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Technology Transfer in Biorefinery Development: A Discourse Analytic Approach

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Abstract

The purpose of this paper is to get the magnitude of parameter on internal and external factor of technology transfer process in biorefinery. The microscale process of technology development open the opportunity to get comprehensive vision in implementing advance technology. This investigation which cover in micro level of technology transfer process would be enriched by provision of useful insights on stakeholders on application of Biorefinery technology. The scope of research was included nation scale. This research covered of transferring technology from public funded institution as the technology provider. In this investigation, the internal and external factor of biorefinery were developed which based on observation, interview and text that enriched by literature review and main theoretical framework. This research contributes to the knowledge of innovation management in particular on technology transfer process which provides empirically description of identification of essential factor of technology transfer. It shows dynamics environment that influence the capacity of technology transfer and the role of each factor. The result of this research are able to enrich the knowledge of policy maker related to innovation process as it embraces appropriate concept and theory of technology transfer in similar type of advance technology. It is unlikely suggest to either structural changing or structural upgrading, however it shows new element that have not been touch by the government. To capture to this objective as innovation strategy, this paper enhances the understanding of innovation as endogenous aspect of economic development and influenced by exogenous forces.

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Earlier research has identified the flow and stage of technology transfer from provider to user in the system, this paper outlines the platform as powerful role in policy making.

Keywords: technology transfer; government; public research institutes; discourse analysis.

1. Introduction

Industrial environment as well as the performance of the organization are acquired in the situational analysis of the industry's External factor of the organization which contribute significantly to the firm. This view could be traced back from the Resource Based View (RBV) developed by Barney and Market Based View (MBV) developed by Michael Porter [1]. Situational analysis include the internal and external factor as the picture of environment of economics of innovation. This SWOT (strengths, weaknesses, opportunities and threats) analysis is utilized the internal and external factor of organization.

Innovation is widely recognized as the important role in strengthening national competitiveness. Technology is one factor that independently move toward the Law of Diminishing Marginal Return (LDMR). The benefit of putting more investment in developing science and technology is not leading to decrease the benefit which different with other factor of production as such as labor and intermediaries goods which reach the optimal point and decreasing the benefit.

As such as it described by Alvin Roth the 2012 Nobel Winner on the potential demand which fail to meet the supply. He proposed the Theory of Stable allocation and the practice of Market Design to analyze the problem of this Matching Market [2]. This approach utilize Shapley Algorithm to build the flow of demand and supply for special needs. New design had been developed which equipped with Game Theory Approach, Market Design and Experimental Economics in recruiting Medical Resident in New York City High Schools and Boston Primary School. This approach describe the shifting model of market which influenced by human behavior that led to the inventing new way in new product and new market.

Demand for research-based-solution as the end product face similar problem as the demand for kidney exchange. It is not only required one side of communication but should include the compatibility. In the case of kidney xchange, potential recipient should be compatible with the potential donor. It should also consider the location and compatibility of blood type. This problem is also acknowledge as the Broken Bridge [3]. This problem also occur in transferring the technology which face the Valley of Death where the invention encounter risk and uncertainty. In some cases the application of technology is equipped with license agreement and price guarantee which facilitate by the government in order to secure the process of technology transfer.

Asymmetry information between the agents in the system occur and lead to unproductive process of technological change. Potential user was not ready for that change while budget was getting larger with no clear target. Based on this problem, the policy maker set the tight and quick target in developing science and technology even though it had been agree that Science and technology as such as education are not to be viewed as the short term project. It should be admitted that number of technology based product have short life cycle such as information technology including program, software and hardware.

It lead to increasing number of importing application technology to Indonesia with followed by lower price than the similar technology produce by local research party. Manufacturing of MNC (multinational company) have depend their new technology and design to their principal which inhibit the application of innovation from local research institute. As it technology introduced in Indonesia, it was not new technology in other countries. The price for product in introduction level of Product Life Cycle (PLC) is still unprofitable compare to point of maturity. From this side of view, the launching of new-technology-based-product is not comparable to the similar product that imported from more advance industry in overseas. However, in other side, the efficiency of production as buying or making turn is worth to consider. In this research, the SWOT analysis is utilized to view the internal and external factor of the technology transfer process in Biorefinery development in the Center for Biotechnology; Indonesian Institute of Sciences. This project utilize the rare collection of super microbe and biomass.

2. Theoretical Background

Innovation is one of important factor of economic development in the form of industrialization and market which in line to Schumpeter of The 5 New which are: (a) Introduction of new product, (b) Innovative activity as the production of ideas and inventions that applied in the form of goods and services, (c) Market in the form of new strategy, new approach of marketing, (d) Organization as new design and form of new management philosophy of organization, (e) Process as the introduction of implementation of new process of production. [4]. He further implied that innovation process is not happened in vacuum room. It aligned and integrated to user, supplier, competitor and social community. Moreover, Lundvall as one among pioneer of the study of National Innovation System implies the relation between regionalization with globalization [5].

