MANUFACTURING AUTOMATION, STRATEGIC ALLIANCE, INFORMATION TECHNOLOGY AND ORGANISATIONAL PERFORMANCE: EVIDENCE FROM INDONESIA

BY

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A thesis submitted in fulfillment of the requirements of the degree of Doctor of Philosophy in the School of Accounting, Finance and Economics, Griffith Business School, Griffith University, Queensland, Australia.

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Declaration

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree or qualification. I certify that any help received in preparing this thesis and all sources used have been acknowledged in this thesis.

Lanita R Winata

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ABSTRACT

This study reports the results of an empirical research investigating the relationships between Indonesian manufacturing organisations' performance and:

(a) adoption of the manufacturing automation;

(b) engagement in the strategic alliance; and

(c) managerial use of the information technology.

The relationships between managerial use of the information technology and adoption of the manufacturing automation, and engagement in the strategic alliance are also investigated.

A comprehensive review of the relevant literature reveals that previous researchers have investigated the relationship between manufacturing organisations' performance and their adoption of manufacturing automation. However, although the extant literature suggests that manufacturers' engagement in strategic alliance and managerial use of information technology could play an important role in the above relationship, the relevant previous studies did not consider the role of these variables. Moreover, since mid 90s many of the manufacturing organisations in Indonesia have been adopting manufacturing automation for improving performance. But, none of the previous studies investigating the manufacturing automation-performance relationship (let alone the role of engagement in strategic alliance and managerial use of information technology) was carried out in Indonesia. Further, none of the relevant

previous studies considered the effect of adoption of manufacturing automation, engagement in strategic alliance and managerial use of information technology on manufacturing organisations' financial performance and non-financial performance (relating to customer, internal business process, and learning and innovation).

The current study addresses the above-mentioned gaps in the literature. It has done so by empirically investigating the effect of Indonesian manufacturing organisations' adoption of the manufacturing automation, engagement in the strategic alliance and managerial use of the information technology on their performance including financial as well as the non-financial performance.

The sample of the study consists of 104 manufacturing organisations, which operate in Java Island, Indonesia. One manager in charge of one business unit of each of the 104 manufacturing organisations participated in this study. Survey and personal interview techniques were used to collect the data and the path analysis was used to test the hypothesised relationships.

The results reveal that there is a positive and direct relationship between adoption of the manufacturing automation and (a) customer-related performance and (b) internal business process-related performance, while there is a positive and direct relationship between the organisations' engagement in the strategic alliance their internal business process-related performance. The results also reveal that there is a positive and direct relationship between managerial use of the information technology and the financial as well as the non-financial performance of the organisations.

Moreover, the results indicate that adoption of the manufacturing automation and engagement in the strategic alliance are indirectly associated with the different attributes of the organisations' performance through managerial use of the information technology. The information collected through personal interviews with the business unit managers provides additional supports for the results.

The results of the study enrich current knowledge on the benefits of adoption of the manufacturing automation, engagement in the strategic alliance and managerial use of the information technology for Indonesian manufacturing organisations. The study suggests that adoption of the manufacturing automation and/or engagement in the strategic alliance may not always have a positive and direct relationship with different attributes of manufacturing firms' performance; factor(s) mediating the relationship are needed. The results reveal that managerial use of the information technology is one of such factors as it acts as a mediator in the above relationships. In other words, the results suggest that to gain the benefits of a manufacturing firm's adoption of the manufacturing automation and engagement in the strategic alliance, managerial use of the information technology is a necessity. Through managerial use of the information technology including Internet, Intranet and videoconference, a manufacturing firm can speed up its information exchange and sharing with its alliance partners and, as a result, can avoid inventory build up as well as idle capacity. Besides, because of its capability to simultaneously transmit designs, graphs and pictures to all relevant parties and facilitate group discussions, the information technology enables manufacturers to improve their performance.

Therefore, it is argued that Indonesian manufacturing firms would benefit from facilitating managerial use of the information technology simultaneously with their adoption of the manufacturing automation and engaging in a strategic alliance to improve their performance.

1

THE STUDY

1.1. Introduction of the Study

Today's business organisations[1] are facing a highly competitive environment due to globalisation, deregulation, corporatisation/ privatisation, and technological innovation. One of the consequences of such competitive business environment is that customers have more choices; they become more demanding for competitive prices, and better quality products and services (Kaplan & Norton, 1996; Lynch & Cross, 1991; Wyle, 2000). Such a competitive environment also encourages changes in customers' behaviour, their tastes and preferences, and a rapid change or innovation in manufacturing technology and processes. To face the increasing competition and its resultant effects, organisations must provide a broad range of high quality products and services at competitive prices.

Manufacturing automation, such as computer assisted design and computer assisted manufacturing (CAD/ CAM) promises organisations capabilities and opportunities to produce a broad range of quality products with less cost and time (Richter, 1996; Tonkay, 1990; Weiermar, 1990; Wyle, 2000). Because of the potential of manufacturing automation to provide more efficient and faster production at lower costs, manufacturers are always on

[1]. The terms 'organisation', 'company' or 'firm' are used as synonyms in this thesis.

the lookout for suitable manufacturing automation to accelerate their production processes and meet the customers' growing demands for quality products and services at competitive prices. There is a strong body of literature suggesting that a suitable manufacturing automation adopted by an organisation may improve the organisation's performance (Blois, 1986; Currie, 1989; Voss, 1988). The performance of an organisation should cover (a) operating performance (e.g., efficiency of production process; success in control of costs, defect rates, and reduction in production lead-time), (b) business performance (e.g., market share, penetration into new market, gaining new customers), and (c) management performance (such as employee satisfaction, and supplier/customer satisfaction) (Forker & Vickery, 1996; Kaplan & Norton, 1996; Mapes & New, 1997). Because of multiple attributes of organisational performance, adoption of manufacturing automation alone may not be sufficient to improve an organisation's performance; the automation needs to be complemented by other supporting factors so that synergy between supporting factors and manufacturing automation can facilitate improvements in the organisational performance.

This is perhaps one of the reasons why manufacturing automation has not always been found to improve organisational performance. There is evidence in the relevant literature showing that not all organisations, which have adopted manufacturing automation, are able to reap the full benefits of the automation (Dimitrov, 1990; Hayes & Jaikumar, 1991; Mollenauer, 1991; Vrakking, 1989; Wong and Ngin, 1997; Zhao & Co, 1997). One of the reasons for this is that manufacturing automation sometimes focuses only on the production (manufacturing floor) activities, thereby it can sometimes create a "dividing wall" between the production plant and the senior management resulting in a communication gap, which may in turn hamper performance within the organisation. This is because not all the information on the manufacturing floor is automatically transmitted to the management; a suitable transmission (communication) mechanism is required for this purpose.

Moreover, there is a strong body of literature suggesting that manufacturing automation adopted by an organisation may increase the organisation's production-related (or operational) performance such as productivity, product quality, and cost efficiency; but it may not improve the overall organisational performance (Beatty 1992; Blois, 1986; Chen & Small, 1996; Currie, 1989; Voss, 1988; Vrakking 1989; Zhao & Co, 1997). Therefore, as highlighted above, implementation of manufacturing automation in an organisation needs to be complemented by other supporting factors so that synergy between supporting factors and manufacturing automation facilitate the organisation's performance. It is argued in this study that engagement in strategic alliance and managerial use of information technology are two such factors, which together with adoption of manufacturing automation can enhance an organisation's performance.

In today's competitive environment, businesses must have a global perspective in order to identify opportunities and threats in the marketplace. The extant literature suggests that to outlive the threats from local as well as global competitors, firms not only should increase product and service quality and offer better value for money, but they should also actively seek to penetrate into foreign/new markets in addition to the local market. One way for a firm to enter into a foreign market is to engage in a strategic alliance with other firms. A strategic alliance is an agreement among two or more independent firms to cooperate with each other for the purpose of achieving common goals such as a competitive advantage and customer value creation. A strategic alliance allows the member firms to share R&D and other fixed costs of, and associated risks in, developing new products, processes and sometimes services (Hill, 1994). It is also a way to bring together complementary skills and resources that a firm could not easily develop on its own.

The relevant literature suggests that a firm's successful adoption of manufacturing automation and engagement in a strategic alliance may depend on collection of accurate and timely data or information on its actual performance, and on issues like market opportunities, customer tastes and preferences, technological innovation, and local and foreign competitors' actions (Dawnson, 1994). Without accurate and timely information, and feedback on these matters, a firm may not be able to monitor its operating environment, plan its actions, and evaluate its own performance effectively (Housdeshel & Watson, 1987). In other words, an organisation needs to have an information system mechanism that can gather, process, and present relevant information on a real-time basis for monitoring, planning, controlling, and spare-parts. This study argues and provides empirical evidence that managerial use of information technology can effectively perform the above functions and thereby promote an organisation's performance.

Managerial use of information technology such as Intra-net, and Inter-net (e.g. net- meeting, net-phone, videoconference) can help the management of an organisation to gather and use real-time information for spare-parts. Real-time and accurate information may help the firm to get the benefit of adopting manufacturing automation and engaging in strategic alliance (Andersen & Segar, 2001). This is particularly the case when a manufacturing firm operates in a highly competitive market, offers a broad range of products, maintains a number of divisions in different locations (regions or countries), and employs a large number of employees (Dickens, 1992; Karake, 1992). Information technology supports adoption of manufacturing automation and effectiveness of engagement in strategic alliance.

1.2. An Overview of the Study

The study examined the relationships between (a) organisational performance and adoption of manufacturing automation, engagement in a strategic alliance, and managerial use of information technology, and (b) the relationships between managerial use of information technology and adoption of manufacturing automation, and engagement in a strategic alliance. The study was carried out in 104 private manufacturing organisations operating in Java Island, Indonesia, where approximately 80% of all manufacturing organisations in Indonesia are located (Stastistic Indonesia, 1999). The sample manufacturing organisations in the study were selected (using stratified random sampling) from firms in various industries, which were included in the initial list of organisations. Large companies with 300 or more employees and a minimum annual sales revenue of 25 billion Rupiah were selected from the initial list. Only big companies were selected because such companies have more resources to afford investment in manufacturing automation and modern information technology. Companies in the sample represented 21 industries including adhesive, automotive and allied products, beverage, cement, chemical and allied products, electric and electronics equipment, garments, fabricated metal products, food, furniture, glass, herbal/traditional medicine, home appliance, metal, paper and pulp pharmaceutical, photographic equipment, plastic, stone and clay, tobacco, and textile. 104 general managers (one from each of the selected organisations) in charge of one business unit each, participated in the study. Pre-tested established questionnaires and personal interviews were used to collect the data for the study. A path analysis technique was used to analyse the data. The results indicate that a business unit's financial performance, as well as performance related to customer, internal business process, and learning and innovation were positively associated with managerial use of information technology. The results also indicate that a unit business's financial performance, as well as performance related to customer, internal business process, and learning and innovation, were positively associated with adoption of manufacturing automation and engagement in a strategic alliance, but the relationship is indirect, via managerial use of information technology.

1.3. Expected Benefits of the Study

Results of the study enrich relevant literature by providing empirical evidence on how adoption of manufacturing automation, engagement in strategic alliances and managerial use of information technology improves manufacturing organisations' performance in Indonesia. The results reveal that an Indonesian manufacturing firm's adoption of manufacturing automation and its engagement in a strategic alliance creates need for its managers to use information technology. The results also suggest that an Indonesian manufacturing organisation is likely to improve its performance as a result of its adoption of manufacturing automation, engagement in a strategic alliance and its managers' use of information technology. Therefore, the findings of the study may encourage Indonesian manufacturers to adopt manufacturing automation together with engagement in a strategic alliance and introduce managerial use of information technology.

1.4. Plan of the thesis

The remainder of the thesis is organised in the following manner. Chapter two discusses the motivation of the study; Economic importance of manufacturing organisations in Indonesia, Indonesian culture and the state of research in manufacturing automation, strategic alliance and information technology are discussed in this chapter.

Chapter three discusses the conceptual model of the impact of manufacturing automation, strategic alliance and information technology on organisational performance. It starts with the overall discussion of variables in the model, followed by an analysis of each variable. The variables are defined one at time.

Chapter four presents a rationale for the hypothesis in this research. Previous relevant research is reviewed, and based on such research, together with the Indonesian business environment and culture, a hypothesis of relationships among the variables is identified. Finally, the hypotheses investigated in this study are discussed.

