

TECHNOLOGY ADOPTION, TECHNOLOGY MANAGEMENT AND ITS IMPACT ON OPERATIONAL PERFORMANCE: A CASE FROM INDONESIA

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The keen of competitive pressure and globalization have provided the impetus for innovation because of innovation implies newness and commercial success. To date, the role of technology management as factors of success in technological innovation has become a subject of significant interest amongst practitioners and academicians. Although the plethora of attention given to the numerous issues of management of new technology adoption and implementation, but many organization still fail to manage their technology efficiently, effectively, and strategically.

This paper is base on a field investigation via face to face interviews with top management, that was done in East Java involved medium and large manufacturing companies. They operate in the tobacco, plastic, pulp, furniture, textile, cable and plywood business area. This research is an exploratory one that was conducted to examine the extent of technology adoption and its management in medium and large manufacturing companies in Indonesia. This study also investigates the impact of technology adoption on performance of the firms.

The analysis of this study has shown that there are many internal and external drivers influencing technology adoption. In addition, the successful of technology adoption and implementation depend on: (1) Management of technology adoption, which includes all of processes before making decision for adopt new technology and how the companies monitor adoption and implementation of technology. (2) Strategy to adopt and implement technology as technology sourcing, choosing product and process technology, and which part the companies develop, adopt, and implement new technology. (3) Development of technology capabilities through introducing new technology, to up grade skills, knowledge, and capabilities of worker, improve organization structure and culture, collaboration with supplier and customer, as well as benchmarking. Finally, the issue of cost, people or human resource, and economic situation were some of the problem faced by these organizations that somewhat affect that performance.

INTRODUCTION

In the last decade, more and more business organizations have invested in new technology, advanced technology, computer-based technology, and also adopted new processes and products to survive and to stay competitive. The increased degree of interests and investments on technology have made researches and investigations on the factors related to the adoption of new technology, how the business organizations manage the technology adoption, technology strategy, and the effects of technology adoption to performance, particularly more interesting for researchers.

Although there have been many studies which focus on the determinants of technological adoption and technological innovation, very little empirical research have been done on the relationship between technology adoption and performance. The reason for this is because of the assumption that the adoption of technology can only benefit it's adopter, via increasing profitability, increasing productivity, and achieving better operational performance, without the need to consider other factors such as management of technology adoption, technology strategy and also integration between technology, business strategy, and manufacturing strategy (Irwin and Hoffman, 1998). Therefore, many past researches were more focused on these factors that make the adoption of technology successful rather than what the consequences of technology adoption it self. Nevertheless, there are numerous articles and conceptual literatures that analyzed the relationship between technology adoption and performance (Porter, 1985; Morone, 1989; Higgins, 1995; Hottenstein and Dean, 1995). Madique and Patch (1988) argued that technology is a critical force for the business organization in competitive environment. Similarly, Morone (1989) viewed technology as a source of competitive advantage, Stacey and Aston, (1990) highlighted that technology advancement played a vital role in long term profitability, and Higgins, (1995) identified technology as a contributing factors to successful operation.

As consequence, it is interesting to conduct a case study on technology adoption, technology adoption management, and technology strategy that influence organization performance. In addition, this study focuses on process technology, which is more popular in China (Chen, 1995), Singapore (Tsang, 1995), Latin America (Correa, 1995), as well as other developing countries as Thailand (Ignance, et al. 1998), South Korea, and Indonesia (Shariff, 1997). The primary reasons why process technology is adopted in these countries are due to the lack of skilled and knowledge workers, and are also due to the capital and funding.

THE OBJECTIVES OF THE CASE STUDY

In view of the background and the corresponding literature review, this case study incorporate the following objectives:

- To identify the general objective of the firms adopting and implementing technology.
- To identify the external and internal driver motivating and influencing technology adoption.
- To identify the type of hard technology and soft technology that have been adopted and to find out whether hard technology or soft technology is more dominant to achieve competitive advantage in Indonesian manufacturing firms.
- To investigate how the firms manage the technology, what was done before adopting and implementing the new technology, which were factors considered in technology adoption, and how firms monitor technology adoption and implementation.
- To identify the key success factors and the barriers in managing technology adoption.
- To find out the technology strategy, technology sourcing, type of technology employed (product or process technology), and which part of firm is the technology implemented.
- To find out how the firms develop their technology capability, and what is the result of technology adoption and technology implementation.

