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# THE MODERATING ROLE OF ENVIRONMENTAL MUNIFICENCE ON TECHNOLOGY-PERFORMANCE RELATIONSHIP: AN EMPIRICAL EVIDENCE OF INDONESIAN MANUFACTURING FIRMS

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**Technology adoption is powerful force for industrialization, increasing productivity, supporting growth, and improving the standards of living. Technology is a critical force for a business organization in a competitive environment, and technology advancement play a vital role in long term profitability. One of the issues raised on the relationship between technology and competitive advantage is whether the relationship is the same for all organization in wealthy (munificence) or poor environment. This study focused on the moderating role of environmental munificence on technology-performance relationship. Data were collected through mailed questionnaires to the CEO of Indonesian manufacturing firms. This study finds that both hard and soft technology have positive impacts on all performance indicators. Furthermore, environmental munificence is found to significantly moderate the relationship between hard technology and manufacturing performance. This study finds that the more munificence the environment, the greater the impact of technology on manufacturing performance.**



***Keywords*** **:** **Technology, Environmental munificence, Manufacturing firms, Performance.**

## INTRODUCTION

With increasing global competition for manufacturers, interest has grown among researchers and practitioners in the role of technology in assisting firms to maintain their competitive advantage. There is an abundant of literature that have analyzed the relationship between technology adoption and performance (e.g. Abernathy & Clark, 1985; Maidique & Patch, 1988; Harrison & Samson, 1997). Technology is powerful force for industrialization, increasing productivity, supporting growth, and improving the standards of living (Clark & Abernathy, 1985). Maidique and Patch (1988) argued that technology is a critical force for a business organization in a competitive environment, while

Stacey and Aston (1990) argued that technology advancement play a vital role in long term profitability. The study by Harrison and Samson (1997) found that technology adoption and technological strength was directly related to the competitive drivers such as average change-over process, finished product defect rate, on-time delivery and productivity. Although there have been many studies focusing on the technological adoption and innovation, there is still a dearth of empirical results that relate to technology adoption and performance, especially in the Indonesian manufacturing sector.

Another issue raised on the relationship between technology and competitive advantage is whether the relationship is the same in all environmental context. Relating to this issue inconclusive results have been found on the impact of environmental munificence on the technology-performance relationship. Meyer and Goes (1988) and Shcroeder and Sohal (1999) found that the relationship between technological innovations and performance will be stronger for bigger organizations that have abundant resources, whereas, Irwin et al. (1998) found that the impact of technology on performance is greater for those organizations operating in less munificent environment, where the resources are scare.

This study was motivated by the following considerations: (1). The dearth of knowledge and empirical research concerns with technology adoption by Indonesian manufacturing firms. (2). The lack of research that investigates the moderating effect of environmental variable on the relationship between technology and performance. Other than to investigate the moderating role of environmental munificence on the technology-performance relationship, this study investigates the impact of the level of technological adoption on financial and manufacturing performance in the Indonesian manufacturing sectors.



## CONCEPTUAL FRAMEWORK

### Technology and Performance

It is generally accepted that technology helps a firm to increase performance, to gain competitive advantage, and to create barriers to competition. Although many prior studies have investigated the impact of a particular technology on performance very few have examined the impact of hard and soft technology comprehensively, in general, the findings tend to indicate that technology has a positive impact on the firm's performance.

Numerous studies (such as Youseff, 1993; Mechling et al., 1995; and Mc Gregor & Gomes, 1999) have emphasized the potential strategic benefit of flexible responsiveness and improved productivity through purposeful adoption of advanced manufacturing technology (AMT). Skinner (1985) argued that AMT has and will continue to play a key strategic role in improving competitiveness by utilizing the manufacturing function more effectively in the overall business strategy. Youseff (1993) found that the adoption of AMT increases efficiency (related to cost) and effectiveness (related to volume) of the firms in producing goods and services. Moreover, Zammuto and O'Connor (1992) found that AMT is more likely to provide productivity improvement rather than gains in flexibility.

There are also numerous articles and empirical studies that investigated the impact of soft technology (e.g. TQM, JIT, TPM, MRP and benchmarking) on a firm's performance. Sohal and Terziovky (2000) argued that the effective implementation of quality improvement practices (TQM, benchmarking, process reengineering) lead to improvements in organizational performance in terms of both productivity and profitability, along with improved customer satisfaction. Ghobadian and Galear (1996) provide evidence that the adoption of TQM helps small and medium companies to improve long-term survive and growth.