Chapter five describes the companies that participated and the procedure for data collection. The chapter also discusses the instruments used to measure variables of interest in this study. The reliability and validity for each of the instruments were done by carrying out factor analysis. Factor analysis results are presented in this chapter.

Chapter six discusses the path analysis technique used to analyse the data obtained in this research. It discusses the advantages of path analysis over ordinary regression methods and provides a rationale for choosing path analysis for this research. In addition, in this chapter, tests for the assumption of path analysis and relevant data screening were conducted, before the data analysis. Finally, the chapter presents the results of the study. It examines the findings with respect to each of the hypotheses investigated.

Chapter seven provides an integrated discussion of the results obtained. Statistical and interview results with managers are discussed for each relationship among variables in the study. Further, this chapter explains the contribution made by the study. It also describes the overall limitations of the research and presents the implications and conclusions of the results.

1.5. Chapter Summary

Section one in this chapter briefly introduces the study to the reader. Section two of the chapter provides an overview of the study and the research site. It explains the sampling procedure followed for the study, describes the participants and the methods of data collection, and highlights the overall results of the study. In section three, the expected benefits of the study are briefly explained. Finally, in section four of the chapter, the thesis plan is described. The next chapter discusses the motivation for the study.

MOTIVATION FOR THE STUDY

2

2.0. Introduction

This chapter explains the motivation for the study. Section one of the chapter presents an overview of the importance of manufacturing industries in the economic development of Indonesia (where the study was conducted). Section two discusses characteristics of the business environment in Indonesia and the relevance of manufacturing automation for manufacturing firms operating in that environment. Section three of the chapter explains the unique nature of organisational culture in Indonesia and highlights the need for the study. It also explains how the Indonesian social norms may be influencing on organisational culture in the country. Section four describes the current state of research on manufacturing automation and its state in Indonesia vis-a-vis Western countries. Finally, a summary of the chapter is presented in section five, which also briefly introduces the next chapter.

2.1. Economic Importance of Manufacturing Organisations in Indonesia

Indonesia has been undergoing a transformation from an agriculture-based economy to an industrial economy. As a result of the transformation, manufacturing industries have become the backbone of Indonesia's export drive (Investment Coordination Board, 1999). Since 1998, the growth in export of non-oil and gas commodities has been dominated by manufactured products. For instance, while in 1998 manufactured products export was US$18.53 billion, it increased to US$21.09 billion in 1999, an increase of 13.8% in one year. This trend has continued (Indonesian Statistic, 2000). Moreover, from 1995 to 1998, 22,000 new manufacturing organisations were established annually. With a population of 220 million (a high proportion of which are relatively young), exceptionally low wages, a huge land mass, vast natural resources, and attractive government investment regulations, Indonesia has been attracting more and more investors to establish manufacturing organisations. This is expected to result in a significant contribution to the Gross National Product. Given the critical importance of the manufacturing industries' performance in the economic development of Indonesia, the focus of this study, investigating potential factors affecting performance of tmanufacturing organisations operating in Indonesia is well placed.

2.2. Indonesian Business Environment

The business environment in Indonesia is shaped by a large, young , a huge landmass, and vast natural resources. Since 1997, Indonesia has been suffering from financial crisis; the value of the Indonesian Rupiah has significantly decreased against hard currencies. As a result, prices for all goods, including imports, have become very high, therefore, the cost of living sky rocketed. Due to exceptionally low wage, Indonesian business firms have been experiencing frequent labour union actions, such as strikes. Union action in the manufacturing industries have been frequent (Kwik, 1996). To avoid such problems, many of the Indonesian manufacturing organisations have been replacing workers with automated manufacturing facilities (manufacturing automation) in spite of the fact that wage rates in Indonesia are exceptionally low. Another plausible reason for adoption of manufacturing automation is that it enables manufacturers to compete in international markets. With automation, manufacturing companies can produce high quality products, effectively control defect rates, and deliver customer orders on time. These are probably the reasons why Indonesian manufacturing organisations have been on the lookout for adoption of manufacturing automation although the country has a huge potential supply of labour at low cost. Manufacturing automation in Indonesian manufacturing firms has been increasing. For instance, the Investment Coordination Board of Indonesia (1999), and the Bureau of Statistic of Indonesia (2000) reveal that since 1997 the number of manufacturing firms in the country has been increasing rapidly. Note, approximately 22.000 new manufacturing firms were set up each year during the 1995 - 1998 period. Yet in manufacturing organisations during the same period increased only by one percent (1%). One explanation for this low increase in the employment rate is that a great majority of the new and existing manufacturing organisations adopted manufacturing automation, rather than employing labour for production. The Investment Coordination Board of Central Java (1999) revealed that investment in production automation during 1997 - 1998 period alone increased by approximately 200%.

Previous studies show that in order to improve organisational performance, manufacturing organisations have adopted manufacturing automation. Attaran (1989), Badiru (1990), Boyer (1996), Hayes & Jaikumar (1991), Patuwo & Hu (1998), Udo & Ehie (1996) argue that manufacturing automation has the capability to standardise quality of products and to reduce production costs. But, other researchers (Beatty, 1992; Blois, 1986; Chen & Small, 1996; Currie, 1989; Shepherd, 2000; Voss, 1988; Vrackking, 1989; Zhao & Co, 1997) report that manufacturing automation does not always have a positive relationship with organisational performance. In other words, the empirical evidence on the benefits of adopting manufacturing automation reported in previous studies is inconclusive. One explanation for such inconclusive results, which were conducted in Western economies, is that the benefits of manufacturing automation may be contingent upon a number of factors. This study argues that engagement in strategic alliance, managerial use of information technology and culture, are among those factors. Consequently, the study investigates the relationship between a firm's adoption of manufacturing automation and its performance, taking into account the role of the firm's engagement in a strategic alliance and managerial usage of information technology. An extensive review of the literature revealed that none of the relevant previous studies investigated the above relationship.

Given that the characteristics of the business environment and the motivation for adoption of manufacturing automation in Indonesia are different from organisations in Western countries and previous studies, would the relationship between the adoption of manufacturing automation and organisational performance in Indonesian manufacturing firms be the same? Given that none of the previous studies on manufacturing automation were conducted in Indonesia, an answer to the above question is not known. This study empirically examines whether Indonesian manufacturing firms' adoption of manufacturing automation has had a positive relationship with their organisational performance, as suggested in the previous studies conducted elsewhere. This study assesses these relationships, taking into account the potential role of the firms' engagement in a strategic alliances and their managers' use of information technology.

2.3. Indonesian Culture

Being an Asian country and having a predominantly oriental society, Indonesia has a culture that is different from those in the West. In addition, almost all private business organisations (large and small) in the country are family-owned. Consequently, almost all organisations in Indonesia has a family oriented culture where organisational hierarchy, loyalty, trust, interpersonal relationships and family relationships dominate over rules, procedures and scientific management systems (Koentjaraningrat, 1974; 1975; 1985). Hofstede (1980) explains that Indonesia is a society characterised by collectivism. In a collectivist society people prefer to work in team rather than individually. Trust, one of Indonesia's cultural values, is an important element in Indonesian business behaviour. Since the Indonesian business community is a close community, having a close interpersonal relationships, people in Indonesia build business relationships based on trust and loyalty and they feel secure and comfortable to do business with trusted business partners. Solidarity, collaboration, and cooperation with business partners or associates are the characteristic of Indonesian organisational behaviour (Koentjaraningrat, 1974; 1975; 1985).

Because of these cultural characteristics, engagement in a strategic alliance in Indonesia may play an important role in improving organisational performance (Axelrod, 1984; Hakansson, 1982; Hakansson & Johanson, 1988). Since previous studies on the role of strategic alliance in improving organisational performance were conducted in Western countries, the question arises: would the results reported in those studies also apply to organisations in Indonesia? The current study is an attempt to answer this question. This has been done by empirically investigating Indonesian manufacturing firms' adoption of manufacturing automation and managerial use of information technology.

2.4. State of the Research in Manufacturing Automation, Strategic Alliance and Information Technology

Previous researchers have investigated the impact of manufacturing firms' adoption of manufacturing automation on their performance (Anderson & Schroeder, 1989; Attaran. 1989; Badiru, 1990; Chen & Small, 1996; Hayes & Jaikumar, 1991; Huang Sakurai, 1990; Meredith, 1987; Poo, 1990; Somer & Gupta, 1991; Willis & Sullivan, 1984). Similarly, previous researchers have also investigated the relationship between manufacturing firms' engagement in strategic alliance and their performance (Champagne, 1999; Grote, 2000; Stivers et al, 1996). These studies report that on an individual basis, the adoption of manufacturing automation and the engagement in a strategic alliance are positively associated with organisational performance. However, none of the previous studies examine whether adoption of manufacturing automation, and engagement in a strategic alliance together influence organisational performance, and if they do, what the nature of the relationships. The motivation for this study is to examine the synergy effect of a firm's adoption of manufacturing automation and engagement in a strategic alliance on organisational performance in Indonesian manufacturing firms.

Theory and anecdotal evidence imply that engagement in strategic alliances is a major strategic move for manufacturing organisations, as the alliance increases efficiency and market power (Forrest, 1990; Lee & Mulford, 1990; Powel et al, 1996). Strategic alliance brings together independent organisations to share resources in product design and manufacturing, marketing and distribution. Forging an alliance enables an organisation to focus resources on its core skills and competencies, while fulfilling lacking competencies and capabilities from other allies. Strategic alliance can be an important source of competitive advantage as it enables alliance partner organisations to be more flexible and able to the changing environment. Further, strategic alliance can be more cost effective, as it does not involve any equity or investment or business risk such as bankruptcy or profit declination (Hu & Korneliussen, 1997).

Managerial use of information technology is another important factor influencing a manufacturing firm's performance, as it helps managers collect accurate and timely data to support spare-parts (Bennet et al , 1987); Cooper & Kaplan, 1998; Hoque, 2000; Housedshel & Watson, 1987; Vijayan, 2000) But, an extensive review of the relevant literature revealed that none of the studies in Western countries, let alone in Indonesia, examined the relationship between an organisation's performance and its adoption of manufacturing automation, incorporating the role of the firms' engagement in a strategic alliance and managerial use of information technology. This study aimes to address such a gap in the literature.

2.5. Chapter Summary

This chapter explains the motivation for the study. In doing so, it explains the economic importance of the study with respect to the role of manufacturing organisations in Indonesian economic development. The chapter also described the distinct nature of the Indonesian business environment and culture. The next chapter presents the model of the study.

THE MODEL OF THE STUDY

3

3.0. Introduction

Section one of the chapter presents an overview of the model of the study (Figure 3.1). Section two explains the rationale for selecting the variables of interest in the study followed by definitions of the variables in section three. In section four, a summary of the chapter is provided and the next chapter is introduced.

3.1. The Model

Due to globalisation, manufacturing organisations (like many other organisations) are facing increasing competition; customers today are more demanding than ever before for competitive prices, quality customised products and services, and on-time delivery of orders (Kaplan & Norton, 1996; Lynch & Cross, 1991; Wyle, 2000). The result is that manufacturing organisations have a greater need for reduction in production costs, improvement in production flexibility, shortening of production process time, improvement in product and service quality, and improvement in reliability and timeliness of product and service delivery (Koch & Smalec, 1999). The extant literature suggests that adoption of manufacturing automation, engagement in a strategic alliance, and managerial use of information technology (such as Intranet, Internet and videoconference) may facilitate manufacturing organisations' performance, thereby assisting the organisations to survive and succeed in the globally competitive market. However, none of the relevant previous studies investigating the potential impact of these factors on organisational performance were carried out in Indonesia. Therefore, it is not known if the impact of manufacturing automation, strategic alliance, and information technology reported in previous studies conducted elsewhere would also apply in Indonesia. This study addresses the issue. Figure 3.1 presents the conceptual model for a potentially successful organisational performance that underlies this research. The posited relationships among the variables in the model are:

1. Managerial use of information technology in a manufacturing organisation is positively associated with the organisation's adoption of manufacturing automation.

2. Managerial use of information technology in an organisation is positively associated with the organisation's engagement in a strategic alliance.

3. Financial performance of an organisation is positively associated with the organisation's adoption of manufacturing automation.

