IMPACT AND BENCHMARKING STUDY TOWARD TECHNOLOGY AND INNOVATION CAPABILITIES ON OIL PALM BASED INDUSTRIES

by

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LIST OF ABBREVIATIONS

BSN	National standardization agency of Indonesia
CBS	Cacao butter substitute
CPO	Crude palm oil
CPKO	Crude palm kernel oil
df	Degrees of freedom
IC	Innovation capability
IC_{INDV}	Innovation capability based on individu
IC_{COM}	Innovation capability based on company
IC_{PROD}	Product innovation in innovation capability
IC_{PROC}	Process innovation in innovation capability
IC_{PAT}	Patent license in innovation capability
IC_{PENT}	Penetration in innovation capability
IC_{NET}	Network in innovation capability
ISO	International standardization organization
MP3EI	Master plan for enhancement and expansion of Indonesian economic development
QMS	Quality management system
R & D	Research and development
RDB	Refined, bleached and deodorized oil
SNI	Indonesian national standard
SPSS	Statistical package for the social sciences
SWOT	Strength, weakness, opportunity, threats
TC	Technological capability
TC_{COM}	Technological capability based on company

TC_{RD}	Research and development in technological capability
TC_{HR}	Human resources in technological capability
TC_{STR}	Strategic planning in technological capability
TC_{INFR}	Technology infrastructure in technological capability
TC_{MAN}	Manufacturing in technological capability
TC_{INDV}	Technological capability based on individu
X	Variable technological capability
Y	Variable innovation capability
Y_{INDV}	Innovation capability based on individu

IMPAK DAN PENANDA ARAS MENGENAI KEUPAYAAN TEKNOLOGI DAN INOVASI INDUSTRI BERASASKAN MINYAK SAWIT

ABSTRAK

Pembangunan industri hiliran minyak sawit mentah (CPO) di Indonesia belum dioptimumkan berbanding dengan Malaysia meskipun sebagai pengeluar terbesar. Indonesia perlu mempelbagaikan produk hiliran untuk meningkatkan keuntungan dan mengurangkan pergantungan kepada harga minyak sawit mentah dunia. Pada masa ini, Indonesia hanya mempelbagaikan dua puluh tiga produk hiliran yang sepatutnya boleh dipelbagaikan lebih daripada seratus produk. Meningkatkan keupayaan teknologi dan keupayaan inovasi akan membolehkan industri minyak sawit mentah Indonesia menghasilkan lebih banyak produk hiliran. Malangnya keupayaan belum diketahui. Oleh kerana itu, objektif awal dari kajian ini adalah untuk membangunkan alat pengukur keupayaan teknologi dan keupayaan inovasi khas industri, dimana metrik untuk pengklasifikasian keupayaan teknologi dan inovasi ditentukan. Kajian dilakukan terhadap sebelas buah syarikat dengan tiga puluh satu responden bagi mengumpulkan data dan menilai indikator yang berhubung kait dengan keupayaan teknologi dan inovasi. Alat pengukur khas dibangunkan dengan memilih indikator dan parameter yang berkaitan dari pelbagai industri. Alat pengukur dipergunakan sebagai penanda aras untuk mengkategorikan syarikat bagi mendapatkan model syarikat terbaik. Statistik infrensi digunakan untuk menganalisa kesan komponen keupayaan teknologi kepada keupayaan inovasi dan disebaliknya. Pengukuran keupayaan teknologi menunjukkan bahawa 55 % syarikat kategori rendah selebihnya berada pada kategori tinggi sementara pengukuran keupayaan inovasi menunjukkan bahawa 82 % syarikat adalah dalam kategori rendah

dan selebihnya dalam kategori sederhana. Alat pengukur juga boleh digunakan untuk mengenali kelemahan yang ada pada sesebuah syarikat. Keupayaan teknologi dengan komponennya mempunyai kesan yang positif dan linear terhadap keupayaan inovasi dan sebaliknya. Keupayaan teknologi diperlukan untuk membina inovasi. Kajian ini juga membolehkan syarikat untuk mengetahui kedudukan keupayaan mereka, serta mengenali kelemahan untuk dibaiki dan merancang strategi bagi meningkatkan produktiviti mereka.

