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Critical Role of Intermediaries on Technology Transfer: Case Study of BIOTROP and Center for Mariculture Development of Lampung

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Abstract. *Relationship among technology generator and technology user is one of factors determining successful technology transfer, but the existence of intermediaries is proven to enhance the absorptive capacity of technology user, especially in rural areas. Government can enact as intermediary by supporting the relationship generator-user, which is commonly found in agriculture and fishery sectors. The aim of this study is to demonstrate how government can support technology transfer from academic institution to rural industry. Using case study method, this study focused on the critical role of Center for Mariculture Development of Lampung (CMDL) which acts as an intermediary of technology transfer process from Southeast Asian Ministers of Education Organization- Southeast Asian Regional Center for Tropical Biology (SEAMEO-BIOTROP) to seaweed farmers. This study shows that intermediary agent plays an important role in articulating demand from technology user to technology generator, creating network between adopter-generator, and providing resources (fund, technician, industrial-scale laboratory) for technology commercialization. Intermediary with strong commitment to deliver technology to society is highly needed in successful technology transfer.*

Keywords: *Intermediary, seaweed, technology transfer, technology adoption, tissue culture*

Abstrak. *Hubungan antara penghasil dan pengguna teknologi merupakan salah satu faktor yang menentukan keberhasilan transfer teknologi, tetapi keberadaan lembaga perantara telah dibuktikan mampu meningkatkan kapasitas absorbsi pengguna teknologi, terutama di daerah pedesaan. Pemerintah dapat berperan sebagai perantara antara penghasil dan pengguna teknologi, seperti yang umum ditemukan di sektor pertanian dan perikanan. Tujuan penelitian ini adalah untuk menunjukkan bagaimana pemerintah dapat mendukung transfer teknologi dari lembaga akademis ke industri pedesaan. Menggunakan metode studi kasus, penelitian ini fokus pada peranan vital Balai Besar Pengembangan Budidaya Laut (BBPBL) Lampung sebagai perantara proses transfer teknologi dari Southeast Asian Ministers of Education Organization- Southeast Asian Regional Center for Tropical Biology (SEAMEO-BIOTROP) ke pembudidaya rumput laut. Hasil penelitian menunjukkan bahwa agen perantara memainkan peranan penting dalam menerjemahkan permintaan dari pengguna teknologi ke penghasil teknologi, membangun jaringan antara pengguna-penghasil teknologi, dan menyediakan sumberdaya (dana, teknisi, laboratorium skala industri) untuk komersialisasi teknologi. Perantara dengan komitmen kuat untuk mengantarkan teknologi ke masyarakat sangat dibutuhkan untuk keberhasilan transfer teknologi.*

Kata kunci: *Perantara, rumput laut, transfer teknologi, adopsi teknologi, kultur jaringan*

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Introduction

Creating and developing technology are essential, but technology will become meaningless without implementation. Thus, the issue of technology transfer has grabbed scholars' attention, both in developed (Weber III, Gray,Jackson, & Steele, 1993; O'Shea, Allen, Chevalier, & Roche, 2005; Lam, 2011; Caldera & Debande, 2010; Nelson, 2014; Wu, Welch, & Huang, 2015) and developing countries (Fontes, 2001; Hsu, Shen, Yuan, & Chou, 2015). However, technology transfer is mostly discussed from the view of source of technology, such as university and research institution. As technology generator becomes the focus, the relationship between developer and user is often overlooked (Dardak & Adham, 2014).

Relationship among technology generator (academics) and technology user (industry/society) is one of factors determining successful technology transfer (Hsu et al., 2015), but the existence of intermediaries is proven to enhance the absorptive capacity of technology user, especially in rural areas (Theodorakopoulos, Deycy, Sanchez, & Bennett, 2012). Most studies put emphasis on how the link between academics and industry encouraging the process of technology transfer (Santoro & Chakrabarti, 2002; Ponomariov, 2008; Van Rijnsoever, Berg, Koch, & Hekkert, 2008; Giuliani et al., 2010; Dardak & Adham, 2014). However, studies by Theodorakopoulus et al. (2012), Bastos and Cooper (2005), Beddington and Farrington (2007), and Reece and Sumberg (2003) has shown that intermediaries or interventionist also play role in successful technology adoption by users in rural areas.

Boardman (2009) suggested that government can enact as intermediary by supporting the relationship between technology generator and technology user since government can provide center faculty and projects and also support integration between scientific and technical resources. In most cases, the role of government in technology transfer is viewed still weak, especially in developing countries (Theodorakopoulus et al., 2012).

Indonesia is facing the same problem as the link among triple-helix actors is not well-established. However, for the case of technology transfer to rural industry (such as agriculture and fishery), government hold quite a significant role. It is a common practice in Indonesia that technology related to agriculture and fishery are disseminated by technical units under Ministry of Agriculture or Ministry of Marine and Fisheries, since most farmers have limited access to research institution and these types of technology are less attractive for private firms.