Research has shown that JIT practices provide several potential benefits. First, JIT tends to eliminate waste in production process and material. Second, JIT has the potential to reduce lead-time, decrease throughput time, improve product quality, increase productivity and enhance customer responsiveness (Yasin et al., 1997). Similarly, a study by Kee (2000) amogst Malaysian SMEs found that JIT implementation plays an important role in improving operation performance such as inventory reduction, lead time reduction, increase efficiency and increased worker's morale. Sakakibara et al. (1997) found that JIT practices (set up time reduction, schedule flexibility, maintenance, equipment layout, and JIT supplier relationship) increase manufacturing performance, which in turn creates competitive advantage for the firms. Further, they explained that infrastructure alone is not sufficient to increase manufacturing performance without JIT practices.



Adoption and implementation of TPM help increase the productivity of plant and equipment in order to achieve maximum productivity (Al-Hassan et al., 2001). A study about TPM practices in Malaysia by Seng (2002) showed that the greater extent of TPM practices in an organization would bring higher performance in term of reduced product defect, better quality, and increase cost efficiency. Adoption of TPM is a contributing factor to reduce work in process (WIP), improving response to customer through reduced cycle time and improved product quality (Tsang & Chan, 2000). TPM brings the maintenance function into focus as a necessary and important part of firms which aim to increase their performance (Yamashima, 2000).

Humpreys (2001) showed that the adoption of MRP2 can enhance firms competitive positions through improved customer service level, increased plan efficiency and more efficient production scheduling. When MRP was implemented with JIT, it reduced cost, increased productivity and integrated all functions to manufacturing (Lowe & Sim, 1993). Benchmarking has also proven to be a common tool for enhancing organization performance (Hinton, 2000). It can be used to transfer the best practices and continuous learning to the other functions or organizations (Zairi & Whymark, 2000)

Boumount and Schroeder (1997) suggested that achieving competitive cost and quality may not be possible without some sophisticated technologies and modern management practices. They found that although sophisticated technologies, JIT and TQM are not strongly associated with cost reduction and dependability, these technologies give benefits in terms of increasing flexibility (reduction in new product development time) and increasing employees' morale. Sim (2001) investigated the impact of TQM, JIT, and AMT on performance. Successive incremental improvement could streamline the production process through the elimination of non-value added activities. On the other hand, capital investment in advanced manufacturing technology is often associated with a 'quantum leap' in performance. The above literatures indicated that neglecting improvement techniques and management systems (soft technology) may result in companies not getting a pay off from investment in technology. Thus, the following hypothesis is proposed:

$H_1$ : There is a positive relationship between the level of technological adoption on firms performance.

**Technology-Environmental Munificence-Performance Relationship**

Prior researches have also indicated that environmental munificence is positively associated with the range of strategy and organizational options available to firms. In this context, environmental munificence can be defined as the scarcity or abundance of resources needed by firms operating within the environment (Dess & Beard, 1984). Meyer and Goes (1988) study of hospital assimilation of innovations included environmental wealth (munificence) as a positive influence on the adoption of innovations. Hospitals in a wealthy environment benefit more from technological innovation since there would be greater demand for, and more resources available to support the use of technological innovation in a wealthy environment. In addition, Schroeder and Sohal (2000) found the same phenomenon where a greater slack of resources in the organization increases benefit of technology adoption in manufacturing firms.

Irwin et al. (1998) study of technology adoption in the hospital sector, included environmental wealth (munificence) as a moderator on the relationship between technology and performance. They found that for hospitals operating in a munificent environment the effect of technology on performance is negative. In contrast, hospitals operating in a poor environment, the impact of technology on performance was positive. The negative effect of technology on performance for hospitals operating in munificent environment is caused by over-adoption of technology. They explained that over-adoption could lead to decreased performance in two ways. First, if a particular technology is over-adopted, any competitive advantage gained through increasing differentiation will be lost. Second, over-adoption may cause an under-use of technology. They suggested that hospitals need to be more selective in deciding which technology should be adopted and to make sure that the technology can be supported by adequate usage. Based on the above findings, the present study considers environmental munificence will negatively affect the impact of technology. Then we posit the following hypothesis:

$H_2$ : The impact of technology on performance is greater in less munificent environment.