IMPACT AND BENCHMARKING STUDY TOWARD TECHNOLOGY AND INNOVATION CAPABILITIES ON OIL PALM BASED INDUSTRIES

ABSTRACT

The development of downstream industries of crude palm oil (CPO) in Indonesia compared to Malaysia has not been optimised yet, although being the world largest producer. Indonesia needs to diversify it into several downstream products to increase its profitability and lower its dependence on the CPO world price. Indonesia currently produces twenty three types of downstream of CPO products although more than one hundred assorted products can be produced from the derivative. Increasing technological capability and innovation capability will enable Indonesian industries of crude palm oil to produce more variety of downstream products. Unfortunately even the current capabilities are not known. Therefore, the initial objective of this study is to develop measurand for technological capability and innovation capability specific for the industry, whereby metrics for the classification of technological capability and innovation capability was determined. A survey was conducted in eleven industries with thirty-one respondents to collect data and assess indicators pertaining to their technological and innovation capabilities. A specific assessment tool was developed by selecting relevant indicators and parameters from various industries. The measured result was applied to benchmarking procedure for categorizing companies to attain best practice model. Inferential statistic was used to analyze the impact of technological capability components towards innovation capability and vice versa. The results on technological capability showed that 55% are low category companies while the others are in high category and the results on innovation indicated that 82 % of the companies are in low category while the rest

are in moderate category. The assessment tools also enable identification of the surveyed companies' weaknesses. Technological capability components were found to have a linear positive impact to innovation capability and vice versa. Technological capability is needed to cultivate innovation. This study also make the companies be more aware of their position and condition thus able to know their capabilities, hence recognizing their weaknesses to be improved and to decide on strategy to increase the productivity.

CHAPTER ONE
INTRODUCTION

1. 0 Overview

Industrial companies are faced with the challenge to adopting best practices in their business and production processes. In order to be a world-class company, it is recommended to examining itself comprehensively and learn from the best what are one's strengths and weaknesses as well as to identify where are the opportunities to improve its capability and consequently be more competitive. It is necessary to measure the capability of their processes based on some indicators and also compare its capability with other companies. The benchmarking methodology is based on indicators related to different areas of the companies. The benchmarking integrates the picture of practice and capability across the organization.

This research is focused on framework assessment and technological capability and innovation capability of palm oil-based industries. The main objective of this study is to develop an assessment tool, benchmark the palm oil-based industries and investigate the impact of technological capability on innovation capability of palm oil-based industries. This chapter is organized as follows. Section 1.1 presents the background of the research, followed by section 1.2 with the explanation of problem statement. Section 1.3 is the research question and section 1.4 explains the objectives of the study. Section 1.5 is the significance of the research and followed by section 1.6 with the scope of the research. Section 1.7 contains the definition of terminologies. Section 1.8 consists of the structure of thesis.

1. 1 Research background

World Trade Organization and other international trade consensus have urged worldwide industries to sustain the development of profound global competition. To face the stress of competition, it is a necessity to continuously construct and innovate as a foundation for firm's excellence. Conversely, disability to innovate consequently makes companies become stagnant and even get out of business. Therefore, firms have been forced to immediately adopt the strategies in order to improve the organizational capability and global viewpoint (Yam, et. al. 2004). The business atmosphere has been changed significantly by globalization which emerges the opportunities and threats of the global market. The environment has forced the organizations to react immediately and concentrate on the organizational strategies in order to improve the companies' capabilities and worldwide viewpoint (Cox and Bridwell, 2007; Chaiprasit and Swierczek, 2011). According to Cooke (2008), in Asia, a certain method should be employed by companies as a strategy to achieve the main solution. These encompass business diversification, global market, innovativeness, and reformed management. It is necessary to improve their capabilities as a strategy to modernize to be more advanced technology (Huggins and Izush, 2008).

In a global market atmosphere, technology is considered as the most crucial component in worldwide competition. Most of the Asian economies (i.e: Korea and Taiwan) achieving the successful industries are based on their ability to utilize technological capabilities. Those countries have intensified from at first importing overseas technology to becoming builders for their own technology. As a developing country, the industrialization of Malaysia also sped up in consequence of technology

acquisition program. That country attempts to alter its manufacturing industry to be flexible and globally competitive (Jabar, et. al. 2011).

In past few years, it is designated by a trend as a worldwide market. That means the industries in developing countries have to secure their trade for survival since the industrialized countries may invade the domestic market. Globalization has allowed not only for international commerce, which carries a lot of trading chances, but also for many competitors. At the same time, technology will be under pressure to improve because of competition. Hence, developing countries encounters severe challenges nowadays in establishing their industries. Foreign competitors will be easier to access the domestic market if their competitiveness is not strong enough to enter the global market. The fast modernization of technology have been evolving worldwide transformation of the competition. Hence, conventional management is not suitable as a strategy for competition nowadays. Therefore, the industries should compete for the survival by means of restoration and innovation.

Indonesia as an agricultural country has a potential to develop agro-based industries for economic growth and to increase the livelihood. Many sources of growth in agro-based industries that can be used for the future development. Developing agro-based industries can be as a key economic sector by increasing productivity. Agro based industries plays an important role in generating employment and income opportunities. It can be indicated that agro - based industries have a significant impact on economic development and poverty reduction. The agro-based industries in Indonesia encompass palm oil processing, rubber and rubber goods, cocoa, coffee processing, furniture, fish processing, pulp and paper.