The aim of this study is to demonstrate how government can support technology transfer from academic institution to rural industry. More precisely, we study the role of government technical implementation unit on mediating, advising, and supporting technology transfer from research center to farmers. The practical knowledge of the role of government in technology transfer will be the main contribution of this study.

Technology Transfer

Technology transfer can be defined in various ways depending on the discipline and purpose of research, for example economists focus on production and design, sociologists focus on reducing the uncertainty of cause–effect relationships, and anthropologists focused on cultural change (Bozeman, 2000). Generally, technology transfer is defined as the movement (through a mechanism) of an idea, method or device from a source (original context and purpose) to a destination (new context and purpose) (Bauer & Flagg, 2010). In this study, the source of technology is academic institution and the user is rural industry. Technology transfer from academic institution to users could be conducted in various mechanisms, there are research collaborations, research contract and consultation, training for industrial workers, human resource exchange between academic institution and industry, and commercialization (e.g. intellectual property protection, technology incubator, science park, and technology spin-off) (Hsu et al., 2015; Eun, Lee, & Wu, 2006).

Meanwhile, Perkmann, Tartari, McKelvey, Autio, and Brostrom (2013) divided technology transfer mechanisms in to two categories, there are academic engagement and commercialization. Academic engagement is the cooperation between academic and non-academic through research collaboration, research contract or consultation. Commercialization is the activities involving patenting and licensing of invention, and academic entrepreneurship activities (Perkman, et al., 2013). For commercialization, it can be classified in to disclosure of invention through intellectual property rights, and initiation of business development through incubator or spin-off (Hindle & Yencken, 2004).

Technology transfer is a process consisting of several stages. Balachandra, Nathan, and Reddy. (2010) proposed the concept of technology transfer process which is consist of three stages, there are research phase including basic and applied research, demonstration phase when prototype is developed, and commercialization phase when technology is introduced to market. Meanwhile, Bauer and Flagg (2010) presented the model of technology transfer based on Lane's (1999) work, which provide three key elements of technology transfer, there are events, activities and stakeholders. In line with Balachandra, et al. (2010), model developed by Bauer and Flagg (2010) consist of three event: 1) idea which is generated in technology application activities (basic research activities), 2) prototype as the output of technology research and development (applied research activities), and 3) product as the output of product development activities (market analysis, design, and development). Those activities is conducted by several actors. Research activities is conducted by technology producers (university, Public/private R&D institution), and product development activities is conducted by private sector as technology user. In connecting every stage in technology transfer process, it needs technology transfer intermediaries (Bauer & Flagg, 2010).

Technology Transfer Intermediary

In achieving the effectiveness of technology transfer process, there are several barriers due to the gaps between technology producers and users. Those gaps could be cognitive gaps (different background, norms, and incentive system), information gaps, and managerial gaps (Klerkx & Leeuwis, 2009). In order to reduce that gaps, it needs intermediary (Beaur & Flagg, 2010; Klerkx & Leeuwis, 2009).

Intermediary in technology transfer is the actor that connect, translate, and facilitate flows of knowledge (Van Lente, Hekkert, Smits & Van Waveren, 2003; Beaur & Flagg, 2010). It can be defined as "an organization that acts an agent or broker in any aspect of technology transfer process between two or more actors. The intermediaries activities including providing information about potential collaborators, brokering transactions, mediating, helping find advice, funding, and support for the outcome of collaboration (Van Lente, et al., 2003).

Intermediary institutions in technology transfer could be classified based on their characteristics, such as ownership, objective, source of funding, and type of services (Van Lente, et al., 2003). Küçüksayraç, Keskin, and Brezet (2015) divided the type of technology transfer into: 1) innovation and business development agency; 2) university and research center; 3) chamber of commerce and business association; 4) incubator and science park; 5) private consultant; and 6) other types. He also divided based on the nature (public, private, NGO, social enterprise) and target group (start-ups, SMEs, Les).

Van Lente, et al. (2003) categorized intermediaries in technology transfer into three types, there are Knowledge Intensive Business Services, Research and Technology Organizations, Public Organization or Industry Associations.

Table 1.
Classification of Intermediary in Technology Transfer

No	Intermediary	Ownership	Objective	Source of Funding	Services
1	Knowledge Intensive Business Services	Private	Profit	Fees charged to clients	Technical and Management
2	Research and Technology Organization	Semi-public	Supplying technical knowledge to industry, non-profit	largely government funding and additional income from clients	Technical knowledge
3	a. Industry Association	Independent association	Support of the industry, non profit	Membership fees or government subsidies	Various
	b. Chamber of commerce	(local) Government	Support commercial activity within its area	Annual fees of business in its area and fees for additional services	Support, training
	c. Innovation center	Government	Support or facilitate innovation	Government funding	Support, training, network building
	d. University-liaison office	university	Earn additional income for university	University and industry	Brokerage of applicable (science based) knowledge

There are three basic functions of technology transfer intermediary: 1) demand articulation (articulating innovation needs and corresponding demands in terms of technology, knowledge, funding, and policy); 2) network formation (facilitation of linkages among relevant actors, such as scanning, scoping, filtering, and matchmaking of possible cooperation partners); and 3) innovation process management (enhancing alignment and learning of the multi-actor network which involves facilitating learning and cooperation in the innovation process) (Klerkx & Leeuwis, 2009).