2.1. Modern Evolutionary Economics

The classical evolutionary economics developed by Schumpeter implied The Theory of Economic Development in 1934 emphasize on profit, capital, credit, interest and the business cycle [6]. While in the input side of neo-classical-economics emphasizes in land, labor, capital and technology as the factor that influence the growth of economics which have been viewed as idea, creativity, talent and entrepreneurship [7] which lead from economic model of public sector innovation [8]. The dynamics of development of science and technology changed the way people in their daily activities. New technology was either replacing or improve the old products. This evolutionary process is in line with FA Hayek and Karl Popper that emphasizing on contribution to science through trial and error which accumulated in the form of supply and demand [9] It concluded that the nature of capitalism encourage the non-stationary economic growth based on technology innovation, new organization and significant role of entrepreneurs [10]

2.2. Defining Research and Technology

Research could be divided into basic research or fundamental research and Applied research. Fundamental research mostly contribute to the world of science (science for science). In this project the scientists work to satisfy their interest to develop theory and concept. On the other hand, applied research leads to technological

development which aim to utilized commercially or not-commercial application [11]. It is also defined as the science of practical industrial arts or technical terminology [12]. However, Branscomb also implies that it is absurd to put aside between basic and applied research.

It provide the example of observation of the black holes in the centre of galaxies that could tell the ultimate fate of solar system which could be viewed as basic but some experts found it as more practical science. Application of technology is recommended to blend with others in the form of product.

The combination of varies technology for smart phone, for example, includes approximately 10 patent in their the system and more than 300 patents for supported feature [13].

It is different with times of "the Lone Researcher" in the 19th century which single invention such as Marie Curie and Albert Einstein. However, it should consider the science as the source of science which not lead to the commercialization [14]

2.3. Technology Transfer

Development of science and technology is communicate through dissemination, diffusion and transfer [15]. Moreover, technology transfer is one kind of innovation diffusion which bring the technology as the object from technology provider to the user of technology [16]. Bozeman provide the rich definition of technology transfer with different point view as [17]:

- …the basis of properties of generic knowledge and focusing particularly on variables that relate to production and design [18]
- … link to innovation to view technology which include social technology as a design for instrumental action that reduces the uncertainty of cause-effect relationship involved in achieving a desired outcome [16].
- Concept of the movement of know-how, technical knowledge, or technology from one organizational setting to another [19]

In this article, technology transfer is defined as the transfer of technical knowledge and knowhow of noble technology in Biorefinery development which occurs between firms, research institution and government agencies.

This limitation implied different process with innovation diffusion where goods and services move from one source as they called as technology provider to technology user as commercialization and market adoption through certain channels over time among the member of a social system (Bozeman, 2000; Rogers, 2002). Operation of moving technology from labs to market is varies which depend on the stage of development of the technology [20] which flow into three transformation point as it figure 1

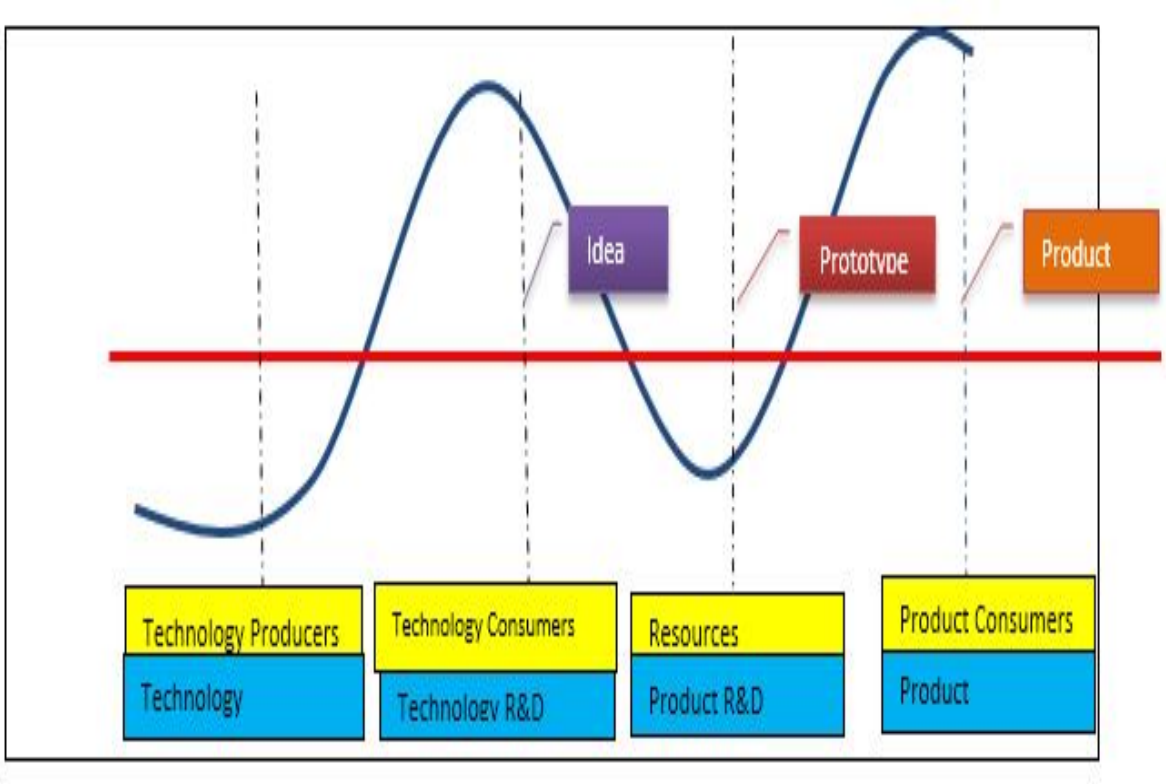

Figure 1: A Composite of All Technology Transfer Element

Source: [20]

In the point of idea, technology transfer was indicated by inventions or new application of technology which developed in labs. Most of them were not ready to be used by the end-user.

