MAY 2016

Transformative Innovation for International Development

Operationalizing Innovation Ecosystems and Smart Cities for Sustainable Development and Poverty Reduction

PROJECT DIRECTORS
Naohiro Kitano
Daniel F. Runde

PRINCIPAL AUTHOR
Helen Moser

CONTRIBUTING AUTHOR
Charles Rice

A Report of the
CSIS PROJECT ON PROSPERITY AND DEVELOPMENT
AND THE JICA RESEARCH INSTITUTE (JICA-RI)

CSIS | CENTER FOR STRATEGIC & INTERNATIONAL STUDIES

JICA

MAY 2016

Transformative Innovation for International Development

Operationalizing Innovation Ecosystems and Smart Cities for Sustainable Development and Poverty Reduction

PROJECT DIRECTORS
Naohiro Kitano
Daniel F. Runde

PRINCIPAL AUTHOR
Helen Moser

CONTRIBUTING AUTHOR
Charles Rice

A REPORT OF THE
CSIS PROJECT ON PROSPERITY AND DEVELOPMENT
AND THE JICA RESEARCH INSTITUTE (JICA-RI)

CSIS | CENTER FOR STRATEGIC & INTERNATIONAL STUDIES

ROWMAN & LITTLEFIELD
Lanham • Boulder • New York • London

About CSIS

For over 50 years, the Center for Strategic and International Studies (CSIS) has worked to develop solutions to the world's greatest policy challenges. Today, CSIS scholars are providing strategic insights and bipartisan policy solutions to help decisionmakers chart a course toward a better world.

CSIS is a nonprofit organization headquartered in Washington, D.C. The Center's 220 full-time staff and large network of affiliated scholars conduct research and analysis and develop policy initiatives that look into the future and anticipate change.

Founded at the height of the Cold War by David M. Abshire and Admiral Arleigh Burke, CSIS was dedicated to finding ways to sustain American prominence and prosperity as a force for good in the world. Since 1962, CSIS has become one of the world's preeminent international institutions focused on defense and security; regional stability; and transnational challenges ranging from energy and climate to global health and economic integration.

Thomas J. Pritzker was named chairman of the CSIS Board of Trustees in November 2015. Former U.S. deputy secretary of defense John J. Hamre has served as the Center's president and chief executive officer since 2000.

CSIS does not take specific policy positions; accordingly, all views expressed herein should be understood to be solely those of the author(s).

About JICA-RI

The JICA Research Institute (JICA-RI) was established on October 1, 2008, as the research arm of the Japan International Cooperation Agency (JICA). It supersedes and strengthens the research capabilities of the former JICA and the Japan Bank for International Cooperation (JBIC).

Over the last eight years, JICA-RI has laid firm foundations as a research institution, by developing research networks worldwide and creating opportunities for dialogue between researchers and practitioners.

Together with various partners, JICA-RI has conducted policy- and operations-oriented, academically solid studies in four focused research areas: peace and development, growth and poverty reduction, environment and development/climate change, and aid strategies, aimed at not only supporting the Agency in the delivery of effective development cooperation, but also contributing to the international debate.

In pursuing its work, JICA-RI has the advantage of having full access to the abundant information obtained from development projects and programs on the ground.

ISBN: 978-1-4422-5953-9 (pb); 978-1-4422-5954-6 (eBook)

Center for Strategic & International Studies
1616 Rhode Island Avenue, NW
Washington, DC 20036
202-887-0200 | www.**csis**.org

Rowman & Littlefield
4501 Forbes Boulevard
Lanham, MD 20706
301-459-3366 | www.**rowman**.com

Contents

Acknowledgments

The authors would like to thank the individuals who contributed to the research that informed this report. In particular, this includes representatives of the U.S. and Japanese governments; the Japan International Cooperation Agency (JICA); and the private-sector, civil society, and multilateral institutions who participated in working groups in Tokyo and Washington, DC, in summer and fall 2015. This also includes those individuals who participated in interviews in Indonesia and the Philippines to inform this report's case studies. Special thanks go to the JICA offices in Indonesia and the Philippines for supporting the authors' visits there and to Akio Hosono, Tomoyuki Naito, Koji Yamada, Hironobu Murakami, Rinko Jogo, and Sayuri Uematsu for their contributions to the authors' understanding of the issues addressed in this report. The authors would also like to thank CSIS interns Amy Chang and Ryan Lasnick for their research support.

This report was made possible by JICA-RI's generous support for and cooperation with the Project on Prosperity and Development.

Executive Summary

Recent history has seen the emergence of new industries and exploding technologies that are transforming the world. They are also changing the context for international development. "Transformative innovation," or system-level innovation that shifts the existing system toward a totally new and sustainable way of operating, holds certain promise for developing countries seeking high-yield economic growth. One can look to the rise of the Internet in the 1990s as an example of this kind of transformation.[1]

It is important that international development stakeholders, including developing countries themselves, understand this potential. As more countries move into middle-income status and face stagnating growth prospects, their needs and wants for their own development are changing. If scaled to their potential and made sustainable, transformative innovation approaches can enable a new path to economic growth, sustainable development, and poverty reduction.

This report looks at the *how* of operationalizing transformative innovation by focusing on two concrete opportunities for developing contexts: innovation ecosystems and smart cities. The report considers the application of these approaches in countries where the United States and Japan, demonstrated leaders in innovation, have significant development engagement—the Philippines and Indonesia.

Innovation ecosystems are environments that encourage the innovation of new ideas that respond to "what is needed by a society, market or individual."[2] These environments then support ideas' application in society, through scale-up or commercialization. While there is no simple formula for

1. Andy Stirling, Frank Geels, Ivan Scrase, Adrian Smith, and Patrick Van Zwanenberg, "Transformative Innovation: A research report for the Department for Environment, Food, and Rural Affairs," SPRU—Science and Technology Policy Research, University of Sussex, August 2009, https://www.sussex.ac.uk/webteam/gateway/file.php?name=spru-for-defra---transformative-innovation.pdf&site=264/.

2. "National Innovation Initiative Summit and Report: Thriving in a World of Challenge and Change," Council on Competitiveness, 2005, 46, http://www.compete.org/storage/images/uploads/File/PDF%20Files/NII_Innovate_America.pdf.

building an innovation ecosystem, the common thread is that these ecosystems involve strong linkages and collaboration among policymakers, academia, and the private sector. These actors provide human capital, financial capital, physical infrastructure, and enabling policy to support innovation.

In developing-country contexts, one or all of these inputs may be missing from an ecosystem. Or, if present, an actor may not have the requisite capacity to support innovation. Mapping of a local innovation ecosystem is an essential exercise to determine gaps and how best to fill them. Bilateral donors and multilateral organizations can then serve as catalysts for responses, with the long-term goal of enabling local governments to implement and scale innovation ecosystem–building efforts themselves.

In regions where there may not be established local innovation ecosystems, Fabrication Laboratories or "Fab Labs" can be a catalyst. Fab Labs are "technical prototyping platform(s) for innovation and invention, providing stimulus for local entrepreneurship."[3] They offer specific technological infrastructure, including 3-D printers and laser cutters, that support open innovation; a user can enter a Fab Lab and exit having made almost anything. Fab Labs have been used to make diverse products ranging from soap molds to low-cost prosthetic legs and low-cost artificial organs.

While Fab Labs cannot solve every problem in low-income areas, it is clear that they have the potential to serve as a catalytic input for constructing and connecting new innovation ecosystems in the developing world. They provide individuals the opportunity to connect with the broader global innovation community while enabling positive spillover effects in the area where the Fab Lab is located, including through building community engagement around the innovation ecosystem, increasing the capacity of local firms and individuals to actively innovate, and building a skill base in the local population to drive forward innovative activity.

This report considers the specific example of the innovation ecosystem in the Philippines and the contribution of Fab Lab Bohol, which opened in May 2014. There are pockets of innovation in the Philippines, but the overall innovation ecosystem is still weak, given an overall low base of technology and technical knowledge, a dearth of downstream opportunities for product production, lack of access to technology and collaborative spaces, bureaucratic university procurement policies, and uncoordinated government leadership.

In this landscape, Fab Lab Bohol demonstrates the potential of Fab Labs to catalyze innovation ecosystems in developing contexts. In largely rural and agricultural Bohol, it has become a well-regarded platform for creation and collaboration that has enabled local people and businesses to innovate new products, add value to existing products, and generate new streams of income. It has also enabled the development of low-cost solutions to community challenges. The challenges facing Fab Lab Bohol, namely financial sustainability, are emerging in the process of the development of innovation ecosystems at large. While innovation-enabling platforms can be designed as public goods and it is not realistic to expect Fab Labs in developing countries to be financially independent from their start-up due to weak local innovation ecosystems, it is important that they pursue sustainable business models that reflect the local circumstances in the long run. Bilateral

3. "What is a Fab Lab," Fab Foundation, http://www.fabfoundation.org/fab-labs/what-is-a-fab-lab/.

donors and multilateral organizations can catalyze this evolution, providing initial funding and capacity building while enabling Fab Labs to pursue revenue generation.

There are existing financially sustainable Fab Labs in Kamakura, Japan, and Utrecht, Netherlands, and Fab Labs in both Soshanguve, South Africa, and Nairobi, Kenya, are pursuing self-sustained financial models. As these examples demonstrate, there is potential for Fab Labs to operate in ways that achieve financial sustainability beyond donor funds. Overall, this sustainability is critical to achieve these platforms' long-term goal of enabling transformative innovation.

The report provides the following recommendations for building innovation ecosystems in developing contexts:

Developing-Country Governments

- Conduct mapping exercises of local innovation ecosystems.
- Support public provision of technological goods and platforms for innovation.
- Pursue a combination of approaches that target high-yield economic growth and train local citizens in entrepreneurship.

Bilateral Donors and Multilateral Organizations

- Support more private-sector approaches to transformative innovation, including tiered financing and providing funding for results.
- Serve as the catalyst for innovation-enabling platforms that achieve financial sustainability and accessibility.

Universities, Nongovernmental Organizations (NGOs), and Research Organizations

- Encourage researchers and participants in innovation-enabling platforms to develop innovations that respond to specific local needs and development challenges.
- Pursue joint research between innovators in a developing country and innovators in a developed country.

The report next moves to a second concrete opportunity for developing countries to pursue transformative innovation: building "smart cities." Today over half of the total human population lives in an urban setting. This is a radical shift, with large implications for governance, economic growth, health, and security. The United Nations estimates that the urban population will grow by an additional 2.5 billion people by 2050, with nearly 90 percent of that growth occurring in Africa and Asia.[4] Managing urban growth, particularly the haphazard city expansions that are common in developing countries, will be one of the most critical challenges of the coming century. Smart city technologies can promote growth that is sustainable, energy efficient, and environmentally conscious. These technologies are a critical tool for transforming urbanization from a challenge into a global social dividend.

4. "World's population increasingly urban with more than half living in urban areas," UN Department of Economic and Social Affairs, July 10, 2014, http://www.un.org/en/development/desa/news/population/world-urbanization-prospects-2014.html.

At root, smart cities require three components. First is effective governance in public safety, city planning and operations, and government and agency administration. Next is quality infrastructure that enables economic productivity, inclusive growth, and resilience. This includes infrastructure that provides energy, transportation, and water. Finally, smart cities support "the needs of each citizen through social programs, healthcare and education."[5] These services promote an inclusive society.

This report considers the opportunity of transforming Jakarta, Indonesia, into a smart city. Jakarta faces significant challenges given rapid urbanization and its strain on already weak city infrastructure, but several facets of Jakarta provide an enabling environment for a smart cities approach. This includes strong political leadership and desire from the people for good services delivery; a high number of smartphone and social media users; and a thriving innovation scene. Various entities in Jakarta are pursuing vehicles to make the city a higher-quality and more productive place to live.

Jakarta's government is responding to citizen demand with the Smart City Unit, a strong local example of the smart cities approach at work. Housed in the city government, this office is collecting big data and processing it to drive accountable governance and improve services delivery. Other cities should take note of its approach and its success. Donors and multilateral organizations can support such efforts by providing technical capacity building and mentorship in areas where gaps are identified. They can also promote global standards that provide incentive for cities to fare well in the smart cities arena.

Donors also play a role in catalyzing the take-up of new technologies that can positively affect the day-to-day lives of citizens, as well as more productive and energy-efficient operations for businesses. The chapter considered these goals in regards to the JICA–funded mass rapid transit (MRT) system in Jakarta, which is building the city's first underground and aboveground metro lines. It also explores the Joint Crediting Mechanism (JCM) in Indonesia, which is an authoritative carbon trade scheme providing subsidies to Indonesian companies taking up technologies from Japan that are low carbon, promote climate change mitigation, or make use of renewable energy. Technologies such as these have demonstrated success for the businesses that have qualified for the subsidies, but questions remain about how they can be scaled to have transformational impact.

This report provides the following recommendations for enabling smart cities in developing contexts:

Developing-Country Governments

- Plan and prioritize development projects and determine gaps that can be filled through foreign partnership.
- Pursue schemes that facilitate joint ventures between local companies and those in developed countries.
- Consider how big data can catalyze the better coordination and delivery of public services.

5. "Smarter Cities," IBM, accessed April 13, 2016, http://www.ibm.com/smarterplanet/us/en/smarter_cities/overview/.

Bilateral Donors and Multilateral Organizations

- Develop and promote a smart cities ranking that will help cities to benchmark their performance against other cities and measure their effectiveness with key performance indicators.
- Support city and national governments to improve their capacity to collect, analyze, and operationalize big data for improved services delivery.
- Provide catalytic funding and capacity building for the implementation of smart city technologies in developing countries.
- Promote quality infrastructure.

01

Introduction

CONTEXT

The past few years have seen the emergence of new industries and exploding technologies that are transforming the world. They are also changing the context for international development. In his 2016 book *The Fourth Industrial Revolution*, World Economic Forum (WEF) founder and executive chairman Klaus Schwab describes the pending technological revolution, which will involve the "fusion of technologies that is blurring the lines between the physical, digital, and biological spheres."[1] This revolution is unlike anything the world has experienced. Innovations that leverage new technology and promote economic integration are fundamentally altering the way that people work, live, and relate to one another.

It is important that international development stakeholders, including developing countries themselves, understand this revolution and its capability for profound and systemic change. This revolution holds opportunity for emerging markets in particular, offering the potential to "integrate the unmet needs of two billion people into the global economy."[2] However, there is not enough leadership or understanding at the international and national levels. To benefit from this "fourth industrial revolution," leaders must promote institutional frameworks that "govern the diffusion of innovation and mitigate the disruption."[3]

This report is the culmination of the first year of a research partnership between the Project on Prosperity and Development at the Center for Strategic and International Studies (CSIS) and the JICA Research Institute (JICA-RI). In the past year, the researchers have explored the potential of transformative innovation for international development, and how specific approaches to building

1. Klaus Schwab, "The Fourth Industrial Revolution: What it Means, How to Respond," World Economic Forum, January 14, 2016, https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond.

2. Ibid., 9.

3. Ibid., 33.

innovation ecosystems and smart cities can be operationalized to yield sustainable development and poverty reduction.

In line with the fourth industrial revolution, "transformative innovation" refers to system-level innovation that shifts the existing system toward a totally new and sustainable way of operating.[4] This includes "far-reaching changes in technology, affecting several branches of the economy, as well as giving rise to entirely new sectors."[5] Transformative innovation is differentiated from other forms of innovation in that it is a multi-actor process that moves society to a new way of operating, rather than making piecemeal improvements to an existing system. Transformative innovation typically begins with experimentation and learning, building momentum until the new system is stabilized as the norm.[6]

Transformative innovation is a key driver of high-yield economic growth, as exemplified by the economic dividends brought by transformative innovations such as the Internet in the 1990s and more recently the expansion of mobile phone technology in Africa. As more countries move into middle-income status and face stagnating growth prospects, their needs and wants for international development are changing. Transformative innovation approaches can enable a new path to economic growth, sustainable development, and poverty reduction.

This report comes at a time when both the United States and Japan have embraced the power of transformative innovation in their international development agendas. Presidential Policy Directive 6 on U.S. Global Development Policy, issued by President Barack Obama in 2010, emphasizes the need to support game-changing innovations by seeking and scaling up technologies that enable sustainable development outcomes.[7] Since 2012, the President's Global Development Council has supported research in both applied science and implementation, as well as private and public efforts to accelerate innovation.[8] The U.S. Agency for International Development (USAID) Global Development Lab was created in 2014 to strengthen partnerships in science, technology, and innovation to maximize development impact; in that same year, USAID partnered with the United Kingdom, Australia, Sweden, and the Omidyar Network to create the Global Innovation Fund, collectively pledging $200 million for innovative development solutions.[9] The U.S. government similarly embraced the importance of strengthening partnerships to maximize innovative development solutions in its 2015 Quadrennial Diplomacy

---

4. Andy Stirling et al., "Transformative Innovation: A Research Report for the Department for Environment, Food, and Rural Affairs," SPRU—Science and Technology Policy Research, University of Sussex, August 2009, https://www.sussex.ac.uk/webteam/gateway/file.php?name=spru-for-defra---transformative-innovation.pdf&site=264/.

5. Christopher Freeman and Carlota Perez, "Structural Crises of Adjustment, Business Cycles, and Investment Behavior," in *Technical Change and Economic Theory*, ed. Giovanni Dosi et al. (London: Pinter Publishers, 1988), 46.

6. Stirling et al., "Transformative Innovation," 21.

7. "Presidential Policy Directive/PPD-6," The White House, September 22, 2010, http://fas.org/irp/offdocs/ppd/ppd-6.pdf.

8. "Fact Sheet: The President's Global Development Council's Second Report," The White House, May 15, 2015, https://www.whitehouse.gov/the-press-office/2015/05/15/fact-sheet-president-s-global-development-council-s-second-report.

9. Ibid.

and Development Review, recognizing it as a "strategic, economic, and moral imperative" for U.S. foreign policy.[10]

In its 2015 Development Cooperation Charter, the government of Japan emphasizes enabling "quality growth," identified as economic growth that is inclusive of society as a whole, sustainable for future generations, and resilient to external shocks.[11] To achieve this, Japan will promote innovative solutions in infrastructure, finance, urbanization, science and technology, and vocational training and job creation, as well as various aspects of health and environmental policy.[12] As global challenges are increasingly transboundary in nature, the Development Cooperation Charter recognizes the limited role of Official Development Assistance (ODA), and emphasizes leveraging more intercountry cooperation and private-sector partnerships.[13]

The newly adopted Sustainable Development Goals (SDGs) have set the agenda for international development cooperation until 2030, highlighting the role that transformative innovation should play in a host of development challenges, and especially for economic growth. Goal 8.3 mentions that innovative policies are needed to create employment; promote entrepreneurship; facilitate growth of micro, small, and medium-sized enterprises; improve access to financial services; and provide affordable Internet access.[14] Research and development (R&D) is key to the focus of Goal 9, which encourages public and private spending for industrial diversification and value addition for domestic commodities.[15] The SDGs further emphasize the need for global cooperation in Goal 17 in order to build knowledge-sharing platforms. Partnerships are important to fully maximize the transformative potential of science, technology, and innovation in developing economies.[16]

JICA has taken an active role in adopting the SDGs, with the Japanese government, private companies, civil society, universities, and research institutes all committing to global cooperation through mutual learning. As JICA president Shinichi Kitaoka has stated, "efforts on the SDGs represent a one-time opportunity for Japan to demonstrate its presence and leadership in the international community."[17] JICA has committed to strategic cooperation, and aims to encourage quality growth, promote peace building, strengthen operational engagement, expand and deepen strategic partnerships, and support women who are taking active roles in their empowerment. Approaches that embrace transformative innovation are needed to achieve these priorities.

---

10. "Quadrennial Diplomacy and Development Review: Enduring Leadership in a Dynamic World," U.S. Department of State, 2015, 19, http://www.state.gov/documents/organization/241429.pdf.

11. "Development Cooperation Charter: for Peace, Prosperity and a Better Future for Everyone," Ministry of Foreign Affairs of Japan, February 10, 2015, 5, http://www.mofa.go.jp/files/000067701.pdf.