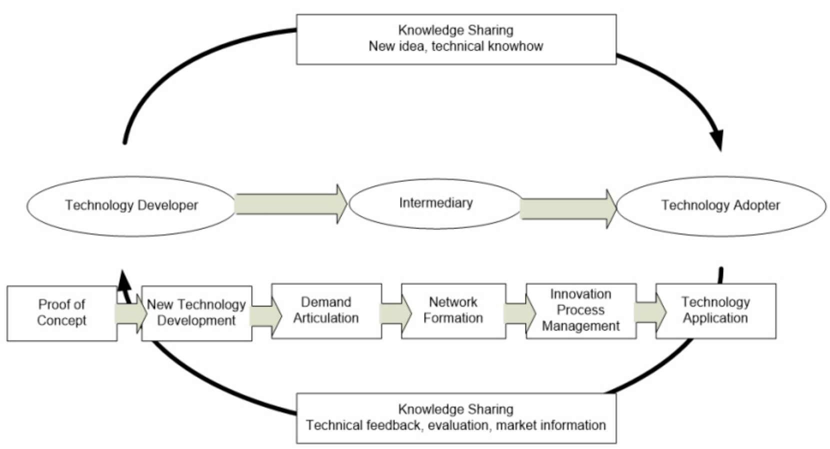
Howels (2006) expanded the functions of technology transfer intermediaries into: 1) foresight and diagnostics; 2) scanning and information processing; 3) knowledge processing and combination/recombination; 4) brokering; 5) testing and validation; 6) accreditation; 7) validation and regulation; 8) protecting the results; 9) commercialization; 10) evaluation of outcomes.

Meanwhile, the role of intermediary in transferring technology from university to rural industry in developing country has been studied by Theodorakopoulos, et al. (2012). They emphasized on two key components of success.

The first component is supply side. It is related to the role of intermediary as a broker in nurturing a coalition among actors that concerned with technology transfer (academic, government). Intermediary should be brokering to create a balanced membership structure, establish agreed accountabilities, and set common agendas and goals, action plans and technology transfer assessment frameworks. The next component is demand side, which is linked to the role of intermediary as a broker in the development of community of practice among technology users (farmers). In this role, intermediary should involve in the workshop and assistance visits activities and has a function as an interface between coalition (academic and government) and technology users. Those activities could give coalition the information from the demand-side, so that the technology transfer activities can be effective.

Research Methodology

This study is developed under conceptual framework of technology transfer process which involves technology generator, intermediary, and technology user. The figure shows that technology flows from technology generator or academic institution to technology user through intermediary agent. In technology transfer process, technology generator conducts concept proving which implies on "the marketability of a technology", then generating new technology that could improve the life of technology users (Dardak & Adham, 2014).Before the technology being applied, it should go through the process of demand articulation, network formation, and innovation process management under intermediary agent (Klerkx & Leeuwis, 2009).



Source: Modified from Dardak & Adham (2014); Klerkx and Leeuwis (2009)

Figure 1. Conceptual Framework of Technology Transfer Process

Technology transfer also involves mutual knowledge sharing among technology generator, intermediary, and adopter. Technology generators share their idea and technical knowhow to intermediary agent and technology users, while users provide technical feedback, evaluation, and information about market to developers through intermediary. Case study methodology on technology transfer of seaweed tissue culture was used in this study. As Abercrombie, Hill, and Turner (1984) stated, case study is "the detailed examination of a single example of a class of phenomena".

It implies that case study is suitable for an in-depth understanding of technology transfer process from academic institution to intermediary agent and technology user. In social sciences, case study is a "necessary and sufficient method" for some imperative research goal (Flyvbjerg, 2006). This study focused on the relationship between academic institution and government in process of technology transfer of seaweed tissue culture.

Data was obtained from in-depth interview with researchers and officers of SEAMEO-BIOTROP (Southeast Asian Ministers of Education Organization- Southeast Asian Regional Center for Tropical Biology), a public research institution which has generated seaweed seed from tissue culture; seaweed farmers in Ketapang, Lampung province as technology user; and Center for Mariculture Development of Lampung (CMDL), a government technical implementation unit which acts as an intermediary between BIOTROP and seaweed farmers. To help the analysis stage, the interview were documented and transcribed. We then analyzed the role of CMDL in going through three phases of technology transfer: research phase, demonstration phase, and commercialization phase (Balachandra et al., 2010).

In order to validate our findings, triangulation method was utilized in this study. The triangulation uses multiple data sources from investigation to produce understanding about of technology transfer process from BIOTROP to seaweed farmers. According to Denzin & Lincoln (2005), *triangulation* involves the use of different methods, different types of informants and different sites. Triangulation was first conceptualized as a strategy for validating results obtained with the individual methods. The focus, however, has shifted increasingly towards further enriching and completing knowledge and towards transgressing the (always limited) epistemological potentials of the individual method. We used triangulation method by checking consistency of information obtained from BIOTROP, CMDL, and seaweed farmers. We also confirmed the interview results with paper documents and secondary data.