It was the ideas in the form of plan or presentation. Prototype, the second point, was the development of the ideas in the form of tangible or process.

The sources in this phase are labs in research institute, RD department or universities. Coaching and controlling is essential in developing prototype

The third point is the product which transform the output of technology provider to the user. Research activities had been reduced in this stage.

Exhibition, advertising and selling activities are dominant in this stage. In particular cases the flow is not always from idea to prototype and product. In electronic products and software, for example, the life cycle of product source from ideas.

Each point is discrete which divide into four stage of technology transfer process. As idea development that occur in the labs so it is kind of appropriateness when it put in the front line of supply chain equipped with price,

brand and advertising. Moreover, the four-phase of technology transfer describe in table 1:

Table 1: Stakeholder and technology transfer stage

Technology Transfer Stage	Stakeholders
Technology Producer	Inventor, researcher, laboran
Technology RD	Private institution, public institution, patent-broker, distributor
Product RD	Intermediation, public institution
Product/commercial	End-user, community, professional

Source : [20]

Research institution and university actively involves in the first stage which include contemplation, reflection, exploration and trial of concept and new idea. This stage emphasize on reconstruction, documentation and consideration of intellectual property right for industrial application. Intellectual faulty occur when the policy maker draw this stage to the edge of technology transfer process.

The outcome of research put in readiness level measurement and value the research in form of price of product. In the end, most of product would fail in next stage of technology transfer. In informal discussion, one expert describe technology valuation as the valuing of Picasso's art in the beginning of process. In other discussion with the respondent regarding the issue of property right, he mention how the industry prefer to utilize the invention from their own labs as NIH syndrome (not invented here syndrome) due to more expensive cost in utilizing external technology with no guarantee that it fit with existing manufacturing operation.

Research institute and university play essential role in the second stage. Either proof of concept or protection of intellectual property is the precondition in this stage.

Scientific activities have been reduced and followed by commercial activities such as technology valuation. Promotion in this stage is addressed to identification of collaboration. The same innocent fraud occur when promotion was conducting of selling the product.

The display of prototype in the exhibition were labelled with brand and price tags. Most products are not ready in industrial and commercial used so disappointment of user is not a good beginning.

The third stage is RD based product as the transition phase from prototype to application. Blending with other application of technology is recommended. For illustration, the main application for a smartphone include more than 180 patent. In this stage, (CIO) Chief Innovation Officer played significant role in both blending the invention and promoting collaboration.

Commercial, as manufacturing, promotion, distribution and selling activities occur in fourth stage where the product reach the end-user. Research activities are reduced to minimum and product development are conducted to reach better of quality and performance.

2.4. Innovation Technology of Biorefinery

The eight sources of alternative energy are solar, wind, biofuel, biomass, hydro/ocean/tidal, geothermal, hydrogen, and fuel cell technology [21]. Biorefinery is one of the alternative energy which integrates biomass conversion processes and equipment [22]. There are five major feedstock for biomass product.

Table 2: Feedstock and biomass product

Item	Feedstock	Product
1	Sugar/Starch Crops/Sacharose	Ethanol/bio-based chemical
2	Vegetable oil	Biodiesel/waste vegetable oil (WVO)
3	Lignocellulosic Biomass	Biofuels/bio-based chemical
4	Jatropha/Curcass	Biodiesel
5	Micro-algae	Biodiesel

Source: [23]

Due to the high volume of sucrose which easily extracted from the plant, sugar, starch and sacchrose are found in many extraction mills[24]. It is extracting to produce ethanol and bio based chemical through fermentation process. Vegetable oil are extracted from palm, canola, soybean, coconut oil and olive oil. Lignocellulose biomass are composed of cellulose, hemicellulose and lignin as well as other inedible plant material for biofuels and bio-based chemicals [25]. Micro-algae had been attracted crowd for the potential in storing lipids in the form of triacylglycerol that can be utilized and synthesize to biodiesel through trans-esterification [26]. Trans-esterification of plant or algae is a standardized process which developed with methanol. It is widely developed in many laboratories in the government research institute and university. Furthermore, the application of anaerobic digestion is highly use in rural and developed areas where the presence of biodegradable waste are still abundance.

3. Research and Setting Methods

3.1. Research Approach

This is research was conducted as part of dissertation of the first author which strengthened by 16 years of experience of working to utilize the research outcome in the Center for Innovation, Indonesian Institute of Sciences (LIPI). It leaded to development of biorefinery that conducted in the Center for Biotechnology LIPI

The research designed as discourse analytic approach that deal with technology transfer [27]. It is a systematic methodology which refers of talking and writing of objects in the production of texts [28]. It is a perspective on the nature of language and its relationship to the central issues of social sciences and entail of both practices of data collection and meta-theoretical assumption [29]. This research utilizes discourse analytic method that developed by Wetherell and Porter [30] which elaborated the case study of development of Biorefinery. This article is also equipped with illustrative, facts and other evidence that collected through formal communication (meeting, interview, and seminar) and informal discussion.

It emphasizing on one case of technology utilization which allow us to concentrate on developing robust understanding of technology transfer. The case of Biorefinery project was generated insight into the nature of transferring process of advance technology. As the characteristic of the advance technology that varies, however the architectural platform could be drawn from this case.