4. Non-financial performance (including performance related to customer, internal business process, and learning and innovation) of an organisation is positively associated with the organisation's adoption of manufacturing automation.

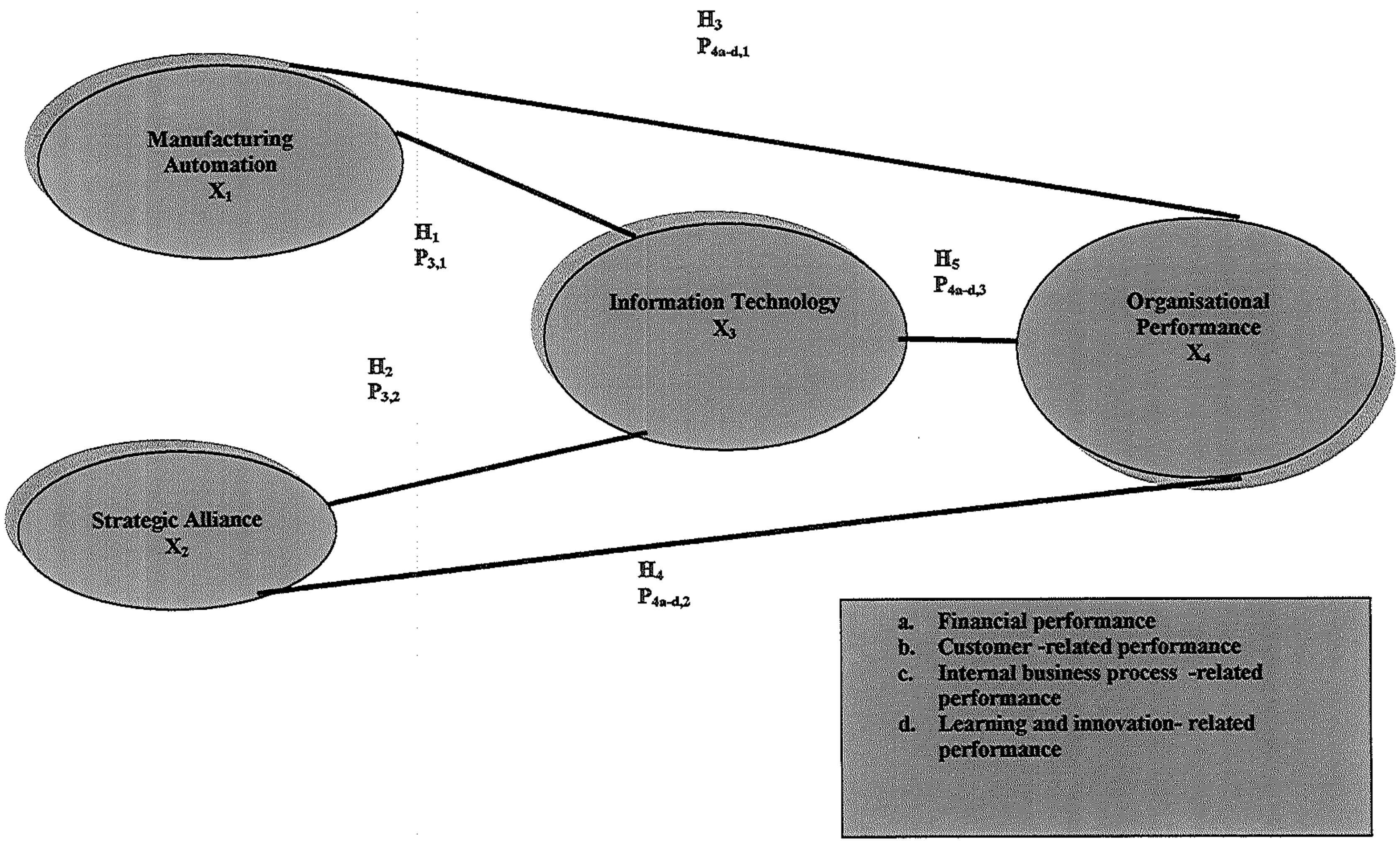
5. Financial performance of an organisation is positively associated with the organisation's engagement in strategic alliance.

6. Non-financial performance (including performance related to customer, internal business process, and learning and innovation) of an organisation is positively associated with the organisation's engagement in strategic alliance.

7. Financial performance of an organisation is positively associated with the organisation's managerial use of information technology.

8. Non-financial performance (including performance related to customer, internal business process, and learning and innovation) of an organisation is positively associated with the organisation's managerial use of information technology.

FIGURE 3.1 The Model of Manufacturing Automation, Strategic Alliance, Information Technology and Organisational Performance.



3.2. The Variables in the Model

There is a body of extant literature (based on research in the West) indicating that a manufacturing firm's performance is positively associated with the firm's adoption of manufacturing automation, engagement in strategic alliance and managerial use of information technology. Following the literature and the discussion in section 1 above, the following variables were selected for this research.

3.2.1. Manufacturing Automation

Companies facing a high market competition must satisfy their customers by improving product quality, broadening product range, and offering competitive price (Kaplan & Norton, 1996; Lynch & Cross, 1991; Wyle, 2000). One way to bring these improvements necessary to satisfy customers is to adopt a suitable manufacturing automation. Manufacturing automation is a computerized manufacturing process, which is now a requirement in the global market economy characterised by the cutthroat competition because the automation has the capability to provide improved product design, shape, finish and quality (Attaran, 1989; Badiru, 1990; Hayes & Jaikumar, 1991; Huang & Sakurai, 1990; Meredith, 1987; Poo, 1990; Somers & Gupta, 1991; Willis & Sullivan, 1984). Moreover, automation is capable of improving organisational performance through (a) reduction in production costs, product defects, and production time, (b) improvement in product quality, and increasing efficiency of production process (Attaran, 1989; Badiru, 1990; Patuwo & Hu, 1998).

To survive in a highly competitive market, an organisation needs to improve its operating performance (e.g., efficiency of production process; success in control of costs, defect rates, and reduction in production lead-time), business performance (e. g., market share, penetration into new market, gaining new customers), and management performance (such as employee satisfaction, and supplier/customer satisfaction). But, the relevant literature suggests that a firm's adoption of manufacturing automation often improves only the operating performance, which is only a part of the firm's overall performance (Blois, 1986; Voss, 1988; Vrakking, 1989). Jaikumar (1991) for instance, reports that many firms, which have adopted manufacturing automation fail to get the full benefits of the automation in improving overall organisational performance. In most cases, the failure is due to lack of integrated improvements (developments) in other organisational factors (aspects). This study argues and empirically tests the argument that the firm's engagement in a strategic alliance and managerial use of information technology are the other necessary organisational factors that, together with adoption of manufacturing automation, may promote overall organisational performance.

3.2.2. Strategic Alliance

A manufacturing firm's engagement in a strategic alliance can help the firm improve its performance. Theory and anecdotal evidence imply that a strategic alliance offers its member organisations a major opportunity to improve efficiency and market power (Forrest, 1990; Lee & Mulford, 1990; Powel et al, 1996). Strategic alliance may play an important role in improving organisational performance by bringing together independent firms to share resources in product design, product manufacturing, product marketing and distribution. Forging an alliance enables an organisation to focus resources on its core skills and competencies while enjoying the benefits of other competencies and capabilities from the alliance members. The alliance can be a firm's important source of competitive advantage as it may enable the firm to be more flexible in adapting to the changing environment. Further, strategic alliance can be more cost effective as it does not involve additional equity or investment and business risks such as bankruptcy or profit declining. For example, when there is a close relationship between alliance member firms, the firms are likely to be more inclined toward each other, thus strengthen their interest in each other's welfare (Hu & Korneliussen, 1997). Moreover, in many cases, strategic alliances are based on trust, which strengthens business relationships among the alliance members (Axelrod, 1984; Hakansson, 1982; Hakansson & Johanson, 1988). Dore (1983) also characterise a strategic alliance as an extensive, unique socially embedded relationship which is governed by trust and relational contract. Consider for example, the case of Chinese business firms, which are known to be some of the most successful in the world. The secret of Chinese business success appears to be business networks. Indeed, interpersonal relationship, trust, and extensive business network are considered to be the key factors of Chinese business success (East Asia Analytical Unit, 1995). Strategic alliance member firms share costs, establish a pool of joint resources, and create a synergistic effect in problem solving (Axelrod, 1984). This study argues that a manufacturing firm's engagement in strategic alliance improves the firm's performance. The argument is empirically tested.

3.2.3. Information Technology

A successful adoption of manufacturing automation and maintenance of strategic alliance require accurate and timely data. Adoption of manufacturing automation unsupported by information technology may lead to a unsatisfactory performance, as automation focuses only on the production activities at the plant level and not on communication of information. To improve overall organisational performance, necessary production related information from the plant ought to be effectively communicated to management for planning, monitoring and spare-parts. Communication network such as Intranet, Internet and videoconference facilitates effective spare-parts, and thereby improves performance (Bititci, 1997; Booth, 2000; Bowers, 1990; Housdeshel & Watson, 1987; Kagan, 2000). By accurately and timely transmitting information to users within and outside a manufacturing firm, information technology plays a crucial role in supporting the firm's adoption of manufacturing automation. Similarly, information technology plays a crucial role in the success of a firm's engagement in strategic alliance. The member organisations of a strategic alliance ought to be in close contact with one another in running their day-to-day operations and also in developing as well as executing strategic plans. Information technology can help the alliance member organisations maintain close contact with each other. The model in this study empirically tests the role of managerial use of information technology in supporting adoption of manufacturing automation and engagement in a strategic alliance, which ultimately promotes the organisational performance.

3.2.4. Organisational Performance

Performance is the ultimate concern of all organisations, as at the end of the day it is the ultimate measure of success (Kaplan & Norton, 1996; Lynch & Cross, 1991; Wyle, 2000). Recently, performance measurement has been an issue of continuing discussion among academics as well as practitioners. The topic of the discussion is about the traditional performance measure, which is solely used for financial performance measure (e.g. return on investment, net earning or budget variance) (Atkinson et al. 1997; Kaplan and Norton 1996; Lynch and Cross 1991; Shields 1997). The concern is that reliance on financial performance measurement alone may encourage managers' dysfunctional behaviour as financial measures are focussed on past performance only during specific time intervals. This focus tends to encourage short-term strategic thinking. To renew managers' interest in developing a more long-term strategy, a relatively new performance measurement framework, which includes measurement of both financial and non-financial performance, called multidimensional performance measurement has been introduced. Further, the multidimensional performance measures are important as in today's fierce competitive environment companies have to monitor their day-to-day operation for comprehensive and correct decisions (Otley, 1999). Such a multidimensional approach to performance measurement is recognised in the recent balanced scorecard approach suggested by Kaplan and Norton (1992; 1993, and 1996).

This approach promotes a balance between outcome measures (past efforts) and the measures, which will drive the future performance. Besides, this approach sets objectives and performance measures in relation to the vision and strategy of an organisation, thus tying measurement to both the long-term and short-term goals of the organisation. The multidimensional performance measurement approach has introduced use of the integrated financial and non-financial performance measures including four dimensions: financial performance, customer–related performance, internal business process-related performance, and learning and innovation-related performance.

Both financial and non-financial attributes of organisational performance are considered in this study. There is a lack of empirical evidence on how the performance attributes identified in the multidimensional approach to performance measurement is associated with a manufacturing firm's adoption of manufacturing automation, engagement in strategic alliance and managerial use of information technology. The current study empirically examines the above relationships.

3.3. Definition of the Variables

3.3.1. Manufacturing Automation

The term 'manufacturing automation' refers to the technology that includes computer-aided design and computer-aided manufacturing (CAD/CAM), computer-aided process planning (CAPP), flexible manufacturing systems (FMS), and automated material handling. CAD/ CAM consists of a series of computerised equipment for designing products, and calculating the time and the costs of producing products (e.g. computer-aided engineering). Computer-aided process planning (CAPP) consists of a series of computerised equipment for production planning (e.g., machine selection, tool selection, process optimatization, and production route). FMS is an integrated computerised system of industrial robots, machining centre; and automatic measuring instruments. Finally, automated material handling systems under computer control allow manufacturing of a great variety of products. (Jonsson, 2000). Other researchers also have defined manufacturing automation. Wyle (2000) for instance, defines manufacturing automation as a production process, which uses highly flexible equipment that (a) consists of the building blocks that allow automatic transportation of products from one station to another station, (b) includes related processes that produce different products on the same line with minimum change over, (c) provides tight process control and has high consistency and uniformity of processes, and (d) provides integrated in-process quality assurance such as in-built automatic inspection and testing system using computer network.