LITERATURE REVIEW

Type of Technology

Technology can be defined as the ability to recognize technical problem, the concept and tangible thing developed to solve technical problem and the ability to exploit the concept and tangibles thing in effective way, in the other hand technology is hardware and software employed to solve operational problems effectively in an organization (Errko and Leimanen, 1995). Generally technology has been classified base upon type of technology that are product versus process technology, and hard versus soft technology. While, innovation of technology has been classified as radical versus incremental innovation and administrative versus technological innovation.

Product technology versus process technology. Product technology is technology that has been used to translate idea in to new products or services for firm's customer (Krajewski and Ritzman, 1999). Development of product technology requires close cooperation with marketing to find out what customer really wants and with operation to determine how the goods and services can be produce effectively. Product technology is important because the production system must be designed to produce product and service spawned by technological advanced. Process technology is the machine, equipment, and device, which help the operation transform material and operations in order to add value and fulfill the operation's strategic objectives (Slack, 2001). Process technology is important because it can improve the method currently used in the production systems (Krajewski and Ritzman, 1999).

Hard technology versus soft technology. Hard technology includes plant, equipment, computer based technology, and advanced manufacturing technology. While, soft technology means the system which control the technical processes and the human resources process within the organization such as TQM (Total Quality Management), uT (Just In Time), TPM (Total Productive Maintenance), MRP2 (Manufacturing Requirement Planning), and benchmarking (Harrison and Samson, 1997).

Radical versus incremental innovation. Radical innovation improve the existing functional capability of existing technology through a discontinuity, so that the new technology capabilities provides opportunity for new business venture and even for new industries. Incremental innovation improve the existing functional capability of existing technology through improve performance, safety, quality, and lower cost (Betz, 1993).

Administrative versus technological. Damanpour, et al. (1989) proposed two type of innovation adoption namely administrative innovation and technical innovation. Administrative innovations are defined as those occur in the administrative component and affect the social system of an organization consist of the organizational members and the relationship among them. It includes those rule, roles, procedures and strength that are related to the communication and exchange between organizational members. Technological innovations are defined as those that occur in operating and affect the technical system of an organization. The technical system consists of equipment and methods of operation used to transform raw materials or information in to products or services. Subramanian and Nilakanta (1996) investigated the effect of technological and administrative innovation on performance and the result has shown that both type of innovation promote organizational efficiency. The result indicated that firms that adopt technical innovation early were more effective in gaining market share than late adopter.

Technology and Competitive Advantage

That technology as potential sources of competitive advantage is not new issue but widely accepted in management and economic literature. Technological adoption and technological innovation have been powerful forces for industrialization, increasing productivity, supporting growth, and increasing standard of living (Abernathy and Clark, 1985).

The success of technology adoption, technology implementation, and empowerment of technology in pursuing competitive advantage depend on how the organization manage the technology itself. Managing technology is concerned with how the organization generates the technology internally, developes technology externally, integrates the technology within operational activities, and how organization manage the existing skilled and operational workers (Morone, 1989). Finally, the balance between internally developed technology and externally developed technology is very important to create and establish technology capability of the organization (Mansfield, 1987).

Schroeder (1990) investigated the impact a new manufacturing technology had on industry competition and competitive strategies. The study found that technology adoption (innovation) created competitive opportunities and threats for firm's that both adopted it and those that did not. Technology adoption and new operation techniques have proven to have positive effect on SME's performance such as payroll size, asset size, financial rating, sales rating and operating problem. (Ignance, et al., 1998). To develop competitive advantage, organization need to choose, design, and implement manufacturing technology that is consistent with the needs of competitive advantage (Hottenstein and Dean, 1995).

Management of Technology

The successful of technology adoption, technology implementation, and empowerment of technology as competitive advantage depend on how the organization manage the technology. Managing technology related to how the organization generated the technology internally, developed technology externally, then integrated the technology within operational activities, included how organization manage the existing skilled and operational workers (Morone, 1989). The balance between internally developed technology and externally developed technology is very important for create and establish technology capability of the organization (Mansfield, 1987).

The concept of technology management covers not only R&D but also the management of product and process technology. Viewed from that perspective, management of technology is actually the practices of integrating technology strategy with business strategy in the company (Betz, 1993). Effective management technology links engineering, science, and management disciplines to address the issues involved in the planning, development, and implementation of technological capabilities to shape and accomplish the strategic and operational objective of organization.