## METHODOLOGY

### Sample and Response Rate

For this study, a list of medium and large companies was obtained from the Directory of Manufacturing Industry, published by the Indonesian Statistic Center Bureau (Badan Pusat Statistik Indonesia, 2000). Data was collected through mailed questionnaires, which were addressed to the CEOs of the selected companies in Indonesia. The unit of analysis is organization and the sample were selected randomly from the directory. The sample selected were the manufacturing firms with more than 250 full time employees.

A total of 1000 questionnaires were distributed, of which, four companies have moved to unknown addresses and the another two companies refused to participate. In addition, 47 responses were incomplete, thus leaving a total of 183 usable responses for the purpose of this study, an 18.41% response rate.

The profile of the sample revealed an interesting spread of Indonesian large companies. Majority (60%) of the responding firms have less than 1000 full time employees with only 11.5% are very large, having in excess of 2500 full time employees. It is not surprising that about 90% of them have assets in excess of 25 million Rupiahs (1 USD equal to 9.850 Rupiahs). Most of them (80%) have been in existence for more than 10 years with only 8 companies (4.4%) being relatively new. In term of industry, 28.4% of the companies are in fabricated metal, machinery and automotive, and electronic industry, while 19.1% in food, beverage, and tobacco industry. The smallest (14.8%) group came from rattan, bamboo, furniture, and handicraft industries. Approximately 87% of the sample are Indonesian owned, while the remainder are either joint venture companies or totally foreign owned. However, locally owned companies do have some degree of alliances, with 47% indicating that they do not have any kind of cooperative arrangement with foreign entities.



### Variables and Measures

The variables of this study were measured using instruments derived from various sources.

### Level of Technological Adoption

The two dimensions include hard technology and soft technology. Hard technology refers to a family of advanced manufacturing technologies and computer based technologies, which include 13 types of hard technology. Five point Likert type scales (1 = not adopted to 5 = very high) are used and in order to measure the level of adoption of hard technology, an instrument developed by Youseff (1993).

The level of sophistication, cost and complexity of the various hard technology varies. Thus to equate one technology with another in coming up with a measure of extent of adoption of hard technology is inappropriate. For this study, we adopted the methodology used by Jantan, Ramayah, Ismail, and Salehudin (2001), where the extent of adoption is measured using the following formula:

$$\text{The extent of hard technology (AMT) adoption} = \frac{\sum i_j \times w_j}{\sum w_j}$$

Where:

$i_j$ = Level of hard technology, where the value of $i_j$ become 1 if the hard technology is not adopted at all and 5 if the hard technology is adopted at very high level.

$w_j$ = The importance (radicalness) index that was obtained from a panel of experts., where, $w_j$ become 1 if the hard technology is considered very unimportant and 5 if the technology is considered very important.

To establish the degree of radicalness or importance of hard technology, a separate questionnaire was prepared and sent to experts (technical or production managers) from large manufacturing companies. These managers have had experience in working with hard technology system. They are also considered as experts, and knowledgeable of the benefits of each type of hard technology and the difficulty in implementing the systems. The purpose of this part of the study is to determine the weights attached to each type of hard technology, in measuring the sophistication or extent of adoption of hard technology by the responding firms.



Soft technology refers to the system, which control the technical processes within the organization such as TQM, JIT, TPM, MRP2, and Benchmarking. TQM measure are obtained and modified from Sohal and Terziovsky (2000). For the level of JIT adoption the components from Yasin, et al. (1997) as well as Sakakibara et al. (1997) were adopted and modified based on the objective of this study. The level of TPM and MRP2 adoption is measured with the instrument developed by Tsang and Chan (2000) as well as Warnock (1996), respectively. While the level of benchmarking adoption is measured based on the general benchmarking practices (Hinton, Francis &Holloway, 2000). A five-point Likert scale anchored by 1 (not practiced) to 5 (very high) is used to measure the level of soft technology adoption.

**Environmental munificence**

it means environment wealth, abundance of resources or capacity to support growth (Irwin et al., 1998). Six items is derived from Badri et al., (2000) to measure the availability of resources using a five-point Likert-like rating scale from 1 (very scarce) to 5 (abundant). As measured by Meyer and Goes (1988) as well as Badri et al. (2000), this study measures environmental munificence as the extent of availability of human and material resources.