Results and Discussion

In this section, we uncovered our findings that obtained from interviews with BIOTROP researchers and administrators, CMDL director and staff, and also the seaweed farmers in Ketapang, Lampung.

We dig the process of how the tissue culture technology for seaweed seeds was transferred from BIOTROP researcher to seaweed farmers and we analyzed the process based on three stages of technology transfer: research phase, demonstration phase, and commercialization phase.

Research Phase

SEAMEO is an organization whose members are Ministers of Education in Southeast Asian countries. This organization was established in 1965, consists of seven regional centers and three sub-regional research centers, in which BIOTROP is one of them. BIOTROP was founded on February 6, 1968 in Bogor, one of the cities in West Java province. As mandated by Governing Board, this center focuses on human resource empowerment in tropical biology field. Besides research, BIOTROP also covers others activities, such as training, networking, and personnel exchange, and information dissemination. There are currently 10 researchers and 7 incubator staffs in this institution. In 2011, BIOTROP started developing a tissue culture method for seaweed aquaculture to fulfill the demand from Natuna government.

Before tissue culture seaweed was invented, seaweed seed was bred through vegetative method. By vegetative method, a small part of seaweed stem is cut and planted as seed. This action is repeated so many times and consequently, the quality of seed is slowly degraded. Therefore, Natuna government initiated the idea to develop seaweed seed through tissue culture method so the seed quality will remain the same.

The key person of this project is Dr. Erina Sulistiani. She is a graduate of silviculture science at Bogor Agriculture Institute (IPB). Since 2000, she has conducted R&D in tissue culture plant at BIOTROP. She then led the development project of seaweed tissue culture as BIOTROP and local government of Natuna signed an MoU to cultivate *Eucheuma cottoni (E.cottoni)*. oratory, also financed by this institution.

Her long-time experience in tissue culture made her finish inventing tissue culture seaweed seed in a year only, while other researchers had to struggle for years. She conducted her research by herself at BIOTROP lab

Demonstration Phase

In early phase, Dr. Erina tested the seaweed tissue culture by herself. The result showed that there were more amount of carrageenan content in seaweed proliferated through tissue culture than the regular one. Afterwards, as a part of seaweed cultivation network under Ministry of Marine Affairs and Fisheries (MMF), Dr. Erina learned seaweed cultivation method from practitioners in Maros, South Sulawesi, where she also got seaweed seed supply.

For unknown reason, the cooperation between BIOTROP and Natuna government had to end before the technology of tissue culture seaweed applied there. At the same time, there was a problem with seaweed production in Lampung due to limited seed supply. The seaweed production and quality decreased year by year because the seed was derived from old seeds through vegetative method[1].

As the implication, seaweed could not grow up rapidly and densely, and the carrageenan content on its *thallus* was very poor. CMDL as a center for mariculture attempted to address that problem by focusing on developing seed of *E.cottoni*. A research generating *E.cottoni* seed was rare in Indonesia, while research and development agency at KKP (Litbang KKP) was only conducting research of gracillaria[2] seed. Through aquaculture consortium under MMF, the Head of CMDL met Dr. Erina and discussed about cooperation to implement tissue culture seaweed seed.

Commercialization Phase

Since 2013, BIOTROP and CMDL officially worked together to develop tissue culture seaweed at small-industry scale. Besides CMDL, another mariculture center in Lombok was also appointed by MMF to test the feasibility of tissue culture seaweed. Those locations were chosen in implementing seaweed seed research because the environment is suitable for seaweed plantation and the local farmers have long experience in growing seaweed. Dr. Erina then examines seaweed starter seed at laboratory scale to be raised at CMDL laboratories until it is ready for plantation. In this first plantation, the tissue culture seaweed was prioritized to yield new seeds before it produces carrageenan. The plantation test showed that tissue culture seaweed is more suitable to grow in Lampung coastal area than in Lombok. Assisted by CMDL, Lampung farmers become the first community who succeeded in growing tissue culture seaweed and also in commercializing the seeds. Until February 2015, there had been approximately 13.5 tons of seeds distributed to many places in Indonesia.

Currently, BIOTROP still produces seaweed starter seeds and sends them to CMDL to be incubated under Dr. Erina's supervision, before distributed to the farmers. Dr. Erina initially accompanied and supervised the process of seaweed seed incubation from proliferation at CMDL's laboratory scale until plantation in the sea. She gradually transferred her knowledge to CMDL's staffs so they are able to generate starter seed by their own. CMDL is also in progress of building advanced laboratory facilities to generate and incubate tissue culture seaweed. At the first phase, BIOTROP prepares tissue culture seaweed starter seeds every six months and sends them to Lampung. CMDL receives the starter seeds (each of seed's length is 1-2 cm) from BIOTROP at no cost (figure 2).

