively, it may be possible to provide any scarce supplies that are required for damaged residences, provide emergency relief (including prosthetic arms and legs) to affected people, and officially dispatch engineers to assist in providing disaster relief as Japan Disaster Relief Team members. This should be considered a useful assistance pattern that is worth considering.

4-4 Copyright Issues to Be Considered When Using Open Innovation in Development

In the previous sections, we focused on Fab Labs and developed hypotheses regarding their applicability to JICA projects with a view to leveraging the benefits of open innovation in development. However, even if our hypotheses are accepted, they merely amount to reviews of the economic rationality and appropriateness of establishing Fab Labs as devices for JICA projects. However, another important issue remains to be examined; that is, how to handle the intellectual property obtained from networking environments. In other words, we need to consider what to do about illegal copying. To examine this issue, I discuss in the section below whether copying should be allowed and what copyright rules should be implemented to ensure that the demand for copying can be fairly managed.

According to Raustiala and Sprigman (2015), receiving a new idea from someone else is similar to passing a flame from one candle to another in that it does not extinguish the original flame. Therefore, prohibiting copying even for a limited period of time sacrifices the competition required to generate valuable cultural energy, thereby incurring great social cost. Based on this argument, Raustiala and Sprigman conclude that, even if this means that everyone is allowed to copy materials freely, there is no need to protect copyright unless the copies are better than the originals. According to these authors, there is a big difference between people who purchase copies and those who purchase the originals. If consumers who maintain a preference for genuine products start purchasing similar copy products, they effectively advertise—free of charge—that these products are worth copying, thereby helping to increase the number of latent customers for the genuine products.[78] It is meaningless to, for example, claim copyright on financial innovations (e.g., derivatives and swaps) in the financial industry. The reason why this is meaningless is because it is more mutually beneficial to develop new markets by sharing specific financial technologies than it is to monopolize them.

The ultimate form of free copying is Linux and other open source software, which is used free of charge around the world but is achieving sustained development. Improved versions of open source software are as important as their originals. Copying inspires innovation by reducing the software utilization costs.

The above is a recent example of the types of arguments that have been made concerning the relationship between copying and innovation.

Meanwhile, new copyright rules for the Internet era are currently being widely approved worldwide. These rules not only allow anyone to publicly release information and copy such information freely, but also define a system that publicly authorizes copying. This system is known as the Creative Commons (CC) licensing scheme. International non-profit organizations that provide CC licenses and their projects are generally known as Creative Commons. CC licenses are marked with various

[78] Kal Raustiala and Christopher Sprigman, *The Knockoff Economy: How Imitation Sparks Innovation*.

designed icons, which serve as a tool for authors wishing to publicly release their works on the Internet to declare their consent for their works to be used freely as long as the specified requirements are met. The use of CC licenses enables authors to freely distribute their works while maintaining their copyright and allows users to redistribute or remix works within the terms of the license. Compared to conventional copyright rules, which unequivocally distinguish rights holders from non-rights holders by means of a symbol alone, the CC license system has the advantage of greatly expanding the scope of productive activities for users.

Suppose, for example, that a work released on the Internet by its author has the design icons shown in Figure 4-4.

Figure 4-4: Example of a CC License Icon on the Internet
Source: Creative Commons (https://creativecommons.org/)

In a case like this, anyone wishing to use this publicly released work must observe the conditions indicated in Figure 4-5.

You must observe the following conditions:

Attribution: You must give **appropriate credit**, provide a link to the license, and **indicate if changes were made**. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

Non-Commercial: You may not use the material **for commercial purposes**.

No Derivatives: If you **remix, transform, or build upon the material**, you may not distribute the modified material.

No additional restrictions: You may not apply legal terms or **technological measures** that legally restrict others from doing anything the license permits.

Figure 4-5: Explanation of the CC License Label Shown in Figure 4-4
Source: Creative Commons (https://creativecommons.org/licenses/by-nc-nd/2.0/uk/)

Japan has an organization that promotes CC licenses, as well: Creative Commons Japan (CCJP; parent organization: Commonsphere, a government-specified non-profit corporation).[79] The CCJP was established by a preparation committee created in 2003 by the Center for Global Communications (GLOCOM) of the International University of Japan. Once a Japanese version of the license system

[79] One of this research committee's outside expert members, Tomoaki Watanabe (Associate Professor at the Graduate School of Media and Governance, Keio University) serves as an executive director of Commonsphere.

had been developed, March 2004 saw the CCJP become the world's second organization, after the United States, to release CC licenses. In March 2006, the organization launched its activities as an independent NPO, with experts from legal and academic circles who were committed to creating new copyright rules for the Internet era actively participating in its activities. Its advisory board members include Joichi Ito (Director of MIT Media Lab) and Jun Murai (Dean of the Faculty of Environmental and Information Studies, Keio University). The CCJP is expected to play a crucial role in the development of a legal governance structure designed to maximize the benefits of open innovation.