Harrison and Samson (1997) categorized fields of management of technology into a number of fields those are technology strategy, the management of technology adoption, identifying barrier and success factors for technology management and development of technological capabilities. Technology strategy is a pattern of decision, which set technological goals, and role of technology for achieving the goals of business strategy and goals of the firms Harisson & Samson, 1997). According to this definition, technology strategy is about: (1) the technological choices that made by firms. (2) The effort to embodied technology into new products and new processes. (3) The implementation of organizational practices and managerial processes for the deployment of technical resources.

In addition, the other thing that is not less important is how to develop technological capability. The development of technology capability is conscious process of investing in technological know-how and organizational capabilities, for effectively building and exploiting the technology that adopted and

implemented by organizations. Technology capability development involves the introduction of new technology and the associated skill, development organizational systems through technological basic are used (Harisson & Samson, 1997). Technological capability will become enabler to enhance innovation capability and to improve operation performance of organizations.

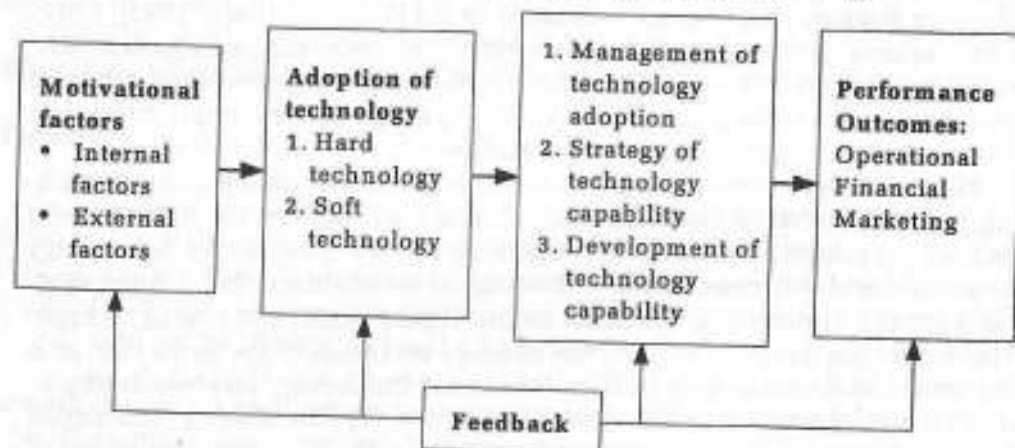
RESEARCH METHOD

There are many approaches to studying technology adoption management. Researchers employed questionnaires to study technology adoption, implementation and organizational performance (Schroeder & Sohal, 1999; Sim, 2001; Koo, et. al. 2000; Burgess, et all, 1998; Mechling, et. al. 1995). The use of interviews by Doms, et al. (1994) suggest that technologies complement human capital. Other researchers conducted case studies to investigate technology adoption, implementation, and performance (Butcher, Ct al., 1999; Harrison and Samson, 1997).

This study uses the modified version of the Processual Model that was developed by Dawson (1994). Importantly, this model was used as a guideline to investigate the experiences of business organizations in adopting and implementing technology. Figure 1 presents the framework for analyzing those factors that can influence new technology adoption success.

FIGURE 1

Framework of The Process of Adoption of Tecnology



For this study, a list of medium and large companies was obtained from the Directory of Manufacturing Industry, published by the Indonesia Statistic Center Bureau (Biro Pusat Statistic Indonesia, 2000). Seven companies were chosen at random from the manufacturing sectors, located in East Java. Data were collected through face-to-face interview with top-level management by

using a *semi-structured questionnaire*. The duration of the interview is about two hours in order to get all the information needed for this study. Classification of the sized of the firms was based on the number of employees: (1) firms with 10-99 employees are classified as small. (2) Firms of 100-499 employees are classified as medium and, (3) firms over 500 employees are classified as large. This short of classification technique was undertaken by past researchers such as Ko, Kinkade, & Brown, (2000) & also Cagliano & Spina (2000).

As shown in table 1, the profile of companies that are participated in this study included the field of business operations, length of operations, number of permanent employees, assets, and the general performance in past three years. The seven chosen companies operate in different field of business, comprising of tobacco, plastic, pulp, furniture, textile, cable, and plywood. All of the companies are private companies that have been operating for more than ten years.