The economic globalization has challenged Indonesian government to evoke domestic economic growth. The globalization should be encountered by formulating

implementable regulation. Accordingly, the government compiles rules to support it. The role of science and technology (S&T) in economic development has also been recognized in Presidential Decree No. 32-2011 on Master Plan for Enhancement and Expansion of Indonesian Economic Development 2010–2025 (known as MP3EI). There are three main pillars for supporting future economic development in Indonesia. Firstly, the establishment of six economic development corridors based mainly on natural resource potentials and geographical characteristics. Secondly, the development of the required infrastructure for strengthening corridor connectivity across and within corridors, especially transportation networks for facilitating workforce mobility, raw materials, and processed products. Thirdly, the improvement of human resource competency and the development of relevant technologies for enhancing economic growth. Indonesia plans on President Act No. 28/2008 about the policy in National Industry decides the priority of crude palm oil (CPO) development. The derivatives of crude palm oil will obtain the value added and potential in prospect both for domestic and export market. The competitive advantages are: 1) the growth of economy; 2) industrial area development; 3) technology transfer; 4) employment; 5) government income; 6) tax.

Indonesia is the biggest producer of crude palm oil (CPO) in the world surpassing Malaysia. Being increased to be 23 million tons in 2012, diversification of CPO to be downstream in the assorted product is needed. Indonesia became the largest global producer of palm oil, reaching 31 million tons in 2013 (Hoffmann, et al. 2015). Food and Agricultural Policy Research Institute (FAPRI) predicted that global palm oil consumption will increase 30 % with total production 60 million tons in 2020. Indonesia is predicted to produce 30 million tons of CPO and contribute 23

million tons for the export market. Thus, palm oil-based industries will be potential in the future (Robbani, et al. 2015).

Processing crude palm oil to be derivatives will gain stabler and higher price in the marketplace. Indonesia has diversified only 35 % of CPO product to be various products as downstream. Actually, the derivatives of CPO consisting of hundreds assorted items can be produced, but now Indonesia has only 23 varieties of CPO product. Malaysia has more advanced technology to manufacture the innovation in new derivatives that can produce 120 varieties of products (Menteri Perindustrian Indonesia, 2010). However, the downstream industries of CPO have not been optimized to develop by the Indonesian government. Based on study of Pahan (2011) the discrepancies of downstream development in Indonesia are undeveloped infrastructure, government policy, and bureaucracy, investment regulation, venture capital, and R & D. Similarly, Harsono, et al. (2012) concluded that there are many handicaps of downstream industries in Indonesia, e.g: infrastructure, effluent processing, skilled human resources, R & D. Conversely, Van Dijk (2012) on his study said that the success of palm oil industries in Malaysia is supported by good cooperation among related aspects and collaboration between government and private sector.

To support the development of downstream palm oil industries, Indonesian government issues Industrial Ministry Regulation No. 13, 2010 about the roadmap of downstream industries cluster in Sumatera Utara, Riau, and Kalimantan Timur. The government's target of midst term in 2010 - 2014 are: 1) The cluster of downstream industries in Sumatera Utara, Riau and Kalimantan Timur are well developed, 2) capital investment support, 3) International standard infrastructure.

Nowadays Indonesia and Malaysia dominate 86.55 % of CPO in the world market, Indonesia contributes 39.34 % while Malaysia 47.21 % and the rest is other countries' contribution. Indonesia makes export 40.34 % of CPO and 59.66 % of derivatives of CPO, while Malaysia makes export 16.38 % of CPO and 83.62 % of derivatives of CPO. It can be postulated that Malaysia can earn much better economically than Indonesia because the downstream has higher added value compared to CPO only. However, referring to government's analysis some obstacles in doing above planning, such as: 1) shortage of CPO raw material because export market is better than domestic market; 2) CPO industry not integrated with downstream industry; 3) industries are not enough supported by infrastructure; 4) inadequate R & D personnel; 5) technology development; 6) reluctant foreign investor.

The outlook for the global oleo chemical industry has emerged positively with demand gradually firming since the beginning of 2010. Indonesia holds huge potential in considering the availability of feedstock for oleo chemical. Investment and partnership opportunities can be found within the sector in order to add further value and bring Indonesia at par with Malaysia in terms of technology and innovation that it can offer to international export markets.

Indonesian government's policy desires to raise export earnings instead of exporting raw material. Diversification and product development should apply new technology including innovation and R & D seriously to generate value addition, increase employment and attain food security.

1. 2 Problem statement

Sumatera Utara, one of Provinces in Indonesia, has abundant of crude palm oil (CPO). The palm oil industries need to diversify their CPO into other products in order to get more added values. Therefore, there is a need to measure the palm oil-based industries capability to diversify their products. However, no such measurement had been done before because there is no such measurand yet in the industries. Measuring technological and innovation capability of the industries is very important in order to classify the potential of palm oil industries. By gauging the capability, the firm might have standardization for making a comparison to operating it and it is expected to be a benchmark for palm oil-based industries. If it cannot be measured, it cannot be improved to succeed in the future. To be effectively implemented, the capability of intended industry needs to be measured so that 1). the industries are able to recognize their level of technological and innovation capability, 2). the industries are able to identify their weakness to be improved, and 3). the industries may develop a strategy to enhance their productivity.