3.2. Research Setting

The case for this current study is the development of Biorefinery as the alternative application of oil-refinery. This technology is utilize biomass and enzyme. Indonesia is well-known as "Amazon in Asia" with abundant of biomass and enzymatic collection. The empirical setting was the Satrep Project (Science and Technology Research Partnership for Sustainable Development). It was the collaboration between Research Center for Biotechnology – LIPI and Kobe University.

We conducted in-depth observation study of technology transfer through two meeting with Chief Operating of Satrep Biorefinery and followed by interviews with the members of the project. The observation include the inceptive phase and rational of the project which lead to the cooperation with Kobe University. The interviews were limited to the frame of SWOT (strengths, weakness, opportunities and threat).

3.3. Data Collection

The size of material is enough to conduct close analysis of the details of rational in developing Biorefinery and applied in larger scale. The recording was transcribed and described from two meetings and 10 interviews was recording.

Questions in the interview was developed through literature review. The opinion and decision that made by the expert were measured and compared with the findings of literature. It was strengthened by informal discussion before and after the interview.

Every respondent was questioned their opinion and statement on strategic factor of technology transfer system. Time of each interviewed varies from 2 hours to 3 hours. However, one respondent lasted 5 hours including his presentation regarding technology transfer system and their mission in strengthening the utilization of technology from university. The scope and size of material had been sending by email to respondent for pre-study of each point in questionnaire. In the analysis of interview transcript, it is concentrated on the vision of candidates were reached and motivated and on the motivation of candidates between selection decisions.

3.4. Data Analysis

This research began with literature review regarding SWOT in Biorefinery development. It was followed by quantitative study based of strategic factor. For each factor linked to description and supported literature. Concretely, the analysis began literature review and reading of material, expressed into hypothesis, validated by interviews. Concretely, the analysis began with literature study on innovation, technology transfer in biorefinery and followed by adopting record and notes from meetings, interview, and discussion.

4. Findings

4.1. Data Structure: SWOT Variable

SWOT analysis is divided into internal factor and external factor. Strengths and Weaknesses are included in internal factor. Opportunities and Threat are included in external factor. This analysis is situational approach which involve financial management. Each variable was put in the questionnaire. This discourse analysis was one of the methodology in dissertation research project among Strategic Factor Analysis Summary (SFAS), Analytical Hierarchy Process (AHP) and Structural Equation Modeling (SEM). We adopted discourse analytic approach to accommodate the discussion over and informal discussion over interviews and talked-based ethnography as well as natural talk-in-interaction over meetings and seminar.

Strength Factor Proposition 1: Capacity of resources is essential in utilizing research in Biorefinery.

Material resources are important factor for industrial development. It is not only about the availability of the resources but also distance and stability of supply [31]. Internal technology transfer by multinational company that had used natural resources in Indonesia lead to positive perception in the global market [32]. Exploration of natural resources should consider the sustainability and the capacity in transforming material to form of product. In energy case, coal and oil exploration were developed as integrated with transportation and agroindustry [33]. Human population has been increased that required more food, housing and energy. Advance technology provide new and effective process in producing food. Inter The distance location between resources and user was put as consideration in building industrial cluster. It reduces transaction cost and open the opportunity of interaction between industry [34]. Furthermore, developing industrial cluster is also contributed to knowledge dissemination [35–38]. The waste from palm mills have been utilized on site in the form of energy, feed, fertilizer and other chemical product. Gas from Palm oil mills effluent (POME) is captured and transforming into energy. Empty Fruit Bunch (EFB) has a number of derivate products. It leads to the abundant sources for biorefinery development. However, as most of advance technology in the early age, the value are still higher compare to existing similar product. The role of government and non-profit organization has significant role in supporting the technology application in a form of financial support (incentive, grant or tax deduction).

Strength Factor Proposition 2: Increasing demand in the market for goods based on Biorefinery contributes significantly in building both research side and industry side. Strengthening of capacity in technology transfer leads to increasing of product in the market as new product or higher quantity [39–42]. Innovation technology also provide eco-product and green product in the field of energy industry [43], and biotechnology [44]. Development of advance technology is influenced by risk and uncertainty so Government has essential role in conducting research which has potential of commercial risk. Wifi and touchscreen are two among many of technology that develop in government funded research institute [45–47]. The flow of transferring technology works when the result of research is utilized and commercialized in industrial sector. So the link between actors which equipped by good understanding of each position is essential. Linkage between actors are not happened when each members think about providing all their needs internally that could reduce the cost of transaction. In other side problem occurs when technology provider selects and develops the path to commercialize by themselves. It followed by developing tools in selecting technology which could be commercialized. This

approach erase number of basic research and development and researcher find other way to get the research funded by modified their research as industrial-research which leads to inefficiency of fund.

Strength Factor Proposition 3: Biorefinery development was influence by quantity of international collaboration in related fields. International collaboration in technology transfer could be view from the linkage between association of technology and business incubator such Asosiasi Inkubator Bisnis Indonesia (AIBI) with international counterpart such Asia Pacific Centre for Technology Transfer (APCTT) or Islamic Network for Science and Technology Park (INSTP). The role of networking in this field plays significant role in transferring technology. The comparative study of international collaboration in Srilanka and China found that impressive application of absorptive capacity as China emphasize successfully providing higher quality inputs for industry [48]. As Indonesia have been widely recognized with mega diversity and some other donor country recognized with their advance technology development so it is such an appropriate way to blending in a collaboration. Each member country contribute equally to biorefinery technology development. In this article, Center for Biotechnology as one of the center in LIPI that engage in collaboration with Kobe University and funded by Japan International Cooperation Agency (JICA). The project had been conducted since 2013 to 2017.