Manufacturing automation in an organisation may range from low automation, which is known as traditional automation, to high automation. Traditional automation or low automation is limited in scope, while high automation is a full range manufacturing automation. In a low automation situation, each computerised equipment does a single task very well, but has little or no ability to adapt to another task. This automation is often known as stand alone automation (Weiermair, 1990). The literature in manufacturing technology and management explains that high automation is a combination of computerised machines and electronics. Electronic or computerised technology makes it possible to produce a wide range of products in smaller quantities using the same technology. Such automation ranges from designing the product and calculating the cost to performing the production jobs by using robots. This type of automation is also called Computer Integrated Manufacturing (CIM) (Weiermair, 1990, Wyle, 2000). CIM systems include the hardware and software required to store and pass information from design systems to manufacturing operations. For example, a product design can be done using and then it can be manufactured using computer (robotics), which may be called.

For the purpose of this study, manufacturing automation is defined following Jonsson (2000).

3.3.2. Strategic Alliance

Strategic alliance refers to a coalition of a number of independent organisations intended to achieve mutually beneficial goals such as competitive advantage and profitability (Jarillo, 1988; Robinson & Clarke, 1994). The relevant literature contains alternative definitions for strategic alliance. Haskins & Petit (1988), for instance, define strategic alliance as an agreement among two or more independent firms to cooperate for the purpose of achieving common goals such as a competitive advantage or customer value creation. Whipple (2000) defines strategic alliance as 'a long term relationship where participants cooperate and willingly modify their business practices to improve joint performance', while Gulati (1998) calls strategic alliance 'a voluntary arrangements between firms involving exchange or sharing, co-development of products, technologies, or services'.

Strategic alliance may occur as a result of a wide range of motives and goals, take a variety of forms, and occur across vertical and horizontal boundaries. A vertical alliance focuses on supplier-manufacturer relationships (Bucklin and Sengupta 1993; Foest, 1990) or on manufacturer-distributor relationships (Andersen & Narus 1984; Anderson & Weitz, 1992). On the other hand, a horizontal alliance consists of relationships between similar firms in the same industry. A strategic alliance may also include a network with strategic departments or institutions, such as government departments, and other business organisations. It also may include business relationships with relatives, colleagues, friends, people in the same group and people having the same ethnicity. The form of strategic alliance may range from joint venture, licensing agreements, long-term purchasing and supply contracts, joint development of projects and resource and or information-exchange (Berryman, 1998). Thus, strategic alliance may be referred to as a network of organisations, representing inter-company cooperative mutual agreements that have purposes of exchanging goods or services.

For the purposes of this study, strategic alliance is defined as a cooperative and mutual agreement between autonomous organisations with a view to improving competitive advantage and long-term profitable value for all the cooperating parties; nonetheless, the agreement may or may not involve cross-partner equity investments (Jarillo, 1988; Miles & Snow, 1986).

3.3.3. Information Technology

The extant literature offers alternative definitions for information technology. Dicken (1992) advocates that information technology consists of computer technology that deals with information processing, transmission and communication. Byrd, et al (2000) and Reichert, et al (1998) define information technology as integration, sophistication, and standardisation of software and hardware. Software (also known as communication networks), includes such means as e-mail, voice mail, fax, net- phone, net- meeting, and videoconference. The relevant literature indicates that communication networks can be classified into two parts: internal to an organisation (Intranet), and external to an organisation (Internet). Intranet is a communication tool to distribute information and knowledge within an organisation (intra-company). The typical uses of intranet are such as forms for request or employee input, purchasing information, sales force automation, time and/or expense accounting. Internet is an external, global, inter-organisational and international computer network or networks connecting a company to many institutions such as government, academic, and business firms, as well individuals. Web sites, including net-meeting, net-phone, and videoconference are examples of internet functions (Forouzan, 2001; Targowski, 2004)

The focus of this research is on use of information technology, which includes use of Intranet, Internet and visual communication including videoconference, and net-meeting (Forouzan, 2001; Targowski, 2004).

3.3.4. Organisational Performance

For purposes of this research, organisational performance is defined as the performance of a business unit. Shah, et al (2000) define a business unit as a corporate's unit with the objective of being competitive and profitable. Such units have their own strategies, including strategies of production and marketing. Likewise, Mia (2000) defines a business unit as a company, which operates as a profit centre and carries out the usual business activities, such as manufacturing and selling products. Correspondingly, Chang & Hong (2000) define a business unit as a diversified corporate unit, which possesses its own resources and competencies. Capturing the definitions presented above, a business unit for the purposes of this study is defined to be a company, which operates as a profit centre, that has its own strategies, competencies, and resources and carries out the usual business activities including manufacturing and selling products.

Although the importance of performance measurement is widely recognized, there has been considerable debate on both terminology and conceptual issues of performance. Some authors include both efficiency-related performance (such as input/output ratio relationship), and effectiveness-related performance (such as business growth and employee satisfaction). Yet others conceptualize performance using financial and non-financial parameters (Kaplan and Norton, 1992; Gopalakrishnnan, 2000). Mapes & New (1997) identify two aspects of performance: operating performance and business performance. Operating performance relates to manufacturing including productivity, quality, production costs, speed and reliability of delivery. Business performance includes performance of the company management in satisfying the stakeholders, such as investors, customers, employees and suppliers. Likewise, Forker & Vickery (1996) argue that business performance involves marketing and financial performance, while operating performance involves product quality, product reliability, product durability, product design and product quality improvement.

Kaplan & Norton (1992; 1993; 1996) suggest that success of an organisation should include a successful financial performance and non-financial performance (see also, Mapes & New, 1997). In line with other researchers (Forker & Vickery, 1996; Mapes & New, 1997; Newing, 1995; Rangone, 1996), Kaplan & Norton (1996) advocate that to achieve competitive strategy and long term profitability, an organisation's financial and non- financial performance should be harmonious. This view is now known in the literature as the 'Balanced Scorecard' approach to performance management.

Following Kaplan and Norton (1996) and other researchers above, this study defines organisational (business units') performance in terms of financial performance and non-financial performance. Financial performance is defined in terms of return on investment (ROI), operating income and sales growth. ROI is explained as the net income before tax over total assets (Martin, 1997). Operating income of a business unit is the difference between the unit's net sales revenue and operating expense while the latter consists of cost of goods sold and selling and administrative expenses (Warren, et al 1996). Sales growth is defined in terms of the percentage increase in the organisation's current period's sales relative to its previous period's sales (Hansen & Mowen, 1997). Non-financial performance is defined in terms of three perspectives: customer, internal business process and learning and innovation. Performance relating to the customer perspective incorporates items like on-time delivery of orders, number of customer complaints, market share, time from order to delivery, customer response time and warranty repair costs. Performance with respect to internal business process is defined in terms of efficiency in using labour and material, ratio of good output to total output, materials scrap loss and manufacturing lead-time. Likewise, performance with respect to learning and innovation is defined in terms of three items. These items are: number of new product launced, number of new patents and time taken to market new products (see Hoque, 2000; Kaplan and Norton, 1992).

3.4. Chapter Summary

This chapter introduces the model of the study and explains the rationale for selecting the variables in the model for investigation. The chapter also provides the definition for each of the variables of interest. The next chapter discusses the theory underpinning the research and development of the hypotheses.

THEORY AND HYPOTHESES DEVELOPMENT

4

4.0. Introduction

This chapter presents a conceptual model of organisational (business unit) performance. In section 4.1, an overview of the model is provided, followed by section 4.2, which presents a review of the relevant literature and provides a rationale for the hypothesized relationships among the variables in the model. Finally, section 4.3 summarizes the chapter and briefly introduces the next chapter.

4.1. The Model Overview

Recall Figure 3.1, which presents the conceptual model of organisational performance that underlies this research. The relationships hypothesized among the variables in the model are:

1. Managerial use of information technology in a manufacturing organisation is positively associated with the organisation's adoption of manufacturing automation.

2. Managerial use of information technology in a manufacturing organisation is positively associated with the organisation's engagement in strategic alliance.

3. Financial performance of a manufacturing organisation is positively associated with the organisation's adoption of manufacturing automation.

4. Non-financial performance (including performance related to customer, internal business process, and learning and innovation) of

a manufacturing organisation is positively associated with the organisation's adoption of manufacturing automation.

5. Financial performance of a manufacturing organisation is positively associated with the organisation's engagement in strategic alliance.

6. Non-financial performance (including performance related to customer, internal business process, and learning and innovation) of a manufacturing organisation is positively associated with the organisation's engagement in strategic alliance.

7. Financial performance of a manufacturing organisation is positively associated with the organisation's managerial use of information technology.

8. Non-financial performance (including performance related to customer, internal business process, and learning and innovation) of a manufacturing organisation is positively associated with the organisation's managerial use of information technology.

4.2. The Variables and Relationships

4.2.0. Introduction

There are four variables of interest in this study. These are (a) adoption of manufacturing automation, (b) engagement in a strategic alliance, (c) managerial use of information technology, and (d) organisational performance. The following subsections provide an extensive review of the extant literature and develop the hypotheses.

4.2.1. Adoption of manufacturing automation and Managerial Use of information technology.

The extant literature suggests that as the level of a manufacturing organisation's adoption of manufacturing automation increases, the information need of managers in the organisation also increases. The information (e.g, cost-related information, production volume and quality-related information) is important for managers and production engineers so that they can monitor day-to-day manufacturing and other related activities of the organisation (Kaplan & Atkinson, 1989, 1998; Hoque, 2000). The literature also suggests that an accurate and detailed cost information is important for management, because detailed and accurate information about specific products is important feedback for effective managerial planning, controlling, and decision making (Bennet et al, 1987; Cooper & Kaplan, 1998; Hansen & Mowen, 1997). Moreover, the information can help managers to track products and production processes continuously, such as tracking the units produced, the materials used, the extent of defective products, and the machine hours worked. Besides, the information is also useful for other departments such as accounting, to report and monitor the whole operation of the organisation, and ultimately helps managers make appropriate decisions (Bennet et al, 1987; Hansen & Mowen, 1997; Hoque, 2000; Young & Selto, 1991). For example, using the cost information, the accounting department is able to monitor the efficiency of the production process and report the production costs to the marketing department, which may use the information to determine the best selling price. Moreover, the cost information is also useful for cost and price benchmarking, especially if the company is operating in a competitive market.

In today's highly complex and competitive business environment, it is not enough for management to receive an adequate amount of accurate information for effective decision making; the information must be available on a real-time basis and online so that managers can have access to the information on-time or immediately when they need such information. Information technology (including Internet, Intranet, teleconference and videoconference) can play a critical role in gathering and presenting the necessary information to managers on a real-time basis (Andersen, 2001).

Managerial use of information technology is essential for internal management effectiveness. Manufacturing automation often becomes focused solely on manufacturing activities. The cost data and other information, which might be released by the automation device, may be only for integrating the plant floor activities. In other words, automation sometimes may create an information gap between the plant and the rest of the firm. As a result, manufacturing automation may only improve the firm's operating performance, such as improved product quality, lower production costs, and higher manufacturing speed, but it does not always facilitate other managerial activities, like marketing, to increase customer satisfaction. For example, if there is a lack of communication between manufacturing and marketing departments within a firm, the marketing manager might not be able to give a quick answer to a customer's query about the product availability, quality and delivery schedule. Also, if the cost information or production data is not transmitted on time to the accounting department, the department might not be able to calculate the production cost timely and accurately, thus monitoring of the production efficiency might become ineffective. This is perhaps one of reasons why Blois (1986) argues that as manufacturing automation is a manufacturing strategy to increase an organisation's ability to cope with high level of competition, it should be balanced with the firm's marketing strategy.