12. Ibid., 6.

13. Ibid., 4.

14. "Goal 8," UN Sustainable Development Knowledge Platform, April 5, 2016, https://sustainabledevelopment.un.org/sdg8.

15. "Goal 9," UN Sustainable Development Knowledge Platform, April 5, 2016, https://sustainabledevelopment.un.org/sdg9.

16. "Goal 17," UN Sustainable Development Knowledge Platform, April 5, 2016, https://sustainabledevelopment.un.org/sdg17.

17. Shinichi Kitaoka, "Message from the President," Japan International Cooperation Agency, April 5, 2016, http://www.jica.go.jp/english/about/president/index.html.

Likewise, the United States has committed to advancing the SDGs with a focus on leveraging critical partnerships and promoting technology innovation. In September 2015, the United States joined other countries in launching the Global Partnership on Sustainable Development Data to "accelerate the data revolution" needed to achieve and measure outcomes under the SDGs.[18]

Operationalizing transformative innovation approaches in developing countries presents many opportunities. If scaled to their potential and made sustainable, these approaches can enable development and poverty reduction through economic growth. This report looks at the *how* of operationalizing transformative innovation by focusing on two concrete opportunities for developing contexts: innovation ecosystems and smart cities.

As part of the pending fourth industrial revolution, innovation ecosystems and smart cities approaches are disrupting the traditional way of doing international development. Development practitioners, and especially those operating in urban contexts in middle-income countries, should embrace this disruption and understand the potential for tools such as Fabrication Laboratories to catalyze transformative innovation. Momentum around these approaches is building, and there is opportunity now to think about how country governments, bilateral donors, multilateral organizations, universities, research institutes, and nongovernmental organizations (NGOs) can best support their introduction, scale-up, and sustainability.

This report serves as a primer for two important approaches by examining their application within specific countries where the United States and Japan share a significant engagement: the Philippines and Indonesia. In discussing the successes and challenges of specific efforts to build innovation ecosystems and smart cities, the report considers the potential for scaling these approaches to achieve the transformative innovation that societies and people need for more productive and better lives.

OVERVIEW OF THE REPORT

This report is divided into two chapters that each explore concrete examples of transformative innovation approaches. The first considers innovation ecosystems, discussing their concept and framework and notable U.S. and Japanese approaches to building innovation ecosystems at home and abroad. It then moves into a specific discussion of Fabrication Labs as innovation ecosystem catalysts, discussing Fab Labs' concept, history, and application for international development. The chapter then considers the specific case study of localizing a Fab Lab in Bohol, Philippines. The case study explores the existing innovation ecosystem in the Philippines, analyzes gaps and challenges, and outlines the opportunity presented by Fab Lab Bohol. In its discussion of Fab Lab Bohol, the chapter presents key information about the Fab Lab and considers its successes and challenges in contributing to an innovation ecosystem in Bohol. It concludes with recommendations for local and international actors on how they can support the building of sustainable innovation ecosystems in developing contexts.

18. "Fact Sheet: U.S. Global Development Policy and Agenda 2030," The White House, September 27, 2015, https://www.whitehouse.gov/the-press-office/2015/09/27/fact-sheet-us-global-development-policy-and-agenda-2030.

The second chapter considers smart cities, exemplified by recent movements in Jakarta, Indonesia. It first presents the concept and framework of smart cities. This is followed by background information on rapid urbanization in Jakarta, including a discussion of key challenges that a smart cities approach must address there. It then analyzes the opportunities in Jakarta that contribute to an effective enabling environment for a smart cities approach. It next considers existing efforts to respond to these challenges with innovative technologies in the governance and information and communications technology (ICT), energy, transportation, and education spheres. The chapter concludes with recommendations for local and international actors on how they can support the creation of smart cities in developing contexts.

The report concludes with some final thoughts on transformative innovation, its potential for international development, and the importance of international development stakeholders joining this global conversation.

02

Innovation Ecosystems

INTRODUCTION

Concept of Innovation Ecosystems

Innovation is broadly recognized as a critical component of modern economic competiveness, and shifting towards an innovation-driven economic model has become an imperative for policy-makers around the world. However, there is no single prescription or formula for establishing an innovation-driven economy. At the 2004 National Innovation Initiative Summit it was noted that "innovation is not a linear process. It emerges from a complex ecosystem of relationships and interactions."[1]

This "innovation ecosystem" is an environment that encourages the innovation of new ideas that respond to "what is needed by a society, market or individual."[2] Following the development of ideas, innovation ecosystems support their application, via commercialization or scale-up, in ways that "generate further innovations, giving rise to new industries and national and global markets; spurring productivity and economic growth; fueling wealth creation and profits; generating high-value, higher-paying jobs; and raising the standard of living, not just for direct beneficiaries of those new jobs, but also for other people touched by the innovation."[3] Creating these ecosystems is a challenge that requires collaboration among a broad array of stakeholders, including policy-makers, academia, and the private sector.

---

1. "National Innovation Initiative Summit and Report: Thriving in a World of Challenge and Change," Council on Competitiveness, 2005, 18, http://www.compete.org/storage/images/uploads/File/PDF%20Files/NII_Innovate_America.pdf.
2. Ibid., 46.
3. Ibid., 46.

Framework of Innovation Ecosystems

Innovation is the product of an interconnected ecosystem of human capital, financial capital, physical infrastructure, and enabling policy that empowers entrepreneurs to deliver new social and economic value. These individual components are bridged together by connective institutions, either formal or informal, that allow free-flowing exchange and collaboration between various actors in the ecosystem. In places such as Boston in the United States and Tsukuba Science City in Japan, supportive innovation ecosystems have pushed forward technological advances, job creation, and enormous economic output.

In many cases, research universities are the critical lynchpin tying together the necessary components of a dynamic and collaborative innovation ecosystem. These universities bring top human capital, R&D funding, and leading private-sector actors within physical proximity. In turn, these communities draw in entrepreneurs, venture capitalists, and incubators to continue fueling innovation-led growth. While it is not necessary for a university to play this role, most innovation clusters have a central convening institution. It is no coincidence that the most famous examples of innovation ecosystems—Boston and Silicon Valley—are built around world-class universities such as Harvard, the Massachusetts Institute of Technology (MIT), and Stanford.

While developed countries tend to house many leading examples of effective innovation ecosystems, there are also examples to be found in emerging economies. The 2015 Global Innovation Index notes that "innovation-driven growth is no longer the prerogative of high-income countries alone," and many developing countries including Malaysia, Vietnam, Jordan, and Kenya have made significant progress towards the creation of innovation ecosystems.[4] There is an opportunity for other developing countries to learn from these experiences as they seek to support indigenous entrepreneurs and innovators.

Fabrication Laboratories as Innovation Ecosystem Catalysts

A key element underlying any innovation ecosystem is open access to research infrastructure. Fabrication Laboratories, or "Fab Labs," offer an example of how this infrastructure can be made available for open innovation. The World Bank notes that Fab Labs enable low-cost prototyping of new products and can provide affordable solutions to community needs. They also enable access to "an interconnected global community of learners, educators, technologists, researchers, makers and innovators, who have collectively created a knowledge sharing network that spans across countries."[5] They can be called a major breakthrough, democratizing access to advanced technologies that enable local people to create prototypes, add value to existing products, and

4. Soumitra Dutta, Bruno Lanvin, and Sacha Wunsch-Vincent, "The Global Innovation Index 2015: Effective Innovation Policies for Development," Cornell University, INSEAD, and World Intellectual Property Organization, 2015, 19, https://www.globalinnovationindex.org/userfiles/file/reportpdf/gii-full-report-2015-v6.pdf.

5. "International Bank for Reconstruction and Development Project Appraisal Document on a Proposed Loan in the Amount of US$40 Million to Georgia for a National Innovation Ecosystem (GENIE) Project," World Bank, February 19, 2016, 93, http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2016/03/03/090224b0841cd488/1_0/Rendered/PDF/Georgia000Nati0stem00GENIE00Project.pdf.

generate new sources of income. Fab Labs are part of the "maker movement," which "leverages do-it-yourself technologies—3D printers, laser cutters, sensors, etc.—and organic communities of innovators to address local challenges."[6]

In regions where there may not be established local innovation ecosystems, Fab Labs offer the opportunity for individuals to connect with the broader global innovation community while providing positive spillover effects in the area where the lab is located, including through building community engagement around the innovation ecosystem, increasing the capacity of local firms and individuals to actively innovate, and building a skill base in the local population to drive forward innovative activity. While the global network of Fab Labs is still operationalizing its application for international development and Fab Labs cannot solve every problem in low-income areas, it is clear that Fab Labs have the potential to serve as a catalytic input for constructing and connecting new innovation ecosystems in the developing world.

BACKGROUND

Review of Notable U.S. Approaches to Establishing Innovation Ecosystems in Developing Countries

Although many international development stakeholders think of innovation as a newer concept, the United States has a lengthy history of enabling technology transfer in developing contexts. There has been strong engagement by U.S. government agencies, nongovernmental organizations, and universities in creating and transferring appropriate science and technologies to developing countries.

For example, in the 1960s the United States was a strong contributor to India's "Green Revolution." Introduced by the Rockefeller Foundation with technologies developed in the Philippines and Mexico, this introduced high-yielding seeds and irrigation and fertilization methods to Indian farmers, resulting in significantly higher food production.[7] The U.S. Agency for International Development (USAID) established the first Indian Institute for Technology (IIT), and made enabling technology transfer a key part of its agenda in India beginning in the 1980s.[8]

With a strong history of contributing to technology transfer, the United States government has been especially successful in recent years in applying approaches of the private sector to yield high-impact innovations for international development challenges. This section discusses the USAID Global Development Lab, and two of its specific mechanisms for encouraging innovation.

6. "Communities of 'Makers' Tackle Local Problems," World Bank, August 11, 2014, http://www.worldbank.org/en/news/feature/2014/08/06/communities-of-makers-tackle-local-problems.

7. "The Green Revolution," U.S. Library of Congress, http://countrystudies.us/india/104.htm.

8. "History," U.S. Agency for International Development India, March 15, 2016, https://www.usaid.gov/india/history.

Global Development Lab

The USAID Global Development Lab was launched on April 3, 2014.[9] The lab seeks to increase the application of science, technology, innovation, and partnerships to extend USAID's impact and contribute to its goal of ending extreme poverty.[10] The lab accomplishes its mission by creating intradepartmental relationships across USAID and bringing together a diverse group of partners to discover, test, and scale innovations to solve development challenges faster and cheaper in nine focus areas: Food Security and Nutrition; Modernizing Food Assistance; Ending Preventable Child and Maternal Deaths; Energy Access; Water Solutions; Child Literacy; Financial Inclusion; Human Rights, Participation, and Accountability; and Humanitarian Response.[11]

The lab is headed by an executive director, Ann Mei Chang, who oversees the work of five directors who administer the lab's programs and management activities across five centers and two offices. The lab has teams that focus on data analysis and research, development innovation, and global solutions. It also has teams dedicated to private-sector and USAID mission partnerships, and evaluation and impact.[12] Public-private partnerships, many under the Global Development Alliance (GDA) mechanism, leverage the skills, assets, technologies, and resources of the public, private, and nonprofit sectors. The lab also conducts innovation prize competitions, including the Grand Challenges for Development,[13] which pay for results. Prizes can deliver greater financial value than traditional mechanisms. In 2014, the lab received "over 3,700 applications and invested in 362 new solutions for food security, health, climate change, energy, and economic growth challenges that improved the lives of 13.7 million people."[14]

Grand Challenges for Development (GCDs)

USAID's Grand Challenges for Development (GCDs) are prize competitions that call on the public to develop science and technology solutions for global problems. Each GCD has a specific topic and is supported by specific partners outside USAID. Partners have included the Bill and Melinda Gates Foundation, the Swedish International Development Agency (Sida), and the Australian government. Six GCDs have been launched since 2011:

- Saving Lives at Birth
- All Children Reading
- Powering Agriculture
- Making All Voices Count

9. "About the U.S. Global Development Lab," U.S. Agency for International Development, https://www.usaid.gov/GlobalDevLab/about.

10. Ibid.

11. Ibid.

12. Ibid.

13. "The Lab Year in Review 2015," U.S. Agency for International Development, 2015, https://www.usaid.gov/sites/default/files/documents/15396/LYR_final_Web_1112.pdf.

14. Ibid., i.

- Securing Water for Food
- Fighting Ebola[15]

Since 2011, partners have contributed $125 million to GCD, matching $76 million in USAID funds. Seventy-four hundred ideas have been submitted and 225 ideas have been funded. Within each challenge, the most promising solutions are selected to be tested, and then the best of these are scaled up. Thirty percent of winners have come from developing countries.[16]

A notable Grand Challenge is Fighting Ebola. This competition was initiated in November 2014 by USAID's Global Health Bureau, the White House Office of Science and Technology, the Centers for Disease Control and Prevention, and the Department of Defense. The challenge received over 1,500 ideas in two months for innovations identifying more effective and timelier approaches for health care workers to contain the virus. In total, Fighting Ebola is funding 14 solutions. One of the winners was a protection suit that provides for safer and quicker removal by health care workers—designed by a team including Johns Hopkins University researchers, representatives of health NGO Jhipego, and a wedding dress seamstress.[17] Another winner was mHero, a SMS-based health platform that enabled the Liberian Ministry of Health to send rapid information to health care workers. mHero has since received additional funding and is being scaled up in Sierra Leone.[18]

Development Innovation Ventures (DIV)

Development Innovation Ventures (DIV) is a prize competition based on the venture capital model of tiered funding to early-stage concepts. "DIV has funded both failures and successes but the model allows the Lab to quickly learn when ideas fail and at relatively low expense. When ideas succeed, the Lab finds out how to reach millions of people. Selection criteria for funding include the the potential for significant cost reduction vs. current practice, evidence of impact or the plan to provide it, and a pathway to scaled impact."[19]

The competition began in 2010 and is open year-round to global entrants. Since it began, DIV has received 6,000 applicants, of which it has invested in more than 100.[20] Approximately half of these have included a randomized control trial for evidence of impact. DIV reaches a audience that has largely not engaged with USAID in the past; as of 2011, 76 percent of DIV applicants were new to USAID.[21]

DIV's portfolio includes projects in nine sectors in 35 countries. One project is "MenCare: Engaging Men in Maternal Health and Gender-Based Violence Prevention" in Brazil. This project received $99,754 in Stage 1 financing to develop an online platform for health workers and participants in

15. "Grand Challenges for Development," U.S. Agency for International Development, https://www.usaid.gov/grandchallenges.
16. "The Lab Year in Review 2015," U.S. Agency for International Development, 23.
17. Ibid., ii.
18. "mHero," Fighting Ebola: A Grand Challenge for Development, http://www.ebolagrandchallenge.net/mhero-1.
19. "The Lab Year in Review 2015," U.S. Agency for International Development, 21.
20. "About DIV," U.S. Agency for International Development, https://www.usaid.gov/div/about.
21. "The Lab Year in Review 2015," U.S. Agency for International Development, 21.

group education on birth-preparedness and domestic violence prevention. Participants are expectant couples, and the education focuses on engaging the male partner. DIV's funding also provides for an evaluation of the impact of the online tool. Another project, "Using Performance-Based Incentives to Fight Tuberculosis (TB) in Remote Areas in India," received $75,103 in Stage 1 funding for a scheme to "increase TB treatment counselors' attendance and commitment, which in remote communities are often very low." The overall goal of the project is to increase TB diagnosis rates and improve treatment outcomes.[22]

In 2014, DIV's model was replicated and expanded by the Global Innovation Fund (GIF),[23] a $200 million partnership supported by four bilateral donors, including USAID and the Omidyar Network.[24]

Review of Notable Japanese Approaches to Establishing Innovation Ecosystems in Developing Countries

In its more than 60-year history of development cooperation, Japan has consistently supported the self-help efforts of developing countries though technical assistance. This tradition has roots in Japan's experience with postwar reconstruction. In Japan's 2015 Development Cooperation Charter, this tradition is described as "the spirit of jointly creating things that suit partner countries while respecting ownership, intentions and intrinsic characteristics of the country concerned based on a field-oriented approach through dialogue and collaboration."[25] Guided by this principle, Japanese government agencies, NGOs, the private sector, universities, and other research bodies have been working together with developing-country partners to realize economic growth through technology transfer.

Agriculture Development in Cerrado, Brazil. One example of such cooperation is an agriculture development project in the Brazilian Cerrado. Since the mid-1970s, the Cerrado region of Brazil, a tropical savanna, has been transformed from barren land into one the most productive agricultural regions in the world. EMBRAPA (Empresa Brasileira de Pesquisa Agropecuária, or the Brazilian Agricultural Research Corporation), a Brazilian public corporation, moved into the area and began conducting agricultural research there. JICA and Japan International Research Center for Agricultural Science (JIRCAS) worked with Cerrado Agricultural Research Center (CPAC) of EMBRAPA from its start to develop technological innovations to make the soil fertile and create soybeans and other grains that could grow in the tropical climate.[26] Japan continued financial and technological support until 2002, and today 70 percent of Brazil's agriculture is produced in the Cerrado region.[27] In 2014, agriculture accounted for a 5.6 percent value-add to Brazil's gross domestic product

22. "The DIV Portfolio by Sector," U.S. Agency for International Development, https://www.usaid.gov/div/portfolio.

23. "The Lab Year in Review 2015," U.S. Agency for International Development, 22.

24. "About Us," Global Innovation Fund, http://www.globalinnovation.fund/about-us.

25. "Development Cooperation Charter: For peace, prosperity and a better future for everyone," Ministry of Foreign Affairs of Japan, February 10, 2015, 4, http://www.mofa.go.jp/files/000067701.pdf.

26. Akio Hosono et al., *Development for Sustainable Agriculture: The Brazilian Cerrado* (New York: Palgrave Macmillan, 2015).

27. "The Miracle of the Cerrado," *Economist*, August 26, 2010, http://www.economist.com/node/16886442.

(GDP).[28] Export value of agribusiness as a total value of exports of Brazil was 42.3 percent in 2013, and agribusiness accounted for 22.2 percent of the total GDP of Brazil in 2011.[29]

The experiences of the Cerrado's development through technological and institutional innovations offer lessons in the socially inclusive and sustainable development of agriculture and agro-industrial value chains in tropical savannas, and hence in the attainment of global food security.

JICA-JAXA Joint Project. Another example is a collaboration project between two Japanese government agencies, JICA and JAXA, which made it possible to monitor tropical rain forests using a new satellite technology. From 2009 to 2012, JICA partnered with the Japan Aerospace Exploration Agency (JAXA) to gather data on illegal foresting in Brazil using JAXA's Advanced Land Observing Satellite (ALOS). JICA's Brazil office provided technical cooperation to monitor and respond to ALOS reports. During this time frame, the satellite allowed staff to discover more than 2,000 cases, and "responses contributed to a 40 percent reduction in the amount of forest area destroyed."[30]

On December 1, 2015, JICA and JAXA announced a scale-up of this successful partnership. The Initiative for Improvement of Forest Governance will develop a new global tropical forest monitoring system. As with the partnership in Brazil, this effort will use JAXA technology in the form of the Advanced Land Observing Satellite-2 (ALOS-2). ALOS-2 will relay information on deforestation and illegal logging to the public via open-access data on its website every six weeks. It is expected that this technology will be of specific interest to countries with large tropical forest areas and help them to take action against illegal logging.[31]

Japan's Research Activities in Developing Countries

The government of Japan has had great success in enabling groundbreaking research in science and technology. Joint research with developing countries provides capacity building and leads to innovations that respond to challenges in both partner countries. This collaborative approach is also embraced by other Japanese entities that pursue innovation.

The Science and Technology Research Partnership for Sustainable Development (SATREPS) is a program created in 2008, following the government's new policy[32] on science and technology diplomacy. JIRCAS and Institute of Tropical Medicine at Nagasaki University (NEKKEN) are two notable examples of Japanese research institutes with long histories of collaborative research activities with developing country partners.

Science and Technology Research Partnership for Sustainable Development (SATREPS). The SATREPS program, created in 2008 by JICA and the Japan Science and Technology Agency (JST),

28. "Agriculture, Value Added (% of GDP)," World Bank, http://data.worldbank.org/indicator/NV.AGR.TOTL.Z.