TABLE 1

Respondent's Profile

Company	Kind of Industry	Length of Operation	Number of employee	Asset (Billion Rp)	Ownership	Performance in last three years
1.	Tobacco	> 30 years	24,000	> 100 Bil	private	Increase > 0,15
2.	Plastic	> 10 years	330	> 75 Bil	Private	Increase 0,10-0,15
3.	Pulp	> 10 years	7,274	> 100 Bil	Private	Decrease 0,05 - 0,10
4.	Furniture	> 10 years	200	> 100 Bil	Private	Increase 0,05-0,10
5.	Textile	> 10 years	2,981	> 100 Bil	Private	Decrease > 0,15
6.	Cable	> 20 years	629	> 100 Bil	Private	Increase 0,05-0,10
7.	Plywood	> 20 years	2,367	> 50 Bil	Private	Increase > 0,15

FINDINGS

General Objectives and Factors Influencing technology adoption

All of the respondents who have participated in this study have adopted and implemented hard technology and soft technology at different level type. According to the result of the interviews, the general objectives to adopt and implement technology are different amongst respondents, but one similarity is that all the respondents' main objective is to enhance competitive advantage. The general objectives of technology adoption are presented in Table 2.

Adoption and implementation of technology consequently demand the companies to change the organization culture, organizational system, as well as the human resource management practices. In other addition, the companies also face business competitions by making various changes within the company.

There are many factors driving the companies to adopt technology, both

internally and externally. The external factors include: (1) global competition (2). increasing customer demand for quality products. (3) the changing economic conditions that cannot be predicted. (4) higher market pressure (5) sustainability of environmental (6) the degree of competition in local market. (7) media coverage. While, internal factors include: (1) implementing technology strategy. (2) increasing material costs of production (3) increasing operational costs. (4) increasing business costs (5) obsolescent plants and equipments. (6) increasing labor cost. (7) decreasing profits 8) decreasing quality of products and, (9). high labor turn over.

TABLE 2

**General Objectives of Technology Adoption and
Technology Implementation**

General objectives	Company							Percentage (%)
	1	2	3	4	5	6	7	
Global competition	x	x	x	x	X	x	x	100
To improve product and process quality	x	x	-	x	x	x	x	85,7
Increase productivity	x	x	-	x	x	x	-	71,5
To meet customer demand	x	x	-	-	-	x	-	42,8
Delivery capability	-	x	-	-	x	-	x	42,8
Increase profitability	x		x					28,6
To extend the market.	-	x	-	-	-	-	x	28,6
Cost reduction.	-	x	-	-	-	-	-	14,3
Survival	-	x	-	-	-	-	-	14,3
Competitive price	-	x	-	-	-	-	-	14,3
Product development	-	-	-	-	-	x	-	14,3
Process development	-	-	-	-	-	x	-	14,3

TABLE 3

External Factors Driving Technology Adoption

External factors	Company							Percentage (%)
	1	2	3	4	5	6	7	
Enhance competitive advantage	x	x	x	x	x	x	x	100
Customer demand for quality	x	x	x	x	x	x	x	100
Change in economic condition	x			x		x	x	57,1
Higher market pressure		x		x	x			57,1
Environment sustainability	x		x	x			x	57,1
Competition in local market	x	x				x		42,8
Media attention	x			x				28,5

TABLE 4
Internal Factors Driving Technology Adoption

Internal factors	Company							Percentage (%)
	1	2	3	4	5	6	7	
To implement technology strategy	x	x	x	x	x	x	x	100
Increasing material cost	x	x	x	x	x	x	x	100
Increasing labor cost	x	x		x	x	x	x	57,1
Increasing the business cost	x	x		x		x		57,1
Plant and equipment obsolescence				x	x	x		42,8
Increasing operational cost				x	x	x		42,8
Decreasing profit				x	x	x		28,5
Decreasing quality of product		x					x	28,5
Labor turn over is high							x	14,3

Hard and Soft Technology Adopted

To face and or overcome various problems such as increasing degree of competitiveness and the more hostile of environment, companies try to survive and to stay competitive by adopting and implementing technology and new management practices. Table 5 to 10 describe technologies that have been adopted by the companies in this study.