It is presumed that the problem with diversification is also related to technological and innovation capability of the industries. Technological and innovation capability in an organization will be the key to achieving the desired diversification. The capability is the way to modify the firm as a response to external or internal changes or as a proactive effort to change the atmosphere. Technological capability is considered as a resource to enable a firm to create innovation in products, processes, and engineering projects (Figueiredo, 2002). Innovation performance will be easy to gain with the availability of technological capability.

1. 3 Research questions

Based on the problem statement, the study intends to develop the answers to the following research questions

1. How to develop an assessment tool which will be used to measure the technological and innovation capability?
2. How to benchmark the palm oil-based industries on their technological and innovation capability perspective?
3. What is the impact of technological on innovation capability and vice versa ?

1. 4 Research objectives

In addressing the research problem and answering research questions, this study seeks to achieve the following objectives, which are:

1). To develop an assessment tool for measuring technological and innovation capability of palm oil-based industries at the firm level.

2). To benchmark the palm oil-based industries in terms of technological and innovation capability perspective.

3). To investigate the impact of technological on innovation capability and vice versa.

1. 5 Significance of the research

The assessment tool is developed to measure the capability of technology and innovation. The result of the measurement becomes a base to benchmark technological and innovation capability of palm oil-based industries. The companies will be classified based on their technological and innovation capabilities. This then

allows the companies to develop plans on how to make the improvements or adapt specific best practices, with the aim of increasing some aspect of capabilities. The benchmarking will be treated as a continuous process in which the industries continually seek to improve their practices. This study also intends to examine the impact of technological on innovation capability and vice versa in palm oil-based industries. These studies are expected to equip in the effort to increase the productivity of the downstream of palm oil. Indonesia's plan on President Act No. 28/2008 about the policy in National Industry decides the priority of CPO development.

To implement the Indonesia plan above, the government produces a Presidential Decree No. 32-2011 on Master Plan for Enhancement and Expansion of Indonesian Economic Development 2010–2025 (known as MP3EI). There are three provinces as target development areas, such as Sumatera Utara, Riau, and Kalimantan Timur (Menteri Perindustrian Indonesia, 2010). Sumatera Utara is very potential to diversify the crude palm oil because there is a large area of oil palm plantations. In fact, Indonesia has started cultivating oil palm since hundred years ago, it began in Sumatera Utara region then followed by other areas of provinces and today some of the areas become government estates (Ministry of Agriculture, 2007). The abundant palm oil product in Sumatera Utara should be followed by the effort to diversify for value added instead of selling the crude palm oil.

Nationally, the Indonesian palm oil industry has arisen rapidly and derivatives of the development palm oil significantly contribute to export earnings, it ranked first among industrial and agricultural products (Indonesian Palm Oil Board, 2007). Indonesia is one of the largest producers of crude palm oil (CPO) and palm kernel oil (PKO) with over 22.5 million ton in 2010 and expected 40 million ton in

2020. Based on the Government policy the priority now is on developing the downstream sector to stimulate value-added. The downstream products are very potential both for the domestic and international market because consumers' demand increases year by year as well as the growth of population. Thus, the palm oil-based industries is supported by ample raw material. According to the Government policy, the national industry development will be a priority on palm oil-based industries. Till 2010 domestic consumption growth 4% - 6% per year and export market growth 5% - 8% per year (Dirjen Industri Agro dan Kimia, 2009). By studying the technological and innovation capability, and developing assessment tool in palm oil-based industries in Sumatera Utara may strengthen the management of technology to intensify the derivative products.

1. 6 Scope of the research

This study is concerned firstly with developing assessment tool framework in the palm oil-based companies. Secondly, it is to perform benchmarking on the technological and innovation capabilities of palm oil-based industries. Thirdly, it is on investigating the impact of technological capability on innovation capability and vice versa in the palm oil-based industries. The industries to be targeted are palm oil-based industries producing the downstream products. They encompass: 1) food products, such as cooking oil, margarine, shortening, CBS, vegetable ghee or 2) non-food products, such as fatty acid, fatty alcohol, glycerin, or 3) oleo chemical or 4) biodiesel. Case study data are from Indonesia specifically from Sumatera Utara region only. This province is one potential area to develop the downstream industry of crude palm oil in Indonesia.

1. 7 Definition of terminologies

The following are the definitions of key terminologies used in this research. Complete variables are depicted in chapter 3.

1) Technological capability

Technological capability indicates the accumulated technological knowledge of the firm that can be employed to develop new products/services and improve the existing ones. Technological capability includes the technology skills of the individuals and teams, the processes and routines followed, and other technological assets (e.g. machines or information and manufacturing systems that together contribute to the firm's path-dependent technology potential (Kylaheiko, et al. 2011).