29. Hosono et al., *Development for Sustainable Agriculture*.

30. "JICA and JAXA Announce Forest Monitoring System Using ALOS-2 Satellite: Constant Monitoring of Deforestation throughout the Tropics and Open Data Access on the Internet," Japan International Cooperation Agency, December 15, 2015, http://www.jica.go.jp/english/news/press/2015/151215_01.html.

31. Ibid.

32. Atsushi Sunami, Tomoko Hamachi, and Shigeru Kitaba, "The Rise of Science and Technology Diplomacy in Japan," *Science & Diplomacy*, March 2013.

enables joint research between Japan and developing countries. Implemented with ODA from JICA and competitive research funds from JST, the program supports technology-based research projects that benefit both the developing country and Japan. Key goals include promoting international cooperation, advancing science and technology that leads to innovations, and developing capacity in partner-country universities and research institutes.[33]

SATREPS projects are selected each year from project proposals submitted by Japanese research institutions. In the first eight years of the program, a total of 99 projects have been initiated in 43 countries. There were 44 international joint research projects in 26 countries in progress as of May 2015. These include those that focus on environment and energy, biological resources, and disaster prevention and mitigation. Each SATREPS project receives about 100 million yen ($850,000) per year.[34]

Projects have demonstrated success in contributing to country needs in both Japan and the developing country. One such example is the SATREPS project in Peru, "Earthquake and Tsunami Disaster Mitigation," which was conducted from 2009 to 2014. Japan and Peru are both located in subduction zones, in which tectonic plate activity raises the likelihood of earthquakes. Thus, both countries receive benefit from research on these zones.[35] Researchers "develop(ed) seismic source models based on past major earthquakes, conduct(ed) tsunami simulations, stud(ied) building earthquake-resistance, develop(ed) retrofitting technologies and present(ed) and published research."[36] These results are being used to create disaster-mitigation plans appropriate for Peru.[37]

Japan International Research Center for Agricultural Sciences. The Japan International Research Center for Agricultural Sciences (JIRCAS) is a national research and development agency. Founded in 1970 as the Tropical Agriculture Research Center by the Ministry of Agriculture and Forestry, JIRCAS was reestablished in October 1993 to include overseas forestry and fisheries research in its mandate. JIRCAS conducts research on agriculture, forestry, and fisheries technology in the tropical and subtropical regions of developing countries. JIRCAS focuses on four main program areas: environment and natural resource management, stable food production, rural livelihood, and information analysis.[38] According to its 2014 annual report, JIRCAS has 17 active projects within these program areas.[39] Active projects include "Development of agricultural technologies in developing countries to respond to climate change" and "Establishment of sustainable and independent farm household economy in the rural areas of Indochina." Projects have concrete

33. "About SATREPS," Japan Science and Technology Agency, http://www.jst.go.jp/global/english/about.html.

34. Ibid.

35. "Earthquake and Tsunami Disaster Mitigation—Global Benefits from Japan-Peru Research" Japan Science and Technology Agency, March 1, 2016, http://www.jst.go.jp/global/english/case/disaster_prevention_1.html.

36. Fumio Yamazaki, "Standing Up to Earthquakes and Tsunamis: Joining Hands with Peru across the Pacific," Japan Science and Technology Agency, http://www.jst.go.jp/global/english/kadai/h2117_peru.html.

37. Ibid.

38. "What's JIRCAS," JIRCAS, http://www.jircas.affrc.go.jp/english/aboutjircas/whats_jircas.html.

39. "Annual Report 2014," Japan International Research Center for Agricultural Sciences, 2015, 2, https://www.jircas.affrc.go.jp/english/publication/annual/annual_report_index.html.

outputs, including the development of new technologies that can be scaled up in the project country and beyond.[40]

JIRCAS takes a collaborative approach to development, with 108 memorandums of understanding (MOUs) with 71 research institutes in 26 countries. JIRCAS sends its staff regularly to the field to work with these partner institutes: In 2014, "134 JIRCAS researchers or administrators were dispatched abroad for a total of 530 duties."[41]

Institute of Tropical Medicine, Nagasaki University. Founded in 1942, the Institute of Tropical Medicine at Nagasaki University (NEKKEN) conducts studies on endemic diseases in East Asia.[42] It is "Japan's leading research institute for tropical medicine" and its missions are "to conduct high-quality research in tropical medicine and international health, to apply the fruits of the research to make a global contribution to the control of tropical disease and health promotion in the tropics, and to cultivate researchers and specialists in the above fields." NEKKEN conducts exchanges with eight international institutes and has research stations in Vietnam and Kenya.[43]

Notable Innovation Ecosystems

Boston Innovation Ecosystem

Boston is a leading global center of innovation and economic dynamism because of a symbiotic innovation ecosystem that brings talent, money, and ideas in proximity to empower visionary entrepreneurs. According to an Organization for Economic Cooperation and Development (OECD) report released in 2013, Boston ranked sixth among all metropolitan areas globally for both total patent applications and patent intensity.[44] This statistic may underrepresent Boston's importance as a global center of innovation given the concentration of patents in high-value advanced industries, which supported more than 338,000 jobs and $75.1 billion in economic output in the Boston area in 2013.[45]

They key ingredient driving forward innovation and economic progress in Boston is intellectual capital. More than 150,000 students were attending institutions of higher learning in Boston in

---

40. "Research Program," Japan International Research Center for Agricultural Sciences, https://www.jircas.affrc.go.jp/english/program/program_index.html.

41. "Annual Report 2014," Japan International Research Center for Agricultural Sciences, 18.

42. "Historical Review," Institute of Tropical Medicine Nagasaki University, http://www.tm.nagasaki-u.ac.jp/nekken/english/outline/history.html.

43. "Institute of Tropical Medicine (NEKKEN), Nagasaki University," Africa London Nagasaki Scholarship Fund, http://www.alnscholarshipfund.org/scholarships/scholarship-fund-partners/institute-tropical-medicine-nekken-nagasaki-university.

44. "OECD Regions at a Glance 2013," Organisation for Economic Co-operation and Development (OECD), 2013, http://www.oecd-ilibrary.org/docserver/download/0413091e.pdf?expires=1457724007&id=id&accname=guest&checksum=287B2530CC91486876C1D178E6D89514.

45. "America's Advanced Industries: What They Are, Where They Are, and Why They Matter," Brookings Institution, February 3, 2015, http://www.brookings.edu/research/reports2/2015/02/03-advanced-industries.

2010,[46] including at top global research universities including Harvard University and MIT. Boston-area universities graduate over 10,000 students a year with degrees in science, technology, engineering, and math (STEM) fields, which provides a near-constant flow of new ideas entering the market.[47] Boston also has one of the most educated workforces in the country: 55.4 percent of people who work in Boston have at least a bachelor's degree and 24.5 percent have a master's degree or higher.[48]

Boston's high concentration of human capital attracts significant R&D investment from public institutions and private corporations. In 2010, Massachusetts ranked second among all U.S. states in total R&D investment and R&D intensity as a percent of GDP.[49] Boston drives this high state ranking, and in 2014 Boston received the most National Institutes of Health (NIH) funding of any city in the United States for the 20th consecutive year.[50] Private companies operating in the Boston area invest significant capital into R&D activities each year; the *Boston Business Journal* estimated that 18 of the top biotech firms in Boston invested nearly $6 billion into R&D during fiscal year 2015.[51]

Venture capital is also readily available in the Boston area for entrepreneurs and start-ups seeking finance to fuel growth and expansion. Boston ranked second globally in terms of total global venture investment with $3.1 billion in 2012, trailing only the San Francisco Bay Area.[52] On a per capita basis the Boston area also ranks second globally with $665 in venture capital investment per capita.[53] If a talented Boston entrepreneur with a compelling idea is seeking funding to scale his or her business, there is arguably nowhere better to be located.

This innovation ecosystem is the result of a collaborative intersection of world-class research universities, R&D funding, private industry, and enabling government policy. Additionally, Boston plays host to a community of start-up accelerators and incubators that support entrepreneurs as they move from idea to company formation, including through access to venture capital, practical business expertise, and like-minded entrepreneurs. This collaborative ecosystem empowers entrepreneurs to take calculated risks and has led to breakthrough thinking, the development of

---

46. "Boston By the Numbers, Colleges and Universities," Boston Redevelopment Authority, 2010, http://www.bostonredevelopmentauthority.org/getattachment/3488e768-1dd4-4446-a557-3892bb0445c6/.

47. "High Tech Industries in Boston," Boston Redevelopment Authority, 2015, http://www.bostonredevelopmentauthority.org/getattachment/6df4a8af-b842-42db-aea1-da6066257588.

48. Ibid.

49. "S&E Indicators 2014—Chapter 4. Research and Development: National Trends and International Comparisons," U.S. National Science Foundation, February 2014, http://www.nsf.gov/statistics/seind14/index.cfm/chapter-4/c4s.htm#sb3.

50. "High Tech Industries in Boston," Boston Redevelopment Authority.

51. "Here's How Much the Biggest Biotech Firms in Massachusetts Are Spending on R&D," *Boston Business Journal*, October 2015, http://www.bizjournals.com/boston/blog/bioflash/2015/10/heres-how-much-the-biggest-biotechs-in.html#g1.

52. "Rise of the Global Startup City: The Geography of Venture Capital Investment in Cities and Metros across the Globe," Martin Prosperity Institute, January 2016, http://martinprosperity.org/media/Rise-of-the-Global-Startup-City.pdf.

53. Ibid.

new technologies, and the emergence of dynamic economic sectors. Please see Appendix A for a discussion of specific actors within Boston's innovation ecosystem.

Approaches to Entrepreneurship within Innovation Ecosystems. As demonstrated by approaches in Boston, entrepreneurship and international development stakeholders fall into at least two groups of thought in terms of how they think it is best to approach innovation-enabling platforms as vehicles for job creation:

- One group holds that innovations with high-yield economic growth potential, and supporting the entrepreneurs who create them, should be prioritized. These entrepreneurs typically have received high-quality education in their home country or abroad. These entrepreneurs can be supported by building attractive, fee-based facilities in desirable areas. These facilities concentrate exceptional entrepreneurs, place them in proximity with those that can help scale up their ideas, and provide them with high-quality support services. The theory of change is that these entrepreneurs then have the most potential to create innovative products and companies that benefit the country's economic growth and create large numbers of jobs. These outputs ultimately reach the lower income groups.
- Another group believes that such approaches do not really trickle down to lower income groups. Instead, members of lower income groups should be empowered to become entrepreneurs themselves, creating clear benefit for their families and potentially their local communities. Innovation-enabling platforms such as start-up incubators can train these people to gain the skills necessary for entrepreneurship and also work to change the culture in a developing country.

Tsukuba Science City

Tsukuba is Japan's largest base for science and technology, with 32 national research and educational institutions, over 300 private research institutes and companies,[54] and more than 20,000 research staff.[55] This city 50 kilometers northeast of Tokyo was designed in 1963 as a way to reduce congestion in the capital, but has since become an international hub for innovation, with nine industrial parks and a total of 231 venture businesses as of 2012.[56]

Located close to Tokyo, with the added advantage of Ibaraki Prefecture tax exemptions,[57] Tsukuba has become a hot spot for businesses seeking a home for their R&D activity. In 2011, the city was designated a Special International Strategic Zone, allowing for relaxed regulations and special tax provisions to promote collaboration among businesses, academia, and the Japanese government. As a result, Tsukuba was able to leverage existing resources to focus on four innovation areas:

54. "Outline of Tsukuba City," Tsukuba City Science Network, http://www.tsukuba-network.jp/english/outline.html.

55. "Messages from the President," Tsukuba Science City Network, 2016, http://www.tsukuba-network.jp/english/message.html.

56. Ibid., 6.

57. Ibid., 4.

next-generation cancer treatments, lifestyle-support robots, algae energy alternatives, and the development of an international nanotech base.[58]

One of the key focus areas in the development of Tsukuba is the promotion of collaborative exchange among researchers, students, businesses, and the broader community. In 1999, the Tsukuba International Congress Center was constructed to promote research exchange, and has since hosted 32 international conferences and welcomed more than 3 million attendees.[59] The Tsukuba Express connects the Science City with Tokyo via a 45-minute ride on trains that run up to 20 times per hour,[60] providing added convenience for those making the commute. Tsukuba also regularly offers tours for the general public, running a Science Tour Bus that links major research institutions and provides detailed explanations of significant projects being developed in these facilities.

Meanwhile, Tsukuba has developed its own ecosystem to support its business and innovation activity, with a robust residential community integrated into the surrounding area. The suburban area provides a generous selection of public and private schooling options, advanced health care facilities, numerous shopping centers, and cultural centers for recreational activity.[61]

With the 2016 G7 Summit being held in Japan, Tsukuba was a natural choice as the venue for the Science and Technology Ministers' Meeting in May.[62] A growing number of research institutes have relocated to industrial parks in Tsukuba since its opening, and the city is now home to over 30 percent of Japan's public and private research institutes,[63] making it the heart of innovation in a country already leading the world in science research.

Keio Shonan-Fujisawa Campus (SFC)

Tokyo's Keio University established its Shonan-Fujisawa Campus (SFC) in 1990 with a focus on research and innovation, and a participatory approach to education.[64] The university challenges students to "think and act daringly" and "put their learning into practice" by transforming "social reality."[65] Students have access to high technology and are encouraged to collaborate with researchers within and outside of the university. Each year the university hosts an "Open Research Forum" to release the results of its research to representatives from business, the public sector, and academia.

---

58. "Tsukuba International Strategic Zone," Ibaraki Prefectural Government, 2013, http://www.tsukuba-sogotokku.jp/wp/wp-content/uploads/2013/05/TISZ_all-en.pdf.

59. Ibid., 9.

60. "About TX," Tsukuba Express, http://www.mir.co.jp/en/about_tx/.

61. "Tsukuba Science City," Ibaraki Prefecture Government, 7–8.

62. "G7 2016 Summit & Ministerial Meetings," Government of Japan, http://www.japan.go.jp/g7/summit/meetings/.

63. "Outline of Tsukuba City," Tsukuba City Science Network.

64. "Keio University Annual Report on Research Activities 2006–2007," Keio University, 2007, http://www.rcp.keio.ac.jp/planning/doc/Annual_Report_E2007.pdf.

65. "Message to Students: In Favor of the Extreme," Keio University Shonan Fujisawa Campus, http://www.sfc.keio.ac.jp/en/about_sfc/message.html.

The Keio Research Institute at SFC is a key actor in carrying out the campus's mission. It is commonly recognized as one of Japan's top innovation incubators, and has the goal of "conducting advanced research and using the results for the benefit of society."[66] The institute promotes and provides funding for joint research conducted by the university, Japanese organizations, and international organizations; it also enables collaboration among faculty and students from varied disciplines. In 2013, the Institute funded 831 million yen for 217 research contracts within its Contract/Joint Research and SFC Research Consortium mechanisms.[67] In 2014, research ranged from projects such as "Study of Auto-Driving" to "A Study on Dependability Management Scheme for Cloud Systems."[68] The institute is also playing a crucial role in the development of a Fab Labs network in Japan and beyond; Dr. Hiroya Tanaka, a professor at Keio University, founded the first Fab Labs in Japan in 2011 (please see "Development and Expansion of Fab Labs" below).

FABRICATION LABORATORIES

Concept of Fabrication Laboratories

"Fabrication Laboratories" or "Fab Labs" are "technical prototyping platform(s) for innovation and invention, providing stimulus for local entrepreneurship."[69] A user can enter a Fab Lab and exit having made almost anything. The Fab Foundation, a U.S. nonprofit that originated from MIT's Center for Bits and Atoms Fab Lab Program, serves as the international convener of Fab Labs, linking them in a network and providing guidance about what constitutes a Fab Lab. Fab Labs must (1) be open for public use, (2) include a specific set of machines, including "a laser cutter that makes 2D and 3D structures, a sign cutter that plots in copper to make antennas and flex circuits, a high-resolution NC milling machine that makes circuit boards and precision parts, a large wood router for building furniture and housing, and a suite of electronic components and programming tools for low-cost, high-speed microcontrollers for on-site rapid circuit prototyping,"[70] and (3) have the ability to connect with the global network of Fab Labs via communications hardware and software.

Development and Expansion of Fabrication Laboratories

Professor Neil A. Gershenfeld, director of the Center for Bits and Atoms at MIT, is the father of Fab Labs. In 1998 Gershenfeld predicted that people would be able to use machines as personal fabricators, and that this would be the next big trend after the last revolution of reducing the size of computers for personal use. He started a course at MIT titled "How to Make (Almost) Anything." The course received great attention from students because it departed from traditional supply-driven teaching lectures and instead functioned as a needs-driven personal fabrication course.

66. "Overview," Keio Research Institute at SFC, https://www.kri.sfc.keio.ac.jp/en/about/overview.html.
67. "Statistics," Keio Research Institute at SFC, https://www.kri.sfc.keio.ac.jp/en/about/statistics.html.
68. "Contract/Joint Research," Keio Research Institute at SFC, https://www.kri.sfc.keio.ac.jp/en/activity/research.html.
69. "What is a Fab Lab," Fab Foundation, http://www.fabfoundation.org/fab-labs/what-is-a-fab-lab/.
70. Ibid.

Students were excited to create their own fabrications and apply them as solutions to issues around them.

With assistance from the U.S. National Science Foundation (NSF), a Fab Lab project was developed in 2002 for those who were not able to visit MIT, setting up venues around the world to promote personal fabrication. The first Fab Labs were established in the United States, India, Costa Rica, Norway, and Ghana, with the cost of setting up each Fab Lab approximately $50,000. Since then, the network of Fab Labs has been expanding; there were 603 Fab Labs in 89 countries as of January 2016.

As of 2010, there were no Fab Labs in the East Asia region. Dr. Hiroya Tanaka, an associate professor at Keio University, was inspired by Gershenfeld's Fab Lab project and decided to initiate the Fab Lab-Japan Association to promote the establishment of Fab Labs in that country. In May 2011, Japan's first Fab Labs were opened in Kamakura and Tsukuba.[71]

Because the development of Fab Labs is still in its early stages, many Fab Labs are still primarily dependent on financial support from either public funding or private donations. Fab Labs can serve as a public good, with return on investment for funders experienced in the form of beneficiaries' integration into the innovation ecosystem and positive spillover effects for local communities. However, some Fab Labs provide technical guidance and training to users for a fee, generating income. Key researchers in the Fab Lab movement have suggested four stages for Fab Labs' development. This is demonstrated in Figure 2.1.

Fab Labs in Kamakura, Japan,[72] and Utrecht, Netherlands,[73] represent the most advanced existing model. These provide technical training, 3-D technologies business consulting, and related planning and research for paying clients. While their fabrication spaces are open to the public with minimum qualifying conditions, they are generating revenue by increasing demand from both the public and private sectors. Therefore, these sites can be categorized as Service Bureaus, as demonstrated in Figure 2.1.

Fab Labs in Soshanguve, South Africa (just outside of Pretoria), and at the University of Nairobi Science and Technology Park in Kenya would be categorized as Training Providers in Figure 2.1, and receive primary financial support from government funds.[74] However, they have initiated technical service provision to outside users, similar to the practice of the Fab Labs in Kamakura and Utrecht. In this context, there may be a development path for Fab Labs to secure financial sustainability beyond government and donor funds.

