

## Appropriate Technology and the Triple-Helix Model: A Case Study of Korea-Tanzania Appropriate Technology Center

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In 2017, aiming at developing, educating, and commercializing innovative appropriate technologies that are suitable for Tanzanian environment, the Ministry of Science and ICT in Korea established an innovative technology and energy center in a Tanzanian university. Using the qualitative methodologies such as an ethnography of a research project, document analyses of memoranda of understandings, journal articles, reports, announcements, and newspaper articles, participant observation of formal and informal meetings, and semi-structured interviews with participants engaging in an appropriate technology center, this study examines how triple helix model in S&T innovation has been applied to the development of the Korea-Tanzania appropriate technology center. Despite growing importance in national S&T policies, only few studies have discussed office development aid (ODA) in association with innovation. The analysis of the appropriate technology center with the framework of the triple-helix model shows the close tie between official development aid (ODA) and the cross national innovation promoted in Korea. This study also contributes to understanding embedded organizational structure, conflicts, and barriers of an ODA project in Korea.

**KEYWORDS:** Innovation, Appropriate technology center, Triple-helix model, ODA, Tanzania

### Introduction

Transitioning from a recipient to donor country of Official Development Aid (ODA) in 2010, the Korean government has strategically utilized appropriate technologies in the aid programs (NSTC 2011, CIDC 2012, NPA 2013, NPA 2017). In particular, in the 21<sup>st</sup> century, the Korean government has used the term “appropriate technology” as a slogan of transferring the economic success of Korea to other developing countries (Lee, 2013). In Korea, appropriate technology,

however, is not a new term that has appeared with financial and technological aids delivered to other developing countries. According to Lee (2013), the term has emerged in Korea in the 1970s with the national economic development programs, also referred to *Semaeul* movement. The author claimed that, in the 1970s, the Korean government used the term for encouraging national movement for the economic development (Lee, 2013). Therefore the Korean government has politically utilized the term “appropriate technology” both nationally and internationally.

Despite growing political importance in the development of national science and technology (S&T) policies, only few studies have discussed appropriate technology in relation with S&T innovation (Smith et al., 2014; Aubert, 2005). In order

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to fill the gap in previous studies, this paper explores the case of an appropriate technology center with the framework of the triple-helix model, which explains national S&T innovation. According to Etzkowitz (2003), in most countries, national S&T innovation has evolved with the frame of triple-helix, a tri-lateral cooperation among government, academia, and industry. In order to investigate the relationship between the national S&T innovation and appropriate technology center, this study answers the following research questions: How is the triple-helix model applied to the development of the appropriate technology center? In particular, is there a government-university-industry connection? Are people from various sectors engaged? Finally, what are conflicts and barriers resulted from the application of the triple helix model?

To examine the appropriate technology center using the triple-helix model, this study uses the definition of Jequier and Blanc (1983:10):

Appropriate technology (AT) is now recognized as the generic term for a wide range of technologies characterized by any one or several of the following features: low investment cost per work-place, low capital investment per unit of output, organizational simplicity, high adaptability to a particular social or cultural environment, sparing use of natural resources, low cost of final product or high potential for employment.

Because the definition of Jequier and Blanc addresses appropriate technology as a variety of technologies, the definition does not limit the range of technologies. Thus it is suitable for studying appropriate technologies relevant to S&T innovation, which refers “new products and processes and significant technological changes of products and processes” (OECD Frascati Manual, Sixth edition).

As methodologies, this study uses the qualitative approach including an ethnography, document analyses, participant observation, and semi-structured interviews with participants engaging in an appropriate technology center. In particular, the study examines how triple helix model in S&T innovation has been applied to the development of the Korea-Tanzania appropriate technology center. The close investigation of the appropriate technology center in terms of the triple-helix model contributes to understanding embedded organizational structure, conflicts, and barriers of official development aid (ODA) programs in Korea. This paper first examines the

triple-helix model, second introduces research design and sites, and then discusses findings based on research questions. Finally, the paper concludes with implications, limits and possible future studies.