Managerial use of information technology can significantly minimize, if not eliminate, the information gap among different departments or functions within an organisation that may be created due to the organisation's adoption of manufacturing automation. Attaran (1996), for instance, advocates that in order to realise the full potential of manufacturing automation, automated production system needs to have an information infrastructure to facilitate cooperation between engineering, marketing, manufacturing, accounting and IS (information system) departments. On time transmission and sharing of information among different departments within an organisation are critical. If they are not on time, there may be information gaps in the organisation. Consequently, an organisation's adoption of manufacturing automation might not be beneficial to the organisation (Mollenauer, 1991). This argument is supported by Hayes & Jaikumar (1991) who suggest that to capture the full benefits of manufacturing automation, the adopting organisations need to broaden the manufacturing emphasis to include product orientation, as well as service orientation as just lower price for, and high quality of, products are not enough to satisfy customers. Additionally, Attaran (1989), Meredith (1987), and Nemetz & Fry (1988) explain that adoption of manufacturing automation needs support from the suppliers. A good internal communication with all functions and external with suppliers and customers supports a successful operation of manufacturing automation in an organisation. Therefore, it is necessary for organisations adopting manufacturing automation to foster closer links with customers and suppliers, with the emphasis being on achieving quick response to customer demand.

To achieve all these, a firm, which adopts manufacturing automation, needs to facilitate its managers' use of information technology. Managerial use of the technology would make necessary information easily accessible to both internal users like managers and external users such as suppliers and customers at low cost. Communication software, such as Intranet, Internet, and videoconference can play a useful role to fill up this need, especially if the company has a broad range of products, multiple departments or divisions, and if it operates in different locations (Dickens, 1992; Haywood, 1999; Karake, 1992; Scott, 2000; Tullo, 2000; Wang, 1997). Vijayan (2000) argues that an electronic communication system increases real time flow of information by providing an information network from the plant to the management of an organisation. Consequently, the functions including resource allocation, quality control, performance analysis and employee management become efficient. The results reported in previous research suggest that managerial use of information technology helps fill the information gap between an organisation's production plant and its management. Transmission and sharing of information between the production plant and management of an organisation is important, as a delay in transmitting, say, the cost information collected by the management or accounting department may have an important impact on cost control, and so, the performance of the organisation. Therefore, information technology is an important requirement for the success of manufacturing automation (Bowers, 1990).

Although some previous studies such as (Hoque, et al 2000) examined the relationship between automation and the need for cost information, the relationship between managerial use of information technology and adoption of manufacturing automation was ignored. The current study tests the relationship as presented in the following hypothesis:

H_1: There is a positive association between a manufacturing organisation's adoption of manufacturing automation and its managers' use of information technology.

4.2.2. Engagement in a strategic alliance and Managerial Use of information technology.

While there are significant potential benefits of a firm's engagement in strategic alliance, Harrigan (1998) reports that the success rate for strategic alliances are low. About 70 percent of strategic alliances fail to maintain relationships among alliance member organisations and capture the benefits of the alliance. A reason for this is that the relationships among the member organisations of an alliance are affected by several factors such as mind-set, culture, behaviour, resources, skills, technology and communication. The biggest barrier for the success of a strategic alliance is the lack of close communication and collaboration among the alliance member firms (Shrader, 2001). Collaboration forms the basis for the success of inter-firm relationships, the foundation of a successful alliance (Shrader, 2001; Steensma & Corley, 2000).

Shrader (2001) suggests that the successful operation of strategic alliance mandates that every member of the partnership must be able to share information with trading partners and customers on a real-time basis. This type of communication not only allows the alliance members to exchange information but also to build up the relationships. More importantly, good communication among the alliance members can indicate the level of commitment of the alliance members, which affects the behaviour of the alliance (Shrader, 2001). Effective communication builds trust, collaboration and mutual cooperation, which brings the alliance member firms together, and in turn leads to success of the alliance (Adobor, 2002; Hamel, 1991; Mintzberg et al, 1996). In other words, close communication and trust are important factors that should get most attention from the alliance member firms (Ohmae, 1986).

As mentioned earlier in this thesis, global competition, technology advancements, and industry deregulations have resulted in increasing customer expectations. Today's customers demand fast order processing and responses as well as on time delivery. To be successful in fulfilling the customer demand and preferences, companies need to implement innovative new strategies that capitalize on both the power of information technology and the changes in market demands and customer preferences. Therefore, strategic alliance needs a state of the art communication system and managerial use of information technology is the answer. Internet is an example of information technology, which may support the success of a strategic alliance. Managerial use of Internet is able to link the alliance member firms' internal and external needs and makes it easy for the alliance members to have access to jointly developed products or services, conclude contracts, query potential partners, share promotional plans and negotiate price. In other words Internet as a business-to-business communication vehicle can facilitate the flow of information and integrate the business processes across their extended enterprise of customers, suppliers and alliance member firms (Papazoglou et al, 2000).

Previous studies suggest that the relationship between a firm's engagement in strategic alliance and its performance may be mediated by other variables. It is argued that managerial use of information technology is one such variable. As mentioned previously, information technology such as Internet and or Intranet is able to transmit information faster. It also can let the users of the technology get instant access to information as well as share the information with the other parties in business (Galbraith, 1994, Haywood, 1999, Huber, 1990; Kaplan & Norton, 1996). Vlachopoulou & Manthou, (2003) suggest that the online flow of the information enhances partnership growth, which serves as a foundation for a good relationship. Information technology can help alliance member firms jointly develop products or services, conclude contracts, query potential partners, share promotional plans, negotiate price and identify potential markets.

Therefore, managerial use of information technology is an appropriate solution for the connectivity and commonality of systems requiring negotiation, coordination and commitment between alliance member firms (Kaplan & Norton, 1996). Since strategic alliance is the form of horizontal and/or vertical inter-firm relationship, it may result in an integrated value chain (Papazoglou et al, 2000). Therefore, a strategic alliance requires distribution of workflow that provides the sequence of business activities, arrangement for delivery of work to the appropriate organisational sites or facilities, tracking of the status of business activities, and coordination of the flow of information of organisational activities. Since, in the global market, the business environment is unpredictable and competition is fierce, strategic alliances need to have flexibility. Therefore, a strategic alliance needs to be jointly supported by all alliance member firms to have an ability to react quickly to new opportunities. The result is that business processes of alliance member firms are flexible and are able to handle changing business needs. In other words, strategic alliance needs an integrated information system that makes the alliance member firms well informed about the changes in the environment.

Also, the use of the technology may enable alliance member firms to benefit from reduced inventories, cost savings, improved value added goods and services to customers, and tighter links with the alliance members. The member firms of an alliance with network connections can exploit each other's core competencies; all these can be supported or facilitated by the use of information technology. The reason for this argument is that managerial use of information technology can play a major role in the success of a strategic alliance as its member firms can use information much more effectively for rapid delivery of goods and services to customers (Brynjolfsson, 1993; Brynjolfsson and Hitt, 1996; DeSanctis and Poole, 1994; Huber 1990; Powell and Dent, 1997; Weill, 1992). Moreover, the use of information technology enables a business process to track transactions across departments, companies and enterprise boundaries (Andersen, 2001; Kettinger et. al, 1994).

Following the above discussion, it is concluded that a strategic alliance and the use of information technology go hand in hand. Hypothesis 2 below summarises the above discussion.

H_2: There is a positive relationship between a manufacturing organisation's engagement in a strategic alliance and its managerial use of information technology.

4.2.3. Adoption of manufacturing automation and Organisational Performance

Many studies have investigated the relationship between manufacturing automation and organisational performance over a considerable period of time. One message that has been signalled by the studies is that the performance effect of adoption of manufacturing automation varies significantly among organisations. Technically, manufacturing automation is viewed to be a capability to improve production in terms of the quantity and quality of products (Attaran, 1989; Badiru, 1990; Hayes & Jaikumar, 1991; Huang & Sakurai, 1990; Lynch & Cross, 1991; Meredith, 1987; Poo, 1990; Somers & Gupta, 1991; Wyle, 2000 Willis & Sullivan, 1984).

Some studies report that adoption of manufacturing automation has a significant positive relationship with organisational performance (Attaran 1989; Hayes & Jaikumar, 1991; Meredith, 1987; Vokurka et al, 1998; Willis & Sullivan, 1984; Zummato and O'Con-nor, 1992;). This is because it enables manufacturing firms to offer a broad range of products by stimulating new product design, simplifying changes in design of existing products, and making small productions run economically (Attaran 1989; Meredith, 1987). But some other studies report no relationship between manufacturing automation and organisational performance. These studies argue that a country's business conditions or environment play an important role in the relationship. In countries where labour rate is relatively low, implementation of manufacturing automation may not be associated with firm performance (Zhao and Co, 1997). For instance, Huang & Sakurai (1989) and Somers & Gupta (1991) suggest that compared to the US, implementation of manufacturing automation in Japan is more effective in labour cost reduction and improvement in firm performance because such cost in Japan is high. Based on their research in the UK, and the US, Dimitrov (1990) and Vrakking (1989) argue that manufacturing automation is ineffective where labour cost is low (it was less than 18% in UK, and 15% in USA at the time of the study). Adoption of manufacturing automation in such situations or countries is only beneficial to operating performance such as product quality and production rate. Wong & Ngin (1997), based on their data from interviews with production managers in Singapore, report that manufacturing automation in Singapore improves firm performance when the manufacturing sector in Singapore experiences a severe labour shortage. Kotha & Swamidass

(2000) argue that manufacturing automation will not affect on performance, when it is implemented in highly competitive business environments as in such business environments, all firms are forced to adopt manufacturing automation (Pine, 1993), hence it becomes a common factor.

From the discussion above, it can be argued that the results on the relationship between adoption of manufacturing automation and firm performance are inconclusive: it is positive in some cases and non-existent in other cases. Further, adoption of manufacturing automation may improve organisational performance in some cases, and in other cases it may only improve a particular aspect of the performance. For example, some manufacturing automation adopters may improve their operating performance, but not their financial performance. The current study tests the above relationship in terms of four perspectives: financial performance, customer-related performance, internal business process-related performance and learning and innovation-related performance, therefore, the test is more comprehensive.

4.2.3.1. Adoption of manufacturing automation and Financial Performance

In today's free market economy, manufacturing enterprises are facing increasing pressure to reduce production costs, improve customer services and product quality as well as offer a broad range of products. This is because customers in such competitive environments demand a broad range of high quality products and customer services at competitive prices; this can be achieved through consistently improving production efficiency and flexibility (Wyle, 2000). To cope with such pressures, many Western companies moved their production divisions (plants) to countries, which have cheap labour and low investment cost, while at the same time are able to maintain high product quality (Naisbitt, 1982). However, this strategy usually runs into problems because of culture differences and political situations, and government regulations in foreign countries. Further, as customers' needs and tastes in competitive market change rapidly, manufacturing companies have to move from mass production to customised production, which requires manufacturing flexibility. Since manufacturing automation increases manufacturing flexibility and reduces manufacturing costs by automating design, fabrication, assembly, and material handling among other things, without compromising quality (Swamidass, 1988), many manufacturing firms have adopted automation to improve performance.

There have been many studies investigating the relationship between manufacturing automation and firms' financial performance. Some studies report that manufacturing automation significantly improves firms' financial performance by reducing production costs through maximisation of production volume and minimisation of costs (Attaran, 1989; Badiru, 1990; Chang & Joshi, 1990; Hayes & Jaikumar, 1991; Huang & Sakurai, 1990; Meredith, 1987; Poo, 1990; Somers & Gupta, 1991; Willis & Sullivan, 1984; Tonkay, 1997). Further, manufacturing automation such as CAD/CAM is frequently cited for its benefits of reducing inventory costs, improving productivity, shortening production lead-time and reducing variable costs[2]. For example, Hayes & Jaikumar (1991) studied 20 manufacturing firms in the US; they report that manufacturing automation reduces labour costs by as much as 80%. Similarly, Vokurka et al (1998) report that manufacturing automation such as a flexible manufacturing system, or an automated material handling system significantly reduce labour and other production costs in US manufacturing firms (see also Badiru, 1990; Boyer, 1996; Swamidass & Kotha, 1998). In another study, Swamidass & Kotha (1998) investigate the relationship between the application of advanced manufacturing technology (AMT) and the performance of manufacturing firms in the US. Swamidass & Kotha measure AMT in terms of information exchange and planning technology (IEPT), product design technology (PDT), high volume automation technology (HVAT), and low volume flexible automation technology (LVAT). The performance is measured in terms of profitability, including after tax return on total sales, net profit, market share gains relative to competitors, sales growth relative to competitors, and overall performance. The results reveal that adoption of manufacturing automation improves profitability.