**Performance**

This study looks at performance from two perspectives. First, the firm performance compared to average performance in industry and second, growth in performance, which is measured by comparing current performance with performance of the previous year. Five-point Likert-like scale ranking from 1 (much lower) to 5 (much higher) is used to measure firm performance compared to average performance in industry, while seven-point Likert-like scale, rating from 1 (decrease more than 10%) to 7 (increase more than 10%), is used to measure growth of performance. The performance measures used include financial performance and non-financial performance. Financial performance refers to performance as measured by ROI, ROA, ROS, growth is sales and profit (Beaumont and Scroeder, 1997), while non financial performance covers performance on five dimensions of manufacturing e.g. productivity, cost, quality, flexibility and delivery (Stonebaker & Leong, 1994; Leong et al., 1990, Bond, 1999).

These measures were subject to factor analyses to identify the structure of interrelationship (correlation) among the items used. Factor analyses were conducted on the 13 questions of hard technology, 32 questions of soft technology, and 13 questions of firms performance. The factor analysis was conducted separately for extent of advanced manufacturing technologies and 32 organizational practices. Two factors emerged and named as hard technology (Cronbach's alpha .9496) and soft technology (Cronbach's alpha .9518.). The results of factor analysis for firms' performance identified two factors, which are named accordingly, financial performance (Cronbach's alpha, 9026) and manufacturing performance (Cronbach's alpha .8762). Similarly, factor and reliability analyses were conducted on growth in firm's performance. Two significant factors emerged from the factor analysis on firm's performance growth. The factors are named financial performance growth (factor 1, Cronbach's Alpha = 93.03) and manufacturing performance growth (factors 1, Cronbach's Alpha = 93.27). Finally, second order factor analysis was conducted to see whether the four dimensions of performance (e.g. financial performance, manufacturing performance, growth in financial and manufacturing performance) are unidimensional factor. The result shows that one factor emerged (Cronbach's alpha .7845). High Cronbach's alpha values of each of the derived factors indicated acceptable reliability level for further analyses (Nunnaly, 1978).

# FINDINGS

## The Impact of Technology on Performance

Table 1 presents the results of multiple regression analyses, which analyzed the impact of technology on firms' performance. The findings can be summarized as follows: (1) both hard and soft technologies have positive impact on all indicators of performance. This result indicates that performance can be improved by adopting more hard and soft technologies. (2). Hard and soft technologies jointly are able to explain 28.1%, 33.6%, 15.7%, 23.1%, and 36.4% of variation in financial performance, manufacturing performance, financial performance growth, manufacturing performance growth, and overall performance. (3). Hard and soft technologies in tandem better explain performance rather than growth of performance. (4). Hard and soft technologies explain manufacturing performance better than financial performance. (5). The impact of hard and soft technology explains manufacturing performance better than in financial performance.

**TABLE 1**

**The Impact of the Level of Hard and Soft Technology Adoption on Performance.**



| Independent Variables | FP | MP | FPGR | MPGR | OVPERF |
|---|---|---|---|---|---|
| $R^2$ | 0,281 | 0,336 | 0,157 | 0,231 | 0,364 |
| Adjusted $R^2$ | 0,273 | 0,329 | 0,148 | 0,222 | 0,357 |
| Sig. F | 0 | 0 | 0 | 0 | 0 |
| **Standardized Coefficients (b)** | | | | | |
| HT | ,184** | ,158** | ,264*** | ,241*** | ,243*** |
| ST | ,402*** | ,475*** | ,181** | ,298*** | ,431*** |

*** : significant at 0.01 ** : significant at 0.05

Note :

HT : Hard Technology
ST : Soft Technology
FP : Financial Performance
FPGR : Financial Performance Growth
MP : Manufacturing Performance
MPGR : Manufacturing Performance Growth
OVPERF : Overall Performance

## The Moderating Impact of Environmental Munificence

Hierarchical regression analysis is used to analyze the moderating impact of environmental munificence on the relationship between technology and performance. Hypothesis 2 of this study expects that the more munificent the environment the less will be the impact of technology on performance. Tables 2 to 6 tabulate the results of regression analysis for testing the moderating effect of environmental munificence (EM) on the relationship between technology and performance.

Table 2 shows that the introduction of environmental munificence (EM) and the interaction terms do not change F-ratio and $R^2$ from step 1 to 2 and from step 2 to 3. This indicates that environmental munificence does not moderate the relationship between technology and financial performance. This is also supported by no significant interaction terms in step 3.