## Triple-helix model

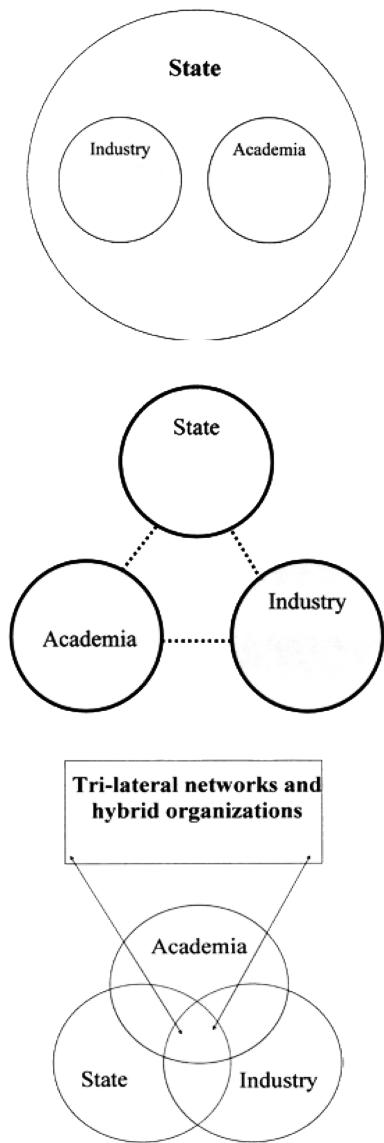
Investigating the emergence of the tri-lateral cooperation among industries, academia, and governments, also referred as the triple helix model, Etzkowitz (2003) argued that universities had evolved as a key actor for transforming knowledge into use while the government has served as a financial supporter and industries have acted as a user of knowledge. That is, the triple-helix model suggests that, at a national level, different organizational actors contribute to S&T innovation. According to Etzkowitz and Leydesdorff (2000:111), the shape of tri-lateral cooperation among three sectors—university, industry, and government—has evolved in the following three phases:

- Triple Helix I: The nation state encompasses academia and industry and directs the relations between them.
- Triple Helix II: Separate institutional spheres with strong borders and highly circumscribed relations among the spheres.
- Triple Helix III: Overlapping institutional spheres with each taking the role of the other and with hybrid organizations emerging at the interfaces.

The above phases address the transition of the relationship among three organizational actors engaging in S&T innovation. Figure 1 shows three models of university-industry-government relations. The role of government is stronger in the first phase than those in the second and final phases. While the second phase entails compartmental roles of each actor, the final phase denotes weak boundaries among three actors.

Etzkowitz and Leydesdorff (2000) claimed that, currently, most countries are in the final phase that each sphere overlaps and generates hybrid organizations. For example, Leydesdorff (2005:4) said:

Industries have to assess in what way and to what extent they decide to internalize R&D functions. Universities position themselves in markets, both regionally and globally. Governments make informed trade-offs between investments in industrial policies, S&T policies, and/or delicate and balanced interventions



**Figure 1.** Three models of university-industry-government (state) relations (Source: Etzkowitz and Leydesdorff, 2000).

at the structural level.

The above passage well illustrates ambiguous boundaries among three actors. The strength of the triple-helix model is that it conceptualizes the evolution of organizational actors and their collaboration for national innovation. However, focusing on the balance among industrial, academic, and government actors for the achievement of national innovation, the triple-helix model failed to entail the role of other actors such as regional environment or individuals. Accordingly, engaging the fourth and fifth actors such as civil society, natural environments, and national economy, Carayannis and Campbell

(2009, 2010) further introduced the quadruple-helix and the quintuple-helix models. However, critiques have suggested that the triple-, quadruple-, and quintuple-helix models do not sufficiently address the role of international collaboration in S&T innovation (Elzinga, 2004, Villarreal and Calvo, 2013).