TABLE 5
Hard Technology Adopted

Hard technology	Company							Percentage (%)
	1	2	3	4	5	6	7	
CNC	x	x	x	x	x	x	x	100
APE	x	x	x	x	x	x	x	100
CAD	x	x	x	x	x	x		85,7
AA	x	x	x	x			x	71,4
FMS	x	x	x	x			x	71,4
CAM	x	x	x	x			x	71,4
CAE	x		x	x	x		x	71,4
SFMC	x	x			x	x	x	71,4
FMC	x		x	x			x	57,1
CAPP	x	x	x	x				57,1
AMHS			x	x			x	42,8
AGV	x		x				x	42,8
Robotic		x				x		28,5

- X : Technology that has been adopted.
 APE : Updating process engineering (7)
 CNC : Computer numerical control (7).
 CAD : Computer Aided Design (6)
 CAM : Computer Aided Manufacturing (5)
 FMS : Flexible manufacturing system (5)
 CAE : Computer Aided Engineering (5)
 SFMS : Shop floor monitoring and control by computer (5)
 AA : Automated assembly (5)
 CAPP : Computer Aided process planning (4).
 FMC : Flexible manufacturing cell (4).
 AMHS : Automated material handling system (3).
 AGV : Automated Guide Vehicle (3).
 Robotic (2)

TABLE 6

TQM (Total Quality Management) Practices Adopted

TQM practices	Company							Percentage
	1	2	3	4	5	6	7	%
Quality management leadership	x	x	x	x	x	x	x	100
Quality information	x	x	x	x	x	x	x	100
Strategic planning of quality	x	x	x	x	x	x	x	100
Statistical quality control	x	x	x	x	x	x	x	100
Quality assurance of product	x	x	x	x	x	x	x	100
Quality assurance of process	x	x	x	x	x	x	x	100
Consideration of employees' satisfaction	x	x	x	x	x	x	x	100
Close cooperation with customer	x	x	x	x	x	-	x	85,7
Cooperation with supplier	x	-	x	x	x	-	x	71,4

TABLE 7

JIT (Just In Time) Practices Adopted

JIT practices	Company							Percentage
	1	2	3	4	5	6	7	%
Modifying plant lay out	x	x	x	x	x	x	x	100
Use multinational machine.	x	x	x	x	x	x	x	100
Increasing the level of automation	x	x	x	x	x	x	x	100
Standardization of operation	x	x	x	x	x	x	x	100
Simplification of operation.	x	x	x	x	x	x	x	100
Reducing machine set up time.	x		x	x	x	x	x	85,7

TABLE 8

TPM Practices Adopted

TPM Practices	Company							Percentage
	1	2	3	4	5	6	7	%
Establish basic TPM policy	x	x	x	x	x	x	x	100
Formulation of maintenance technology.	x	x	x	x	x	x	x	100
Tracking and introduction of new maintenance technology	x	x	x	x	x	x	x	100
Training and education to improve operation and maintenance skills.	x	x	x	x	x	x	x	100
Develop an autonomous maintenance program.	x	x	x	x	x	x	x	100
Develop schedules maintenance program.	x		x	x	x	x	x	87,5

TABLE 9

MRP2 Practices Adopted

MRP Practices	Company							Percentage
	1	2	3	4	5	6	7	%
Sales order processing	x	x	x	x	x	x	x	100
Long term capacity planning	x	x	x	x	x	x	x	100
Material requirement planning	x	x	x	x	x	x	x	100
Resources planning on medium or short horizon	x	x	x	x	x	x	x	100
Purchase order processing	x	x	x	x	x	x	x	100
Master scheduling for facility	x	-	x	x	x	x	x	87,5
Sales forecasting	x	x	x	x	x	x	x	85,7

TABLE 10

Benchmarking Practices Adopted

MRP Practices	Company							Percentage
	1	2	3	4	5	6	7	%
Internal benchmarking	x	x	x	x	x	x	x	100
Competitive benchmarking	x	x	x	x	x	x	x	100
Functional benchmarking	x	x	x	x	x	x	x	100
Generic process benchmarking	x	-	x	x	-	x	-	57,1

TABLE 11

The Role Hard Technology vs Soft Technology

Type of technology	Company							Percentage
	1	2	3	4	5	6	7	%
Soft technology	x	x	x	x	x	x	x	85,7
Hard technology	x	-	-	-	-	-	-	14,3

Based on the results of this survey, Table 11 shows that only one of the seven companies balanced hard technology and soft technology to achieve operational excellence, while, the other six companies adopt more in soft technology.