The relevant literature also suggests that adoption of the automation improves manufacturing flexibility as it makes changeover of product lines quicker and reduces labour costs (Attaran, 1989). For example, Hitomi (1985) & Daito (2000) report that adoption of manufacturing automation saved Toyota, a Japanese automobile industry, from financial trouble. The

[2] This is not to deny the fact that manufacturing automation may increase fixed costs such as equipment depreciation at least in the initial stage of introducing the automation. However, since manufacturing automation is likely to reduce personnel costs like salary and wages, it can be argued that the increase in fixed cost for equipment may offset by the decrease in personnel costs.

problem in Toyota was the high wages during the economic turbulence in the immediate post second worldwar period. Toyota had to cut wages and reduce the number of workers. Worker strikes, high labour turnover and problems with the labour unions delayed production and reduced productivity significantly. Therefore, Toyota incurred a huge loss, to the extent that it had to delay the payment of salary and wages. However, when the economic turbulence was over and the demand for Toyota's products started to increase, Toyota decided to meet the additional demand without hiring additional workers. Instead, Toyota adopted manufacturing automation and continued to renew (upgrade) its automated manufacturing facilities with more advanced technologies. The flexibility of manufacturing automation allowed Toyota to produce in small lot sizes, which was just enough to meet the demand. Further, the automation allowed Toyota to stop production line(s) whenever they found it necessary. By stopping the machines immediately in case of trouble, Toyota could minimise production costs, ensure product quality, saved rework costs and wastes. Manufacturing flexibility allows balancing production lines. The production line balancing reduces excess capacities in production lines and therefore minimises the buffer raw material and in-process inventories. This was another reason why Toyota succeeded in reducing capital tied up in buffer inventories and generated a better profit (White, 1989).

Despite of the positive relationships between a firm's adoption of manufacturing automation and its financial performance as explained above, some studies report no such relationship in certain business environments. For example, Zhao & Co (1997) suggest that the economic justification of manufacturing automation adoption may not be applicable for organisations which operate in a country where there is abundant labour supply and wage rate is relatively low. This argument supports Vrakking (1989) and Dimitrov (1990), who reported that implementation of manufacturing automation for reducing labour costs was ineffective in the USA and UK because the labour cost was less than 15 percent in the USA and 18 percent in the UK at the time of the study. Similarly, Wong & Ngin (1997) report that operation managers in Singapore view adoption of manufacturing automation as a potential means to manage labour-related costs, as effective only when the manufacturing sector experiences a severe labour shortage and high labour turnover (see also Somers & Gupta, 1991; Huang and Sakurai, 1989; Ebel, 1992). In another study, Pine (1993) explains that adoption of manufacturing automation in high competition environment may not be associated with financial performance, as all organisations may implement the automation.

In the case of Indonesia, a firm's application of manufacturing automation is likely to have a positive impact on its financial performance. A reason for the argument is that since the 1990s, Indonesia has been experiencing political instability and frequent labour union problems. To avoid labour unrest, the Indonesian government has introduced new regulations to increase the minimum wage. However, even the increased wage rates have not solved the labour union problems (Kwik, 1996). Labour unrest continues to occur as workers still think that the new wage are not high enough. As a result, companies face problems of higher labour cost, but no improvement in productivity. The situation has created serious problems for the manufacturing companies because, to compete in the global market, they have to keep the production costs low and deliver orders on time (Kwik, 1996). Furthermore, to minimise the impact of labour unrest on business organisations, the Indonesian government also introduced regulations allowing tax exemption for importing production machineries (Decision of Tax and Custom General, 2000) in an attempt to assist manufacturers in replacing their labour force with manufacturing automation. With adoption of manufacturing automation, production becomes faster and uninterrupted as machines can produce quickly and run for 24 hours. Consequently, adoption of manufacturing automation may significantly improve the Indonesian manufacturing firm's financial performance. The proposition below summarises the above discussion.

H_{3a}: There is a positive relationship between a manufacturing organisation's adoption of manufacturing automation and its financial performance.

4.2.3.2. Adoption Manufacturing Automation and Customer - Related Performance

Due to the globally competitive market, manufacturers are facing high competition from both local and overseas suppliers of either the same or substitute products and services. One outcome of such a high level of competition is that customers get a wide range of choices; in the process they become more demanding. Also, as a result of technological development, product life cycle has become relatively short. In a highly competitive market, product features change rapidly leading to fast changes in customer tastes and preferences. Today's customers demand specific design of products that suit their personal needs and tastes, thereby creating more competition among the manufacturers to come up with better products at a competitive price. For example, in 1986 Motorola introduced a mobile phone on a 2-inch by 3-inch circuit board for about US$2,500. Now, with micro-processing power doubling every 18 to 24 months, a lighter, smaller, and more powerful phone is available at about one-tenth of the cost of the 1986 model. In those days, mobile phones' functions were only sending and receiving voice or calls, while today's technology accommodates customer needs by bringing the products to wireless combining the functions of telephones and computers; sending and receiving voice mail, text, graphics, and pictures (Andersen, 2001).

Further, to survive in the competitive market, manufacturers need to have product orientation as well as service orientation including a provision of high quality products, broad range of choices of products, quick response to customers, and high quality pre and post sales services. Also, today's manufacturers need to offer their customers products at competitive prices or with high value for money (Wyle, 2000). In such a competitive business environment, manufacturers ought to be more agile and flexible in their responses and initiatives. The relevant literature suggests that adoption of manufacturing automation increases firms' capability in producing required volume of quality products and also flexibility in product design (Hayes and Wheelwright, 1984; Swamidass, 1988). Due to globalization, rapid changes in technology, high competition, and shortened product life cycle, today's manufacturers need to have constant product renewal. The process and product design flexibility offered by manufacturing automation is critical for producing modified or new products when required. In other words, with the adoption of the automation, a manufacturer may be able to come up with the best response to its customer's needs by offering broader product range including new products, thereby increasing their market share. This argument is supported by previous studies, which report that adoption of manufacturing automation improves firms' customer-related performance through improvement in product quality, timely production and on-time delivery of products to meet customers' demand (e.g., Meredith, 1987; Dean and Snell, 1991; Parthasarthy & Sethi, 1992).

Based on the survey of Australian Manufacturing Council members, Beaumont & Schroder (1997) report that adoption of manufacturing automation improves organisations' customer-related performance as it improves the delivery time to customers (see also Attaran, 1989; Beatty, 1990; Hayes & Jaikumar, 1988; Poo, 1990). Vollmann et al (1993) report that Tenant Company which implemented manufacturing resource planning (MRPII) reduced its purchasing cost of inventory by 42%, increased its production rate by 66%, and increased meeting its delivery promises from 60% to 90%. Another example of improving customer-related performance through adoption of manufacturing automation is Hozelock Company, a manufacturer of garden equipment in the UK (as reported by Rooks, 1997). Hozelock implemented high technology manufacturing automation, which resulted in improved productivity and consistent product quality leading to an enhanced customer-related performance including customer satisfaction. Adoption of manufacturing automation enables firms to produce high quality products uniformly including size, shape, finish and design (Attaran, 1989; Badiru, 1990; Hayes & Jaikumar, 1991), and thereby improves customer satisfaction and market share.

Adoption of manufacturing automation in Indonesia appears to generate a competitive advantage to manufacturers. For example, P.T. Precision Indonesia, located in Batam Island, uses computer-controlled production equipment to produce its products. The company is a world leader in producing high quality products and providing high quality services to its customers. Automation improved the Company's customer services by providing fast response to its customers (P.T. Precindo Indonesia, 2004). Like P.T. Precindo, Honda Motor Co. Ltd invested US$137 billion to build the two most advanced automotive transmission production facilities in Indonesia. The automotive transmission factory is the first in Asia. As automotive transmission, being an automotive component, needs high precision, an advanced automation technology is required to produce it. The transmission production machine has a capability to improve and maintain the product quality and increase the competitive advantage in international markets, and thereby improve market share (Gunarto, 2003). From the discussion above, it can be argued that the flexibility and efficiency offered by manufacturing automation adoption can lead to substantial marketing advantages for a manufacturing firm. This is because the automation is able to increase production, improve product quality, reduce production and delivery time, and consequently, improve customer satisfaction (see also Boer et al, 1990; Vrakking, 1989; Gupta, 1988; Haskin & Petit, 1988).

Following the discussion above, it is argued that adoption of manufacturing automation by a firm in Indonesia would increase its customer-related performance. This is because, with automation, the company should be able to improve its product quality, improve customer response time, and improve market share. The hypothesis below formally presents the argument:

H_{3b}: Adoption of manufacturing automation by manufacturing organisation is positively associated with the organisation's customer-related performance.

4.2.3.3. Adoption of manufacturing automation and Internal Business Process-Related Performance

Due to free markets, companies face high competition. For example, in today's market, mainland China and Taiwan meet most of the demand for electronic products worldwide. Their high tech products are 35 to 40 percent cheaper than their rivals', because the low cost for power, water and land adds to the savings from low wages in those countries (Sourcing report, 2001). To survive the competition, some companies from other countries take advantage of low labour costs by moving their production facilities to low labour cost countries, while others are forced to compete by making themselves more efficient. For this purpose, controlling labour and material inefficiencies are of paramount importance. Defective products which need to be reworked, consume additional materials and labour hours. As a result these reworks increase not only the raw materials and labour costs, but also increase materials scrap and production delays.

Adoption of manufacturing automation increases material and labour efficiency as the automation reduces defective production, which in turn reduces costs (Attaran, 1989). Beaumont & Schroder (1997), for instance, report that manufacturing automation improves detection of defective products as the machine's automatic detection device identifies and drops the defective products. Manufacturing automation also reduces production slack, such as machine downtime or labour downtime (Meredith, 1987). Poo (1990) reports that in most automated manufacturing systems, each product is automatically inspected, and if found defective, it gets either repaired or scrapped immediately. Defective products cause production loss or low production rates, but adoption of manufacturing automation can fix the problem. Yamashina & Mizuyama (1998) report that the number of production stops or the rate of production loss can be reduced by installing automated inspection and repair systems. Since manufacturing automation can automatically and timely detect the defective product, it is expected to minimise production costs and decrease manufacturing lead-time. Yamashina and Mizuyama's (1998) finding is supported by other researchers (e.g., Meredith, 1987; Huang and Sakurai, 1989; Attaran, 1989; Co and Flowers, 1990; Somers and Gupta, 1991).

Evidence for the reduction in manufacturing lead-time due to adoption of manufacturing automation exists in the relevant literature. For example, Huang & Sakurai (1989) and Somers & Gupta (1991) find that manufacturing automation decreases the set-up time and lead- time while it increases productivity. Indeed, the survey by Meredith (1987) on the benefits of adoption of manufacturing automation indicates that it reduces production lead- time by 25% and set-up time by as much as 90%. In another study, Attaran (1989) reports adoption of automation at General Motors reduced the time required to change a dye in a large punch press from 6 hours to 18 minutes. Similarly, adoption of automation to assemble printed circuit boards for engineering departments in Allen-Bradley Company reduced the set up time from 52 weeks to 26 weeks (Co and Flowers, 1990). Ariss et al (2000), examine the impact of adoption of manufacturing automation on firm performance in the US. The results reveal that manufacturing automation lead to improved product quality and faster production as errors are discovered quickly and early in the production process, allowing timely adjustments and corrections before the production goes further.

Manufacturing automation also increases labour efficiency by reducing labour requirements for a given production volume (Dimitrov, 1990; Ebel, 1992; Hayes & Jaikumar, 1991; Willis & Sullivan, 1984; Zummato & O'Con-nor, 1992). Somers & Gupta (1991) and Hayes & Jaikumar (1991) report that manufacturing automation adoption reduces labour requirements by as much as 20%, and 80% respectively. Swamidass (1996) argues that adoption of manufacturing automation such as CAD is able to considerably improve productivity of the white-collar employee e.g., product designers and engineers, by automating the product design process. Consider, for example, the case of a firm in a garment industry; adoption of manufacturing automation can help the firm within the garment industry to reduce its material loss, decrease its material and labour requirements and improve product quality. By installing the automated manufacturing system, a garment company is able to quickly design the pattern of the garments ordered by customers and produce the order efficiently with minimum or no loss of materials and labour due to use of the firm's automated cutting machine and sewing machine (Kanet, 1998). Another example of the beneficial use of manufacturing automation is in the baking industry. Torres (1997) argues that due to changes in customer tastes and needs, the baking industry has to adapt products to the awareness of quality healthy breads. Besides, as the competition in bakery industry is very high, firms within the industry have to come up with strategy to produce healthy, high quality and competitively priced breads. Since there is skilled labour shortage, bakers replace their labour requirements with automated equipment. After installing the automated machine, the production process becomes faster, more flexible and reliable. The automation reduces the labour requirements by allowing centralization of the controls of the ovens with a computerized system. Thus, bakers are able to control ovens and watch the baking process from one central computer. The production runs independently with labour hours, as the task of a labour is only to put the raw materials in the machine and operate the computer.