2) Research and Development (R&D)

Research and development refer to the investigative activities a business performs to improve existing products and procedures or to lead to the development of new products and procedures. The organizations which are constructing technological capabilities need R&D to help in developing the innovation products (Tzokas, et al. 2015).

3) Human Resources

Human resources management is a strategic approach to decision making and planning of the organization related to employment, strategy, recruitment, training, and development which is integrated horizontally and vertically (Armstrong, 2001).

4) Strategic Planning

Strategic planning capability is a firm's ability to identify internal strengths and weaknesses and external opportunities and threats, formulate plans in accordance with the corporate vision and missions and acclimatize the plans to implementation (Yam, et al. 2010).

5) Technology infrastructure

Technology infrastructure refers to machines, equipment, and tools which perform and produce the products (Wu, et al. 2010).

6) Manufacturing

Manufacturing capability refers to a firm’s ability to transform R&D results into products, which meets market needs, accords with design request and can be manufactured in batches (Yam, et al. 2010).

7) Innovation capability

Innovation capability refers to the ability to continuously transform knowledge and ideas into new products, processes, and systems for the benefit of the firm and its stakeholders (Volkan, 2012).

8) Benchmarking

Benchmarking is a management tool for organizations to search the solution based on the best methods and procedures of the industry, the best practices are leading enterprises to the top performances (Kohl, et al. 2015).

1. 8 Structure of thesis

This thesis contains seven chapters and is compiled as follows. Chapter 1 encompasses a brief description of the research, including research background, problem statement, research questions, research objectives, the significance of research, the scope of the research, definition of terminologies, structure of the thesis, and summary.

Chapter 2 consists of a review of the literature on measurement framework, measurement framework for technological capability, measurement framework for innovation capability, benchmark, technology, technological capability, innovation capability, and palm oil.

Chapter 3 presents a description of research methodology covering how to develop assessment tool, questionnaire, interview, benchmarking procedure, flow chart of the procedure, method to apply assessment tool, the method to do the interview for benchmarking, methodology to study impact, normality testing and linearity testing, validity and reliability, pilot study, and hypothesis.

Chapter 4 is the result obtained from reviewing literature and implementation of the methodology section. It provides assessment tool, questionnaire type, variables of the assessment tool, measurement tool, interview, and data of sub-variable TC and IC.

Chapter 5 consists of analysis work from the data obtained in chapter 4. This includes statistical tools application. Chapter 6 contains discussion, where information developed in the analysis section was placed into perspective. Chapter 7 concludes the achievement of the research work and proposal for future research.

CHAPTER TWO
LITERATURE REVIEW

2.0 Overview

This chapter describes review literature work concerning matters being studied related to the objectives of the research. The matters are: measurement framework (section 2.1), measurement framework for technological capability (section 2.2), measurement framework for innovation capability (section 2.3), benchmark (section 2.4), technology (section 2.5), technology capability (section 2.6), innovation capability (section 2.7), oil palm (section 2.8) and ISO and SNI (section 2.9).

2. 1 Measurement framework

Organizations need to be aware and measure about the recent circumstances and development of technological capability and innovation capability in order to ensure the process and outcome well. The measurements of technological and innovation capability are challenging because they are crucial in industry development (Albaladejo & Romijn, 2000). Measuring is crucial for the development of both capabilities and thus important for the future success of the firms. To be able to achieve the goals, the firms should be measured because the measurement is the foundation which is probably to assess, control, and improve the processes. Measurement is the first stage that manages to control and eventually for improvement. Measurement is the basis through which it is possible to control, evaluate, and improve it. Thus, to make sure the performance of industry's operation including systems and functions in good condition measurement is needed.

Pervaiz, et al. (1999) highlighted the quote of the Foundation of Manufacturing Committee of the National Academy of Engineering that a world class manufacturing industry should be aware of the crucial of metrics referring to determine the objectives and performance expectation of the companies. The companies employ suitable metrics to analyze and depict quantitatively and an assessment used to quantify the companies' systems. Organization evaluation is not only to measure the output but also to assess the ability and capacity to produce and innovate. According to Ebert and Dumke (2007), measurement leads to better understand and evaluate the outcomes of the strategy headed to innovation. In management terms, it translates as: "*You cannot manage what you cannot measure or do not measure* (Turker, 2012). Measuring is crucial for the development of technological and innovation capabilities for the future success of the organization. Passos and Haddad (2013) advocated that measuring the capability of an organization is to know how the organization works, what their strengths and their needs are. These are essential inputs to anyone who wants to plan the future.

2. 2 Measurement framework for technological capability

The fruitfulness of technological capability means the organization can fulfill the customer needs with respect to cost, speed, quality and newness. Zahra and Nielsen (2002) advocated that technological capability encompasses four aspects, they are:

- Frequency of introduction of the new products
- Introduction of the new products faster than competitors
- Ability to create highly innovative new products, and
- Knowledge created by the organization as indicated by new patents.