In addition to limits in discussing international collaboration, an empirical study shows that the triple helix model only applies to the regions where industries are capable of assimilate academic knowledge (Pugh, 2016). Investigating the ‘triple helix’ policy in Wales, the UK, Pugh (2016) asserted that the triple helix model is not appropriate for the region where industries do not have the absorptive capacity of knowledge produced in universities. According to the author, because the Welsh industries did not possess capacity to adopt innovative knowledge from universities, most S&T programs driven by universities have failed. That is, while the triple helix model sets a university as a leading actor of the national innovation, universities fail to drive the national innovation in regions where the gap between academic and industrial capabilities in S&T is large. Pugh (2016) suggested that Welsh region needs to increase the absorptive capacity of regional industries prior to apply the triple helix policy. The author successfully showed the weakness of triple helix model through a case study, but the study does not explain the evolution of multi-lateral collaborations crossing regional and national boundaries because it is limited in the regional boundary.

In Korea, the framework of the triple-helix has been applied to the development of both national and cross-national innovations. As for the national innovation, Yoon (2015) suggested that Korean universities have transitioned into leading actors in the triadic collaboration among university-industry-government since 2001. According to the author, transforming universities as key actors, Korean government had tripled their budget for academic research from \$894 million to \$3.4 billion throughout 2002 and 2012. She also suggested that the entrepreneurial paradigms in Korean universities has decreased organizational boundaries and increased university-industry collaborations for national S&T innovation.

In addition to the case of national innovation, a typical case of cross-national innovation that entails the model of triple helix is the case of an appropriate technology center called Korea-Tanzania Innovative Technology and Energy Center. In 2017, the Korean Ministry of Science and ICT established the

center in Tanzania as a part of the Official Development Aid programs. In the case of the Korea-Tanzania Innovative Technology and Energy Center, the government serves as a major financial supporter of the project, a university is the main operator of the center, and a social enterprise supports the commercialization of the invented technologies. While each actor embodies a major role, the organizational boundaries among three actors are ambiguous because the roles of each organization are complexly intertwined. For example, a university not only provides the technological knowledge, but also promotes the commercialization by patenting technologies invented during the project. In advance to examine the close tie between the triple helix model and the Korea-Tanzania Innovative Technology and Energy Center in detail, the following section introduces research design and sites.

## Research Design and Sites

From January to August 2018, I conducted the eight months of field work in an appropriate technology center located in both Korean and Tanzanian universities. During my fieldwork, I observed interactions among participants engaging in the joint projects including laboratory and field experiments, meetings, and conferences, and took detailed notes on my observations. In total, fifteen subjects including directors, professors, researchers, technicians, and managerial staff members in Korea and Tanzania who works for the center were observed and interviewed. I also analyzed the content of relevant documents such as memoranda of understandings, journal articles, social media, event programs, announcements, and newspaper articles.

As for ethnography and participant observation, Babbie (2016) asserted that taking detailed notes of on-going scenes and actions in the field effectively captures the social process. The author suggested that, despite the difficulties of observing and recording everything in the field, researchers should include both observations and interpretations in their notes. He also argued that researchers should be prepared for unanticipated situations even though preparing protocols in advance helps to take notes on important observations in the field. The strengths of ethnography and participant observation as well as other qualitative field research is the depth of understanding and the flexibility of research design (Babbie, 2016). However, the weakness of qualitative research is generalizability.

According to Babbie (2016), focusing on a specific group in the study may lead to an overgeneralization and an oversimplification of the data gathered in the field. Despite weakness in generalizability the qualitative approach in the study not only identified the close connection between the national innovation and the ODA program, but also showed conflicts and barriers of incorporating actors from various sectors.