Conclusion/Acknowledgments

Now widely used by the public at large, the term "open innovation" was first coined by the American organizational theorist Henry Chesbrough in his book entitled *Open Innovation: The New Imperative for Creating and Profiting from Technology* (2003).

As I mentioned in the section entitled "Introduction: Background to the Study Group," ICT is used for a variety of purposes in developing countries in its capacity as a tool that can generate a "leapfrog" effect. The new concept proposed by Chesbrough just 13 years ago is also causing various synergetic effects, as expected of this new phenomenon.

Experts involved in development assistance around the world are no doubt aware of this amazing unconventional phenomenon, but they have been unable to organize information conceptually to demonstrate the impact that open innovation has had on resolving issues in developing countries. This dilemma is what led to our decision to launch our study group.

We held four intensive study sessions between September 2015 and February 2016. This report is the outcome of these sessions. Needless to say, we are still some way from having organized our thoughts on all aspects of the relationship between open innovation and development. However, we believe that, using Fab Labs as examples, we have been able to present some innovative ideas about new options for resolving development issues in developing countries. We will be delighted if, based on the discussions presented in this report that arose from our study sessions, the relevant project departments at JICA are able to continue exploring how best to develop new projects. We firmly believe that the outcomes achieved by our study group deserve to be used in the development of projects.

To conduct our study sessions, we selected expert staff from within JICA to organize a task team. In addition, we also asked outside experts from fields such as development economics, innovation, and information and communications policies to join our study sessions.

Izumi Aizu, one of the organizers of our study group, spent many hours planning and organizing the study sessions as well as coordinating with various experts. Tatsuo Tanaka took time out of his busy schedule to serve as the chief examiner of the study group. Hiroya Tanaka, a prominent researcher representing Japan, provided us with many valuable details about Fab Labs, which we used as examples for our study. Toshiya Jitsuzumi took the trouble to come all the way from Kyushu each time a study session was held and offered many helpful suggestions. Hiroya Izumi provided a number of valuable pieces of information, including details on past studies conducted at the Ministry of Internal Affairs and Communications. Tomoaki Watanabe provided us with useful advice about copyright and other issues from an objective perspective, not only in his capacity as an expert on open innovation but also as an executive director of Creative Commons Japan. In addition, we also received the latest information about maker movement trends in Asia from Masakazu Takasu of teamLab Inc.,

as well as detailed information about a Fab Lab implementation project in the Philippines from Yutaka Tokushima, a researcher at Keio University. We invited them to appear as guest lecturers so that they could provide us with these valuable pieces of information.

The information and latest news provided by these expert study group members and guest lecturers proved to be far more efficient and effective than we originally expected, so this was of great benefit to the study group. As the study group representative, I would like to express my sincere gratitude to all of the participants for their cooperation.

The staff and the senior advisor who wrote the various chapters of this report (Koji Yamada, Hideshi Yamashita, Yuji Shinohara, Yoshiro Masuda, and Tomoyuki Naito) were selected from JICA to serve as task members. They worked enthusiastically throughout all stages of the process, from planning and organizing the study sessions to carrying out the final editing of this report. Their work also proved to be even more efficient and effective than originally expected. I am more pleased than I could ever have hoped for as the study group representative. The Research Institute's Planning Section provided their full support for the study group. In particular, I would like to express my gratitude to Hironobu Murakami, Eriko Sakamaki, Sayuri Uematsu, and Ami Honda for having attended the study sessions from the beginning until the end, even though the sessions were always held outside of work hours. I would also like to thank Yuko Rasulov, the Research Institute's secretary, for always having taken great care in arranging my rather complicated schedule.

In closing, I would like to express my heartfelt gratitude once again to all of the people involved in the study group, including those whose names are not mentioned in this report.

March 2016

Ichiro Tambo

Director of JICA Research Institute