**TABLE 2**

**The Moderating Effect of Environmental Munificence on The Relationship Between Technology and Financial Performance**

| Variables | Step 1 | Step 2 | Step 3 |
|---|---|---|---|
| | Standardized Beta | | |
| HT | ,184** | ,161** | 0,083 |
| ST | ,402*** | ,407*** | ,802* |
| EM | | -0,068 | 0,299 |
| HT x EM | | | 0,067 |
| ST x EM | | | -0,532 |
| $R^2$ | 0,281 | 0,285 | 0,291 |
| $R^2$ change | 0,281 | 0,004 | 0,006 |
| F change | 35.147 | 1.028 | 0,76 |
| Sig, F change | 0 | 0,312 | 0,469 |

*** : significant at 0.01 ** : significant at 0.05
* : significant at 0.1

(Note: Step 1 refers to regression with the independent of hard technology (HT) and soft technology (ST); Step 2 refers to regression with the independent variables and the moderator (EM), whilst step 3 refers to the regression with the independent variables, the moderator and the interaction terms)

Table 3 displays the results of the role of environment munificence (EM) in moderating the relationship between technology and manufacturing performance (MP). We can see that F-ratio and $R^2$ change significantly with the introduction of interactions terms in step 3. The significance of the standardized beta of the interaction term (HTxEM), indicates that EM moderates the impact of hard technology on manufacturing performance.

## TABLE 3

**The Moderating Effect of Environmental Munificence on The Relationship Between Technology and Manufacturing Performance**

| Variables | Step 1 | Step 2 | Step 3 |
|---|---|---|---|
| | Standardized beta | | |
| HT | ,158** | ,135* | -,767* |
| ST | ,475*** | ,476*** | ,785** |
| EM | | -0,085 | -0,233 |
| HT x EM | | | ,814** |
| ST x EM | | | -0,416 |
| $R^2$ | 0,336 | 0,338 | 0,344 |
| $R^2$ change | 0,336 | 0,006 | 0,019 |
| F change | 45,357 | 1,760 | 2,686 |
| Sig, F change | 0 | 0,186 | 0,071 |

*** : significant at 0,01 ** : significant at 0,05
* : significant at 0,1



The moderating effect of environmental munificence (EM) on the relationship between hard technology (HT) and manufacturing performance (MP) is illustrated in Graph 1. It shows that the impact of HT on MP is always positive in high munificence environment. From this graph we can see that when the level of HT is low to moderate, the impact of HT on MP is greater for those companies operating in highly munificent environment, but the reverse is true when level of HT is moderate to high.

## GRAPH 1

**The Impact of Environmental Munificence (EM) on the Relationship between Hard Technology (HT) and Manufacturing Performance (MP)**

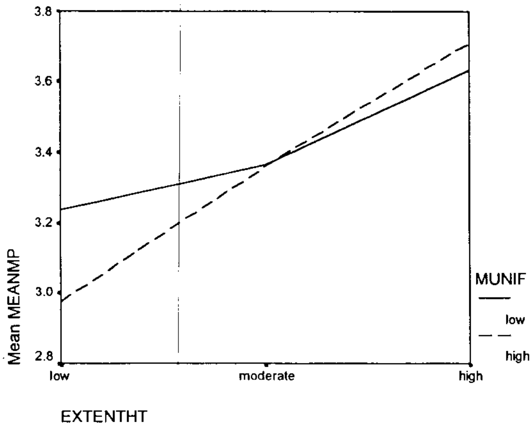


Table 4 presents the moderating influence of environmental munificence on the relationship between technology and financial performance growth. In this case, we do not detect any moderating impact of environmental munificence on this relationship, as indicated by the non significance of F-change, $R^2$ change, and interaction terms.

**TABLE 4**

**The Moderating Effect of Environmental Munificence on The Relationship Between Technology and Financial Performance Growth**

| Variables | Step 1 | Step 2 | Step 3 |
|---|---|---|---|
| | Standardized beta | | |
| HT | ,264*** | ,249*** | ,267 |
| ST | ,181** | ,184** | -0,382 |
| EM | | -0,044 | -0,622* |
| HT x EM | | | -0,003 |
| ST x EM | | | ,761 |
| $R^2$ | 0,157 | 0,159 | 0,174 |
| $R^2$ change | 0,157 | 0,002 | 0,016 |
| F change | 16,750 | 0,363 | 1,677 |
| Sig, F change | 0 | 0,547 | 0,190 |