## Findings

### 1. Government-University-Industry Connection

Since 2015, the Korean Ministry of Science and ICT has established local appropriate technology centers in developing countries such as Cambodia, Laos, Nepal, Tanzania, Ethiopia, and Vietnam as parts of government funded ODA programs in Korea (Go, 2018). The centers focus on sustainable development of the countries by operating S&T programs needed in the recipient countries. The Tanzania-Korea Science and Technology Center, also referred to the Innovative Technology and Energy Center, is one of the appropriate centers established by the Korean Ministry of Science and ICT in 2017 (ITEC, 2018). Therefore, the government, one of the actors in the triple helix model acts as a major financial supporter of the center. Academia, another key actor of the knowledge economy in the triple-helix model, has been selected as the main operator of the program because scientific and technological knowledge is the seed of potential economic benefit for sustaining the center. The research topics of the center focus on renewable energy, agriculture, water, education, and business (ITEC, 2018). As for the renewable energy, the center built 40 kW solar energy generator and its monitoring system in a Tanzanian rural village where the energy accessibility is low. The research on agriculture focuses on the development of storage and packaging system using the generated solar energy, and the study regarding water centers on the development of irrigation system for agriculture. Finally, combining education and business, the center mentors how to start and sustain local start-up companies. Through the mentorship project, a social enterprise represents the rest sphere of the triple helix model, an industrial sector.

In terms of the financial support, the role of governmental organizations is crucial. The Korean government sponsors two billion KRW (Approximately 1,753,000 USD) for three years

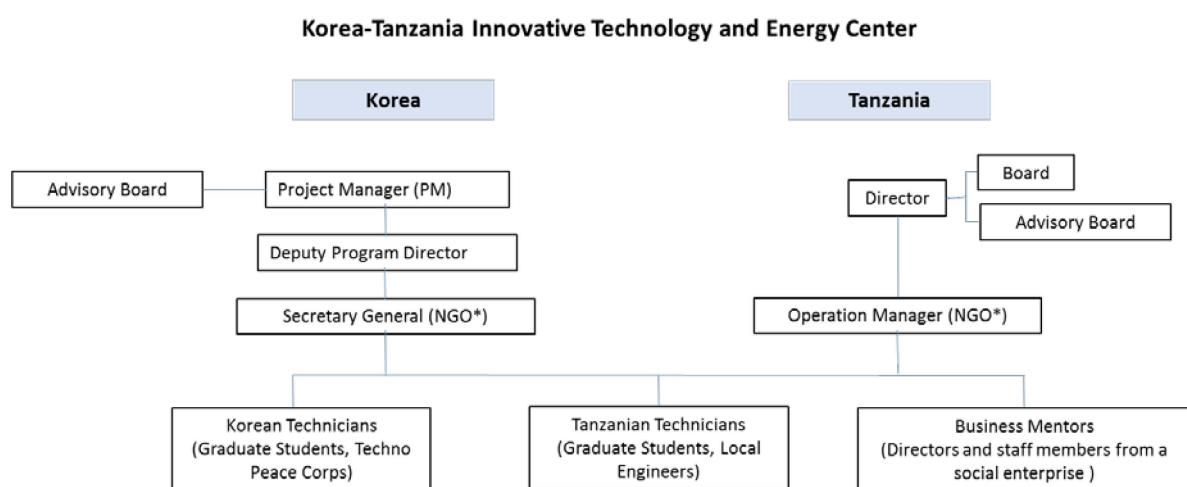
and nine months until 2020. The annual budget of the center is five-hundred million KRW (Approximately 438,000 USD). Financial sources of the center uncover various organizations participating in the establishment of the center. First, the Korean government serves as the financial investor of the development of appropriate technologies in Tanzania. Second, physically, the center is located in a government funded S&T university in Tanzania that has provided administrative offices, research spaces, and engineering equipment as well as professional networks between the Tanzanian and Korean universities. Last, research spaces and equipment in the Tanzanian university were originally founded by the World Bank.<sup>1</sup> Thus, while the Korean government is the initiator of the appropriate technology center, the initiation would not emerge without the land from the government funded Tanzanian university and buildings and equipment from the World Bank.