Management of Technology Adoption

Management of technology adoption is very important to achieve the objectives, and gain the benefits. As shown in table 12, before adopting the new technology companies need to: (1) determine the appropriate technology to adopt (2) collaborate and negotiate with the suppliers. (3) prepare specialized team to handle the new technology that will be adopted. Training is also conducted before adoption and implementation of new technology. In general, all of the companies in this study highlighted the lack of government support in the process of technology adoption and development.

TABLE 12

Process Before Adoption Technology

Process before adoption	Company							Percentage
	1	2	3	4	5	6	7	%
To build specialization team	x	x	x	x	-	x	x	85,7
Discuss with consultant	x	-	x	-	x	x	x	71,4
Negotiation with supplier	-	x	x	x	-	-	x	57,1

Each company has different consideration in adopting and implementing technology, but they have similarities in the decision to adopt and implement the new technology. For example, companies with higher budgets and higher emphasis on technology. Frequently, limited budgets force the companies to survive with existing technology (machine, equipment, hardware, software). Furthermore, the sluggish business condition adversely affects adoption of technology, especially the adoption of hard technology. Table 13 presents the basic consideration of new technology adoption

TABLE 13

Basic Consideration of New Technology Adoption

Company	The reason for adopting of new technology
1.	<ul style="list-style-type: none"> • Base on availability of fund. • The importance of technology for operation process
2.	<ul style="list-style-type: none"> • The importance of technology. • To meet increasing demand. • To improve the quality of existing product. • Budget for adopting new technology is flexible, depend on the urgency of the technology. • To improve process performance and product performance.
3.	<ul style="list-style-type: none"> • The importance of technology for operational process.
4.	<ul style="list-style-type: none"> • Customer and market demand. • Limited budget, survive with existing plant and equipment
5	<ul style="list-style-type: none"> • The availability of fund. The company have the budgeted for adopting and implementing new technology. • Urgency of the new technology that will be adopted
6.	<ul style="list-style-type: none"> • The availability of budgeted • The importance of technology.
7.	<ul style="list-style-type: none"> • The availability of budgeted • The importance of technology.

The process of technology adoption involves idea generation and decision making process. After the adoption of technology, it needs monitoring so the company knows whether the new technology is producing the expected results. This case study shows that idea generation came from various parts of the company. Based on functional area classification, Table 14 shows that the production and engineering functions are the most dominant in generating ideas, then followed by R&D, consultant, finance, supplier and marketing. Interestingly, employees are yet playing a role in creating ideas for adopting new technology.

Based on the level of management classification, Table 15 shows that top management and senior management provide the main drive in idea generation. This is followed by the middle management, junior management and supervisory level. Therefore, the idea for adopting the new technology is top-down and employee participation is very low.

TABLE 14

Idea Generation for Adopting Technology Classified by Functional Area

Functional area	Company							Percentage
	1	2	3	4	5	6	7	%
Production and engineering	x	x	x	x	x	x	x	100
Research and development	x	x	x	x	x	x	-	85,7
Consultant	x	-	x	-	-	x	x	57,1
Accounting and finance	x	-	-	x	x	-	-	42,8
Supplier	x	x	-	-	-	x	-	42,8
Sales and marketing	x	-	-	-	-	-	-	14,2
Personnel/ employee	-	-	-	-	-	-	-	0,00

TABLE 15

Idea Generation Classified by Level of Management

Level of management	Company							Percentage
	1	2	3	4	5	6	7	%
Top management	x	x	x	x	x	x	x	100
Senior management	x	x	x	x	x	x	x	100
Middle management	x	x	-	x	x	x	x	85,7
Junior management	x	-	-	x	-	x	x	57,1
Supervisory	x	-	-	x	-	x	x	57,1
Shop floor individual	-	-	-	-	-	-	-	00,0

In term of the decision making for adopting technology, Table 16 shows that involvement from the production and engineering areas are the most dominant, then followed by accounting and finance, R&D, consultant, and marketing. Consultants have more dominant roles and involvement before the adoption process, but in the decision making process, their roles and involvement are lower comparing with production, finance, and R&D.