*** : significant at 0,01 ** : significant at 0,05
* : significant at 0,1



**TABLE 5**

**The Moderating Effect of Environmental Munificence on The Relationship Between Technology and Manufacturing Performance Growth**

| Variables | Step 1 | Step 2 | Step 3 |
|---|---|---|---|
| | Standardized beta | | |
| HT | ,193*** | ,255** | -,486 |
| ST | ,345*** | ,334*** | ,488 |
| EM | | ,177** | -0,093 |
| HT x EM | | | ,745* |
| ST x EM | | | -0,208 |
| $R^2$ | 232 | 0,260 | 0,280 |
| $R^2$ change | 232 | 0,028 | 0,020 |
| F change | 27,083 | 6,737 | 2,454 |
| Sig, F change | 0 | 0,010 | 0,089 |

*** : significant at 0,01 ** : significant at 0,05
* : significant at 0,1

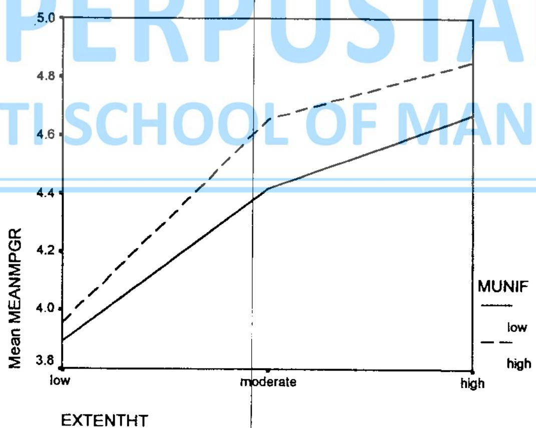
Table 5 shows the moderating role of environmental munificence on the relationship between technology and manufacturing performance growth. The addition of environmental munificence in step 2 results in significant F-change and $R^2$ change. Nevertheless, the addition of interaction terms in step 3 also significantly changes the F-ratio and $R^2$. Thus, environmental munificence is shown to moderate the relationship between hard technology and manufacturing performance growth.

Graph 2 shows how environmental munificence moderates the impact of hard technology on manufacturing performance growth. This graphs indicates that in general the impact of hard technology on manufacturing performance growth is greater for those companies operating in highly munificent environment. Impact of hard technology on manufacturing performance growth is greater in high environmental munificence when hard technology is low to moderate, but no differences in impact of hard technology on manufacturing performance growth when hard technology is moderate to high.

## GRAPH 2

**The Impact of Environmental Munificence (EM) on the Relationship betweenHard Technology (HT) and Manufacturing Performance Growth (MP)**






The results of regression analysis for testing the moderating influence of environmental munificence on the relationship between technology and the overall performance is given in Table 6. The F-change and R-change are not significant. The fact that none of the beta coefficients of the interaction terms is significant, supports the conclusion that environmental munificence does not moderate the relationship between technology and the overall performance.

**TABLE 6**

**The Moderating Effect of Environmental Munificence on The Relationship Between Technology and Overall Performance**

| Variables | Step 1 | Step 2 | Step 3 |
|---|---|---|---|
| | Standardized beta | | |
| HT | ,259*** | ,260*** | -0,189 |
| ST | ,436*** | ,436*** | ,520 |
| EM | | ,003 | -0,171 |
| HT x EM | | | ,452 |
| ST x EM | | | -0,113 |
| $R^2$ | ,387 | 0,387 | 0,394 |
| $R^2$ change | ,387 | 0,000 | 0,008 |
| F change | 56,446 | 0,003 | 1,105 |
| Sig, F change | 0 | 0,960 | 0,334 |

*** : significant at 0,01 ** : significant at 0,05
* : significant at 0,1



## DISCUSSIONS

### Technology and Performance Relationship

Both hard and soft technologies have positive impacts on overall performance. This result indicates that overall performance can be improved by adopting more hard and soft technologies. Soft technology typically leads to incremental improvement in performance by streamlining the production process through the elimination of non-value added activities. On the other hand, capital investment in hard technology is often associated with an effort to achieve 'quantum leaps' in performance. Thus, to achieve excellent overall performance, the companies must be able to manage both hard and soft technology effectively.

This study's finding is consistent with that of previous studies such as Boumount and Scroeder (1997) and Sim (2001). They found that that performance excellence is often the result of the combined use of continuous incremental improvement techniques (such as TQM, JIT, MRP, etc.) and capital investment in equipment or AMT. Further, this finding is consistent with many previous studies about adoption of hard and soft technology that result in various performance improvements (Sim, 2000; Gordon & Sohal 2001). Gordon and Sohal (2001) asserted that companies, which adopt more technologies and put more emphasis on process improvement, will reap greater benefit than those companies do not.