Technological capabilities are multifaceted, it included R & D, manufacturing, and integrated capabilities. Manufacturing technological capabilities can determine whether a firm can transform successful its R & D results into products and improve the quality of product. Technological capabilities have most often been measured by financial matter on R&D spending, patent statistic, new product introduction, and science linkage (Schoenecker & Swanson, 2002). They argued that R&D expenses can be assumed an input measure of technological capabilities because providing financial resources to R&D is a crucial early step in developing new products or new technologies.

According to Madamohan, et al. (2004), international technology transfer is the most preferred way to obtain technology capabilities. The technology transfer especially involves the following stages: discovery, evaluation, acquisition, adaptation, and implementation. The ability of the companies to capture an imported technology depends on their technical and organizational capabilities. In accordance with Archibugi and Coco (2004), there are three main aspects of technological capabilities, i. e: the creation of technology, technological infrastructures, and development of human skill. The aspects which were selected based on the assumption that the three components play a comparative role in making technological capabilities.

Meanwhile, Park, et al. (2008) postulated that there are three concepts of technological capabilities, e.g: technology, human resources and organization, and network. They investigated four capabilities involved in technology: R&D, production and quality management system, technology transfer, and timely investment in technology. The capabilities related to the human resources and organization are recruiting skilled production management labor and assigning them

to the right place and organizing the human resources. The capabilities related to a network are links with suppliers and buyers and global links for sale, production and R&D.

Therefore, technology capability is not only limited to infrastructures, such as machinery equipment, manufacturing, and other facilities but the most crucial are the human capital. The human skill should be more crucial than the physical assets because both physical equipment and nonphysical assets are organized by human skill. Thus, the human skill should be considered as the most important part of technological capability.

Technology must be known as a quantum of knowledge mastered by people and organizations. Figueiredo, et al. (2010) inferred that technological capabilities are defined as a stock of knowledge-based resources in four aspects, namely:

1. Techno-physical. Techno-physical consists of equipment, software, database, etc.
2. Organizational and management system. The organization develops a set of routines that drive activities.
3. People. The capability is indicated through formal education and tacit knowledge, such as: experience, skills, adroitness.
4. Product and services. The organization's capability is integrated into products and services that are designed, developed, manufactured, supplied, and commercialized by the company.

Zhou and Wu (2010) purposed that technological capabilities are indicated by fostering new product and facilitating product development speed. While Kylaheiko, et al. (2011) determined that technological capabilities denote the accumulated technological knowledge that the firm develops new product/service, improves the existing product, establishes technology skill, machines, and manufacturing system.

Table 2. 1 describes the measurements of technological capability proposed by some authors.

Table 2. 1 Measurement of technological capabilities by selected authors

Measurements	Authors
1) Frequency of introduction of new product; 2) Introduction of new products faster than competitors; 3) Ability to create highly innovate new products; 4) Knowledge created by the organization as indicated by new patents	Zahra and Nielsen, 2002
1) R & D expenditure 2) Patents 3) New product introduction	Schoenecker and Swanson, 2002
1) Internal factors: Planning & control, market orientation, training, R&D investment, technical manpower 2) Technology transfer 3) External factors: Government support, National technology	Madanmohan, et al. 2004
1) Creation of technology 2) Technological infrastructure 3) Development of human skills	Archibugi and Coco, 2004
Current technology: a. How new technologies have been used in the last three years b. How many employees of company have passed new technology training course c. How much do employee of company use internet in their jobs	Knowles, 2007
1) Technology: a. R&D capability, b. ability to incrementally improve existing production processes and technology, c. technology transfer from advanced countries, d. timely investment in technology 2) Human resources and organization: a. capability to recruit skilled labor, b. capability to organize human resources 3) Network: a. link with suppliers and buyers, b. global links for sale, production and R&D	Park, et al. 2008
1) Techno - physical: a. equipment, b. software, c. database 2) Organizational and management structure and systems 3) In people: a. experience, b. skills, c. adroitness, d. talents 4) Product and service: products and services are designed, developed, manufactured, supplied, and commercialized by the firm	Figueiredo, et al. 2010
1) New product creativity 2) Product development speed	Zhou and Wu, 2010
1) New products/services 2) Improving existing products 3) Technology skill of individual and team 4) Process 5) Routines 6) Technological assets: machines, information, manufacturing systems	Kylaheiko, et al. 2011
1) Manufacturing capability 2) Research and development capability 3) Organization capability 4) Strategic planning capability	Tseng, et al. 2012