It is important to note that the financial sustainability of Fab Labs in developing countries is not as crucial as in developed countries, where commercial success is essential. The primary benefit of

---

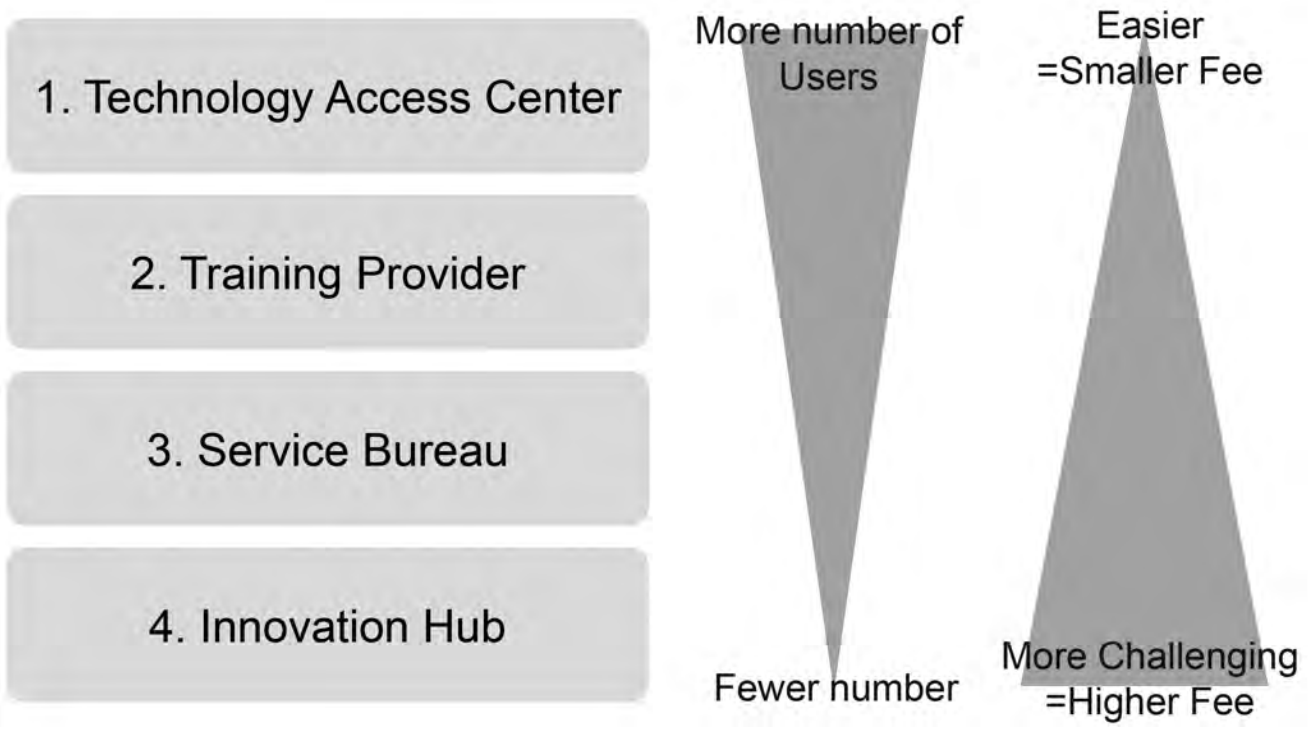
71. Yuka Watanabe, "Innovative Manufacturing by Fab Labs," Mitsubishi UFJ Research and Consulting, August 2013, http://www.murc.jp/thinktank/rc/quarterly/quarterly_detail/201303_47.pdf.

72. Interview with Yuka Watanabe, director, Fab Lab Kamakura, by Tomoyuki Naito, April 9, 2016; and Watanabe, "Innovative Manufacturing by Fab Labs."

73. "The Community Function," Fab Foundation, http://www.fabfoundation.org/fab-labs/setting-up-a-fab-lab/the-community-functio/.

74. Ibid.

Figure 2.1. Four revenue models of Fab Labs



Source: Tomoaki Watanabe and Yutaka Tokushima, "Business Model Typology for Fab Labs: Examining the sustainability question with Asian Labs" (presentation at 2nd International Conference on Digital Fabrication in Tokyo, Japan, March 3–5, 2016).

Fab Labs in developing countries is that they provide opportunities to empower the people to create their own products. One example of this is in the creation of spare parts. It is well known that a large number of donor-funded machines and facilities in developing countries are not functional due to a lack of spare parts. Fab Labs can serve as a catalyst to create spare parts for these machines and facilities at an affordable cost. Fab Labs provide an advantage in lowering the cost of production for necessary parts by using digital design data openly shared through the Internet. Thus, Fab Labs have a unique opportunity to provide solutions to previously unsolved problems in developing countries.

Fabrication Laboratories in the International Development Context

Fab Labs are an important vehicle to enhancing and strengthening innovation ecosystems in developing contexts. They can enable "contextualized innovation,"[75] or a custom approach to local challenges that reflects the ideas, designs, and needs of their makers. They have been recognized in the international development community as a transformative tool for developing local industry, boosting entrepreneurship, and increasing interest in STEM education.[76] While Fab Labs cannot solve every problem in low-income areas, evidence shows that in contributing to

75. Term coined by Yutaka Tokushima.

76. "Communities of 'Makers' Tackle Local Problems," World Bank.

building innovation ecosystems, Fab Labs can lead to transformative innovation for societies. In regions where there may not be established local innovation ecosystems, Fab Labs allow individuals to connect with the broader global innovation community while providing positive spillover effects in the area where the lab is located, including through building community engagement around the innovation ecosystem, increasing the capacity of local firms and individuals to actively innovate, and building a skill base in the local population to drive forward innovative activity.

There have been many promising ways in which Fab Labs have helped local society address development challenges, as exemplified by Fab Lab Bohol, which is creating upcycled fabrication materials from plastic waste to address the difficulty of recycling in Bohol, as well as stimulating income generation for the local economy (please see Case Study: Localization of a Fab Lab in Bohol, Philippines, on page 23). The World Bank has partnered with institutions globally to promote the growth of digital fabrication and served as a sponsor for the 10th International Fab Lab Conference and Annual Meeting in Barcelona in 2014. In collaboration with USAID and Intel, the World Bank hosted a competition for digital fabrication innovations as part of this conference.[77] Showcased projects included a variety of low-cost but transformative solutions created in digital fabrication spaces, ranging from an origami-inspired disposable optical microscope to identify malaria to a self-contained sensing unit to attach to vehicles for crowd-sourced air quality data.[78] The winning team, from Togo, converted broken computer parts into a 3-D printer and open-source sensor to track water flow.[79]

The World Bank's World Development Report 2016 recognizes the increasing role maker spaces such as Fab Labs have in international development as part of its "six digital technologies to watch." These "spaces have democratized access to tools and empowered participants to build and learn on their own."[80] Other international development stakeholders recognize Fab Labs' potential for promoting sustainable economic, social, and environmental development in their host cities. They have the capability to return material production to cities and neighborhoods and enable collaboration among citizens, businesses, universities, and governments.[81]

Specific Recent International Development Efforts that Have Involved Fabrication Laboratories Include:

The World Bank National Ecosystem Project in Georgia

The World Bank proposed the Georgia National Innovation Ecosystem Project (GENIE) in 2016, a $40 million loan to complement the ongoing activities that the World Bank has undertaken to

77. Ibid.

78. "Makers for Development: Showcasing the Potential of Makers," U.S. Agency for International Development, 2014, https://www.usaid.gov/sites/default/files/documents/15396/Makers4Development.pdf.

79. "Communities of 'Makers' Tackle Local Problems," World Bank.

80. "World Development Report 2016: Digital Dividends," World Bank, 2016, 328, http://www.worldbank.org/en/publication/wdr2016.

81. Michel Wilwert, "Fab Labs: Potential for Sustainable Urban Development," URBACT Blog, European Union, February 24, 2015, http://www.blog.urbact.eu/2015/02/fab-labs-potential-for-sustainable-urban-development/.

improve competitiveness, innovation, and ICT capabilities in Georgia.[82] GENIE is expected to benefit innovators, investors, entrepreneurs, and innovative micro, small, and medium enterprises (MSMEs), as the weak performance of those groups is identified as the root of Georgia's productivity challenges.[83] The project aims to develop an innovation-acceleration framework, providing infrastructure, services, and financial support for beneficiaries.[84]

GENIE identifies Fab Labs as a key infrastructure component of its plan, and aims to create three regional innovation hubs with Fab Labs in its pilot phase, consisting of computer workstations, training facilities, and standard Fab Lab prototyping equipment.[85] These regional innovation hubs are expected to leverage the specialization of their respective regions, promoting activity and exchange between firms and individuals. The project identifies Fab Labs as critical in new innovation systems through a multiplier effect, as they are able to contribute to the public good to generate STEM skills for knowledge sharing, job creation, applied R&D, and advanced manufacturing.[86]

The World Bank's Innovation Infrastructure Flagship Projects in Bulgaria

Fab Labs are identified as one of the two main instruments that can best generate innovation in Bulgaria, thanks to their ability to respond to economic drivers in sectors with great potential for growth. A World Bank feasibility study conducted on the innovation infrastructure in Bulgaria[87] highlights the importance of creating advanced-level Fab Labs that focus on product development, including assistance for clients who are seeking business opportunities and funding.[88] The development of Fab Labs in sectors such as pharmaceuticals, food processing, machine building and electronics, ICT, and cultural and creative industries is important in Bulgaria due to their catalytic ability in generating spillover innovation for other sectors.[89] Similarly, the real value of Fab Labs is identified as their ability to spur STEM-focused and entrepreneurial skills to create jobs in commercial R&D, engineering, and manufacturing sectors, as well as promote collaboration that serves other educational, creative, and social purposes.[90] The World Bank encourages the use of Fab Labs to provide Bulgaria with an opportunity to move from manufacturing to more value-added industries that involve greater skills and technology.[91]

---

82. "International Bank for Reconstruction and Development Project Appraisal Document on a Proposed Loan in the Amount of US$40 Million to Georgia for a National Innovation Ecosystem (GENIE) Project," World Bank, February 19, 2016, http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2016/03/03/090224b0841cd488/1_0/Rendered/PDF/Georgia000Nati0stem00GENIE00Project.pdf.

83. Ibid., 3.

84. Ibid., 9.

85. Ibid., 11.

86. Ibid., 83.

87. "Innovation Infrastructure Flagship Projects: Pre-feasibility Study," World Bank, December 2013, http://www.mi.government.bg/files/useruploads/files/innovations/reportinnovationflagships.pdf.

88. Ibid., 11.

89. Ibid., 10.

90. Ibid., 20.

91. Ibid., 35.

JICA- and SolidWorks-supported Fab Lab in Rwanda

After Rwandan president Paul Kagame's visits to the United States, SolidWorks Corporation, a major 3-D software vendor, decided to provide fundamental equipment support to set up Rwanda's first Fab Lab. This project will be financed with a combination of grants and loans through the Fab Foundation.

JICA has been supporting the technical and vocational education and training (TVET) program at the Tumba College of Technology (TCT) since 2007. In the beginning stages of planning, TCT was considered an ideal venue in which to set up a Fab Lab because it could leverage the existing cooperation between TVET and JICA. However, because TCT is located a few hours outside Kigali, the Fab Lab project was transferred to a Telecom House building where the ICT Chamber of Private Sector Federation and JICA–supported Knowledge Lab (K-Lab) are located, in hopes of establishing an innovation ecosystem among the three. This Fab Lab will aim to contribute to Rwanda's ICT sector, the development of which is one of the country's priorities.

During the planning stages, the relevant parties visited Fab Labs in Kenya, Ghana, and Japan in order to better understand how Fab Labs function and contribute to their communities. As of April 2016, JICA is supporting the construction work for the Fab Lab in Telecom House. SolidWorks Corporation provides the equipment and associated cost through a combination of grants and loans through the Fab Foundation. The JICA- and SolidWorks-supported Fab Lab in Rwanda is scheduled for official launch in May 2016.

CASE STUDY: LOCALIZATION OF A FABRICATION LAB IN BOHOL, PHILIPPINES

Discussion of the Existing Innovation Ecosystem in the Philippines

While still a lower-middle-income country with 25.2 percent of its population under the national poverty line as of 2012,[92] the Philippines is making strides economically. A newly industrialized economy, the country is poised to see its GDP grow by 6.3 percent in 2016.[93] Robust innovation ecosystems—environments that encourage the innovation and application of new ideas that respond to "what is needed by a society, market or individual"[94]—will be a key driver of sustained economic growth.

Stakeholders typically agree that there are pockets of innovation in the Philippines, but the overall innovation ecosystem is still weak. Manila and a few other major cities have some form of an innovation culture, including start-up accelerators and entrepreneurs focused on the creation of smartphone applications and 3-D printing centers. However, rural areas are missing some or all inputs to innovation.

---

92. "Data: Philippines: World Development Indicators," World Bank, http://data.worldbank.org/country/philippines#cp_wdi.

93. "Philippines: Economy," Asian Development Bank, http://www.adb.org/countries/philippines/economy.

94. "National Innovation Initiative Summit and Report," Council on Competitiveness, 46.

Box 2.1. Main Takeaways

- While still a lower-middle-income country, the Philippines is making strides economically. Robust innovation ecosystems will be key drivers of sustained economic growth. Manila and a few other major cities have some form of an innovation culture, including start-up accelerators and entrepreneurs focused on the creation of smart-phone applications and 3-D printing centers.
- The overall innovation ecosystem in the Philippines is still weak. Rural areas in particular are missing some or all inputs to innovation. Innovation-enabling platforms operate on a small scale and reach a limited audience. Challenges to innovation include an overall low base of technology and technical knowledge, lacking downstream opportunities for product production, lack of access to technology and collaborative spaces, bureaucratic university procurement policies, and uncoordinated government leadership.
- Innovation that achieves poverty reduction and social impact should involve an approach that focuses on collaboration, not Intellectual Property (IP) or patents, and emphasizes a focus on application**s** for society. Research should be led by industry and driven by need.
- Fab Lab Bohol opened in May 2014 at Bohol Island State University (BISU) and is a specific example of the potential of Fabrication Labs to catalyze innovation ecosystems in developing contexts. It is a public space that offers tools and processes common of Fabrication Laboratories and connects local users with global innovation ecosystems. Fab Lab Bohol receives its primary ongoing funding support from BISU and is also supported by JICA, the Philippines Department of Trade and Industry (DTI), and the Philippines Department of Science and Technology (DOST). It has encountered the following successes and challenges in achieving its mission:
    - Fab Lab Bohol is strengthening some of the crucial elements of the innovation ecosystem in Bohol. It has achieved success in being a well-regarded innovation platform in which users can create and collaborate, enabled by technological infrastructure that supports open innovation. Fab Lab Bohol has made positive steps to engage the local community as innovators and connect them with a global community. The Fab Lab is increasing the capacity of local firms and individuals to actively innovate and building a skill base in the local population to drive forward innovative activity. The Fab Lab has several examples of local entrepreneurs and small and medium-sized enterprises (SMEs) who generated new ideas via the Fab Lab, used it to create prototypes, or added value to existing products. It has also extended income-generating opportunities to local women. These examples demonstrate the potential of the Fab Lab to add value to the local entrepreneurship ecosystem and promote self-employment through entrepreneurship. Fab Lab Bohol has also positively impacted the community through projects that promote environmental sustainability and by enabling local people to develop low-cost solutions to local challenges.
    - Local stakeholders of Fab Lab Bohol assert that not enough has been done to market the facility to local SMEs. There are questions regarding whether the Fab Lab reaches

Box 2.1. (Continued)

beyond a limited set of users with its current operations, and uncertainty regarding its financial sustainability. There are disadvantages to hosting the Fab Lab within BISU, including challenges to accessibility for community users and administrative hang-ups.

- Following the positive outcomes of Fab Lab Bohol, the government of Philippines has decided to set up 10 Fab Labs nationwide in 2016. Moreover, some universities are seeking to establish their own Fab Labs. There is local demand in Bohol for a second Fab Lab to be built. It has thus become a national movement with the government's support.

Gaps and Challenges to a Robust Innovation Ecosystem Include Those in the Following Areas:

Base of technical knowledge: The overall base of technology and technical knowledge in the Philippines is low, and this presents challenges to innovation. The Philippines has only 80 scientists and engineers per 1 million of the population. In comparison, the United States had 4,663 as of 2007.[95] Additionally, while the Philippines generally embraces technology, it lags behind in adopting newer technologies. Most Filipinos are not aware of 3-D printing at all, or how it works. Only 3 percent of Filipinos use credit cards, and there are few people available to provide training in new technologies. Building capacity through education and training should be a priority among efforts to strengthen an innovation ecosystem. The current education system does not support acquiring knowledge of modern technologies, and stakeholders see a disconnect between the intellectual capability in the Philippines and its impact. The Philippine Information Technology General Certification Exam,[96] which is recognized by the EU, Japan, and Filipino companies in Cebu, saw a 24 percent passage rate by university students nationwide in 2015; Bohol Island State University (BISU) only had a 9 percent passage rate.[97] Software and computers are outdated in schools. Educators need to be retained, as talented teachers are often attracted to work abroad. Additionally, many teachers feel as if they are behind in technical competency as compared to their millennial students.

Access to technology and collaborative spaces/broad reach: The Philippines provides poor Internet connectivity to individuals; only large businesses are able to afford good connectivity. Additionally, there is limited access to facilities such as coworking spaces. The maker space needs community facilities that offer access to good Internet and provide opportunities for collaboration and mentoring. Stakeholders think the lower income groups in the Philippines are far from using

95. *UNESCO Science Report 2010*, United Nations Educational, Scientific and Cultural Organisation (UNESCO), 2010, 328, http://unesdoc.unesco.org/images/0018/001899/189958e.pdf.

96. "Philippine Information Technology General Certification Examination," Cebu Educational Development Foundation for Information Technology, http://cedfit.org/philitgce.php#2015.

97. Meeting with Bohol Information and Communication Technology Council, December 9, 2015.

3-D printing labs or Fabrication Laboratories for their own designs. The future of these technologies depends on accessibility, and the government has unique reach and should foster this accessibility as a public good. However, resource and knowledge gaps within the government make this difficult. Additionally, because the Philippines covers a large landmass with many islands, economic progress in Manila does not necessarily reach the rural poor.

Government leadership: There are pockets of good practice and expertise in the Filipino government, but this is not enough and it is not cohesive. There is lack of a national direction; a national innovation strategy termed "Filipinnovation" announced in 2007[98] was not really executed. A unified national strategy is important, as now government officers are involved in interdepartmental rivalries. The Philippines has funding for research, but there is not enough effort made to spend this in line with national priorities.

Financial sustainability of platforms: Many innovation-enabling platforms are created without a clear business model or plan for financial sustainability. Some platforms depend entirely on donor funds and do not charge adequate fees for services rendered. This can be especially of concern when platforms are supported by strong champions in government or academia. When champions leave office or donor funding ends, these platforms often must end their work. Thus, platforms should consider ways to ensure their financial sustainability that recognize the local context and users' ability to pay.

Scaling up: There are high risks in trying to reach scale. That is typical of most innovations. Scaling up is often difficult because it requires transformational change. Business models to implement scaled solutions cannot be taken off the shelf or easily replicated from one context to another (also known as external validity). Business models should be designed and contextualized with the goal that scale lasts many years.[99]

Please see Appendix B for examples of notable approaches to building an innovation ecosystem in the Philippines, including those that demonstrate the importance of ecosystem mapping and research that is led by industry and driven by need. One important opportunity for building an innovation ecosystem in the Philippines is localizing Fab Labs there. This report presents the example of Fab Lab Bohol and discusses its contributions to building an innovation ecosystem in Bohol, Philippines, and its potential for achieving transformative innovation there in the long term. Successes and challenges identified from the Fab Lab Bohol case and other global Fab Labs can be used to inform the planned development of 10 additional Fab Labs in the Philippines in 2016.

Fab Lab Bohol

Background and Key Operating Details

In 2012, Yutaka Tokushima was dispatched to Bohol, Philippines, as a Japan Overseas Cooperation Volunteer (JOCV). His responsibility was to promote Bohol's local industry by using the industrial

98. Adoracion M. Navarro, "National Innovation System in the Philippines," Philippine Institute for Development Studies, http://apctt.org/pdf/Philippines-Dr-Navarro.pdf.

99. Laurence Chandy, Akio Hosono, Homi Kharas, and Johannes Linn, eds., *Getting to Scale: How to Bring Development Solutions to Millions of People* (Washington, DC: Brookings, 2013), 5.

design experience he gained in Japan. Before he went to Bohol, he read Gershenfeld's book *Fab: The Coming Revolution on Your Desktop—from Personal Computers to Personal Fabrication*,[100] which inspired him to adopt Fab Labs for development policy. As Bohol is a small and rural island, Tokushima found it difficult to promote industry there due to the lack of human resources and infrastructure. In order to tackle this problem, Tokushima proposed setting up a Fab Lab at BISU.[101] The local government was inspired by Tokushima's nontraditional approach and helped him launch Fab Lab Bohol in May 2014 with funding support from the JICA Philippines Office. Fab Lab Bohol started to create locally made products, and these were sold into the domestic economy.