As expected, we find that the soft technology has a greater impact on overall performance. It is due to the fact that Indonesian manufacturing companies typically adopt more soft technology than hard technology. The lower risk during adoption or implementation and the lower investment involved lead to the greater impact on performance. This finding is consistent with the trend of technology adoption in Japan (Yamashima, 2000) and other developing countries such as India (Dangayach & Deskmuch, 2000), China (Tsang & Chan, 2000), Korea (Kim & Ro, 1995), Thailand (Wong, 1995), Turkey (Burgess, 1998), and Latin America (Correa, 1995). However, the impact of hard and soft technology on performance varies by indicator of performance used.

Regarding to the impact of technology on manufacturing performance, we find that hard and soft technology have positive significant effects on manufacturing performance. This finding indicates that companies can improve manufacturing performance by adopting hard and soft technologies. Adoption of hard technology is a vehicle to increase process and product quality, process and volume flexibility, as well as delivery reliability. Thus, improvement of manufacturing performance and its growth can be attained. Hard technology is essential in modern manufacturing firms to increase efficiency. The adoption of hard technology has a positive relationship with operation efficiency and effectiveness of companies in producing goods and services. The proper implementation and utilization of hard technology leads to improved manufacturing productivity as measured by efficiency and effectiveness. In turn, this will increase the flexibility in responding customer needs and in meeting customer demands. This finding is in line with a large number of previous studies done by Meredith (1987), Zammuto and O'Connor (1992), Youseff (1993), Godhar and Lei (1994), Mechling et al. (1995), Baumounth & Schroeder (1997), Gupta et al. (1997), Brendeberry et al. (1999), Sohal et al. (1999), Buthcher et al. (1999).

This finding shows that the effective implementation of soft technology leads to improvement in manufacturing performance. Implementation of this technology can reduce rework, scrap, and product defect. Soft technology also plays an important role in shortening process/product development time, and in enhancing delivery capability. The findings of this study appears to be in line with many previous studies about adoption of soft technology. Most of previous studies investigate the impact of particular soft technology on performance (Sohal & Terziovsky, 2000; Sakakibara et al. 1997; Gamyah & Gargeya, 2001; Tsang & Chan, 2000; Sum & Yang, 1993; Kumar & Chandra; 2001) and only a few studies investigate the impact of soft technology comprehensively (Currie & Seddon, 1992; Lowe & Sim, 1993; Rishel & Burn, 1997; Sim, 2001). However, the result of this study is supported by the above mentioned studies. It shows that adoption of all types of soft technology will result in better performance than adoption of the specific technology. It is due to complementary factors among all types of soft technology.

This study also finds that the impact of soft technology is greater than hard technology. Adoption of soft technology will give more benefits than hard technology. It is largely due to some factors that inhibit adoption and implementation of hard technology such as disruption during implementation, lack of integration of AMT with operation systems, skill deficiency, technical difficulties etc. These difficulties cause the impact of hard technology on manufacturing performance is lower than soft technology. This finding is in line with Butcher et al. (1999) who found that some difficulties during adoption and implementation of advanced technology inhibit the impact of technology to achieve improvement of production processes.

The impact of hard technology and soft technology is positive on financial performance and its growth. Adoption of hard technology will increase financial performance through the cumulative effect of cost reduction and efficiency. On the other hand, soft technology can streamline the production process through the elimination of wastages or non-value added activities and reduction of work in progress. By adopting soft technology, the quality of product and process can be improved, leading to efficiency, which in turn increase profitability (Link 1993; Beaumount & Scroeder, 1997).

The impact of soft technology compared to hard technology is greater on financial performance, but lower on financial performance growth. The possible reason for this is due to the fact that hard technology requires higher initial investment, for which the cost to be re-coup cannot be achieved immediately. Furthermore, hard technology investment can be seen as investment for the future and therefore, its impact is more on financial performance growth.

Regarding the impact of technology on performance, the following findings also need to be highlighted: First, hard technology and soft technology jointly better explain performance rather than growth. This finding is in line with Beede et al. (1998) who found that the relationship between technology adoption and growth performance tends to be positive but is often weak. However, they did not explore why the relationship between technology and growth performance is weak. Butcher et al. (1999) explained that the weakness of relationship between technology and growth performance is caused by other factors such as disruption during implementation. This could also be due to the time lag for initial investment to break-even before it shows any return.