Though the discussion above shows that manufacturing automation adoption may lead to business process efficiency, some conflicting opinions have also emerged. Notable among these are Boyer et al (1997) and Safizadeh (1996) who report that lack of integration of automated manufacturing equipment may greatly hamper production efficiency. If different equipments in a firm's production process are not compatible, those machines can create even more inefficiency than using labour force. Further, non-technological factors such as skilled operators, close relationships with suppliers and integration of production plant and departments within a manufacturing organisation, may significantly influence the production efficiency (Feraro et al 1988; Synder and Eliott, 1988; Siebeneicher 1987; Van Houten, 1998).

Indonesian manufacturing firms may improve their internal business process efficiency by adopting manufacturing automation because automation would enable the companies avoid labour unrest, which in turn, might increase productivity and labour efficiency. Also, Indonesian manufacturing firms build up alliances with suppliers of raw materials and spare parts. The alliances help companies to have a regular supply of required raw materials and spare parts, which in turn helps the companies minimize defective products. Further due to tax exemption for imported production machines, manufacturing companies in Indonesia take advantage of this and import quality production machines to produce their products.

Following the discussion above, it is hypothesized that there is a positive relationship between a manufacturing organisation's adoption of manufacturing automation and its internal business process-related performance. The hypothesis is presented below.

H_{3c}: Adoption of manufacturing automation by a manufacturing organisation is positively associated with the organisation's internal business process related performance.

4.2.3.4. Adoption of manufacturing automation and Learning and Innovation-Related Performance

As a result of the impact of globalization, manufacturing organisations have faced considerable challenges in terms of shorter product life cycle, increased product proliferation and greater customer expectation.

Moreover, standardised manufacturing products in mass volume are no longer the norm and companies need to respond quickly to the change. These challenges require manufacturing organisations to make continuous improvements across multiple manufacturing performance dimensions including process flexibility, product reliability and quantity, process speed, and product costs in order to remain competitive. Traditional manufacturing systems allow companies to produce high volume standardized products with low costs per unit. The system uses simple controls, which is easily operated by plant workers. However, this system is inflexible, as it cannot easily be converted to low-volume needs or customized products without a major commitment of costs and time. But, today's competitive environment does not permit high costs and long turnaround times to meet customer demand. Improvements in manufacturing functions are the key sources of an organisation's competitiveness (Vokurka et al, 1998).

Patuwo & Hu (1998) report that rapidly changing technology has shortened the average life cycle of many products and the change requires manufacturing firms to improve the design and style of their existing products as well as increase new product development and product differentiation efforts. Adoption of manufacturing automation allows companies to reduce production time, reduces labour requirements and boosts productivity. Automation facilitates integration of product design, product engineering and processes more effectively; it also promotes development of new products. Therefore, adoption of the automation helps manufacturers to respond to changing market demand, changing customer tastes and requirements, take advantage of technological innovations and rapidly changing competitive conditions. Since time-to-market is a critical factor in today's business, adoption of manufacturing automation acts as an effective "weapon" to compete in highly competitive markets. Patuwo & Hu (1998), for instance, argue that manufacturing automation may reduce the time to market new and differentiated products (see also Tonkay, 1997; Chang & Joshi, 1990; Udo & Ehie, 1996; Jonsson, 2000). Co & Flowers (1990) report that adoption of automated manufacturing shortens time-to-market, while Lei & Goldhar (1990) suggest that automation improves production flexibility, therefore improves time- to- market of a greater variety of products (see also Pine, 1993).

The relevant literature suggests that manufacturing automation provides more opportunity for companies to offer a broader range of products by stimulating new product design and style. Attaran (1989), for instance, argues that the benefits of adopting of manufacturing automation are gained because the flexibility provided by automation enables manufacturers to offer a broad range of products, by stimulating new product design, simplifying style changes, and making small production runs economical. Since manufacturing automation has the capabilities, such as flexibility, to produce different products, change production rate and shorten production time, organisations which adopt the automation are able to lift product innovation. Swamidass (1996), for example, reports that the advantage of automated manufacturing is production flexibility, which allows its users to switch machines from producing one kind of product to another instantly. Also, programs controlling a machine can be changed from one to another by punching a few computer keys; therefore, the set-up costs for product changes are virtually zero. Such flexibility permits the production of a wide variety of products at low volumes without consuming a lot of time for machine set-up. Taheri (1990) reports that with the flexibility of manufacturing automation, the production of parts which are having similar physical configurations or those parts which can be partitioned into distinct product families, can be produced by the same machine. The manufacturing organisations in Indonesia are expected to be benefited similarly from automated manufacturing

Based on the discussion above, it is argued that adoption of manufacturing automation by Indonesian manufacturing organisations may improve their new product development, improve learning, and reduce time- to- market product.

H_{3d}: Adoption of manufacturing automation by a manufacturing organisation is positively associated with the organisation's learning and innovation-related performance.

4.2.4. Engagement in a strategic alliance and Organisational Performance.

As explained earlier in Chapter 3, strategic alliance may be viewed as an agreement between two or more independent firms to cooperate towards achieving common goals, such as a competitive advantage and customer value creation. It is a long-term relationship in which alliance member firms cooperate and willingly modify their business practices to improve all of their performance (Harris et al, 1993; Whipple, 2000). In today's globally competitive market, companies must be more responsive to their customers, they must be able to receive their customer orders immediately, process the order faster than ever before, and shorten the order cycle time. These capabilities ultimately result in customer service improvement. One way for companies to succeed in such a competitive environment is to find ways to work together with partners to provide customers with a range of services that knot together. This is why many firms today increasingly engage in inter-firm relationships (strategic alliances) (Miles & Snow, 1992).

In the early 1990s and before, companies coped with dynamic environments by buying other companies in the distribution channel (Miles and Snow, 1994) During that era, vertically organised inter-firm structure was appropriate and was quite adversarial. Buyers and sellers typically operated in arm's-length, had independent relationships, and they competed for resources instead of engaging in cooperative efforts. Furthermore, short-term partnering and multiple-vendor sourcing was prevalent (Wyle, 2000). The primary benefit associated with this structure was cost efficiencies. By creating and maintaining an adversarial and competitive environment, firms were able to realise significant cost benefits when managing external sourcing.

Reeves et al (2002) argue that in highly competitive environments, companies need to actively seek to penetrate markets and one way to do this is to engage in a strategic alliance; an inter-firm relationship which is a move from competition to collaboration. A collaborative relationship occurs when two or more companies agree to work together for mutual benefits. Co-operative relationships are long-term associations including repeated transactions with the same partner(s) over several years, a low frequency of changing alliance members, high mutual obligations, close information sharing that surpasses straightforward data exchange (about price, quality, and quantity) and risk sharing (through undertaking joint research projects, joint ownership, and cross-shareholdings) (Whitley et al., 1996). The collaboration may involve both short-term cost-based relationships as well as strategic value-added long-term relationships (Novack et al., 1995). A strategic alliance may take the form of a collaborative effort, licensing of technology, and joint venture (Berryman, 1998).

A strategic alliance is an important competitive tool as it enables the alliance members to be more flexible in adapting to the changing environment. It may play an important role in improving organisational performance as it brings together independent companies to share resources in product design, production, marketing and distribution. Further, a strategic alliance can be more cost effective as it does not involve any additional equity or investment, business risk such as bankruptcy or profit declining.

The relationship between an organisation's engagement in a strategic alliance and its performance has been examined by researchers for some time. However, an extensive review of the extant literature reveals that the relationship is inconclusive. Some researchers report a positive relationship between a firm's engagement in a strategic alliance and performance (e.g. Bresser & Hari, 1986; Dunford, 1987). However, there are researchers who fail to find a direct relationship between strategic alliance and the performance; they argue that the relationship exists via mediating factors (McGee, Dowling & Megginson, 1995; Steensma & Corley, 2000). On the other hand, some researchers (e.g. Shrader, 2001) report no association between a firm's engagement in a strategic alliance and its performance while others (e.g. Tehrani, 2003) argues that the nature of the relationship varies from country to country. Given that no study investigated the above relationship in Indonesia, we do not know if there is a (direct or indirect, positive or negative) relationship between a manufacturing firm's engagement in a strategic alliance and its performance in an Indonesian environment. This study attempts to fill in the gap.

4.2.4.1. Engagement in a strategic alliance and Financial Performance

This study defines financial performance in terms of return on investment (ROI), operating income and sales growth. The relevant literature suggests that strategic alliance is a mutual cooperation among the alliance member firms and it is aimed improving the member firms' financial performance. A reason for the argument is that forging the alliance enables a member firm focus its resources on its core skills and competencies while acquiring other capabilities that it lacks from the other firms within the alliance. Klunk & Rose (1988) argue that the following potential financial benefits may occur from a firm's engagement in a strategic alliance:

(a) Economy of scale, greater scope for buying and selling products and services, and greater scope for enhancing alliance member firms' infrastructure effectiveness (for example, a central computer system for all members of the alliance).

(b) Reduction in capital requirements, sharing risks in development of new service programs, new products, or new technology; and greater possibility of influencing the structure of competition in the relevant market.

Klunk & Rose (1988) also report that cooperation among strategic alliance member firms increases efficiency and reduces operating costs of the firms. Engagement in an alliance with supplier firms, for instance, may improve marketing efficiency (e.g, product price and product availability). Having strategic alliance with suppliers may help a company to reduce its transaction costs (e.g. order-processing costs). In many cases having the alliance with suppliers may also improve inventory management as it eliminates supply chain discontinuities and reduces inventory-carrying cost (McGee et al, 1995; Shan, 1990). Weng (1999) reports that a strategic alliance between manufacturers and distributors improves the alliance member firms' profitability, and reduces their ordering costs. Yasuda & Muldford (1980), for instance, report that Japanese companies join strategic alliance for future development and expansion, future security of survival and success, mutual trust, ease of obtaining information, mutual assistance, and possibility of improved profit. This is because strategic alliance is a pool of competitive advantages, which are beneficial to the alliance member firms; they gain advantages from each other and reduce competition among themselves. These benefits create opportunities for the allied companies to increase their market share and improve profitability (Reeves et al, 2002).

Dunford (1987) argues that a strategic alliance may let the alliance member companies establish a pool of joint resources, and create a synergistic effect in problem solving with less cost, thereby it may improve the member firms' financial performance. Dunford for example, reports that having the alliance for marketing campaigns (e.g., sharing marketing technology and cross licensing) reduce the alliance member firms' operating costs, increase revenue and enhance competitive advantages, which ultimately enhance the competitive position of the firms. Tehrani (2003) studies the impact on performance of high tech industry firms' engagement in a strategic alliance in the United States (US) and the European Union (EU). The results indicate a significant positive relationship between the firms' engagement in the alliance and their financial performance. Tehrani's (2003) results support Reijnders & Verhallen's (1996), who compare the differences in market approach and financial performance of alliance and non-alliance retailers in Netherlands. The findings show that alliance member retailers' financial performance is better than non-alliance member retailers' performance.

Though the above discussion suggests that a strategic alliance improves a firm's financial performance, there is evidence in the literature that the relationship may be dependent on some other mediating variables (McGee et al, 1995). A number of researchers (e.g., Li & Atuahene-Gima, 2001; Peng & Heath, 1996) suggest that although a strategic alliance is beneficial for firms to secure resources, such an alliance is difficult to manage because other factors including trust, communication and collaboration among the alliance member firms may affect the success of the alliance in improving the firms' financial performance. Further, business environment within which the alliance member companies operate, may also affect the success of the alliance in improving performance. Tehrani (2003), for instance, reports that engagement in a strategic alliance has a stronger effect on firms' financial performance in Europe than in the US. An explanation for the results is that companies in the US operate in a product differentiation environment rather than in competitive cost environment.