Philippines president Benigno Aquino visited Fab Lab Bohol in 2014 during the Fab Lab Asia Network's first international conference, and noted the huge potential for Fab Labs in promoting local industry. Immediately after his visit, President Aquino ordered to the Philippines government to create a Fab Lab expansion program, which resulted in 10 Fab Labs scheduled for launch in 2016. Some Filipino universities are also seeking to establish their own Fab Labs, and there is demand in Bohol for a second Fab Lab to be built to meet local demand. It has thus become a national movement with the government's support.

Fab Lab Bohol is a specific example of the potential of Fabrication Labs to catalyze innovation ecosystems in developing contexts. It is the first Fabrication Laboratory in the Philippines, created with a primary focus on improving the productivity and competitiveness of MSMEs in Bohol, and ultimately improving the local economy.[102] Its mission is to be a space to "create and collaborate," "learn and prototype," and "promote entrepreneurship." In a 2015 case study and auto-ethnography of Fab Lab Bohol, Tokushima asserts that it has led to the "formation of an innovation cluster and the emergence of a creative class" and stimulated innovation-led economic development in Bohol.[103] The Department of Trade and Industry (DTI) of the Philippines also facilitated a data-collection survey of Fab Lab Bohol, which was carried out by JICA and the Nomura Research Institute in Singapore and released in February 2016.

Fab Lab Bohol is staffed by four full-time staff and one JOCV volunteer. DTI Bohol employees also routinely support the work of the Fab Lab. Fab Lab Bohol is open for use on weekdays by the local public, including BISU students, local SMEs, and other users. The Fab Lab hosts free regular workshops and courses on how to use the Fab Lab, and in 2015 hosted an innovation competition in collaboration with start-up incubator Ideaspace. Users pay a modest fee for operation of their selected machine(s) and are provided with materials free of charge. Students receive a 30 percent discount on costs. The Fab Lab estimates that 10 percent of their users use the lab to make prototypes. The Fab Lab does accept some mass-production clients, including local resorts making

100. Neil Gershenfeld, *Fab: The Coming Revolution on Your Desktop—from Personal Computers to Personal Fabrication* (New York: Basic Books, 2007).

101. Yutaka Tokushima, "Economic Development Using and Enabling Environment for Contextualized Innovation: The Case of the 'Poverty Reduction Project by Building-up the Innovation Environment Using Fab Lab,' Bohol Province, The Philippines," JICA Research Institute, July 2015, https://jica-ri.jica.go.jp/publication/assets/Tokushima_paper_EN.pdf.

102. "Data Collection Survey on Fabrication Laboratory (FabLab) Utilization in Priority Areas Final Report," Department of Trade and Industry (DTI), Republic of the Philippines, Japan International Cooperation Agency, Nomura Research Institute Singapore Pte. Ltd. Branch, February 2016, 5.

103. Tokushima, "Economic Development Using an Enabling Environment for Contextualized Innovation."

Box 2.2. Bohol, Philippines

Bohol is an island province in the central Visayas region of the Philippines. As of the 2010 census, the population was approximately 1.3 million. Largely rural, Bohol has one city—the capital of Tagbilaran, where Fab Lab Bohol is located.[1] Bohol's economy is based on agricultural production, with main crops consisting of fish and palay (pre-husked rice).[2] The province depends heavily on its tourism industry, with more than a third of economic activity in this industry generated by foreign tourists.[3] Bohol offers numerous beaches and resorts. Its most visited tourist destination is the Chocolate Hills, limestone rock formations covered in grass. Many tourists also visit Bohol to scuba dive.

The latest Philippines Human Development Report released in 2009 shows Bohol having a Human Development Index (HDI) of 0.482, compared to an average HDI of 0.609 across the Philippines.[4] In 2012, the Philippines National Statistical Coordination Board released data showing a poverty rate of 30.6 percent in Bohol,[5] slightly above the average of 27.9 percent in the country that year.[6] This meant that a total of 83,455 poor families lived under the annual poverty threshold.[7] Bohol improved a tier in its standing of poorest provinces from Cluster 1 (the bottom or poorest group of provinces in the Philippines) in 2006 to Cluster 2 in 2012.[8]

1. "Bohol Quickstat—January 2015," Philippine Statistics Authority, January 2015, https://psa.gov.ph/content/bohol-quickstat-january-2015.
2. "Province: Bohol Statistical Profile, 2012," Philippine Statistics Authority, http://nap.psa.gov.ph/countryside/showperregion.asp.
3. "Annual Report 2014," Bohol Provincial Government, 2014, 29, http://www.ppdobohol.lgu.ph/plan-reports/annual-reports/annual-report-2014/.
4. "Human Development Index: 1997, 2000, 2003, 2006 and 2009," Philippine Statistics Authority, http://www.census.gov.ph/sites/default/files/table1_1997_2009HDI_0.pdf.
5. "Province: Bohol Statistical Profile, 2012," Philippine Statistics Authority.
6. "Poverty Incidence," Government of the Philippines, http://www.gov.ph/report/poverty-incidence/.
7. "Annual Report 2014," Bohol Provincial Government, 2014, 31, http://www.ppdobohol.lgu.ph/plan-reports/annual-reports/annual-report-2014/.
8. "Annual Report 2014," Bohol Provincial Government.

products for their customers and other small crafts firms, but this is limited and takes a lower priority than other uses.

The budget of the Fab Lab was $700,000 in 2015, and in 2016 this will increase to $1.7 million. JICA sponsored two of the Fab Lab's original machines and funds the stipend of one JOCV participant to provide technical assistance. BISU pays for ongoing maintenance and other costs, including labor costs, associated with the Fab Lab. DTI pays the Fab Lab when local SMEs use the services and also funds occasional workshops for the public.

Successes in Achieving its Mission

Space to create and collaborate: Fab Lab Bohol is strengthening some of the crucial elements of the innovation ecosystem in Bohol. The Fab Lab has achieved success in terms of being a space for students and others to create and collaborate, enabled by technological infrastructure that supports open innovation. Fab Lab Bohol has also made positive steps to engage the local

Figure 2.2. Fab Lab Bohol at Bohol Island State University

Photo by Helen Moser.

community as innovators and connect them with a global community. Various trainings have reached diverse participants, including women, the elderly, and people from outside of Bohol. Eight hundred users had attended workshops and trainings in the Fab Lab in 2015 as of December of that year. Users are excited by the Fab Lab; they view it as offering technology that is not offered elsewhere in Bohol, and report that it is a space that encourages them to work together and think of new ideas and affordable solutions to community problems. In this way, it functions as an important innovation-enabling platform, with the potential to foster transformative innovation in Bohol.

Benefits for local entrepreneurs: The Fab Lab is increasing the capacity of local firms and individuals to actively innovate and building a skill base in the local population to drive forward innovative activity. Fab Lab Bohol has several examples of local entrepreneurs who generated new ideas via the Fab Lab, used it to create prototypes, or added value to existing products. A "Made in Bohol" brand was created in collaboration with an Australian volunteer as a distribution channel for SMEs and local artisans to access the tourism market. The Fab Lab was used to design and build three

Figure 2.3. A Fab Lab Bohol employee demonstrates the large computer numerically controlled (CNC) milling machine, which cuts designs into 3-D

Photo by Helen Moser.

distribution kiosks that are located in resorts in Bohol. The approach has been a big success—generating between 1 million and 2 million Philippine pesos per year for local SMEs—and will be rolled out to three more provinces. The Loboc Ginger Company, a local chocolate entrepreneur, and a local cooperative making water buffalo soap have used the machines in the Fab Lab to develop efficient and creative molds for their products, increasing distribution opportunities and profits. These examples demonstrate the potential of the Fab Lab to add value to the local entrepreneurship ecosystem and promote self-employment through entrepreneurship.

Community impact: The Fab Lab has also had other positive impacts in the local community. A "leaf manipulation" project is teaching a local women's cooperative, composed of women affected by Typhoon Haiyan, to transform leaves into plastic coasters, boxes, or artwork that can be sold in the Made in Bohol kiosks. This project allows them to make their own income, increasing their sense of dignity. An "upcycling" project is gathering plastic bags from a local dumpsite facility and transforming the bags into raw materials for the Fab Lab. The plan is for all *barangays*,

Figure 2.4. A selection of products made at Fab Lab Bohol

Photo by Helen Moser.

or community government centers, to have a heat-press machine created by the Fab Lab in collaboration with Keio University. Local women's groups can then collect the bags and upcycle them locally. Fab Lab Bohol has also experimented with making affordable prosthetics for amputees (See Box 2.3),[104] demonstrating the lab's potential for enabling low-cost solutions to community needs. Another community outreach effort involved building a "WikiHouse" that now serves as a day-care facility in an earthquake-affected area. This reconstruction was achieved in a short period using the large CNC milling machine.

104. "Super Low Cost Prosthesis Project by Frontier Makers Policy," Fab Lab Kannai and Fab Lab Bohol, April 8, 2015, https://www.youtube.com/watch?v=iK05NV9hEP4.

Box 2.3. Affordable Prosthetic Leg Created in Fab Labs

The Delta 3-D printer in Fab Lab Bohol used for making prosthetics

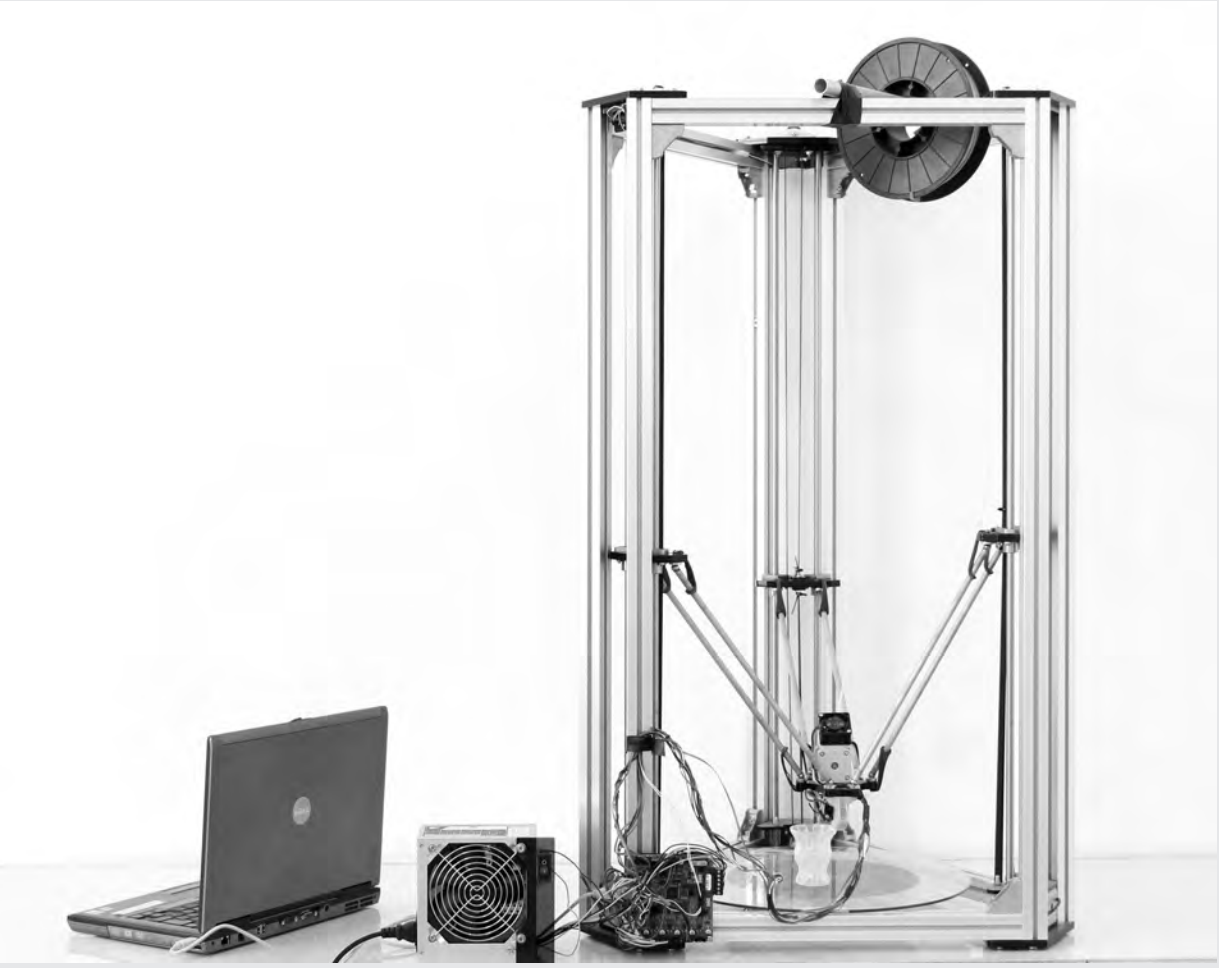


Photo by SHC Design Inc.

As a continued development of the innovations enabled by Fab Labs, Tokushima and his colleagues are working on a new project, "Super Low-Cost Prosthesis Leg using 3-D Scan and Print Technology," with the team from Fab Lab Bohol. There are many amputees in the Philippines, but most of them are not able to get a prosthetic leg due to the high costs. Tokushima and his team believe that this problem, coupled with a strong prejudice against disabled people in rural areas, leads to the worsening of poverty. They designed an affordable prosthetic leg by scanning an amputee's working leg and modeling the opposite missing leg with 3-D software. Finally, the design data is transmitted to a specialized 3-D printer, which prints it with soft material. The resulting 3-D-printed prosthetic leg is much cheaper than a conventional prosthesis. The parts of this specialized printer can be obtained in local markets, ensuring the sustainability of this approach. Tokushima and his team are planning to scale this project to other parts of the world.

Box 2.3. (Continued)

Prosthetic leg created at Fab Lab Bohol using 3-D scan-and-print technology

Photo by SHC Design Inc.

Challenges in Achieving its Mission

Community accessibility: Many local stakeholders assert that DTI and the Fab Lab have not done enough to market the facility to local SMEs. The Fab Lab is currently not able to produce metrics for JICA on how many of the initially targeted 170 SMEs in Bohol have been reached by the Fab Lab, and the DTI data-collection survey final report has recommended that the lab set measurable targets and implement proper recording in the future. Many stakeholders assert that local industry is generally unaware of the possibilities offered by the Fab Lab, despite DTI's strong network of SMEs in Bohol.

There are also barriers to accessibility affiliated with hosting the Fab Lab within BISU. The gate and guard at the university can intimidate those who are not BISU students from entering. The limited weekday working hours of the Fab Lab can make it difficult for people to find time to use the facility. The Fab Lab is first come, first serve and does not accept appointments. This can make it difficult for users outside of Tagbilaran to access the facility. Users wish there were an online or text-based appointments platform. Paying for Fab Lab services is a bureaucratic and

time-consuming process, requiring signatures from two other offices in the university. One must bring receipts from the accountant and treasurer at the university to the Fab Lab to be able to use the machines. Additionally, users can be intimidated by not knowing the equipment and thus not feeling comfortable to run it. There is the general expectation that one must be at a certain skill level before using the Fab Lab. While the Fab Lab does offer many training programs, users question the capacity of all of the Fab Lab employees to be able to operate all the machines Many BISU students view the facility as being for people from other nationalities, or requiring a formal letter for usage.

Broad reach: There is question as to whether the Fab Lab has a broad reach with its current operations. While the Fab Lab has initiated several projects that positively benefit the local community, most current users of the Fab Lab are students from BISU, students from other universities in Bohol, and local entrepreneurs who are not among low-income groups.

Financial sustainability: The DTI assessment of Fab Lab Bohol found that "monthly revenue of [the] Fab Lab is not stable."[105] With its current level of revenue, the Fab Lab covers 57 percent of its operating costs and would not be able to sustain itself financially without outside funding.[106] Fab Lab Bohol currently benefits from the political support of strong individual personalities and donor funding. In the long run, it will have to pursue a more defined revenue generation model to achieve financial sustainability, as in the Fab Labs in Kamakura and Utrecht. However, it is not realistic to expect Fab Labs in developing countries to be financially independent from the outset due to weak local innovation ecosystems. Considering the benefit of Fab Labs as providers of low-cost solutions to local problems, it is important for donors and local governments to support Fab Labs until they develop revenue-generation models.

RECOMMENDATIONS FOR BUILDING INNOVATION ECOSYSTEMS IN DEVELOPING CONTEXTS

Developing Country Governments

- *Conduct mapping exercises of local innovation ecosystems*. Robust mapping allows country leadership to evaluate which inputs to innovation are present and which inputs are missing. In the case of missing inputs, countries can determine what makes sense to cultivate locally and what opportunities exist to fill these gaps with outside partnerships. Countries can also identify via mapping where capacity can be strengthened to support innovation and scale-up of promising ideas. This could potentially be achieved by enlisting in-country expertise. Another option is using "global mentors" to visit the country or engage remotely to conduct capacity building and provide mentorship to local actors.
- *Support public provision of technological goods and platforms for innovation*. In the Philippines, citizens have called for government-funded or subsidized wireless Internet access and coworking spaces that offer computer use. Spaces that offer users the ability to create and collaborate, including Fab Labs, can catalyze the foundation of an innovation ecosystem.

105. "Data Collection Survey on Fabrication Laboratory (FabLab) Utilization in Priority Areas Final Report," 21.

106. Ibid., 23.

- *Pursue a combination of approaches that target high-yield economic growth and train local citizens in entrepreneurship*. This can include enabling the creation of attractive coworking spaces that provide services for exceptional entrepreneurs, as well as providing funding for Fab Labs, start-up incubators, and other mechanisms that offer entrepreneurship training and access to technologies. However, with limited funding an issue, one approach may need to be prioritized.

Bilateral Donors and Multilateral Organizations

- *Support more private-sector approaches to transformative innovation, including tiered financing and providing funding for results*. A key avenue to supporting local innovation in a financially sustainable way is to provide incentives for results. Additionally, competitions such as USAID's Grand Challenge for Development and Development Innovation Ventures that offer tiered funding as viability is tested can yield more efficient and higher-impact outcomes. These competitions can also support scale-up by identifying the innovations that can create impact in a variety of contexts.

  Impact can be further accelerated through entering into more multi-stakeholder, systemic partnerships that involve the multinational and local private sector, nonprofit organizations, local governments, and other stakeholders. These types of partnerships can pursue integrated development approaches in multiple countries and regions, identifying how innovations can be applied on a grand scale to have maximum impact.

- *Serve as the catalyst for innovation-enabling platforms that achieve financial sustainability and accessibility*. Donors and multilateral organizations play an important role as catalysts for introducing innovation-enabling platforms in developing countries. While these platforms, including Fab Labs, can be designed as public goods, it is important that they pursue sustainable business models that reflect the local circumstances in the long run. This can include approaches such as adopting tiered fee models from the start that take into consideration local users' ability to pay. These actors should also consider all real and perceived barriers to access when determining where to locate a facility, especially in low-income areas.

Universities, NGOs, and Research Organizations

- Encourage researchers and participants in innovation-enabling platforms to develop innovations that respond to specific local needs and development challenges. In order for the outputs of innovation-enabling platforms to have broad reach, it is important that their missions emphasize applications for society. As the example of the Ateneo Innovation Center in Manila demonstrates, when prospective innovators have a specific focus and think about the benefits their outputs will have for a group of people, this spurs new ideas. Innovators should ask challenging questions and focus on the low-hanging fruits that a community can benefit from. This can lead to the development of innovations that are accessible to, and improve the lives of, diverse groups.

- Pursue joint research between innovators in a developing country and innovators in a developed country. As demonstrated by Japan's many successful research partnerships, these

ventures can yield high-quality scientific innovations that have benefit for both countries. They can also build capacity in developing-country research institutions. As research is pursued, barriers to innovation—such as bureaucratic procurement policies—should be analyzed and remedied.

CONCLUSION

At root, a productive innovation ecosystem encourages the innovation and application of new ideas that respond to "what is needed by a society, market or individual."[107] Innovation ecosystems necessitate strong linkages and collaboration among a broad array of stakeholders, including policymakers, academia, and the private sector, and require human capital, financial capital, physical infrastructure, and enabling policy. If they are productive, innovation ecosystems are key drivers of economic growth.