2. 3 Measurement framework for innovation capability

There are some models of innovation capability measurement. One of the model is presented by Muller et al. (2005), which advocated a matrix for the measurement of innovation. The matrix is divided into three classifications: resources, capabilities and leadership. Different researchers have a different idea about models that are especially focused on the measurement of innovation capability. Adams, et al. (2006) had described the pattern of innovation capability measurement. The framework consists of seven categories, such as inputs, knowledge management, innovation strategy, organization and culture, portfolio management, project management, and commercialization. Epstein (2007) had designed a model for innovation capability measurement, which encompasses input, process, output and outcome measures. The model focuses on consequences of an investment in innovation. Carayannis and Provance (2008) postulated a 3P-framework for innovation evaluation processes. The framework is categorized with attitude, tendency and performance. The framework consists of the measurement of innovation inputs and process capabilities. As additional to the thoughts above, therefore, new knowledge also plays role in innovation capability. According to Albaladejo and Romijn (2000), the best measurements are the ones which concentrate on inputs and outputs of innovation, while Tura, et al. (2008) focused on input only. Tura, et al (2008) inferred that input measures evaluates the arrangement of innovation activities and resources allocation including funds used in R&D and education program. Conversely, Albaladejo and Romijn (2000) argued input measures is a problem because it indicates how big the dedication, not if anything has been reached. Moreover, smaller companies do not have any chances to fund in R&D. It means an input measures do not describe the real innovation capability.

Contrary to this thought, Tura, et al. (2008) advocated that output measures assess the impact of innovation capability only. According to Albaladejo and Romijn (2000), output measurements consist of patents and licenses of the firm. The output measures is only suitable for certain types of innovations and companies. They are not suitable for small and medium service companies.

Thus, the measures of patent and R&D are only for big companies because the big companies have enough financial and management support to afford it, while the small and medium companies are quite difficult due to many funds needed to achieve it.

Albaladejo and Romijn (2000) restricted the measures of innovation capability only for product innovations with three measurements. The first one is to know the quantity of product innovation in a three-year period. The second measurement is to evaluate the number of patents obtained. The third one is to measure index which shows the significance of the organization's innovative outputs in a three-year period. They further proposed that current measures of innovation capability can be categorized into input measures and output measures. While Cavusgil, et al. (2003) advocated the measurements of innovation capability encompass five points, they are: the frequency of innovations, the order of market entry, simultaneous entry in multiple markets and the ability to penetrate new markets to tap the various facets of innovation capability. Table 2. 2 shows the measurements of innovation capability proposed by some authors.

Table 2. 2 Measurement of innovation capability by selected authors

Measurement	Authors
1) At least one product innovation in a three-year period 2) Number of patents 3) The significance of innovation outputs in a three-year period	Albaladejo and Romijn, 2000
1) Internal sources: a. professional background of founder/manager; b. skills of workforce; c. internal effort to improve technology 2) External resources: a. intensity of networking; b. proximity advantages related to networking; c. receipt of institutional support	Romijn and Albaladejo, 2002
1) Frequency of innovations 2) Order of market entry 3) Simultaneous entry in multiple markets 4) Ability to penetrate new markets and tap the various facets of innovation capability	Cavusgil, et al. 2003
Numerical value is not always the best, it is more important to notice the change in the measurement results	Yliherva, 2004
1) Number new products to the market: how many new market in the last three years 2) New method: how many new approaches for marketing, retail, trade, sales in the last three years	Wang and Ahmed, 2004
1) Resources 2) Capabilities 3) Leadership	Muller, et al. 2005
1) Number of new products or processes has developed over the last three years 2) Number of new products or processes has developed in current year 3) More/less innovative than the average in the industry	Wan, et al. 2005
1) Inputs 2) knowledge management 3) innovation strategy 4) Organization and culture 5) portofolio management 6) project management 7) Commercialization	Adam, et al. 2006
1) Input; 2) Process; 3) Output; 4) Outcome measures	Epstein, 2007
1) Input measures: fund used in R&D, education. 2) Output measures: patents, licences	Tura, et al. 2008
3P framework: 1) posture; 2) propensity; 3) performance	Carayannis and Provance, 2008
1) Potential; 2) processes; 3) results; 4) business goal	Saunila and Ukko, 2012
Patent	Mei-Chih Hu, 2012
1) New product; 2) new process	Vicente, et al. 2015

The Tables 2.1 and 2.2 are the extracted indicators from some authors. Table 2. 3 is the summary of relevant studies on technological capability and Table 2. 4 is the summary of relevant studies on innovation capability.