Strength Factor Proposition 4: Industry has essential role for both user and developer of research in biorefinery. The interaction between University- industry and government have significant role in technology transfer system [49–55]. In the process of converting biomass to chemicals and fuels has been developed in university and industry [56]. It is supported with global network of university and industry as well as international body. As it shows in the diagram 1, commercialization to end user are fit when it conducted by private sector. Efficiency of fund and cost of human resources should be considered when it was developed in public sector. The function of production, promotion, distribution and pricing are appropriately analyse and measured as marketing in private sector. Research institute in public sector would do better in other side of the game. Incubator technology is good example of research utilization in small and medium size of business. It provide the access for technology application such as labs, literature as well as consultation with researcher. Researcher was also benefited in trialling and walking their research into appropriability-regime and commercial side. In Indonesia, the mobility of government employees to public sector is not possible. So researcher in institution and university should choose whether work in their home research institute or exit if working and application technology in the downstream of the cycle.

Strength Factor Proposition 5: Research and utilization of research in Biorefinery was influenced by economic, social and culture environmentTechnology as the integral part of culture could be trace back the way tribes was providing basic necessity. The climate and condition of environment are influencing the way they growing particular seed or making kitchen utensil. Promoting science and technology has influenced by these environment which supported by the awareness of government, community and academicians. As advance technology, biorefinery inserted into social phenomena indirectly through research and development. Shifting of new generation that born in the era of information technology make easier in exploring information regarding their curiosity of new things. It change the way people do transaction by application of only store as well as bitcoin. In biorefinery case, industrial visit and excursion are two possible methods in inserting biorefinery to grassroots of economy, social and culture environment [57]. Social factor in the form of better quality of life,

health, employment and increasing both quantity and quality of data/knowledge base motivate the process of technology transfer. Economic factor as efficiency, economic growth, increasing income per capita, strengthening of competitive advantage, creating export, increasing tax, royalty are also important factor in technology transfer [58].

Weakness Factor Proposition 6: Government still lack in allocating expenditure in research of Biorefinery. It is admitted that budget allocation is one of problem in developing science and technology in particular in least developed country. The development aim people welfare through provision of basic needs which put science and technology development as luxurious needs. Financial benefit from research in most cases were pulled in the short run target. It turned as unexpected result of research.Mazzucato implied that the government expenditure on research and development plays important role in economic growth which mostly viewed as the development of infrastructure [59] It is recommended in operating innovation-friendly of financial scheme. Indonesia's GERD (Gross domestic expenditure on research and development) was 0.1. It has not been growing since 2015 and put Indonesia at rank 87th.

Table 3: GII comparison of Indonesia, Thailand and Vietnam 2017

STRUCTURE	SUB-STRUCTURE	INDONESIA	THAILAND	VIETNAM
Institution	Government effectivness	36.4	51.3	44.1
	Ease of starting a business	76.4	87.0	81.8
Human capital and research	Expenditure on education (%GDP)	3.3	4.1	5.7
	Gross Expenditure on RD (%GDP)	0.1	0.6	0.4
Infrastructure	ICT access	47.1	55.0	46.0
	Pengguna TIK	21.7	43.3	35.1
	Electricity output, KWh/cap	898.2	2,563.6	1,553.1
Business sophistication	GERD financed by business (%GDP)	n/a	0.4	0.2
	University/industry research collaboration	57.0	46.2	38.9
	State cluster development	57.0	46.2	47.5
	GERD finance by abroad %	n/a	1.5	1.5
	Strategic alliance deals	0	0	0
	Intellectual property payments, % total trade	0.9	0.1	n/a
	Research talent, % business enterprise	35.5	50.1	21.1
GII		30.1	37.6	38.3
Rank		87	51	47

Sources: [60]

Compare to Thailand that improved the GERD from 0.4 in 2015 to 0.6 in 2017 at rank 51st. Vietnam allocate higher GERD at 0.4 at rank 47. It reflect to the quantity and quality of research activities in the form of academic publication rank of 124 of 126 countries.

The GERD issue was addressed by source person in the interview on Technology Transfer System:

Source (withheld): It is hard to expect research institute to come up with good proposal that meet our demand which in line with the problems that we face. Well then, say we don't have to put the national agenda in scoping your agenda, then we see most of the time the same old project come to our desk. So let say we would increase the budget on RD, then what will you develop. So, I don't think budget is the main constraint of developing science and technology.

Source 2 (withheld): The candidate of President came to our office late September 2014 and witnessed the poor condition of research equipment. It was offered of increasing the budget if he succeeded. Then in February 2015 we performed financial acrobatic to reconstruct our budget. Probably it is true that budget is not the main constraint but the commitment is.

Weakness Factor Proposition 7: Industry are still reluctant of utilizing research in Biorefinery

GERD that source from overseas was not available. Most of MNC (multi-national company) depend on their principal. It should be admitted that internal RD activities reduce cost of transaction. Moreover, it could escalate moral of RD personnel and avoid the symptoms of NIH (*not invented here*). It also avoid risk relating to operation of new application in the product when it failed.

The contract which include responsitility and contribution of each party could decrease that risk. Borderless world make international research collaboration easier. As such in biorefinery project that derive to research collaboration between Center for Biotechnology LIPI with industry in Indonesia.

In one interview with the owner of big pharma in Solo (Central Java) for research of Innovation Process in Public Research Institute in 2003, we ask the reason of lack of cooperation with university and research institute near the production site.