In developing country contexts, one or all of these actors may be missing from an ecosystem. Or, if present, an actor may not have the requisite capacity to support innovation. Mapping of a local innovation ecosystem is an essential exercise to determine gaps and how best to fill them. Donors such as JICA can then serve as catalysts for responses, with the long-term goal of enabling local governments to implement and scale innovation ecosystem–building efforts themselves.

This chapter has considered the specific example of the innovation ecosystem in the Philippines and the opportunity presented by Fab Lab Bohol, an operational example of how Fabrication Labs can strengthen some of the crucial elements of an innovation ecosystem. While Fab Labs cannot solve every problem in low-income areas, they can enable and strengthen local innovation ecosystems by serving as spaces in which citizens can create and collaborate, enabled by technological infrastructure that supports open innovation and the development of low-cost solutions to local challenges. They can be called a major breakthrough, democratizing access to a global community and to advanced technologies that enable local people to create prototypes, add value to existing products, and generate new sources of income. These activities can lead to transformative innovation for a society.

The challenges listed in this chapter about Fab Lab Bohol are the same ones facing the development of innovation ecosystems at large; key questions to consider when introducing a platform to build an innovation ecosystem in a developing country include how the platform will be accessed by the community and how it will be sustained financially. Too many innovation-enabling platforms start with great success but then must give up their good work because donor funding ends or a leadership change removes political support.

While innovation-enabling platforms can be designed as public goods and it is not realistic to expect Fab Labs in developing countries to be financially independent from their start-up due to weak local innovation ecosystems, it is important that they pursue sustainable business models that reflect the local circumstances in the long run. Bilateral donors and multilateral organizations

107. "National Innovation Initiative Summit and Report," Council on Competitiveness, 46.

can catalyze this evolution, providing initial funding and capacity building, while enabling Fab Labs to pursue revenue generation.

As international development stakeholders move to expand the cohort of Fab Labs in the Philippines and other developing countries, the successes and challenges experienced by Fab Lab Bohol and others in the Fab Lab global network can be used to inform this scale-up. Financial sustainability beyond donor funds is critical to achieve these platforms' long-term goal of transformative innovation. The four revenue models for Fab Labs suggested in Figure 2.1 suggest there may be a path for Fab Labs to develop in this way.

03

Smart Cities

INTRODUCTION

Concept of Smart Cities

Today just over half of the total human population lives in an urban setting. This is a radical shift—in 1960 only 34 percent of the global population was urbanized[1]—with large implications for governance, economic growth, health, and security. The United Nations estimates that the urban population will grow by an additional 2.5 billion people by 2050, with nearly 90 percent of that growth occurring in Africa and Asia.[2] Managing urban growth, particularly the haphazard city expansions that are common in developing countries, will be one of the most critical challenges of the coming century. Smart city technologies offer a critical tool for transforming urbanization from a challenge into a global social dividend.

Smart cities is a concept that came into the modern consciousness in 2005, when the Clinton Global Initiative challenged Cisco to devise ways to use its technology to make cities more sustainable. This challenge led to a $25 million Connected Urban Development Program.[3] Cisco worked with Amsterdam, San Francisco, and Seoul on "using network connectivity for communication, collaboration, urban planning, and other activities." Its goals included improving services delivery, traffic flow, and public transportation and ultimately reducing carbon emissions.[4] After a

1. "Global Health Observatory (GHO) Data," World Health Organization, http://www.who.int/gho/urban_health/situation_trends/urban_population_growth_text/en/.

2. "World's Population Increasingly Urban with more than Half Living in Urban Areas," UN Department of Economic and Social Affairs, July 10, 2014, http://www.un.org/en/development/desa/news/population/world-urbanization-prospects-2014.html.

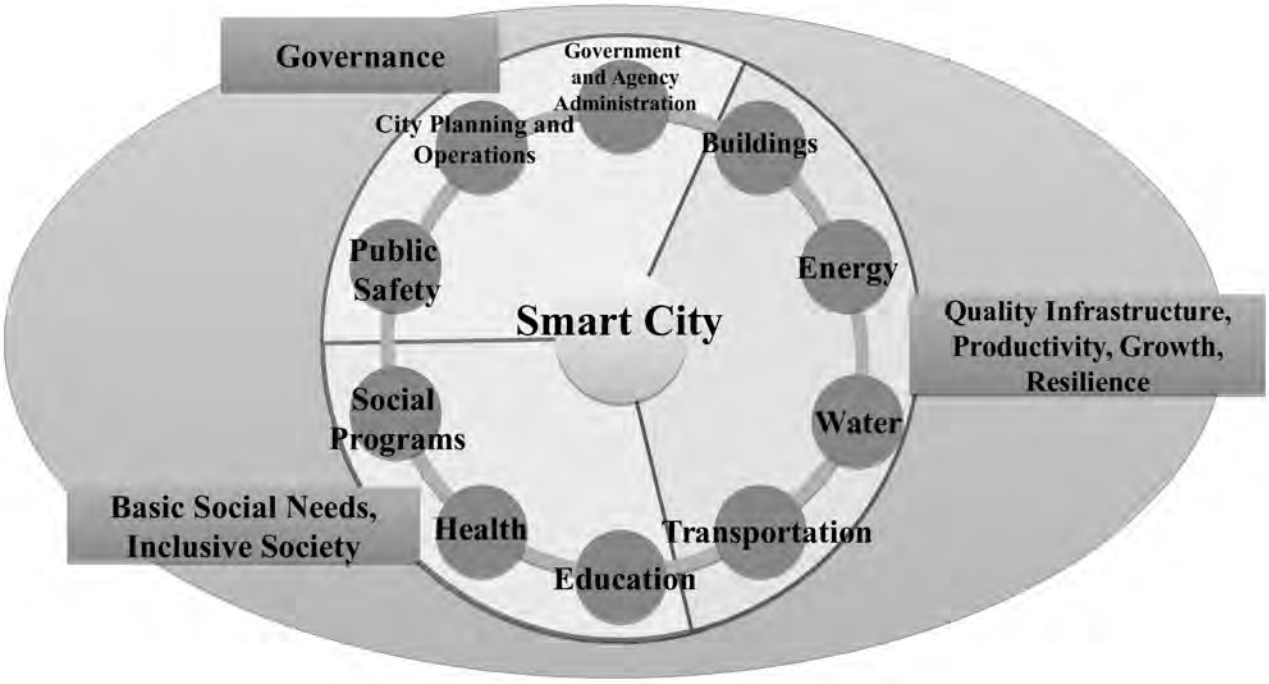
3. Pete Swabey, "IBM, Cisco and the Business of Smart Cities," *Information Age*, February 23, 2012, http://www.information-age.com/industry/hardware/2087993/ibm-cisco-and-the-business-of-smart-cities.

4. "Connected Urban Development," Cisco, http://www.cisco.com/c/en/us/about/consulting-thought-leadership/what-we-do/industry-practices/public-sector/our-practice/urban-innovation/connected-urban-development/cud-global conference-amsterdam-september-2008/final.html.

successful five-year pilot, Cisco created its Smart and Connected Communities Division and worked to commercialize its products and services in this space.[5]

IBM launched its own Smarter Planet Initiative in 2008 and a Smarter Cities program the following year.[6] Smarter Cities works in locations around the world on using new technologies and data to improve the cohesiveness and functionality of a city's operations, services delivery, and systems.[7] Following the lead of these initiatives and others, "smart cities" has become a buzzword, one that most people in developed countries link to the application of high technologies that improve a city's services delivery and quality of life.

Figure 3.1. Concept of a Smart City



Source: Created by CSIS and JICA-RI based on information from the following: "Smarter Cities," IBM; Boyd Cohen, "What Exactly is a Smart City," Co.Exist, September 19, 2012, http://www.fastcoexist.com/1680538/what-exactly-is-a-smart-city; and presentation by Hisakazu Okamura to Asia University Urban Innovation, April 2016.

Framework of Smart Cities

At root, smart cities require three components. First is effective governance in public safety, city planning and operations, and government and agency administration. Next is quality infrastructure that enables economic productivity, inclusive growth, and resilience. This includes infrastructure that provides energy, transportation, and water. Finally, smart cities support "the needs of each

5. Swabey, "IBM, Cisco and the Business of Smart Cities."

6. Ibid.

7. "Smarter Cities," IBM, http://www.ibm.com/smarterplanet/us/en/smarter_cities/overview/.

citizen through social programs, healthcare and education."[8] These services promote an inclusive society.

As cities continue to grow, governments, infrastructure, and social services are pushed and stressed in new and unexpected ways. Rising demand for water, food, and electricity necessitates efficient systems for managing increasingly scarce resources. Many cities have to confront large informal settlements, and address concerns around security and health. Despite these challenges, cities have the potential to link a greater number of citizens to basic social goods and drive forward increased economic productivity.

Smart cities technology provides municipal leaders the opportunity to integrate planning and management, infrastructure, and social-good delivery to improve the livability and competitiveness of their cities. From a workforce perspective, cities with low-cost housing, convenient and affordable transportation, and quality education and health care are able attract and retain top global talent. Consistent access to these public goods also supports an inclusive economic order, which benefits all citizens and maximizes the economic potential of a given city, making it an attractive destination for people, businesses, and investment.

Smart Cities in the International Development Context

The development of smart cities requires strong collaboration between the private and public sectors. Most innovations in data collection and data systems originate from the private sector, and require cooperative government policy to be implemented on a citywide scale.[9] At the same time, efforts by bilateral donors and multilateral organizations can catalyze the adoption of smart cities approaches through early-stage funding and capacity building.

The World Bank proposed a "smart cities development framework" in January 2015 to help burgeoning cities deliver more efficient services. The five main components in this framework for cities to pursue include creating a tailored government road map, identifying city priorities and public needs, cocreating solutions from citizens and government, establishing an Urban Innovation Lab to test new ideas and solutions, and participating in networks with other cities to share applications and best practices.[10]

Smart city development projects have recently emphasized sustainability and inclusion. The World Development Report 2016 identifies three exemplary practices for smart cities: using data to address the most vulnerable populations (e.g., São Paulo, Brazil, prioritizing housing upgrade investments by compiling a geographic database of socioeconomic indicators), opening up data to promote accountability (e.g., Nairobi, Kenya, mapping the community needs of its largest informal settlement, Kibera), and using mobile connectivity to enhance civic participation (e.g., the Philippines using crowdsourced data to identify smoke-belching vehicles).[11]

8. "Smarter Cities," IBM.

9. "Smart Cities," World Bank, January 8, 2015, http://www.worldbank.org/en/topic/ict/brief/smart-cities.

10. Ibid.

11. "World Development Report 2016 Sector Focus 4: Smart Cities," World Bank, 2016, http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2016/01/13/090224b08405ea05/2_0/additional/310436360_201602630200228.pdf.

Governments around the world have recognized the importance of addressing challenges in urban environments, and have devoted significant funding to smart city projects. The United States created an $8 billion investment fund for smart cities,[12] and Japan has been promoting the "FutureCity" Initiative.[13] India has planned to leverage its information technology industry to build 100 smart cities. Kenya has built Konza Techno City near Nairobi, and Rio de Janeiro, Brazil, has created the Intelligent Operations Center, which brings 30 government agencies together in a technologically advanced command center.[14]

The development and scale-up of smart city solutions requires global collaboration and exchange. ICLEI—Local Governments for Sustainability was created to assist cities in learning from one another through expert consultation and knowledge-sharing platforms. It counts 1,000 towns, cities, and metropolitan areas among its members.[15] The East Asia Low Carbon Growth Partnership Dialogue and East Asia Platform for Low Carbon Growth, both led by Japan, are examples of successfully bringing together researchers and policymakers to address matters relating to emissions control. Development banks have been able to support the smart cities agenda by offering knowledge-sharing programs, undertaking cross-country data collection, and conducting feasibility studies to identify and implement best practices. In 2010, collaborative research from the World Bank, Asian Development Bank, and JICA on climate risk in Asian coastal cities developed a framework for resilience in these climate-vulnerable environments.[16]

The United States has expressed its commitment to furthering projects involving smart cities in developing countries, as demonstrated by its organizing of a Smart Cities Conclave in Delhi in 2014. This conference convened the U.S.-India Business Council, India's Ministry of Urban Development, and the mayors of Ajmer, Allahabad, and Vishakhapatnam to discuss urban planning efforts, and created high-level committees in each of the smart cities composed of both state and local actors.[17] USAID has also partnered with the city of Visakhapatnam to tackle its rising urban challenges through the design and creation of a sanitation system that involves new methods to improve water supply and waste disposal.[18] In January 2015, USAID, the Bill & Melinda Gates Foundation, and the government of India partnered to advance the Swachh Bharat Clean India

12. Ibid.

13. "Concept of 'FutureCity' Initiative," FutureCity Initiative, http://future-city.jp/en/about/.

14. Ibid.

15. "ICLEI—the Global Cities Network," ICLEI—Local Governments for Sustainability, http://www.iclei.org/iclei-members.html.

16. "Climate Risks and Adaptation in Asian Coastal Megacities: A Synthesis Report," World Bank, 2010, http://siteresources.worldbank.org/EASTASIAPACIFICEXT/Resources/226300-1287600424406/coastal_megacities_fullreport.pdf.

17. "U.S.-India Joint Statement—Shared Effort; Progress for All," The White House, January 25, 2015, https://www.whitehouse.gov/the-press-office/2015/01/25/us-india-joint-statement-shared-effort-progress-all.

18. "India—Our Work," U.S. Agency for International Development, March 14, 2016, https://www.usaid.gov/india/our-work.

Mission, establishing a knowledge partnership to identify and scale best practices, build technical capacity, and advance public-private partnership focused on sanitation.[19]

JICA has also recognized the importance of addressing urban issues for sustainability, and established six focus areas for its development policy: urban reconstruction, core infrastructure development, residential improvements, low-carbon technologies, disaster-resilient solutions, and sound urban management. Japan aims to create secure, inclusive, competitive, creative, and environmentally friendly cities through evidence-based planning with civic participation.[20] Cities in Japan have been able to share their expertise in urban planning to help their counterparts around the world: the Japanese city of Kitakyushu cooperated with Surabaya, Indonesia, to address pollution-management problems,[21] and Yokohama supported Metro Cebu, Philippines, in completing the Roadmap Study for Sustainable Urban Development for that city.[22] Furthermore, JICA partnered with Austria, Switzerland, and the Inter-American Development Bank in the Emerging and Sustainable Cities Initiative in 2013, a program that helps cities in Latin America and the Caribbean (LAC) target urban sustainability, environmental sustainability, and good governance. The initiative has fostered partnerships with 71 cities to provide both financial and technical aid in a range of sectors: energy, land use, citizen security, solid-waste management, transportation, and water and sanitation.[23]

Quality Infrastructure

"Quality infrastructure" is an important approach to highlight when discussing smart cities in developing contexts. Quality infrastructure is infrastructure that emphasizes cost effectiveness, ease of use, durability, environmental friendliness, and disaster resilience in the long run.[24] While the cost of the initial investment may be higher, quality infrastructure delivers greater returns over a project's lifecycle than traditional infrastructure projects.[25] Quality infrastructure is included as an aim of SDG Goal 9 and has been emphasized as an important objective by the G20 and Asia-Pacific Economic Cooperation (APEC), among other institutions.[26]

---

19. "USAID and the Bill & Melinda Gates Foundation Partner with Ministry of Urban Development to Help India Achieve Sanitation for All," U.S. Agency for International Development, January 13, 2015, https://www.usaid.gov/india/press-releases/jan-13-2015-usaid-and-bill-melinda-gates-foundation-partner-ministry-urban.

20. "JICA Assistance for Sustainable Urban Development," World Bank, 2015, http://www.worldbank.org/content/dam/Worldbank/Feature%20Story/japan/pdf/event/2015/070115_JICA.pdf.

21. Ibid.

22. "JICA Concludes Metro Cebu Roadmap Study for Sustainable Growth toward 2050," Japan International Cooperation Agency, November 2, 2015, http://www.jica.go.jp/philippine/english/office/topics/news/151102.html.

23. "IDB and JICA Strengthen Cooperation: Focus on Emerging and Sustainable Cities," Inter-American Development Bank, November 7, 2013, http://www.iadb.org/en/news/announcements/2013-11-07/esci-and-jica-cooperation,10640.html.

24. "Partnership for Quality Infrastructure: Investment for Asia's Future," Japanese Ministry of Foreign Affairs, May 21, 2015, http://www.mofa.go.jp/files/000081298.pdf.

25. Shinzo Abe, "The Future of Asia: Be Innovative" (speech by Prime Minister Shinzo Abe at the banquet of the 21st International Conference on the Future of Asia in Tokyo, May 21, 2015), http://japan.kantei.go.jp/97_abe/statement/201505/0521foaspeech.html.

26. "'Quality Infrastructure Investment' Casebook," Government of Japan, 2, http://www.mofa.go.jp/files/000095681.pdf.

Japan's prime minister, Shinzo Abe, announced the "Partnership for Quality Infrastructure: Investment for Asia's Future" in May 2015, a collaboration between the government of Japan and the Asian Development Bank (ADB) to provide $110 billion for quality infrastructure investments in Asia. Through 2020, Japan and the ADB will support quality infrastructure projects that enhance connectedness among Asian countries, create jobs, build local capacity, and improve people's lives.[27] Quality infrastructure is a key component of achieving inclusive, sustainable, and resilient "quality growth."[28]

An example of quality infrastructure is the Delhi Mass Rapid Transport System or "Delhi Metro" in India, which provides daily transport for 2.5 million citizens and has reduced the number of vehicles on the road in Delhi by 120,000. The Metro contributes to pollution and traffic reduction and provides an attractive commuting option for locals. Japan has supported the Delhi Metro through three phases of ODA loans since 1998, and construction has been pursued with innovative Japanese technology and knowledge sharing.[29]

CASE STUDY: A SMART CITIES APPROACH IN JAKARTA, INDONESIA

Background

Jakarta, Indonesia, is one of the world's "megacities," with a population of more than 10 million.[30] The larger Jakarta metropolitan area, Jabodetabek, has a population of more than 28 million.[31] Jakarta's population continues to grow rapidly; from 2000 to 2010 Jakarta gained 7 million more inhabitants, a growth rate of 3.7 percent. If this trend continues, Jakarta's population will double between 2000 and 2020.[32] This population expansion has taxed an already weak local infrastructure base, causing high traffic congestion; environmental concerns; and gaps in provision of essential services, including potable water, sanitation, and energy. A World Bank Urbanization Review of Indonesia cites significant missed economic growth opportunities due to the infrastructure deficit.[33]

---

27. "Partnership for Quality Infrastructure: Investment for Asia's Future," Japanese Ministry of Foreign Affairs.

28. "'Quality Infrastructure Investment' Casebook," Government of Japan, 2.

29. Ibid., 8.

30. "Urban Expansion in East Asia—Indonesia," World Bank, January 26, 2015, http://www.worldbank.org/en/news/feature/2015/01/26/urban-expansion-in-east-asia-indonesia.

31. "Jakarta Population 2016," *World Population Review*, 2016, http://worldpopulationreview.com/world-cities/jakarta-population/.

32. "Urban Expansion in East Asia—Indonesia," World Bank Group.

33. "Development Policy Review 2014: Indonesia: Avoiding the Trap," World Bank, May 2014, http://www.worldbank.org/content/dam/Worldbank/document/EAP/Indonesia/Indonesia-development-policy-review-2014-english.pdf.