Human resources of the center also suggest that various types of organizations such as university, government, and social enterprise participate in the project. The center consist of a Korean project manager, a deputy director, a Korean local director, administrative and engineering staff members including engineering students under the academic supervision of the Korean program director, a director and staff members of a participating social enterprise, and the technicians of the “Techno Peace Corps (TPC)” project sponsored by the Korea International Cooperation Agency (KOICA). In addition,

professors in the Tanzanian university are actively engaging in the projects of the center as the project expands. Figure 2 shows the map of human resources of the center based on the project website and the fieldwork. As the composition of human resources shows, not only universities, but also the government and the enterprise support managerial, administrative, research, and technical personnel for the center. Although the center has not yet actively engaged with industries other than partnering with a social enterprise, as commercializing technologies invented in the center is one of the final goals, social enterprise has been providing business mentoring from the initial stage.

## 2. Engagement of People from Various Sectors

The Korea-Tanzania Innovative Technology Center emerged with the launching of a new project and the gathering of people from various sectors. After the establishment of local appropriate technology centers in Cambodia, Laos, Nepal, the Korean Ministry of Science and ICT released a similar project that builds and operates an appropriate center in a Tanzanian university. Because the ministry requested the inclusion of a project manager (PM) from a university in Korea, a director from a social enterprise that has been providing solar panels in rural Tanzania contacted a professor in a national university in Korea to form a consortium. According to an interviewee from the social enterprise, people from a non-government organization (NGO), which later merged to the social enter-



**Figure 2.** The map of human resources (Source: ITEC 2018, Participant observation)

\*Non-Government Organization (NGO) participating in the project later has merged with a social enterprise

<sup>1</sup> Interviewed on June 29, 2018.

prise also participated from the stage of writing proposals for the project. Regarding the emergence of the project and gathering personnel from various sectors, the interviewee from the social enterprise said:

Because we are a small company, the donor of the project [, which is the Korean government,] has asked us to apply the project as a consortium. To be a consortium, we need a PM from a university. ... A professor who has been working in the field of an appropriate technology introduced us a current PM of our project. ... An NGO helped us write the proposal when we applied for the project. Then we merged with the NGO and built the Korean branch of our company.<sup>2</sup> The above short excerpt from an interview shows that the existent social ties among people who have served in the field of an appropriate technology in academia, industry, and NGO created another connections and gathered people for the new project.

Participants from a Tanzanian university emerged through co-organizing the conference and signing the memorandum of understanding (MOU). According to a professor from a Tanzanian university,

I think it is through MOU that our Korean partners came and visited us. We met, and we had some discussion. Now they have concrete project, you know, without projects, MOU is just a piece of paper. When they visited me, it was amazing that, you know, the kind of things they were talking about were fitting very well in what we have been doing.<sup>3</sup>

The MOU was signed in December when professors and students from Korea visited Tanzania before the official initiation of the project (ITEC 2018). The above excerpt shows that signing MOU between Korean and Tanzanian universities was the initial step for operating the appropriate technology center in Tanzania. However, the signing of MOU did not just occur out of previous engagement. Prior to signing the MOU, both universities co-organized the international conference on Energy and Sustainability (ICES) 2017 that was held in Tanzania in August 2017 (ITEC 2018). Thus, based on social networks created during the conference, both partners signed MOU and began the project.

<sup>2</sup> Interviewed on June 22, 2018.

<sup>3</sup> Interviewed on June 29, 2018.

### 3. Conflict and barrier

In the field, the engagement of people from different sectors such as government, academia, and industry created the question of “who’s taking in charge of what?” To put it differently, in the beginning of the project, unclear role assignment among actors from different sectors led conflicts among participants in Korea. A typical example was a communication problem. An interviewee from the university in Korea said:

Communication was the hardest part of this project. Because different institutions were gathered, for example, one of researchers in our team had trouble with people from an NGO, and our team had another trouble with upper institution within our university. It was first time for our upper institution and us to conduct an ODA project so we had a lot of trouble. We are still in the beginning stage, but things are more organized than the first year. In the first year, we didn’t know the work scope and who should be taking in charge of it. It is getting better because we understand collaboration among different institutions is more than necessary to sustain this project.<sup>4</sup>

While the communication caused conflicts among participants, the above interviewee suggested that the conflicts occurred in the first year tightened the collaboration among the actors in the second year. Etzkowitz and Leydesdorff (2000) argued that the boundaries among organizations are weak and the role of each organization overlaps in the third stage of the triple helix model. As their organizational roles overlap, in practice, participants struggled to reset the work boundary and reduce conflicts.