Sources 1 (withheld): "We have a lack of information on what university or institution in Solo (neighbourhood) or others that meet our needs.

It is kind of costly to find some kind of solution from the centre and it is not cheaper but it create pride when we are able to fix the engine, installation or invent to drug. Let say, our fermentation unit was not running. The welder and mechanics in the house could not fix it.

When we push them to figure out and fix with their limited knowledge and tools, it would be repaired not more in two weeks. Can you imagine how long I should contact your engineer when it's happen? As a matter of fact, I don't know who I should contact regarding this issue in your office, for example."

Weakness Factor Proposition 8: Lack of coordination between government institution contribute to the unproductive impact in research of Biorefinery

When it comes in utilization of waste of oil palm production the problem appear relating location and regulation of environment. In a project of utilization of palm oil mill effluent (POME) for fuel we found different regulation of treatment in utilization of waste from palm oil as well as the different tools to measure the price of products from waste such as power electricity, fertilizer and other chemical substance.

Source (withheld): we have KEK (special economic zone), OVOP (one village, one product) and other programs…. It should be synergy not fragmented. But each Ministry has its own program. However it is better than not doing anything.

Weakness Factor Proposition 9: Transaction cost in Biorefinery industry is still high

Source person (withheld) share his experience in providing palm oil fiber for their manufacturing that produce high quality broom that it was not only about the cheaper price that the supplier in India and China that able to provide the fiber but also they were able to meet the standard. They paid higher price for fiber that comes from Lampung and West Sumatra and most of time they found the content moist was still very high. It turned to be a big problem relating to the schedule of production and delivery. The production would operate when all the materials had been collected. If one of the supply was not ready, the production would be halted.

In one of the seminar, the expert compare how transaction cost was still a big problem in developing of biorefinery product to his experience of buying the coconut in producing herb medicine. The price was cheaper when we bought from Malaysia than Lampung. It was not because the price of the coconut ansich but how the coconut reach the production unit in Jakarta. So instead of deliver the supply from the location in one place in Sumatra and send to Jakarta, it is much cheaper and low-risk to buy from our close neighbour countries. Probably, those coconut we bought sent from Padang (West Sumatra) but the price was cheaper when it bought from Malaysia.

Weakness Factor Proposition 10: Government financial system does not go with the dynamic in advance technology such as research in biorefinery

Source (withheld): I don't motivate our staff to propose the project to hibah bersaing (competitive grant). Some swap to musibah bersaing (disaster) it is not easy to follow the administrative procedure of financial. We were not only have to collect the receipt but also tax number, certificate of commencement business etc. Can you imagine if we take EFB as a size of small truck and it should be equipped with those kind of documents? It is wasting of time. Sometimes in the ME session, we had to explain how we get the EFB and why there is no document regarding this. Then we refocus to find or make those documents.

Opportunities Factor Proposition 11: Increasing demand of industries in Asia have positive impact on research in biorefinery

Increasing mid-class was in line with increasing demand of product. It is range from basic needs such wealth, plastic and textile. In conjunction to limited of old source, it is important in developing alternative source of product processing. Technology of biorefinery dis able to decrease the dependency to old resources. Indonesia

which is also called “the Amazon of Asia”, provide abundant capacity of biomass as the main sources of development in biorefinery. While the demand of plastic and bioethanol increased, biorefinery technology provide alternative-green sources for bioethanol and polylactic acid (PLA).

Opportunities Factor Proposition 12: Geographical position of Indonesia in the intersection lead to global attention to biorefinery development.

Location is one important factor in promoting research in biorefinery that have people as end-user. The exit strategy of this research should consider the location with close to the resources to the user. In this situation, it is admitted that the growing of population in Asia leads to abundant capacity of resources in needs. Most of sources admitted that this advantage is not relevant the shifting of economic paradigm to *knowledge-based economy*. However, this gifted had not been utilized appropriately. Our capacity of sea port is not the supported compare to this facility in Singapore for example. So it this factor is still relevant if it accompanied with good program such as Sea Toll that President Joko Widodo set up.

Opportunities Factor Proposition 13: Increasing of patent registration.

Increasing number of patent registering has been successfully put Indonesia out from watching list country which also attract global attention to involve in research of biorefinery. Intellectual property right is a sensitive case in developing advance technology. Clear statement of contribution and responsibility in research contract is essential to avoid the conflict.