[1)]By vegetative method, sprout of seaweed is cut and cultivated again continuously without generation of new seed. It caused growth of seaweed not optimally, and its carrageenan content is little (small thallus). In May-June 2014, their seaweed production decreased. Local farmers squawked to CMDL, until CMDL gave tissue culture of seaweed developed by Dr. Erina to replace old seed.

[2)]Gracillaria is one of three genus of seaweeds growing in Indonesia. They are gracillaria, Eucheuma cottoni, and sargassum. Each of them has unique characteristic and function. And gracillaria is the easiest seaweed to be cultivated in several sea areas of Indonesia. Surely, the number of gracillaria is more dominant than E.cottoni and sargassum.

Then the starter seeds are incubated at laboratory for acclimation process. After that, the seeds are stored at the small green house until they are ready for cultivation. This process needs long time (11 months) from starter seed to ready-to-plant seed. They monitor the cycle and the weight of seaweed seeds every 30 days to observe their growth. Until February 2015, CMDL has successfully observed 22 cycles of incubation process.

After incubation, the next stage is cultivation of seaweed seed in plantation area which initiated by CMDL involving local farmers. In this stage, farmers proliferate seaweed seed and also observe its growth together with CMDL. There are currently seven seaweed plantation areas monitored by CMDL, and the best area is located in Kalianda-South Lampung. In this location, CMDL has seaweed nursery *(kebun bibit)* which is strictly supervised to minimalize any hindrances[3]. The tissue culture seaweed seed can grow more rapidly and densely than the conventional one. It yields higher quality of both the seed and carrageenan.

In early stage of cultivation, CMDL provides ready-to-plant seeds as much as 0,7 kg to farmers at no cost. In the sea, the seeds are proliferated for about 25 days to generate another seeds for their own use or for sale. Some other seeds are proliferated for about 45 days for seaweed manufacture supply. In the hand of farmers, technology generated by BIOTROP is applied, yielding commercial product (seed and seaweed).

Then, farmers sell seeds to other mariculture center and other farmers in other part of Indonesia, also sell seaweed to local carrageenan factories. All sales income go to farmers' pocket. Factories that have bought tissue culture seaweed have proven that this new type of seaweed yields more amount of carrageenan than the conventional one.

[3]For instance, there are three pests disturbing seaweed growth in this area namely "ice-ice" (white-spotted seaweed), "bulu kucing" sticking on seaweed stalk (thallus), and baronang fish eating seaweed sprout. When cultivation begins, wave and season is important factors to be considered by local farmers in proliferating seaweed seed.

While BIOTROP transfer the technology of tissue culture seaweed to CMDL to be applied by farmers, farmers also provide report on how the seaweed grows. The report gives feedback to CMDL on how well the incubation process went. CMDL also gives report every six months to BIOTROP as feedback for Dr. Erina in developing the tissue culture technology.

The cooperation between BIOTROP and CMDL is still going on and it is directed to more intensive joint research. The two institutions are currently studying and developing manure for thriving seaweed at CMDL's green house. It aims to test whether tissue culture seaweed seed can grow up elsewhere or not. They have found that tissue culture seaweed can also be well cultivated in Lontar, a sea area located in Western of Java Island.

The Critical Role of Intermediary

The process of technology transfer of tissue culture seaweed from BIOTROP to seaweed farmers with the help of CMDL was illustrated on . The process was in line with the concept modified from Dardak & Adham (2014); Klerkx and Leeuwis (2009) as illustrated on .BIOTROP as technology generator run its function in proofing the concept and developing the new technology of tissue culture seaweed. However, the demand of this technology was articulated first by BIOTROP, then CMDL as intermediary agent continued to correspond the demand in terms of finance and knowledge. Afterwards, CMDL build the network among BIOTROP, local government of Lampung, and local seaweed farmers. After the network was established, CMDL began to manage the innovation process by introducing this new technology to the seaweed farmers and monitoring the implementation of the new technology. CMDL also started to build their own laboratory for developing the tissue culture by themselves, so in the future they do not need to depend on BIOTROP in yielding the tissue culture seaweed parent seed. Finally, technology application was conducted by seaweed farmers as technology user, as they successfully bred the tissue culture seaweed.