In addition to conflict caused by vague boundaries among various sectors, the application of the triple-helix model resulted in administrative and financial barriers. According to an interviewee from the social enterprise,

Partnership became problematic when we wanted to be outsourced from the center. That is, my company serves as a partner of the university in Korea and the university is not allowed to outsource any project to partner companies because it is considered favoritism. We wanted to join the project because we are specialized in training and mentoring the commer-

<sup>4</sup> Interviewed on May 24, 2018.

cialization of business projects developed in the center. But, to outsource any project, the university must find another company that is not a partner. If you are not allowed to work with your partner, what's the point of the partnership?<sup>5</sup>

Criticizing the partnership system of the project, the above interviewee also mentioned that it is not a problem of the university regulations. It is the regulations of ministry in Korea that does not allow outsourcing projects to partner organizations. As shown in the interview excerpt, outsourcing to a partner organization is viewed as a “favoritism” under current regulations in the Korean government. Because this study only focuses on the relationship between the national innovation model and the appropriate technology center, determining the appropriateness of current government regulations is difficult. However, in order to sustain close ties among participant organizations from various sectors, a balance must be made between administrative procedures that are necessary and bureaucratic regulations that hinder active participation of actors.

## Conclusion

This study investigated the Tanzania-Korea appropriate technology center with the framework of S&T innovation called the triple-helix model. The Ministry of Science and ICT in Korea applied the triple-helix model to establish an appropriate center in Tanzania by setting a PM from a university and promoting the commercialization of technologies developed in the center. The Tanzania-Korea appropriate technology center that was built in Tanzania in 2017 entails participants from a university, a social enterprise, and an NGO that later merged with the social enterprise. As the foundational triple-helix model suggests, the government provides financial resources, the university shares knowledge, and the social enterprise supports the commercialization for the center. The major roles are different for actors from each sector. However, as it is noted in the third stage of the triple helix model, various roles overlap and the boundaries among different organizations are unclear in the project.

The close investigation of the appropriate technology center in relation with the triple-helix model contributed to under-

standing the social ties, conflicts, and barriers inhered in the project. To initiate and operate the project, participants from universities, an enterprise, and an NGO gathered together. An interview with the participant showed that existing social connections were crucial for gathering experienced personnel. In the beginning of the project, vague boundaries among various sectors generated conflicts among participants. Because the boundaries and role assignments were not clear, participants tried to reorganize the boundary in order to reduce conflicts. In addition, another interviewee claimed that the government regulation prohibits the outsourcing of the project to the partner organizations and creates administrative and financial barriers. According to the interview, universities are not allowed to outsource project to partnered organizations because of “favoritism.” Even though this study does not determine whether the prohibition of outsourcing to partner organizations is necessary or not, the identified barrier shows hardships that partner organizations encounter during the project.

This study implies that future policies of official development aid (ODA) programs in Korea should focus on understanding merits and demerits of engaging actors from various sectors in order to reduce institutional conflicts and barriers that hinder the sustainable development of ODA programs. In addition, to reduce administrative barriers, government and institutional regulations must reflect what are needed in the field. That is, administrative procedures should be set to encourage cross-national innovative activities in the field of the appropriate technologies. Because the study only discussed a case of Tanzania-Korea appropriate technology center, which is the currently on-going program, more case studies pertaining to other appropriate technologies centers will contribute to further understanding the relationship between appropriate technology centers and S&T innovation.

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<sup>5</sup> Interviewed on June 22, 2018.

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