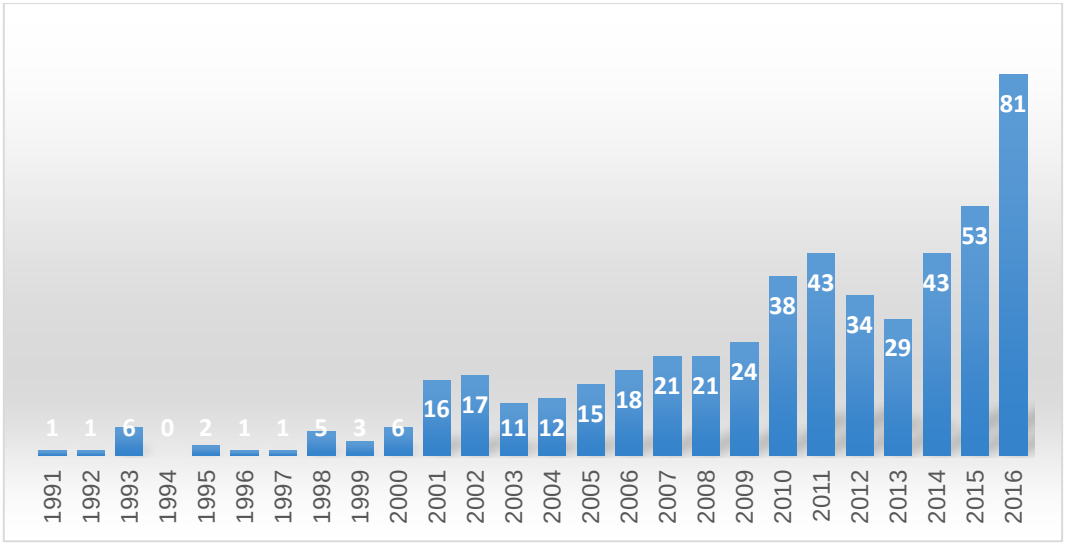

Figure 2: LIPI’s patent 1991 to 2016

Source: [61] (modified)

The growth of patent registered in LIPI had been significant since the establishment of Center for Innovation. This center was one of the result of collaboration of LIPI with Commonwealth Scientific Industrial Research Organization (CSIRO Australia) which provide assistantship for researcher in commercializing their research

output as well as registering patent.

There was a case when a partner group of researcher in Indonesia was put in annex of report project of research in sea-sponge cancer research. Number of research put in the annex together with Divers and Diving Club. The question arise when the intellectual contribution of each partner is not recognized. So, the socialization of intellectual property had been delivered and we are very happy to see the growing of the number of patents. However, in the other side, we should admit that we are not a business entity. It would be hard for us earn money from the patent. The number of patent had been raising which in-line with maintenance-fee that government pay.

Opportunities Factor Proposition 14: Academic publication increased gradually and it followed by productive development in research of biorefinery

One important result of research is publication as intellectual media in communication their research. It is not only the contribution to the world of knowledge but also dissemination the result of research activities. In biorefinery project, the super microbe as the unique collection that origine from Indonesia mixed with scientific skill in analysicng new application of bio-based refinery. It related to capacity of biomass and bioresource that attract the scientist to conduct research exploration. Foreign experts are advised to equip with certification in conducting research in Indonesia organized by the office of Ministry of Research Technology and Higher Education.

Partnership in research has increased gradually that in line with number of student pursing their degree overseas. Internet utilization in the form of sharing information regarding research activities turn was very essential. In conjunction with interactive communication, it is important to also equip with reliable capability of internet connection. Advance communication equipment were required in conducting research in rural area where most of the project occur. It also influence the ability to access academic databases as the sources for literature study.

Opportunities Factor Proposition 15: It should be admitted that loose of standard in international put Indonesia in better bargaining power which lead to good environment in conducting research in biorefinery

It is easy to find imported fruit in grocery store in Indonesia that most of those products are genetic modified food. In opposite, it is not easy to find local fruit in our neighbour country. There was Vietnam Grocery Store in Darra Brisbane sold “Ting-ting”, Indonesian-traditional food of nut and sugar candy but the label is “Made in Malaysia” in the label. Or a shrimp-paste with Indonesian name of producer but we could see a “Made in Thailand” in its label. Based on this case, to exporting Indonesian product is harder than importing goods related to standard of products.

The utilization of derivative product of bioreinery is supported by lose standard of processing and large number of biomass capacity. It is a good opportunity conducting research and producing derivative product which came from biorefinery research.

Threats Factor Proposition 16: Infrastructure in research and development is not sufficient in conducting

advance technology

It has correlation with the budget allocation for research and development as the limited funding in procurement of labs equipment as well as supply. It is common to see the students have to extend their PhD due to delay delivery of sample for their research. Problem occur usually due to public financial system that take longer times and standard of expenditure that did not meet the price that the dealer offer to researcher.

Threats Factor Proposition 17: Lack of science authority

Science authority relates to the power of nation in protecting the land, sea, air and water including the properties as the object of science. Science is universal so they could be utilized in science activities. Problem occur when it has intellectual and commercial value. One important objective in monitoring of foreign researcher in Indonesia is to protect those sources. However in some cases research activities that involve foreign researcher were not holding the permit. It lead to high risk of researcher as well as to local researcher relating to intellectual property (patent and publication) as well as commercial opportunity.

Threats Factor Proposition 18: Indonesia is attract international attention for marketing the product not in development their RD.

Number of technology-based product such as smart-phone, automobile, electronic, etc, which sold in Indonesia are not include in-house research and development. The manufacturer equipped their RD division in their main-country or others. Some have production installation in Indonesia which is good for employment.

In interview session with staff from one of biggest automobile manufacturer in Indonesia, he refers to one of Southeast Asian Country that his principal set up the RD division. This manufacturer had reputable as the favourite car in Indonesia. They also rely on the principal in deciding and discussing on modification or application of new technology in one of their product. It is recommended to equip the both production and marketing unit with RD in target country to enable local researcher in collaborating related research.

Threats Factor Proposition 19: Stability of politic, social and economy

Political stability plays important role in promoting science and technology. Government as the budget set the priority of research and allocate the budget. As policy maker, government also involve in setting up the strategy in developing science and technology. As least developed country, Indonesia has some homework in prevailing appropriability of basic needs. Agricultural sector plays important has a highest priority in providing food, feed and energy. However, the commitment in developing ST is still questioned. In some semi popular publication such as theconversation.com, number of policy were developed with limited research background. Also in some cases, the research which had had been conducted as the basis of decision but it the decision was far from the recommendation. It should be admitted of policy over science occur in developing ST.