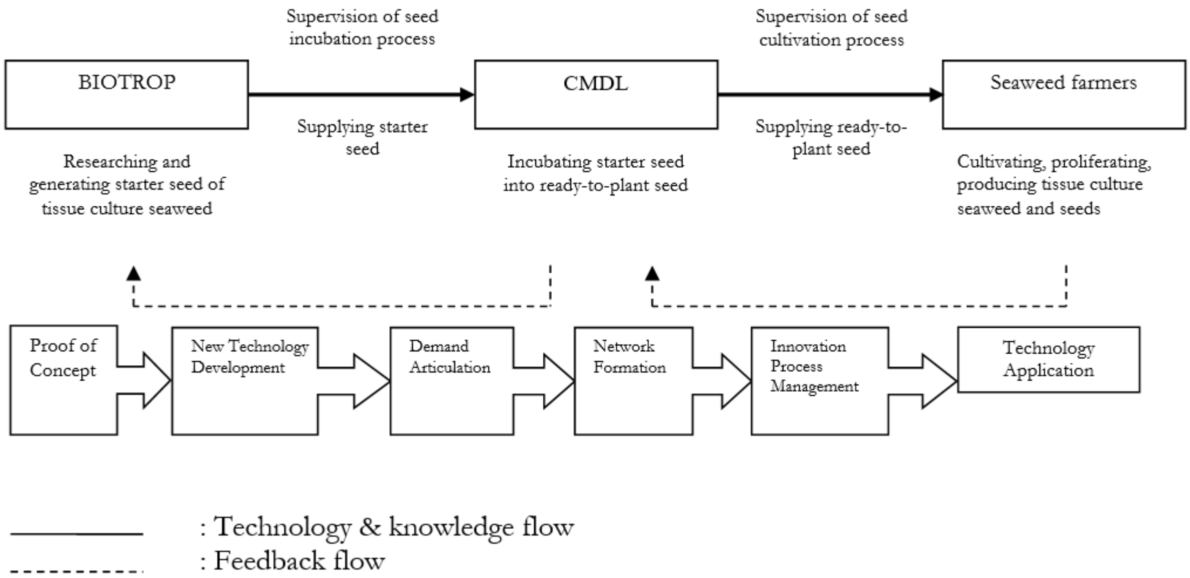


Figure 2. Process of Technology Transfer from BIOTROP to Farmers

Before applying seaweed tissue culture technology, seaweed farmers and coastal community in the Ketapang area, Lampung has embraced the traditional seaweed technology. They used seaweed seed derived from nature or other region and used vegetative technique in cultivation. With the knowledge of the previous cultivation, seaweed farmers in Ketapang, Lampung can easily accept and adopt the new technology developed by SEAMEO-BIOTROP and CMDL. Basically, there is no big difference in the cultivation of seaweed from tissue culture and non-seaweed from tissue culture. Before and after using seaweed from tissue culture, seaweed farmers in Ketapang, Lampung used a long line made of poly propylene size of 0.2 inches with a length of 40 meters and tied with a rope anchor along the 100 meters for seaweed cultivation.

Technology transfer of seaweed tissue culture conducted by CMDL and BIOTROP provided a significant impact to the coastal community in Ketapang, Lampung. Cultivation of seaweed from tissue culture emphasized the economic benefit that shown by the increasing socio-economic conditions of coastal communities that have adopted the cultivation of seaweed from tissue culture as their main livelihood.

With the quality of seeds, seaweed farmers got certainty and confidence to cultivate seaweed for their livelihood. As previously described above, poor quality seeds become the main problem of seaweed farming in this area. This problem caused reduction in the number of seaweed farmers. With the seaweed tissue culture technology, the availability of seeds in quantity and quality guarantee seaweed farmers for seaweed cultivation. They were not haunted by the risk of crop failure or not getting seeds for cultivation. Seaweed from tissue culture has the advantage of being able to be cultivated in murky waters, to survive in low salinity and to be resistant to high rainfall. With the advantages of seaweed from tissue culture, the growth of seaweed from tissue culture is also faster than the natural seaweeds. Natural seaweed seeds increases until 12 times, whereas in seaweed seeds from tissue culture seaweed can increase to 15 times. Technology transfer of seaweed tissue culture not only had made Ketapang area as a producer of dried seaweed and wet seaweed but also as a center for production of *Euchema cottonii* seaweed seed. Seaweed farmers in Ketapang areas had some seaweed nursery. Seaweed farmers in this area had learnt from CMDL in building nursery for seaweed from tissue culture.

CMDL supervised seaweed farmers the things that must considered when establishing a seaweed nursery. After the nursery been built, CMD Lampung supervised seaweed farmers in the breeding process. CMD Lampung set the seeds standard that produced by seaweed farmers in Ketapang with the aim of maintaining the quality of the seaweed seeds so that seaweed farmers can get a good price. Besides that, CMDL not only helped the farmers to make the nursery garden but also helped the seaweed farmers in Ketapang to market the seeds. Seaweed seeds produced by seaweed farmers in Ketapang had been sold to other areas such as Ambon, Belitung, Aceh, etc. This activity definitely increase the income of seaweed farmers in Ketapang, Lampung.