Box 3.1. Main Takeaways

- In the common lexicon, a "smart city" is typically linked to the application of high technologies. However, stakeholders in Jakarta presented various definitions of the term, many related to capable public administration. A key component of the success of smart cities is strong political leadership and sufficient governmental capacity.
- Several facets of Jakarta provide opportunities for a smart cities approach, including strong political leadership and desire from the people for good services delivery; a high number of smartphone and social media users; and a thriving innovation scene.
- The Jakarta Smart City unit is a strong local example of the smart cities approach at work. Housed in the city government, this office is collecting big data and processing it to drive accountable governance and improve services delivery.
- The JICA-funded mass rapid transit (MRT) system in Jakarta will provide an attractive and modern alternative to vehicular transport when its first section becomes operational in 2018 or early 2019. While it will cover only a limited part of Jakarta initially, it has the potential to be a game changer in easing the heavy traffic in Jakarta—currently 90 percent dependent on vehicular transport.
- The Joint Crediting Mechanism (JCM) in Indonesia is an authoritative carbon trade scheme that promotes cooperation among Japanese and Indonesian companies to achieve Japan's and Indonesia's greenhouse gases (GHGs) emission reduction targets.[1] JCM demonstrates how adoption of new technology can have a significant impact on energy efficiency for businesses. While the scheme has enabled discrete companies to take up the improved technology through subsidies, there is a need for models that scale such approaches and make them sustainable.

1. "Progress of the Joint Crediting Mechanism (JCM) in Indonesia," Joint Crediting Mechanism Indonesia-Japan, November 2015.

The meaning of a "smart city" differs for various stakeholders in Jakarta. Some definitions mentioned were:

- Doing government the right way
- How to manage and make use of our resources to solve city problems in more expedient ways and avoid problems in the future
- Access to more information that one can analyze to provide insights for a city
- Smart planning and budgeting
- The best possible use of technology to enable good governance
- Applying technology to make cities more livable

- Using available innovations (this can include technology but does not have to be technology) that change the way people do things in a city
- One-stop service centers—if you need anything from a city, you get it quickly and in one place from common centers
- Cities that provide efficient and effective services

Key Challenges in Jakarta that a Smart City Approach Will Need to Address Include:

Local governance: Indonesia shifted to a decentralized governance system in 2001. There has been significant transformation in administration and empowerment of local government since then. However, the biggest challenge for smart cities in Indonesia is still governance. The smart cities concept needs to be matched by an increase in the capacity of the city government. Technology application alone is not the recipe for good governance. There are good leaders, but they are limited to terms. Exemplary leaders inherit offices that are not always familiar with the latest technologies. For technology companies the challenge is not in dealing with the top leaders, but with small district offices. These offices are not using technology to the best of their abilities. Challenges in local governance include financial gaps and weakness in planning:

- Financial gaps: Still over 60 percent of local government funding is transferred from the central government. Local governments' own sources of revenue are limited because it is difficult to issue local bonds, contributing to the large infrastructure gap at the local level.
- Weakness in planning: Good planning is essential for effective and efficient management of cities. In many cases, local governments in Indonesia do not have overall master plans. A master plan to cover the Jabodatabek area was established by the Indonesian government in 2012 in collaboration with the Japanese government.[34] The status of this master plan changed due to the change of Indonesian government in 2014; however, it still serves as a framework for managing priority projects in the area.

Infrastructure shortfalls: Jakarta is a highly vehicle-dependent and congested city. A World Bank Urbanization Review of Jakarta found huge missed opportunities due to the infrastructure deficit, estimated at $5 billion per year at the local level. Significant gaps exist in water and sanitation and in informal settlements:

- Water and sanitation: The government provides services for removing waste, but it is said that only 5 percent of septic treatment plants are functioning. Only 60 percent of Jakarta is served by the current water supply, and piped water is not potable.[35] Private companies are investing in water, but not sanitation. Access to water and sanitation facilities is especially an issue in informal settlements.

34. "Fourth Steering Committee Meeting Held by Cabinet Members of the Governments of Japan and Indonesia on the Metropolitan Priority Area for Investment and Industry (MPA) in Jabodetabek," Japan International Cooperation Agency, December 11, 2013, http://www.jica.go.jp/english/news/press/2013/131217_01.html.

35. Meeting with Asian Development Bank Indonesia Office, February 8, 2016.

- Informal settlements: There are many informal settlements in Jakarta that face significant challenges to effective services delivery. Informal settlements are often located in disputed areas along Jakarta's river, and it is difficult to offer infrastructure improvements in these illegal settlements. The city is moving residents of these informal settlements to government housing and providing them with furniture, including refrigerators, at affordable rates. However, many informal settlements remain. Companies claim to increase water access to the informal settlements, but acceleration of this is not fast enough. This is especially an issue in North Jakarta; it is swampy and water is more expensive there. The connection fee is prohibitive for the poor—costing about $100 to $150. The capacity of people to improve their conditions in informal settlements must be included as part of any response. The people in informal settlements need access to financial instruments.

Several Facets of Jakarta Provide an Effective Enabling Environment for a Smart Cities Approach:

Strong political leadership and desire from the people for good services delivery: Jakarta's move towards a smart cities approach, including opening a Jakarta Smart City Unit at the provincial government level, was the result of strong political will from former Jakarta governor and current Indonesian president Joko "Jokowi" Widodo as well as the current governor of Jakarta, Basuki Tjahaja Purnama "Ahok." These candidates ran on a platform of strong public services delivery, and Ahok is involved in the day-to-day oversight and accountability of the Smart City Unit and visits parts of the city that need improvement. Ensuring a track record of effective services delivery will be critical for his reelection. Indonesian leaders are beginning to run on platforms that take a rational approach towards services, and citizens expect that they will deliver—or they will be voted out of office.

High number of smartphone and social media users: People in all age groups in Jakarta have smartphones. Jakarta is the number one city for Twitter use in the world—"everyone tweets" there. Facebook is preloaded on phones, and the country has 63 million active Facebook users.[36] This access to technology allows for a new form of accountable governance, as citizens can be engaged in their city government's decisionmaking in real time.

A thriving innovation scene that has led to the creation of several popular applications: The maker and innovation scene is thriving in Indonesia, and there is much ambition towards this. President Jokowi has an innovation advisor. USAID spends time with the maker's movement, and tries to get people to think about innovating for social good. Huge, family-owned companies are investing in start-ups and start-up accelerators. Because of these investments, the environment in tech is exploding. An innovator does not have to have a minimum viable product (MVP) or prototype to have their ideas purchased, and there is a large cohort of angel investors. A couple notable examples of successful smartphone applications are:

- GO-JEK: provides on-demand rides, food, shopping, massages, messaging, cleaning
- Tokopedia: offers an online marketplace for various businesses and products

36. Meeting with UN Global Pulse Lab Jakarta, February 4, 2016.

- Happy Fresh: provides grocery delivery from supermarkets
- GrabBike: provides on-demand motorcycles and taxis
- Uber has also been "disruptive" in Indonesia

It is important to note that the ones innovating are typically educated people who study in technology schools and people who have lived and studied abroad. The working poor may have more and more easily accessible job opportunities through these new applications, but they are not the ones innovating.

Approaches to Respond to the Challenges with Innovative Technologies

Governance and ICT: Jakarta Smart City Unit

Jakarta's city government opened an impressive Smart City Unit in 2014 that focuses on collecting big data and analyzing it to drive the city's decisionmaking. This unit has 30–40 contracted workers, and the office is also a coworking space. The unit has a city-monitoring system, displayed across several big screens and smaller computers. This system can toggle among various programs that show traffic conditions in Jakarta, track government staff in the field, access "city feeds" (there are approximately 600 locations with government cameras), and monitor complaints from the smartphone application Qlue.

Qlue invites users to submit reports of anything ranging from potholes to bribery to broken streetlights. Complaints are funneled via the Smart City Unit to the appropriate agencies, and then the agencies must provide photo verification through the application that the problem has been fixed. Some stakeholders question whether the new technology has been matched by adequate capacity in the government to respond to complaints. However, the Smart City Unit asserts that prior to Qlue, it took the government between three days and one week to respond to something like a pothole; now the response time is one day. The Smart City Unit is readily able to demonstrate how the city has used Qlue to paint over graffiti, pick up trash, and move a parked car that caused a traffic jam.

The Smart City Unit also hosts hackathons and other events to promote the use of data, with the approach that "civic hackers," or web developers using big data, will develop private applications that can improve services in Jakarta. For example, a recent hackathon provided access to highway routes and ambulance data. Participants developed applications to enable ambulances to navigate the fastest and most efficient highway routes.

The director of the Smart City Unit said that donors and multilateral organizations can be the biggest support to smart cities by developing global standards for smart cities, or a "smart cities index" that will guide them to measure their effectiveness with key performance indicators.

Energy: Joint Crediting Mechanism Projects

Background and Key Operating Details. Joint Crediting Mechanism (JCM) is an authoritative carbon trade scheme that promotes cooperation among Japanese and Indonesian companies to

Figure 3.2. The main screen at the Jakarta Smart City unit

Photo by Helen Moser.

achieve Japan's and Indonesia's greenhouse gases (GHGs) emission reduction targets.[37] Introduced by Japan, JCM has the long-term goal of international recognition. JCM in Indonesia was signed on August 26, 2013. It is governed by the governments of Japan and Indonesia through participation in a joint committee. The government of Japan subsidizes the scheme, and a JCM secretariat acts as the focal point for JCM-related matters. Through JICA technical cooperation, JICA is assisting with the establishment of a mechanism to operationalize and increase awareness of the JCM.

JCM's model is to incentivize Indonesian companies to take up technologies in their business operations that achieve greater energy efficiency; are low carbon; enable climate change mitigation; or make use of renewable energy. JCM disseminates and promotes the scheme in Indonesia to attract participant companies, and companies submit applications in which they propose their methodologies. These applications are reviewed by a joint committee with members from Japan

37. "Progress of the Joint Crediting Mechanism (JCM) in Indonesia," Joint Crediting Mechanism Indonesia-Japan, November 2015.

and Indonesia. Selected companies then submit a project design document, which is validated by a third-party entity (TPE). The joint committee then determines the subsidy that a company will receive and registers the project. Depending on the specific finance scheme, the subsidy can be up to 50 percent on a technology sold by a Japanese company, according to the Ministry of the Environment, Japan. Companies then implement the new technology and participate in the JCM monitoring process. Finally, a TPE verifies the GHG emission reduction or removal according to the JCM methodology and its monitoring plan. To become a JCM TPE, an entity must be either accredited under International Organization for Standardization (ISO) 14065 or a Designated Operation Entity (DOE) accredited by the executive board under the Clean Development Mechanism (CDM). The governments of Japan and Indonesia then issue the carbon credits.

There are currently 23 projects in the JCM pipeline in Indonesia; five are officially registered and eligible for carbon credits. When these credits are issued they will be the first in Indonesia and also the world; Indonesia is regarded as the most progressive country in the scheme, which has 16 partner countries.

The JCM scheme in Indonesia demonstrates how adoption of new technology can have a significant impact on energy efficiency for businesses. While the scheme has enabled discrete companies to take up the improved technology through subsidies, there is need for models that scale such approaches and make them sustainable.

Successes in Achieving its Mission. This case study considers four specific Indonesian company sites currently participating in the JCM (Please see Appendix C for details on each site). Each demonstrated significant energy savings using the new technology provided by various Japanese companies. For example, use of Mayekawa refrigerators enables a 25 to 30 percent reduction in electricity consumption per month for PT. Adib Global Food Supplies Companies appreciated the opportunity to participate in the scheme, and said it offered the company additional advantages, including being able to market itself as eco-friendly. PT. Adib Global Food Supplies said that the more efficient refrigerators have been attractive selling points for foreign clients, including GlaxoSmithKline.

Japanese companies also provide on-site technical assistance on how to use these new technologies, enabling local capacity building. PT. Adib Global Food Supplies said that Mayekawa sent their engineer from Japan to train Indonesian engineers on how to use and maintain the machines. They can also expect support from Japan when anything goes wrong with a machine.

Challenges in Achieving its Mission. Take-up of the new technology was heavily influenced by the subsidies offered through JCM—most companies received a 50 percent subsidy on the cost of the new equipment, which was in some cases three times more expensive than their old equipment. Companies did not indicate that they would purchase more of the same kind of equipment without a subsidy or a low-interest loan.

Most companies were not able to provide the time frame in which they could make up the additional costs for purchasing the advanced technology with energy savings, but PT. Adib Global

Food Supplies offered the following analysis: Energy savings with the Mayekawa refrigerators translates to approximately 80 million rupiah in energy costs saved per month. These machines are three times more expensive than the old technology, costing approximately $900,000 per machine without the cost of installation. It will take five years to make up the higher machine costs with no 50 percent subsidy and approximately three years with the subsidy.

Given that donor funds are limited, consideration of the payback period is of utmost importance. For this kind of scheme to be widely viable, companies must be able to see financial returns without a subsidy. This is also a key point of consideration for national or local government policies, which play a large role in the enabling environment for new technologies. Determining how to scale up and mainstream the JCM and similar initiatives through Indonesian government policy should be a key step in encouraging new technologies that promote energy efficiency; are low carbon; enable climate change mitigation; or make use of renewable energy.

Transportation: Mass Rapid Transit Project

Background and Key Operating Details. The Jakarta mass rapid transit (MRT) system will be a modern and technologically advanced method of transport in Jakarta when it opens in 2018 or early 2019. The Jakarta MRT is the first tunnel of its kind in Indonesia, using impressive Japanese technology and capacity for its construction. JICA has been involved in this project for about 15 years and is funding almost the entirety of the $1.4 billion cost.

Most citizens in Jakarta still rely on private transport for their commute—the city is home to 6.4 million private vehicles, and vehicle use is growing by 11 percent annually.[38] The MRT follows on the existing major public transport system in Jakarta, the Transjakarta busway. Transjakarta offers dedicated bus lanes, which run in 11 corridors for a total length of 184 kilometers. There are 208 stations,[39] and daily ridership is estimated at approximately 350,000 passengers.[40]

The Jakarta MRT is one of the priority projects in the master plan for the Jabodetabek area, which was established in 2012 as the result of collaborative study between the Indonesian and Japanese governments. The master plan lays out a comprehensive plan for infrastructure development to be constructed in the Jabodetabek area, with the target year of 2020.[41] This also serves as a framework to facilitate JICA's cooperation projects in the area.

Owned by PT. Mass Rapid Transit Jakarta (MRTJ), the MRT utilizes four Japanese supervisors and about 1,000 local workers, all of whom were trained to work in the tunnel either in Singapore or

38. Muhammad Syarifullah, "Governor Ahok's Policy to Solve Jakarta's Traffic Jams," New Cities Foundation, April 30, 2015, http://www.newcitiesfoundation.org/governor-ahoks-policy-to-solve-jakartas-traffic-jams/.

39. "Project for the Study on Jabodetabek Public Transportation Policy Implementation Strategy in the Republic of Indonesia (JAPTraPIS) Final Report Volume 1: Summary," Japan International Corporation Agency, Almec Corporation, and Oriental Consultants Co., May 2012, http://open_jicareport.jica.go.jp/pdf/12078994_01.pdf.

40. Corry Elyda, "Develop Busway before LRT: ITDP," *Jakarta Post*, November 11, 2015, http://www.thejakartapost.com/news/2015/11/11/develop-busway-lrt-itdp.html.

41. "Jakarta Mass Rapid Transit (MRT)," Jakarta City Government, March 9, 2011, http://www.jakarta.go.id/v2eng/news/2011/03/jakarta-mass-rapid-transit-mrt#.VxkGMfkrLct.

Figure 3.3. A shield tunnel at the Jakarta MRT's future Senayan Station

Photo by Helen Moser.

on-site. Currently construction is taking place at the MRT's future Senayan Station in central Jakarta. The Senayan Station is one of four underground stations in the lower part of the North-South line (section CP104-105), which will be the first part of the MRT to become operational in 2018 or early 2019. When complete, this section will stretch 3.89 kilometers. Two large tunnel-boring machines were imported from Japan in pieces and reconstructed on-site to dig the shield tunnels. JICA estimates future ridership at 280,000 persons per day. Trains will run every five minutes at rush hour and every 10 minutes at off-peak times. As railway facilities have the potential to encourage the creation of transit-oriented developments and commercial businesses, the MRT may bring added value to Jakarta.

The upper portion of the North-South line is expected to commence construction in 2019, with completion sometime in the 2020s. The East-West line has had no progress to date; its basic design study is expected to commence in 2017. After the construction of two lines, ridership is estimated to be 370,000 persons a day. The operation and maintenance (O&M) of the Jakarta MRT will be regulated and managed by the provincial government of Jakarta (DKI) and MRTJ. JICA is also providing training courses to share Japan's know-how on O&M.

Successes and Challenges in Achieving its Mission. While not yet operational, the MRT has great potential to create a better transportation experience for Jakarta's citizens. Jakartans frequently complain about traffic on Twitter. With 90 percent of transport in Jakarta dependent on road vehicles and this leading to high traffic congestion, use of the MRT can potentially boost economic productivity in Jakarta and lessen the damaging environmental repercussions of vehicle emissions.

A key success of the project to date has been building local capacity in new construction techniques. Because the North-South line will be the first MRT system to be managed by MRTJ, it is important that the MRTJ staff to be well prepared for the operation to commence in early 2019.

It is important to note that it will take time for the MRT to have a clear impact in solving Jakarta's traffic problem, as it will cover only a limited part of Jakarta initially. Delays due to issues with land acquisition have presented challenges to the timely construction of the aboveground portions of the line.

Education: Indonesian Science Fund

The Indonesian Academy of Sciences (AIPI) launched the Indonesian Science Fund (ISF) in May 2015 with support from USAID and the Australian government. The fund offers three-year research grants to Indonesian scientists and engineers for research that will "promote innovation, technological advances, and economic prosperity."[42] It is a notable addition to the research ecosystem in Indonesia given that science funding is low overall and the national Ministry of Research, Technology and Higher Education only offers one-year research grants.[43]

42. "Strengthening Collaborative Achievements in Science, Technology, and Innovation (ST&I)," USAID Indonesia.

43. Meeting with USAID Indonesia Mission, February 1, 2016.

ISF's model is similar to that of the National Science Foundation in the United States; it is structured as an independent agency that is able to receive outside funding. ISF issued its first call for science research in July 2015.[44] Grants are competitive and merit based; they offer flexible funding as well as incentives for yielding quality research. In the future the ISF plans to create specific funding models framed around developing innovative responses to Indonesia's development challenges.[45]

RECOMMENDATIONS FOR BUILDING SMART CITIES IN DEVELOPING CONTEXTS

Developing Country Governments

- *Plan and prioritize development projects and determine gaps that can be filled through foreign partnership*. It is important for local governments to have cohesive plans that lay out their development priorities and the projects needed to achieve them. These plans can determine where gaps exist, including those in financing, and where these gaps can best be addressed through foreign partnership. Projects that will deliver the most impact in the way that citizens experience their daily lives and contribute to economic productivity should be prioritized.
- *Pursue schemes that facilitate joint ventures between local companies and those in developed countries*. As with the example of the JCM in Indonesia, these can support technology acquisition and capacity building. These actors can also introduce schemes to incentivize the take-up of an advanced technology such as providing low-interest loans or subsidies. However, it is important that schemes examine the long-term financial incentives for developing-country actors to ensure sustainability. Marketing a realistic payback period for companies that take up more efficient technologies is one approach.
- *Consider how big data can catalyze the better coordination and delivery of public services*. Following the example of the Jakarta Smart City Unit, city leadership has the opportunity to collect and analyze data on local conditions and service delivery. If combined with accessible applications and other feedback mechanisms, this data can be used to improve city responsiveness, decrease corruption, and improve city conditions. It can also increase a city government's interactions with citizens, building trust.

Bilateral Donors and Multilateral Organizations

- *Develop and promote a smart cities ranking that will help cities to benchmark their performance against other cities and measure their effectiveness with key performance indicators*.

---

44. Ibid.

45. "Minister of Finance, State Minister of National Development Planning Support the Autonomous Funding Mechanism for Science in Indonesia," Knowledge Sector Initiative, June 1, 2015, http://www.ksi-indonesia.org/index.php/news/2015/06/01/55/minister-of-finance-state-minister-of-national-development-planning-support-the-autonomous-funding-mechanism-for-science-in-indonesia.html.

An index should draw on the ISO/TS 37151 (Smart community infrastructures—principles and requirements for performance metrics),[46] which looks at 14 basic community needs to "measure the performance of smart community infrastructures."[47] However, there is opportunity to build on ISO/TS 37151 and other existing indicators such as those suggested by the Comprehensive Assessment System for Built Environmental Efficiency for Cities (CASBEE-City)[48] by incentivizing cities through a ranking system. This could follow the model of the World Bank's highly regarded Doing Business Indicators.[49] Effective promotion of the index to city leaders will be important to ensuring its accessibility and wide reach.