Secondly, the adoption of hard technology and soft technology explains better the manufacturing performance than in financial performance. This is largely due to the fact that technology directly affects the manufacturing system in organization, whereas, the translation of improved manufacturing performance into financial figures may require some time lag. It is also influenced by other factors (such as strategy, marketing, and contextual factors) within the organization but outside the bounds of production functions. This is in line with Sim (2001), who cited that financial performance is the results of manufacturing performance improvement, such as low cost, high flexibility, high speed and high flexibility, although increases in manufacturing performance does not assure increases in financial performance (Sim, 2001). It can be caused by the instability of business environment, such as high inflation and economic recession so that the purchasing power of buyer decreases too. The impact of technology on performance varies across various contingencies. The finding across various contingencies of strategy and environment are discussed next.

## Technology-Environmental Munificence-Performance Relationship

Environmental munificence reflects how favorable or benevolent is the environment to business. Munificence in this study reflects the availability of resources, including skill worker, technical worker, and material resources We postulated that the more munificent the environment, the lower the impact of technology on performance will be, because a favorable environment does not allow for a firm to differentiate itself (through technology) from others to gain competitive advantages.

The findings indicate that environmental munificence moderates only the relationship between hard technology and manufacturing performance indicators. The result shows that the impact of hard technology on performance is greater in highly munificence environment. This phenomenon shows that hard technology and the munificence of environment (that measured in terms of the availability of resources) is compatible. Firms operating in a munificent environment and abundant resources benefit more from technological adoption since they have resources to support the use and implementation of sophisticated technology.

The finding indicates that hard technology supported by skilled workers, technical worker and the availability of material will result in high performance. This finding is consistent with that of Schroeder and Sohal, (2000) who found that the availability of resources increases the benefits of AMT adoption. In addition, Beede et al. (1998) also found that technology complements human capital. However, the result is contrary to the expectation with the finding of Irwin et al. (1998). This is largely due to the fact that in the context of Irwin's study, environmental munificence is seen from the context of generating demand for high-tech services, whereas our study looks at environmental munificence to support the use of technology in the production function.



However, environmental munificence does not moderate the relationship between hard technology and financial performance. It may be due to the large initial investment involved in initial adoption of hard technology, and the revenues gained cannot cover the initial expenses. Thus, although the resources are abundant, it has no impact on the relationship between hard technology on financial performance and overall performance.

On the other hand, this study does not find the moderating impact of soft technology on performance. The impact of soft technology on performance does not depend on the munificence of environment. It may be due to the intangible nature of soft technology as organizational management practices, and therefore subsumes the dimensions of munificence (availability of skills). This finding is in line with Dean and Snell (1996), who found that munificent environment does not moderate the impact of TQM on performance.

## IMPLICATIONS, LIMITATIONS AND SUGGESSTIONS FOR FUTURE RESEARCH

Several implications are advanced from the outcome of this research. This study finds that technology positively influence performance. Thus, Indonesian manufacturing firms should consider adopting more of both types of technology. In the real world, the evidence shows that the effective adoption and mastery of technology requires not just the establishment of new production facilities, but also the knowledge and expertise for implementing technical change. The findings of this study also imply that the impact of technology on performance is depended on the availability of resources, in terms of human and material resources. Aligning the resources required to support manufacturing strategies in achieving better performance.

We recognize that this study has a number of limitations. Data were collected based on perceived, self-judgment, multiple-choice questionnaire. This approach is adequate to gather a large amount of data within limited time. It should be desirable to develop a longitudinal study, but it was entirely beyond the scope and the possibilities of the study. The questionnaires address to CEO (Chief Executive Officer), thus only CEOs responded as their perception of the extent of technological adoption, the environment to be faced and the performance achieved. In this case the potential mono response bias emerges. The limitation is ' would manufacturing executives response the same way toward the extent of technology adoption.

Although this study has presented a systematic approach to investigate the extent of technology adoption, however, it could not cover all the important issues in this field. Through this study, we still know little about the relationship between technology and performance. This study only considering environmental munificence as moderator, and also not consider other environment perspectives such as dynamism, hostility and complexity that may moderate the technology-performance relationship. Thus, we suggest that taking consideration to these environmental perspectives will open up a new avenue for technology –environmental variable-performance relationship.



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