Table 2.
Activities in Technology Transfer Process

Phases	Processes	Activities	Actors
1	The development of new technology	Generating idea Experiment Lab-scale test Producing starter seeds	BIOTROP
2	The evaluation of technology and approval for commercialization	Field test Novelty of innovation Potential market	BIOTROP and CMDL
3	Pre-commercialization	Select location and farmers Production on small-industry scale Market testing	CMDL
4	Commercialization	Sharing knowledge Training for farmers Production of tissue culture seaweed seed Marketing and selling products	BIOTROP, CMDL and farmers
5	Post-commercialization	Monitoring and supervision Feedback from farmers	BIOTROP, CMDL and farmers

Source: Field survey

CMDL is one unique example of intermediary agency that rarely found in other countries. Technology transfer from technology generator to user through intermediary agency also happened in UK, in which they contributed as agents between institutions to overcome the problem of imperfect knowledge market; as liaison officers for firms that have external know-how; and as access provider to complementary assets for internal technologies development (Shohet & Prevezer, 1996). There are several kinds of intermediary institutions, both public and private sector which link to host (technology generator) or sponsor (technology user), or independent.

Also in US, intermediary agents play an important role in facilitating a range of technology transfer activities, such as market research, grant development, brokering, and technical support (Bauer & Flagg, 2010).

However, mostly the public intermediary agents in both countries are university TTOs, not a government agency like CMDL. University TTOs in UK already have established mechanism in finding financial sponsor from private sources. Also, they already have close relationship with industry, hence they are able to act as intermediary agents.

Furthermore, UK government represented by the Department of Trade and Industry's Technology Audit Scheme, created a scheme where TTOs are allowed to bid for funds for technology audits and to hire external experts. Meanwhile in Indonesia, university TTOs are often inhibited by university bureaucracy (especially public university) and the network between university and industry has not been well established. Therefore, government agency like CDML took over the role of TTOs although technology transfer is not their main task.

Academic institution is the source of technology, but recently it is demanded to also transfer the technology to society. Therefore, academicians are also hoped to be able to identify the potential market of their technology. Observing technology opportunity needs entrepreneurial ability, which usually becomes academicians' limitation. There is also often a gap between generator and user since they operate in different field. The role of intermediary agent is urgently needed here to fill the gap. Intermediary agent can play role as a "translator" between technology generator and user, as a facilitator providing supporting resources for commercialization, and as a network architect.

Technology transfer is a long and dynamic process, from the generation of the idea until the sale of the product. The case study shows that idea generation of academic institution resulted from formal mandate from the government (MMF). Thus, in this case the identification of technology needs is conducted by the government, which departs from problems faced by rural industry.

In this technology development phase, researcher becomes the key person for developing the idea and concept, experimenting, and producing prototype. The role of academic institution's leaders also takes part in this phase since they provide fund and physical facility support.

Intermediary agent starts to play role at the phase of evaluation approval for commercialization. Intermediary has closer relationship with technology user, thus it has better understanding on which technology that has commercial prospect. Intermediary has to recognize the value of the technology, how useful it is for society and how profitable it is for the producer. This agent does not only take the technology from the generator and give it away to the user, but also help to incubate the technology, to develop from laboratory-scale prototype to commercial product. Thus, intermediary needs to take knowledge from generator on how to develop the technology, then pass it to the technology user.

In introducing new technology to user, intermediary should communicate it carefully. Naturally, rural industry tends to easily resist any new technology due to lack of finance and knowledge. Therefore, intermediary should practice good communication strategy. After passing the knowledge and technology to the adopter, the duty of intermediary has not end yet. Intermediary still needs to supervise product testing and also the industrial-scale production to make sure that the commercialization runs smoothly. After the technology finally come into product, intermediary receive feedbacks from technology user, then send it back to the researcher. Feedbacks from the user and intermediary are very useful for the researcher to keep the technology updated. In technology transfer process, the knowledge sharing is not a one-way flow from generator to user only, but a two-way flow among generator, intermediary, and user.

There are several limitations in this study. First, there is lack of analysis from the technology user side. In further study, the effect of technology transfer and intermediary on technology user should be analyzed. Second, one case study might not represent the whole phenomenon, hence more case study in the next research will provide more comprehensive understanding about the role if intermediary agents in technology transfer process.

Third, further study to compare the condition before and after the existence of intermediary agents needs to be conducted in order to provide more validation on the importance of intermediary agents.

Conclusion

This study aims to show that intermediary plays an important role in technology transfer process. Intermediary agents can come from public or private sector, in form of university, government institution, business service, or independent association. There is often a knowledge and financial gap between technology generator and technology user, therefore intermediary agent is needed to fill those gaps in form of financial support, technical support, or brokering.

This study has concluded two points. First, intermediary agent requires entrepreneurial capability, technological capability, and also communication strategy. Intermediary has tasks in technology incubating and also marketing. High commitment is absolutely necessary since technology transfer is a long and dynamic process. Second, it is proved that a government unit can be an effective intermediary agent in technology transfer process. Government has financial resources, human resources, and also authority. These three aspects are important factors in successful technology transfer. As we have shown the critical role of intermediary agents in technology transfer, this study is expected to contribute to the knowledge of the importance of technology transfer intermediary unit and how to manage it. The case study shown above can be the best example to be adopted.

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References

Abercrombie, N., Hill, S. & Turner, B. (1984). *Dictionary of sociology.* Harmondsworth, UK: Penguin

Bastos, M. I., & Cooper, C. (2005). *Politics of technology in Latin America*. London: Taylor & Francis.