TABLE 16

Decision Making of Technology Adoption and Implementation

Functional area	Company							Percentage
	1	2	3	4	5	6	7	%
Production and engineering	x	x	x	x	x	x	x	100
Accounting and finance	x	x	x	x	x	x	x	100
Research and development	x	x	x	x	x	x	-	85,7
Consultant	x	-	x	-	-	-	x	42,8
Sales and marketing	x	-	-	-	x	-	-	28,5
Supplier	-	-	-	-	-	x	-	14,2
Personnel/ employee	-	-	-	-	-	-	-	0,00

For the monitoring process, Table 17 show that all the companies are aware of the importance of monitoring after the adoption and implementation of technology.

TABLE 17

Monitoring of Adoption and Implementation New Technology

Company	Monitoring of adoption and implementation technology
1.	All management level.
2.	Top management. Operation manager. Financial manager.
3.	Top management.
4.	All level management
5.	Production department. Financial department. Top management.
6.	Top management. All level management
7.	All level management

The achievements of successful technology adoption and implementation require key success factors such as the openness of innovation culture in all management levels and in the whole organization, top management support and involvement, monitoring systems toward adoption and implementation regularly, the availability of resources that support technology adoption, the open communication system both vertical and horizontal, cross functional working system, employee evaluation, personal employee selection and involvement or participation from all workers.

The availability of resources will help the technology adoption process. Further more, availability of resources suggest the availability of workers (managerial staff, technician, operational, and specialist or skill worker), materials, and natural resources. In this study, the companies suffer lack of specialists and skilled workers for handling and operating advanced manufacturing technology. As consequence, the operational cost for implementation is very high because company has to pay for skilled foreign workers.

In addition, the companies also face some barriers such as: (1) Resistance to change, (2) Conflict, say between management lines, between management and worker, and conflict amongst worker. (3) Lack of skilled and specialist worker (4) High cost of adoption and implementation of technology. (5) Lack of implementation skills.

After a certain period of adoption and implementation of technology, the companies evaluate the impact of the adoption on performance, to investigate

whether technology adoption and implementation has produced the expected results. They realized that it is not easy to evaluate the impact of technology on performance because technology is not independent and they have synergy with other factors. Nevertheless, a company tries to measure and evaluate the impact of technology implementation as follows: (1). Increasing or decreasing operational costs. (2). Increasing or decreasing quality of products (through product defect inspection). (3) Customer response towards the product. (4) Product efficiency (5) Increasing or decreasing production capacity per time unit. (6) Increasing or decreasing production flexibility.

Technology Strategy

Technology is the key to achieve suitable competitive advantage. While, technology can create an opportunity, it can also become a threat for business organizations. Table 18 describes how the companies consider the technology. One of the seven companies states that technology is a threat, four companies consider technology as opportunity and two others companies assert that technology can become an opportunity and threat. Those companies that consider technology as an opportunity suggested that technology become main weapon to create competitive advantage through faster product and process development and technology is the enabler for creating better design. Technology provides an opportunity to expand market share and to create new market niche. Other companies state that technology is a key success to survive in turbulent and competitive business environment. With technology, the overall performance of an organization will be improved. On the other hand technology is considered as a threat because technological failures can affect the survival of the company in the long term.

TABLE 18

Technology as Threat and Opportunity

Technology as threat or opportunity	Company							Percentage
	1	2	3	4	5	6	7	%
Opportunity		x	x	x		x	-	57,1
Threat and opportunity	x	-	-	-	-	-	x	28,7
Threat			-	-	x	-	-	14,2

Table 19 presents technology sourcing and domination of product versus process technology. If classified by its source, technology can be acquired from external sourcing and or developed internally by the organization's R&D. The reasons why some companies prefer external technology sourcing (such as from technology supplier) are the limited time and limited skills for developing technology. While, other companies prefer to develop technology internally through R&D because they consider the fit and appropriateness of tech-

nology for the companies (for example, developing new software). Some companies have yet fictionalized their R&D to develop their needed technology. This survey shows that the company emphasizes more on adoption of process technology than adoption of product technology. Only one of seven companies (operate in furniture industry) asserts that the development of product technology was emphasized and performed.