Table 2. 3 Summary of relevant studies on technological capability

Measurements	Authors
R & D	Schoenecker & Swanson, 2002 Madanmohan, et al. 2004 Park, et al. 2008 Ehie & Olibe, 2010 Tzokas, et al. 2015
Human resources	Amstrong, M. (2001) Madanmohan, et al. 2004 Park, et al. 2008 Figueiredo, et al. 2010 Kylaheiko, et al. 2011
Strategic planning	Madanmohan, et al. 2004 Yam, et al. 2010 Tseng, et al. 2012
Technology infrastructure	Madanmohan, et al. 2004 Archibugi & Coco, 2004 Knowles, 2007 Park, et al. 2008 Wu, et al. 2010 Figueiredo, et al. 2010 Kylaheiko, et al. 2011
Manufacturing	Yam, et al. 2010 Kylaheiko, et. al. 2011 Tseng, et al. 2012

Table 2. 4 Summary of relevant studies on innovation capability

Measurements	Authors
Product innovation	Albaladejo & Romojin, 2000 Wang & Ahmed, 2004 Wan, et al. 2005
Process innovation	Wan, et al. 2005 Epstein, 2007 Saunila & Ukko, 2012
Patent	Albaladejo & Romojin, 2000 Tura, et al, 2008
Penetration	Cavusgil, et al. 2003 Wang & Ahmed, 2004
Network	Romijn & Albaladejo, 2002

2. 4 Benchmark

Benchmarking was firstly developed by Robert C. Camp (1992) as a management tool for companies to seek the solutions referred to the best method, procedures and best practices to conduct the organizations to the top achievement. Benchmarking was in effect invented in the late 1970s when Xerox corporation

studied the performance of its Japanese associate to find out how Eastern rivals could sell the excellent photocopiers cheaper. Xerox's achievement is the first in the history of benchmarking implementation (Bhutta and Huq, 1999). Benchmarking is a medium to improve both the capability and competitiveness of the company (Kyro, 2003).

Benchmarking is a systematic and continuous process of searching, learning, adapting and implementing the best practices from within own organization or from other organizations towards attaining superior performance. Malaysia Productivity Corporation has four types of benchmarking:

1. Internal benchmarking

A comparison of one specific process within your own organisation or across different departments and business units. Example : studying and comparing the billing process among various branches / subsidiaries of the company.

2. Competitive benchmarking

A comparison of a specific process with that of a direct competitor. Example : Nokia studying customer problem resolve at Samsung.

3. Functional benchmarking

Focuses on comparison of a specific process externally with a similar one within a broad range of your industry and business line. Example : xerox studying warehouse order picking operations at L.L. Bean (is an American privately held mail-order, online and retail company) to help them improve their parts distribution process.

4. Generic benchmarking

A comparison of specific processes from unrelated industries or business lines towards identifying innovation. Example: Municipal Local Authority studying waste management at Henkel International Lubricant.

Benchmarking consists of internal (comparing performance between different departments or teams within an organization) and external (comparing performance with companies in a specific industry or across industries). One of the intention of benchmarking is proposed by Yasin (2002) that is a managerial help to improve the capability and productivity. The best implementation way of the benchmarking includes identification of the best company, making a comparison of the specific achievement metrics and learning from the best organization how the practice can be improved. According to Dooley et al. (2002), the best practices are the tactics or methods implemented to perform in an organization to improve the process. Further they stated that evidence supporting the importance of these best practices varies in its strength. Maire et al. (2005) defined that a benchmarking as a process related to the improvement by adopting the better process of others named a reference process. Furthermore, Deros et al. (2006) proposed that the benchmarking may motivate an organization to be unfastened for the new methods, ideas, processes, and practices to make better in efficiency, effectiveness and performance.

Therefore, the benchmarking is not only based on the best practices of the company but also a well-managed organization. A model company should be seen entirely in order to be a proper benchmark to the others.

The strength of a benchmarking is that it allows the decisions to be made based on facts, not intuition. It helps the organizations that are internally focused and have a predominantly reactive approach towards competition to become more proactive and externally oriented (Azhar and Omar, 2008). Likewise, another thought by Deros, et al. (2009) on their studies in Malaysia automotive manufacturing highlighted to recommend for more and various companies that benchmarking

should be employed as a useful tool in the effort to survive and get more competitive not only in the local market but also in the global market.

Asrofah, et al. (2010) proposed that performing benchmarking in the companies is one of the methods to develop an awareness of their position and condition has to be and what has to be done to get there. They further inferred that a benchmarking process does not only collect data on practices of an organization achieves against other companies but also the way how to recognize a new idea and a new method to improve the process and to be better to meet the customer's expectation. The advantages of benchmarking are the better realizing about the strengths and weakness of processes, such as improved cycle time, improved supplier's management, minimized production costs, etc. Overcoming the blindness paradigm is also another benefit of benchmarking because it is considered as a potent management tool in an organization (Asrofah et al. 2010).

The benchmarking has been performed in assorted industries as well as manufacturing and services industries. Benchmarking can be a systematic method to quantify and assess the products, services and practices of the best organization in order to classify the stage of one's company and hereafter to adopt the best practices in order to attain a good capability and improve the quality of the product. Based on the study of Norashikin, et al. (2015) on benchmarking in Malaysia palm oil milling industry implied that benchmarking is a tool that may give a guidance to the improvement of a company.

The benchmarking process is more than just a means of gathering data on how well a company performs against others. It is also a method of identifying new ideas and new ways of improving processes and, therefore, being better able to meet the expectations of customers. Benchmarking is the process by which companies