Balachandra, P., Nathan, H. S., & Reddy, B. S. (2010). Commercialization of sustainable energy technologies. *Renewable Energy 35* , 1842-1851

Bauer, S. M., & J. L. Flagg. (2010). Technology transfer and technology transfer intermediaries. Assistive technology outcomes and benefits, focused issue: state of the science for technology transfer. *Summer (6), 1.*

Beddington, A., & Farrington, J. (2007). Governments, NGOs and agricultural development: perspectives on changing inter-organisational relationships. *Journal of Development Studies 29(2)* , 199–219.

Boardman, P. C. (2009). Government centrality to university–industry interactions: University research centers and the industry involvement of academic researchers. *Research Policy 38* , 1505–1516.

Caldera, A., & Debande, O. (2010). Performance of Spanish universities in technology transfer: An empirical analysis. *Research Policy 39* , 1160-1173.

Dardak, R. A., & Adham, K. A. (2014). Transferring agricultural technology from government research institution to private firms in Malaysia. *Procedia - Social and Behavioral Sciences 115* , 346 – 360.

Denzin, N. & Lincoln,Y.S. (eds.) (2005a) *Handbook of qualitative research* (3rd edn). London: SAGE.

Eun, J. H., Lee, K., & Wu, G. (2006). Explainng the "University-run enterprises" in China: A theoretical framework for university-industry relationship in developing countries and its application to China. *Research Policy 35* , 1329-1346.

.

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualitative Inquiry 12(2)*, 219-245.

Fontes, M. (2001). Biotechnology entrepreneurs and technology transfer in an intermediate economy. *Technological Forecasting and Social Change, 66(1)* , 59-74.

Giuliani, E., Morrison, A., & Pietrobelli, C. (n.d.). Who are the researchers that are collaborating with industry? An analysis of the wine sectors in Chile, South Africa and Italy. *Research Policy (Article in press)* , 2010.

Howells, J. (2006). Intermediation and the role of intermediaries in innovation. *Research Policy 35*, 715–728.

Hsu, D. W., Shen, Y. C., Yuan, B. J., & Chou, C. J. (2015). Toward succesful commercialization of university technology: Performance drivers of university technology transfer in Taiwan. *Technological Forecawsting & Social Change 92* , 25-39.

Klerkx, L., & Leeuwis, C. (2009). Establishment and embedding of innovation brokers at different innovation system levels: Insights from the Dutch agricultural sector. *Technological Forecasting & Social Change 76*, 849–860

Küçüksayraç, E., Keskin, D., & Brezet, H. (2015). Intermediaries and innovation support in the design for sustainability field: cases from the Netherlands, Turkey and the United Kingdom. *Journal of Cleaner Production 101*, 38-48.

Lam, A. (2011). What motivates academic scientists to engage in research commercialization: 'Gold', 'ribbon' or 'puzzle'? *Research Policy 40* , 1354-1368.

Nelson, A. J. (2014). From the ivory tower to the startup garage: Organizational context and commercialization processes. *Research Policy* , 1144-1156.

O'Shea, R. P., Allen, T. J., Chevalier, A., & Roche, F. (2005). Entrepreneurial orientation, technology transfer and spinoff performance of U.S. universities. *Research Policy 34* , 994-1009.

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., & Brostrom, A. (2013). Academic engagement and commercialisation: A review of the literature on university-industry relations. *Research Policy 42* , 423-442.

Ponomariov, B. L. (2008). Effects of university characteristics on scientists' interactions with the private sector: an exploratory assessment. *Journal of Technology Transfer 33* , 485-503.

Reece, J. D., & Sumberg, J. D. (2003). More clients, less resources: toward a new conceptual framework for agricultural research in marginal areas. *Technovation 23(5)* , 409–421.

Santoro, M. D., & Chakrabarti, A. K. (2002). Firm size and technology centrality in industry–university interactions. *Research Policy 31* , 1163-1180.

Theodorakopoulos, N., Deycy, J., Sanchez, P., & Bennett, D. (2012). Transferring technology from university to rural industry within a developing economy context: The case for nurturing communities of practice. *Technovation 32*, 550–559.

Van Lente, H., M. Hekkert, R. Smits, & B. Van Waveren. (2003). Roles of Systemic Intermediaries in Transition Processes. *International Journal of Innovation Management 7(3)*, 1–33

Van Rijnsoever, F. J., Berg, J. v., Koch, J., & Hekkert, M. P. (2015). Smart innovation policy: How network position and project composition affect the diversity of an emerging technology. *Research Policy 44* , 1094-1107.

Weber III, W.J,Gray,V.W., Jackson, B., & Steele, L.C. (1993). A systems approach to the commercialization of space communications technology: The NASA/JPL Mobile Satellite Program. *Acta Astronautica*, 29(9, September), 667-675

Wu, Y., Welch, E. W., & Huang, W.-L. (2015). Commercialization of university inventions: Individual and institutional factors affecting licensing of university patents. *Technovation 36-37* , 12-25.