TABLE 19

Technology Sourcing and Domination Process vs Product Technology

	Company						
	1	2	3	4	5	6	7
Technology sourcing	Internal and external	External	Internal	External	Internal	External	External
Product/process technology	Process	Process	Product	Process	Product	Process	Process

TABLE 20

Development and Adoption Of new Technology

Respondent	Recognizing and Developing New Technology
1.	Plant Equipment Computer hardware Computer software Apply new management practice.
2.	Plant & equipment Computer hardware Computer software New management practices.
3.	Plant & equipment Computer hardware Computer software New management practices.
4.	Plant & equipment Computer hardware Computer software New management practices.
5.	Apply new management practices
6.	Apply new management practices
7.	Plant & equipment

Table 20 describes investment of technology performed by each respondent. Adoption of new technology based on the degree of urgency of the technology for company while considering the availability of budget, degree of preparation for adopting and implementing the new technology, and also anticipation toward risks and difficulties of adoption and implementation. Each company have different policies in adopting new technology and depend on their preferences, such as developing technology in plant and equipment, computer hardware, computer software, new management practices and new techniques of management.

Technology Capability

Technology capability is as important as other functional capability in organizations, particularly as competitive weapon. Technology capability can be used as a strategic tool for developing products and processes, expanding market share, and increasing profitability.

TABLE 21

**Integration Between Technology Capability
with other functional capabilities**

Integrated/Not integrated	Company							Percentage
	1	2	3	4	5	6	7	%
Yes	x		x		x		x	71,5
No		x		x		x		28,5

Development of new capability of technology expands and changes rapidly. Base on respondent's experiences, they develop technology through many ways:

- Introducing new technology that is important to be adopted technical and operational capability of organizations.
- Enhancing skills, knowledge, and abilities of employee through courses.
- Improving and changing organizational culture. (According to this case study highlights that a centralization ideology is more dominant in Indonesian companies).
- Creating innovative culture that encourages participation and involvement of workers, so that technology capability can be improved.
- Enhancing collaboration with suppliers.
- Enhancing relationship and collaboration with customers.
- Collaborating with other companies, even with the competitor, through benchmarking.

Many literatures have studied, discussed, and presented (conceptually and empirically) about benefits and advantages obtained after adopting and implementing technology. Table 22 shows performance outcomes after adopting and implementing technology. Each company obtains different benefits after adopting various technology, both hard and soft technology.

TABLE 22

**The Performance Outcome Achieved by Companies
after Technology Adoption**

Company	The result of technology adoption
1.	<ul style="list-style-type: none"> ▪ Reducing production cost. ▪ Reducing process cycle time. ▪ Increase capability of delivery time ▪ Reducing product defect. ▪ Increasing labor productivity. ▪ Efficiency. ▪ Improving working environment ▪ Increase sales
2.	<ul style="list-style-type: none"> ▪ To reduce time of production process ▪ Increase productivity. ▪ Delivery capability ▪ Eliminate waste of material and energy. ▪ Improving production controlling. ▪ Reducing inventory of work in progress product. ▪ Reducing overhead cost. ▪ Solving the technical problem.
3.	<ul style="list-style-type: none"> ▪ Reduce time of production process.
4.	<ul style="list-style-type: none"> ▪ Better management control, to make management control easier. ▪ Reducing time to process. ▪ Improving the capability of product delivery. ▪ Reducing product defect ▪ Improving the capability to develop product design ▪ Increasing market share ▪ Increasing productivity
5.	<ul style="list-style-type: none"> ▪ Reduce product defect ▪ Stabilize product process ▪ Reduce cycle time out production
6.	<ul style="list-style-type: none"> ▪ Reduce cost of production ▪ Reduce average cycle time of production ▪ Improve delivery time capability ▪ Improving product quality. ▪ Increase productivity ▪ Eliminate waste ▪ Increase flexibility
7.	<ul style="list-style-type: none"> ▪ To defend from the hostility of business environment ▪ Improve working environment. ▪ Overcoming skills deficiencies. ▪ Improve response to customer demand.

CONCLUSION

Findings from this case study concludes that:

1. Adoption of technology has been motivated and derived by internal and external factors, the need of change in companies, the objectives and goals of the companies.
2. The importance of management in technology adoption and implementation. This study suggests that participation and involvement of employees still very low, so the companies need to encourage employee involvement and to create innovative culture. In managing adoption of technology, key success factors are needed and barriers have to be overcome.
3. The importance of formulating technology strategy formally. For example in choosing of technology investment and technology sourcing.
4. The importance of developing technology capability continuously such as introducing new technology, enhancing technological skills and capabilities of employees, and also creating culture that encourages technology advancement.

The other factors that should received attention are various barriers that impede development of technology and investment of technology, such as limited budget or fund and lack of specialists or skilled workers. Poor economic condition or recession can hamper investments on technology, give negative impact on adoption and implementation of technology, and affect performance.

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