Science is not free from value, so it is different with military institution, politics plays important role in directing ST institution. In 2000, Indonesian Institute of Sciences conduct dissemination program called: “Science

Briefing". In this session, trend of science and technology related to economy and earthquake were presented. In the present, researcher and administrator were invited to the parliament to be questioned about the program budget in the form of monitoring and evaluation. Allocation of budget for developing science and technology had influenced by the composition of allocation for basic needs like food, electricity and housing. This post was the most flexible budget.

Threats Factor Proposition 20: Indonesia is still lack in science diplomacy which put the research of biorefinery in poor position.

Indonesia is one of least developed country that not open representative offices for science and technology in overseas. As dynamics of ST is un-boundary, Increasing number of alumni from higher education institution overseas build tight networking which lead to the organizational environment of their home institution. In one range of time there was episode for A alumni which most of officers graduated from one particular country. It will change and leave some programs when it change to different alumni. Establishment of flagship was like ordinary project. It is not very productive in a short and long run.

On the other side, Science Diplomacy should translated as the two way communication. Establishing of representatives is required in modern society.

This issue was not have sufficient support as it approach by short analysis of cost and benefit. When it comes ot the office of Education and Culture Attaché as the representatives of science and technology. However the function is much different as it showed in the table 4.

In responding to the statement issue relating to ST representatives one respondent stated about irrelevant subject due to the merging of Ministerial Office for Research and Technology with Directorate Office for Higher Education. According to the main objective of that representatives, shows the different vision between what he mention. The recruitment for that representatives was also required teaching certificate (NIDN/Nomor Induk Dosen Nasional).

As economic grow globally, it is admitted about the contribution of ST in both policy and technology. General Practices Technology (GPT) as the technology which influence economic system such as electricity, food, telecommunication, cars and internet lead to borderless world which indicated by expanding access of information, global research funding etc [64].

On the other side the access to pathogenic virus, classified information and recirculating of hoax have been easier. It is far than biosecurity when it come to the threat in community, child abuse and gender in STEM.

Table 4: Comparing main priorities of science and technology representatives

Attaché for Education and Culture of the Republic of Indonesia in the United Kingdom	**The Office for Science and Technology of the Frenceh Embassy in the United States**
1. Increasing cooperation in the fields of education,	1. Monitor and report advances in Science and

culture, research, science and technology between the two countries. 2. Maintaining Indonesian language and cultural education in the UK. 3. Making recommendations on national education policies based on observations of recent developments in the fields of education, culture, research, science and technology in the UK. 4. Attending meetings and seminars on education, culture, research, science and technology in his/her accredited territory. 5. Engaging the Indonesian community in the UK, especially Indonesian students, increasing their nationalism and encouraging them to introduce Indonesia more to the people in the UK. 6. Conducting programme of activities according to the prevailing rules and regulations. 7. Delivering periodic and annual reports to the Ministry of National Education in Jakarta.	Technology in the US through newsletters and diplomatic channels 2. Promote bilateral partnerships in science, technology and innovation 3. Foster exchanges and increase mobility of researchers, doctoral students and entrepreneurs 4. Serve as a liaison between French and American academic and scientific organizations as well as between the two countries' central governments and the European Delegation 5. Increase the visibility of France's foremost laboratories, universities and start-ups 6. Support young innovative companies and the internationalization of competitiveness clusters

Source: [62,63]

5. Discussion and Conclusion

Science and technology development plays essential role in economic growth. Research shows the shifting of economic driven from supply driven to investment and now it reach innovation driven economy. Capability of nation in utilizing technology appropriately is the foundation to reach the sustainable growth since that innovation technology is the only term which not follow to the law of diminishing return (LDMR). Based on this rational, Government of the Republic of Indonesia put ST development in the agenda. Soekarno the first President of the Republic of Indonesia granted a land in Cibinong to Indonesian Science Council (SCI) in 1964. The impact of science was significant in the field of agriculture, transportations and health.

When the research is differentiate by the utilization of the result so it lead to the concept of basic and applied research. Most of basic research was design to encourage the researcher to explore and satisfied their curiosity. While the applied research lead to the final customer. However it is absurd to separate the activities which activities as basic science or for application. It is a myopic view to see and developing policy based on this view. Short term project would highly likely to get bigger fund than the research that fail to proof their customer. It applied technology readiness level and quick-win as the short term view in developing science and technology.

Imported technology-based-product are relatively cheaper which lead to unproductive environment of innovation process. Standardization of product is the issue which put those product in the weak position in the market.

Factor of biomass and wide range collection of genuine-super-microbe are the advantage on research of Biorefinery which strengthened capacity of researcher which engage in international collaboration.

6. Recommendation

As borderless word being admitted, subsequently it is also required to represent science and technology as the hub in diplomacy. Research shows how it contribute significantly in strengthening their economic capability. Then if it is viewed as the short term and calculate the budget that should be allocated and the earning in the form of currency that earn so it will again reach the innocent fraud.

Government commitment on budget in developing advance technology should be viewed as long-term investment. Consideration of science and technology as a quick-win target is like planting Tulip in tropical climate which only supplied of sufficient water and fertilizer. Inceptive development of biorefinery should be protected to achieved efficient level of production.

Culture is the essential part of science and technology. Development of biorefinery is recommended to be attached with the factor of social, political and cultural.

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