- *Support city and national governments to improve their capacity to collect, analyze, and operationalize big data for improved services delivery*. This can include conducting capacity building, embedding experts in government units to provide on-site mentorship, and serving as an on-call resource when questions regarding big data and approaches to improve government efficiency cannot be answered locally.
- *Provide catalytic funding and capacity building for the implementation of smart city technologies in developing countries*. Bilateral donor and multilateral organizations can support developing countries to take up new technologies at an early stage through financing and training. These activities should be pursued with the long-term goal of national and local government-led scale and sustainability of smart cities approaches.
- *Promote Quality Infrastructure*. Smart cities should be built on infrastructure that is resilient to natural disasters and environmentally sustainable. As infrastructure should be built to last for long periods of time, it is important to prioritize life cycle costs over the initial investment. Bilateral donors and multilateral organizations should support developing countries in building quality infrastructure by using innovative technologies.

CONCLUSION

As cities around the world strive to become "smart," they will need to consider how they can obtain and make use of big data and new technologies to improve city coordination and services delivery. There is also another important part of the equation: Strong political will and adequate government capacity are key to supporting the advancement of smart cities in developing countries. New technologies can improve services delivery when government officials have the capacity to use and respond to them.

---

46. "ISO/TS 37151:2015(en)," International Organization for Standardization, 2015, https://www.iso.org/obp/ui/#iso:std:iso:ts:37151:ed-1:v1:en.

47. Maria Lazarte, "How to Measure the Performance of Smart Cities," International Organization for Standardization, October 5, 2015, http://www.iso.org/iso/home/news_index/news_archive/news.htm?refid=Ref2001.

48. Fujino Junichi, Shuzo Murakami, Toshiharu Ikaga, and Shun Kawakubo, "CASBEE-City Pilot Version for Worldwide Use (2015)," (PowerPoint presentation at the 2015 Conference of Parties, Paris, December 2, 2015), http://cop21-japanpavilion.jp/program/151202/1330-1500/pdf/cop21-jp-151202-1330-1500-presentation-03.pdf.

49. "Doing Business: Measuring Business Regulations," World Bank, http://www.doingbusiness.org/.

This chapter has considered the specific example of a smart city approach in Jakarta, Indonesia. Various entities in Jakarta are pursuing vehicles to make the city a higher-quality and more productive place to live for its citizens. Jakarta faces significant challenges given its rapid urbanization and the accompanying strain on weak city infrastructure, but several facets of Jakarta provide an enabling environment for a smart cities approach. This includes strong political leadership and desire from the people for good services delivery; a high number of smartphone and social media users; and a thriving innovation scene.

Jakarta's government is responding to citizen demand with the Smart City Unit, a strong local example of the smart cities approach at work. Housed in the city government, this office is collecting big data and processing it to drive accountable governance and improve services delivery. Other cities should take note of its approach and its success. Donors and multilateral organizations can support such efforts by providing technical capacity building and mentorship, where gaps are identified. They can also promote global standards that provide incentive for cities to fare well in the smart cities arena.

Donors also play a role in catalyzing the take-up of new technologies that can positively affect the day-to-day lives of citizens, as well as more productive and energy-efficient operations for businesses. The chapter considered these goals in regards to the JICA-funded MRT system and the JCM. Technologies such as these have the potential to be transformational, but questions remain about how they can achieve scale. Pursuing joint ventures between local and foreign companies that build domestic capacity and marketing realistic payback periods that incentivize take-up of new technologies are two recommended approaches. This is also a governance issue—national and local policies that create a strong enabling environment for technology application are key to building the smart cities of the future.

04

Conclusion

Approaches to transformative innovation, or system-level innovation that shifts the existing system toward a totally new and sustainable way of operating,[1] are building momentum. These approaches, including efforts to build innovation ecosystems and implement smart cities technology in urban contexts, are part of the so-called fourth industrial revolution. This revolution is "changing how we work, how we live, and how we relate to one another" through revolutionary technologies.[2] It holds certain promise for people in developing countries.

International development stakeholders, including the governments of the United States and Japan, are putting greater emphasis on transformative innovation as a key driver of high-yield economic growth in their development policies and programs. As more countries move into middle-income status and face stagnating growth prospects, their needs and wants for international development are changing. If scaled to their potential and made sustainable, transformative innovation approaches can enable a new path to economic growth, sustainable development, and poverty reduction.

This report has considered the *how* of operationalizing transformative innovation by focusing on two concrete opportunities for developing contexts: innovation ecosystems and smart cities.

Building effective innovation ecosystems requires enabling linkages and collaboration among a broad array of stakeholders, including policymakers, academia, and the private sector. They require human capital, financial capital, physical infrastructure, and enabling policy. These ecosystems encourage the innovation and application of new ideas that respond to "what is needed by a society, market or individual."[3] Critical components of modern economic competiveness, these ecosystems enable societies to move toward transformative innovation.

---

1. Stirling et al., "Transformative Innovation."

2. Daniel Runde, "Is America Ready for the 'Fourth Industrial Revolution'?," *Foreign Policy*, April 4, 2016, http://foreignpolicy.com/2016/04/04/is-america-ready-for-the-fourth-industrial-revolution/.

3. "National Innovation Initiative Summit and Report," Council on Competitiveness, 46.

A key opportunity for developing countries that wish to strengthen innovation ecosystems is to localize Fabrication Labs. Fab Labs cannot solve every problem in low-income areas, but as spaces to create and collaborate and develop low-cost solutions to local challenges, they are useful vehicles to catalyze the development of local innovation ecosystems. They can be called a major breakthrough, democratizing access to technological infrastructure that supports open innovation and enables users to increase their skills as innovators, create prototypes, add value to existing products, and generate new sources of income. Successes and challenges experienced by Fab Lab Bohol and other Fab Labs cited in this paper can be used to inform the scale-up of Fab Labs in the Philippines and elsewhere. Key things to consider as Fab Labs are operationalized in developing contexts are their accessibility and financial sustainability.

A smart cities approach can enable highly urbanizing contexts to improve services delivery through the application of innovative technologies. This report has considered the specific examples of the Jakarta Smart City Unit, the Joint Crediting Mechanism, and the Jakarta Mass Rapid Transit system in Indonesia. As these examples demonstrate, smart cities require capable public administration as a match to new technology. Additionally, new technologies are often expensive for actors in developing countries, and donor funding is limited. Sustainable ways of scaling these initiatives are needed.

The Sustainable Development Goals have set the agenda for international development until 2030, and they highlight the importance of multi-stakeholder partnerships that embrace the transformative potential of science, technology, and innovation in developing economies. In this context, country governments, bilateral donors, multilateral organizations, universities, research institutes, and NGOs have the opportunity to learn about and embrace transformative innovation approaches in their work.

This report has presented a call to action to these stakeholders on how they can best support the introduction, sustainability, and scale-up of specific approaches to build innovation ecosystems and smart cities. There is opportunity now to continue this global conversation and operationalize transformative innovation for international development.

Appendix A. Specific Actors in Boston's Innovation Ecosystem

THE DESHPANDE CENTER FOR TECHNOLOGICAL INNOVATION, MIT

The Deshpande Center for Technological Innovation awards grants and other forms of assistance to researchers at MIT "whose work shows the potential to benefit society, transform markets and industries, and improve the quality of life for people across the globe."[1] The center works with a portfolio of technologies and focuses on the period prior to company formation and getting technology to a point when it can be licensed or commercialized. The Deshpande Center has funded more than 125 projects with grants totaling more than $15 million; of these projects, nearly 30 percent were spun out into a new venture.[2]

MASSCHALLENGE

MassChallenge runs a competition and accelerator for start-ups with a mission to "catalyze a startup renaissance."[3] MassChallenge does not take equity from successful companies; instead it seeks to build trust with higher-quality startups to attract them to the region. Each start-up vies for a portion of several million dollars in cash awards given at the end of the challenge. Since 2010, 835 start-ups have passed through MassChallenge's accelerator program and have raised over $1.1 billion in outside funding, generated over $520 million in revenue, and created over 6,500 jobs.[4] MassChallenge has recently begun to expand internationally with a global network of accelerators in Boston, the United Kingdom, Israel, Switzerland, and Mexico.

1. "Mission and History," MIT Deshpande Center for Technological Innovation, http://deshpande.mit.edu/about.
2. "Our Impact," MIT Deshpande Center, http://deshpande.mit.edu/about/our-impact.
3. "Impact Report 2015," MassChallenge, 2015, http://masschallenge.org/files/2015_Impact_Report.pdf.
4. Ibid.

CAMBRIDGE INNOVATION CENTER

The Cambridge Innovation Center (CIC) provides office space and management services for individual entrepreneurs and emerging start-ups. CIC was founded in 1999 as a community of entrepreneurs. By providing a professional office environment at a reasonable cost CIC allows entrepreneurs to focus on driving innovative and successful businesses. The model also helps entrepreneurs build networks within the broader start-up community. The center has housed over 900 companies that have attracted more than $3 billion in professional investment since its founding.[5]

MIT REGIONAL ENTREPRENEURSHIP ACCELERATION PROGRAM (REAP)

REAP is an initiative at MIT designed to use entrepreneurship as a way of helping developing regions around the world accelerate economic growth and job creation. A cohort of eight regions is selected to participate in a two-year engagement, at which point each participating region forms a team of five to eight members. Teams participate in two-and-a-half-day workshops at MIT twice each year, but receive guidance and coaching throughout the period of engagement.[6] REAP evaluates the strengths and weaknesses of a region's innovation ecosystem, and performs an assessment of the conditions necessary for change in that environment. REAP's theory of change is that connecting research to practical action is the only way to drive forward innovation and development.

MIT LEGATUM CENTER

The Legatum Center at MIT aims to accelerate social and economic progress across the developing world through innovation-driven entrepreneurship. In order to accomplish this goal the center facilitates a fellowship program, seed grants, and research assistantships that are available to MIT students from developing countries. These students are encouraged to develop innovations relevant to their home-country context. The fellows at the center have launched enterprises in nearly 20 industries across 40 countries and on 5 continents.[7]

5. "Who We Are," Cambridge Innovation Center, http://cic.us/who-we-are/.

6. "Regional Entrepreneurship Acceleration Program," MIT Sloan Executive Education, http://executive.mit.edu/openenrollment/program/regional-entrepreneurship-acceleration-program#undefined.

7. "Our Programs," MIT Legatum Center, http://legatum.mit.edu/our-programs.

Appendix B. Notable Approaches to Building an Innovation Ecosystem in the Philippines

USAID SCIENCE, TECHNOLOGY, RESEARCH AND INNOVATION FOR DEVELOPMENT (STRIDE) PROJECT

USAID STRIDE is a five-year, $32 million program under the White House Partnerships for Growth initiative that began its work in the Philippines in 2013.[1] It is the result of the USAID/Philippines Mission's recognition of the importance of inclusive economic growth in the Philippines. STRIDE seeks to achieve this economic growth through strengthening higher education innovation. It operates on the concepts that collaboration is a key to innovation and linkages pave the way for sustainability. STRIDE's primary activity is providing grants for university research projects, in which local recipients work with industry or a U.S. university. The grants thus foster collaboration and enable capacity building. STRIDE is implemented by RTI International.

Once STRIDE began its work, program staff saw a great will to research and innovate by Filipino universities, but specific challenges stood in the way. RTI authored a Philippines Innovation Assessment white paper, which established a report card on innovation in the Philippines. This paper found that a key bottleneck to innovation is procurement policies; procurement in particular causes a chain reaction leading to brain drain, as researchers do not get the supplies they need. Both legislation and internal processes need to be reformed in response. For example, the state universities' board of regents is not well trained and only meets three to four times a year to approve large purchases. The white paper also identified limited research capacity, an emphasis on

1. "Science, Technology, Research and Innovation for Development (STRIDE) Project," U.S. Agency for International Development, https://www.usaid.gov/philippines/partnership-growth-pfg/stride.

intellectual property (IP) rather than collaboration, and a lack of trust between industry and universities as key limitations.[2]

As part of its work, STRIDE held a procurement summit and is also mentoring knowledge and technical transfer offices (KTTOs) at Filipino universities. Officers from seven KTTOs are undergoing training to set up single points of contact for external partnerships at their universities, understand the university's internal network, and build a value proposition. One danger of KTTOs is that they tend to focus on revenues, an approach driven by the national government. Many universities in the Philippines have structured their research or innovation platforms around a quest for IP, patents, or start-ups. STRIDE and other stakeholders see danger in this stifling collaboration, as people become more protective with their ideas and there is less sharing when the focus is on revenue. Universities that adopt the mindset that innovative ideas should be the focus, and that these ideas can make money down the road, will be more successful in achieving innovative outcomes. Good ideas speak for themselves and attract company investment. Additionally, there are benefits to collaborative innovation other than revenue, including internships for students.

There will be an exchange program arranged for select KTTO officers to visit a U.S. university in the future; it is important to note that this will not be an institution such as MIT. This is "too big of a leap for universities in the Philippines. It sets too high of expectations."[3] The program staff is instead considering community colleges for the exchange.

ATENEO INNOVATION CENTER

The Ateneo Innovation Center at Ateneo de Manila University has achieved success in spurring innovations by encouraging its researchers to conduct research that has applications for society. Successful innovations that have come from the center include a program to monitor water quality in Lake Palakpakin that has drawn on the knowledge of the local community and benefits local fishers. The center has also developed an array of low-cost products that respond to challenges in lower-income communities. This includes a solar-powered clean water system, which transforms rainwater into potable water, a nebulizer for asthma patients made from a bike pump, a phototherapy light for jaundice that costs approximately $10, and a waterproof cloth that holds a reusable heat pad for transporting babies in boats.

Ateneo believes it is important to ask challenging questions and focus on the low-hanging fruits that a community can benefit from. When prospective innovators have a specific focus and consider the benefits their outputs will have for a group of people, this spurs new ideas. Research should be led by industry and driven by need.

2. STRIDE, "Philippines Innovation Ecosystem Assessment: Executive Summary," *International Journal of Philippine Science and Technology*, March 8, 2015, http://philscitech.org/2015/1/1/002.html.

3. Meeting with David Hall, Chief of Party, USAID Science, Technology, Research, and Innovation for Development (STRIDE) Program, December 7, 2015.

Appendix C. Joint Crediting Mechanism (JCM) Indonesia Sites Included in Case Study

CSIS and JICA-RI researchers visited four Indonesian companies participating in the JCM:

- *Project of Introducing High-Efficiency Refrigerator to a Food Industry Cold Storage in Indonesia*
    - Technology: High-efficiency refrigerator
    - Project Owner: PT. Adib Global Food Supplies
    - Technology Provider: Mayekawa Manufacturing Co.
- *Energy Saving through Introduction of Regenerative Burners to the Aluminum Holding Furnace of the Automotive Components Manufacturer*
    - Technology: Regenerative burners
    - Project Owner: PT. Yamaha Motor Parts Manufacturing Indonesia
    - Technology Provider: PT. Toyota Machinery Corporation, Hokuriku Techno Co., PT. Toyota Tsusho Indonesia, PT. MatahariWasisoUtama
- *Energy Saving for Textile Factory Facility Cooling by High-Efficiency Centrifugal Chiller*
    - Technology: High-efficiency centrifugal chiller
    - Project Owner: PT. Nikawa Textile Industry
    - Technology Provider: Bara Refrigeration Equipment & System Co.
- *Energy Saving at Convenience Stores*
    - Site Location: AlfamidiTebet
    - Technology: LED lighting, natural refrigerant, inverter air-conditioning

- Project Owner: Lawson-Alfamidi
- Technology Providers: Lawson and Panasonic

Note: Under the JCM subsidy program, the project owner can also be the technology provider.

About the Project Directors and Authors

Naohiro Kitano is director of the JICA Research Institute, Japan International Cooperation Agency (JICA). In 1983, he graduated from the Civil Engineering Department at Waseda University and joined the Overseas Economic Cooperation Fund, Japan (OECF). Prior to his current assignment, he served in various positions, including representative, Beijing Representative Office, OECF, from 1992 to 1996; associate professor, Graduate School of Economics, Kyoto University, from 2003 to 2005; director general, Development Assistance Department II, Japan Bank for International Cooperation (JBIC) in 2008; director general, East and Central Asia and the Caucasus Department, JICA, from 2008 to 2012; and deputy director, JICA Research Institute. He studied in the Department of Civil and Environmental Engineering, Tsinghua University, Beijing, from 1981 to 1982, and obtained a PhD in city and regional planning from Cornell University in 1997.

His publications include: N. Kitano, and Y. Harada, "Estimating China's Foreign Aid 2001–2013," JICA-RI Working Paper 78 (2014); "China's Foreign Aid at a Transitional Stage," *Asian Economic Policy Review* 9, no. 2 (2014): 301–317; "Japanese Development Assistance to ASEAN Countries," in *ASEAN-Japan Relations*, ed. T. Shiraishi and T. Kojima (Institute of Southeast Asian Studies, 2014); and "Analysis of Spatial Organization and Transportation Demand in an Expanding Urban Area: Sendai, Japan, 1972–92," in *Facets of Globalization: International and Local Dimension of Development*, ed. S. Yussuf, S. Evenett, and W. Wu (World Bank, 2001).

Daniel F. Runde is director of the Project on U.S. Leadership in Development and the Project on Prosperity and Development and holds the William A. Schreyer Chair in Global Analysis at CSIS. His work centers on leveraging American soft-power instruments and the central roles of the private sector and good governance in creating a freer and more prosperous world. Previously, he led the Foundations Unit for the Department of Partnerships & Advisory Service Operations at the International Finance Corporation. His work facilitated and supported over $20 million in new funding through partnerships with the Bill and Melinda Gates Foundation, Rockefeller Foundation, Kauffman Foundation, and Visa International, among other global private and corporate foundations.

Earlier, Mr. Runde was director of the Office of Global Development Alliances at the U.S. Agency for International Development (USAID). He led the initiative by providing training, networks, staff,

funds, and advice to establish and strengthen alliances, while personally consulting to 15 USAID missions in Latin America, the Middle East, and Africa. His efforts leveraged $4.8 billion through 100 direct alliances and 300 others through training and technical assistance. Mr. Runde began his career in financial services at Alex. Brown & Sons in Baltimore and worked for both CitiBank and BankBoston in Buenos Aires, Argentina. He received an MPP from the Kennedy School of Government at Harvard University and holds a BA, cum laude, from Dartmouth College.

Helen Moser is a research fellow with the Project on U.S. Leadership in Development and the Project on Prosperity and Development at CSIS. Her research interests include good governance approaches, private-sector engagement in international development, and women's political participation. Prior to joining CSIS, she conducted research with the Brookings Institution on shared value approaches in the public-private partnerships of the U.S. Agency for International Development. She has also worked with the Georgetown Institute for Women, Peace, and Security; Save the Children, in Sri Lanka; Vital Voices Global Partnership; and the Asian University for Women, in Bangladesh. Her experience additionally includes positions in the nonprofit and public sectors in the Federated States of Micronesia, Germany, Scotland, and Taiwan. She is a Phi Beta Kappa graduate of the University of Southern California and holds an MA in global human development from Georgetown University's School of Foreign Service.

Charles Rice is a research assistant with the Project on Prosperity and Development, where he has worked in trade, investment, and governance in international development. Prior to joining CSIS, he worked as an English language teacher in Beijing and Yinchuan, China, for the Bainian Vocational Schools, a nonprofit vocational education program funded through the China Youth Development Foundation. Mr. Rice holds a BS in international political economy from the Edmund A. Walsh School of Foreign Service at Georgetown University.

COVER PHOTO FAB LAB BOHOL

CSIS | CENTER FOR STRATEGIC & INTERNATIONAL STUDIES

1616 Rhode Island Avenue NW
Washington, DC 20036
202 887 0200 | www.**csis**.org

ROWMAN & LITTLEFIELD

Lanham • Boulder • New York • London

4501 Forbes Boulevard
Lanham, MD 20706
301 459 3366 | www.**rowman**.com

ISBN 978-1-4422-5953-9