Close communication, collaboration, and trust are also critical factors for success of a strategic alliance. In many cases strategic alliances fail to improve alliance member firms' performance, including financial performance, because of inadequate communication, collaboration and trust among the member firms (Bruner et al, 1992; Sabel, 1993; Shrader, 2001). Trust among member firms is important for success a strategic alliance because it: (1) facilitates investment in assets (Abodor, 2002; Fichman & Levinthal, 1991; Gambetta, 1988), (2) promotes cooperation among the alliance member firms (Buckley & Casson, 1988; Dwyer, Schurr & Oh, 1987; Jarillo, 1988), and (3) reduces transaction costs associated with the exchanges among the alliance members (Zaheer & Venkatraman, 1995). Further, trust promotes sustained contact among the alliance member firms so, through close contact, the companies can learn about each others' strengths and share in it for mutual benefits (Nooteboom, Berger & Norderhaven, 1977).

Following the discussion and previous research highlighted above, it is arguable that the relationship between a firm's engagement in a strategic alliance and financial performance is affected by factors including the extent of communication, collaboration and trust among the alliance member firms. The nature and extent of these factors could vary from one country or society to another. Hofstede (1980; 1994) suggests that Indonesian society is characterised by collectivism. Business relationships in such societies are based on mutual trust, and business transactions take place on mutual relationships and obligations of mutual protection in exchange of loyalty. Following Hofstede (1980, 1994), it is argued that Indonesian manufacturing firms' engagement in a strategic alliance is likely to be guided by mutual trust, loyalty and protection, therefore, successful. Following the above discussion, a positive relationship between a manufacturing firm's engagement in a strategic alliance and its financial performance is predicted in Indonesia. The hypothesis is formally presented below.

H_{4a}: There is a positive relationship between an Indonesian manufacturing firm's engagement in a strategic alliance and its financial performance.

4.2.4.2. Engagement in a strategic alliance and Customer-Related Performance

Customer-related performance in this study incorporates attributes like on-time delivery of orders, number of customer complaints, market share, time from order to delivery, and customer response time. The relevant literature indicates that strategic alliances may enhance the alliance member firms' access to broader markets with lower investment, decrease their resource dependency, assist them in facing environmental uncertainty and managing inter-organisational dependency, and improve their brand name and control over markets in gaining competitive advantages (Astley & Foomburn, 1983; Shrader, 2001; Steensma & Corley, 2000).

A manufacturing firm's engagement in a strategic alliance may have a positive impact on the firm's product quality because an alliance with suppliers, for instance, helps the firm obtain quality materials and spare parts, also resulting in increased productivity (Tehrani, 2003). Building up the alliance also helps companies to respond faster to customer demand and maintain, as well as improve, customer services. Similarly, alliances with distributors and marketing agents may help companies to provide high quality customer and support services (see also McGee etal 1995). Stucky (1983) and Dunford (1987) report that a strategic alliance supports alliance partners' to make faster responses to market changes, gain better understanding of buying patterns, increase collaboration and information sharing across the supply chain, and collective ordering of necessary materials, which can increase control over supply sources and help ensure on time delivery of quality materials in the required quantity.

Brand alliance, a form of strategic alliance, improves not only the availability of quality materials, but also brand image, which ultimately improves market share. Brand alliance being a combined brand name (e.g. IBM and Intel or Bacardi Rum and Coca Cola) may improve the image of product quality and expand the market or increase the market share (Akshay et. al, 1994). The alliance between Rover and Honda is another example of brand alliance. Alvarez & Gonzales, (1999) report that Honda design of Rover models increased the alliance partners' product image, reputation, reliability and quality. Consider also the case of Arnotts' (a biscuit maker in Australia) alliance with other local biscuit manufacturers. Arnotts, through the alliance and with its product quality, has been able to beat the competitors in gaining market share. Recently, through alliance with America's Campbell Soup, Arnotts has entered the US market, and by making and selling American Campbell cookies, it has increased its Australian market share to 75% (Dettre, 1986)

Prior research has focused on identifying the behaviours (such as trust and commitment) that are required for building successful alliances (Abodor, 2002; Fichman & Levinthal, 1991; Gambetta, 1988). The results reveal that, in many cases, behaviour discrepancies among alliance partners create barriers against the partners continuing the cooperation (see Collinson, 2000). Trust and commitment among alliance partners are critical for the alliance to improve customer satisfaction and market share (Adobor, 2002; Whipple & Frankel, 2000). Trust is important for success of an alliance because it promotes cooperation (Buckley & Casson, 1988; Dwyer, Schurr & Oh, 1987; Jarillo, 1988), and the speed of negotiations (Reve, 1990). Besides, communication is also an important factor as it allows alliance partners to exchange information useful for building and maintaining relationships among the partners. Effective communication builds trust and cooperation among alliance partners (Buckley & Casson, 1988).

Following the discussion above, it is argued that participation in a strategic alliance is likely to improve customer-related performance of manufacturing firms in Indonesia. This argument is consistent with Hofstede (1994) and Koentjaraningrat (1975); these researchers argue that Indonesia is a society of collectivism, where trust and collaboration are two common characteristics of business behaviour. Further in a collectivist society, people promote group interest and have strong loyalty to groups or organisations (Hosftede, 1994). This behaviour is generally congruent with having a successful strategic alliance, which may lead manufacturing companies in Indonesia to successfully build up their alliances with their suppliers and customers. The hypothesis below formally presents the argument.

H_{4b}: There is a positive relationship between a manufacturing firm's engagement in a strategic alliance and its customer–related performance in Indonesia.

4.2.4.3. Strategic Alliances and Internal Business Process-Related Performance

In this study, performance with respect to internal business process is defined in terms of efficiency in using labour and material, ratio of good output to total output, materials scrap loss and manufacturing lead-time. The extant literature and anecdotal evidence imply that a strategic alliance is a critical success factor for companies as it increases the alliance member firms' efficiency (Powel et al, 1996; Forrest, 1990; Lee & Mulford, 1990). For example, an alliance with suppliers helps the its member manufacturing firms in getting supply of quality materials on time, quickly responding to production changes and shrinking production and delivery lead-time.

Having an alliance with customers also helps a manufacturing firm to improve its product and service quality through early recognition of, and quick response to, changes in customer tastes and demand. Previous studies reveal that strategic alliances with suppliers help manufacturers to get desired quality raw materials and spare parts, thereby to reduce or eliminate production delays and defective products. These benefits ultimately increase raw material and labour efficiency as well as shorten manufacturing lead-time (Baumgartner et al, 2001). The efficiency increase in terms of reduction or elimination of defective products, production delays, and manufacturing lead-time means that companies also reduce or eliminate their waste. Ono (1998) explains that in order to compete in tough competition and improve performance, companies need to eliminate wastes activities (e.g., production of goods not yet ordered, rectification of mistakes, excess processing, excess movement, and excess stock), as the activities add cost but no value. For example, a company having an alliance with its suppliers may be able to eliminate raw material inspection activities and the related costs, as the company can be confident that its suppliers will send good quality materials. Since there are no defective raw materials, the production process runs smoothly, therefore, production delays and the resultant additional labour costs are avoided.

One of the problems for manufacturing companies is to manage inventory and delivery of products to customers. It begins with the forecasted demands, which in turn drive the inventory purchasing, determine the inventory level and customer service level. This process repeats itself for each product and each buying cycle and needs good management, otherwise, inventory may inexplicably increase for some products, while other products may be chronically out of stock. If this process is not well monitored the company will find it difficult to keep the production running smoothly and to fulfil customer demand. Further, cost which is related to the process (e.g. ordering cost, inspection cost, carrying cost and delivery cost) significantly affect production costs and selling price (Sum et al, 2001). Empirical evidence indicates that building up an alliance with suppliers helps companies increase its material and labour efficiency as they can manage inventory and delivery of products to customers well.

Prior research indicates that building up an alliance with suppliers can help companies increase their material and labour efficiency, as well as reduce the manufacturing lead-time and waste. Klunk & Rose (2000) study the materials and purchasing alliance at the Exide Electronics (EE) manufacturing plant, USA. EE manufactures uninterruptible power systems (UPS); a high-level technology that has a world-wide market. As customers continue to raise their expectations for quality, reliability, product availability and competitive prices, the success of EE becomes dependent largely on the cost, quality, capability and responsiveness of suppliers, as well as their speed to deliver the product to customers. For this reason, EE built up a strategic alliance with suppliers. EE selected the best suppliers as its alliance partners. 80% of spare-parts are bought form EE's alliance partners and the result shows that while defect percentage of spare parts from non-alliance suppliers was 0.49%, it was only 0.03% for the spare parts from alliance partners. Within four years of the alliance, the overall component defect percentage of EE was reduced by 97%.

An alliance also minimizes waste such as handling and inspection activities. Further, customers find the product superior. Similarly, Aerospace companies also pursue strategic alliances with their suppliers. For example, Lockheed Martin Aeronautics, USA, , reduced purchasing costs by US$410 million, improved acceptance rate of quality parts by 48%, reduced parts shortage by 60%, and improved inventory turnover by 38%, after working closely with its suppliers. More importantly, the company reduced non-value added activities, such as excess of spare parts purchases and quality inspection of parts sent by suppliers, and minimized transaction costs, such as ordering and warehouse costs (Stundra, 2000).

For increasing efficiency, companies need to have alliance with its customers also. By cooperating with its customers, a company is able to respond better to its customers needs. For example, Rubbermaid Canada teamed up with its customer: Kmart Canada. The alliance eliminated specific shipping costs for Rubbermaid goods coming to Kmart distribution centres. In the process, Rubbermaid saved packing, delivery and labour costs. Also, Rubbermaid's delivery lead-time to Kmart was reduced to 16 days from 21 days (Anonymous, 1993).

The discussion above indicates that building up alliances with suppliers and customers has a major role in lowering wastes and defective products, reducing production lead-time, and ultimately improving internal business process performance. However, to develop alliances between suppliers and customers means bringing them in on business decisions. Japanese companies, which are well known as successful companies in building supplier alliances, believe that building up an alliance with a supplier is not just a matter of a manufacturer-supplier relationship, but a matter of manufacturer-supplier partnership. For this, trust, information sharing, and supplier involvement are essential. Manufacturers have to guide and help their suppliers to make supplies meet the manufacturers' needs, while the suppliers are improving their own performance. In other words, both parties have to be in a situation where they have a commitment to help each other to achieve their own goals. One way to improve suppliers' commitment is to involve them in the early stages of the manufacturing process, like product design and sales forecasting (Sheridan, 1990). By involving them in the early stages, suppliers gain understanding of how to support production.

Honda has successfully improved its internal business process through its alliance with suppliers. In building and maintaining its alliance with suppliers, Honda helped its suppliers to be successful. For example, Honda helped the suppliers to develop their employee involvement program, to provide engineers to help improve their product quality and to solve their technical and managerial problems. Honda also involved all suppliers in the decision-making process. Honda's suppliers, month-in and month-out, send products that are 100% defect free and 100% on time. Because of Honda's high level of confidence in its suppliers' quality, virtually all parts directly to the assembly line, without inspection at the receiving dock. Because Honda is successful in eliminating defect products and wastes, Honda has increased its material and labour efficiency. Honda has also reduced its manufacturing lead-time and responds better to its customers. This alliance plays a big part in Honda's success and for twelve years Honda ranked number one in customer loyalty (Sheridan, 1990).

However, maintaining an alliance with suppliers or customers is not always successful. Smagala (2004), for instance, reports that a strategic alliance between manufacturers and suppliers in Japan generates different results from similar strategic alliances in Europe. Europeans prefer to have short-term relationships and separate the business relationship from friendship, while vendors in Japan build up their relationships based on trust and friendship. Therefore, they like to maintain a long-term relationship with their customers/manufacturers. Indonesia, as an Asian society with a strong collectivist culture (Hofstede, 1980), may have a similar pattern when building up strategic alliances, to the Japanese. Indonesian manufacturing organisations are likely to maintain long-term relationships with their alliance partners and work closely for their mutual benefits. The interpersonal relationships based on trust and friendship may increase commitment between alliance partners, which ultimately may make the alliance successful and improve organisational performance (see also Johnston et al., 2004). Thus, it can be proposed that Indonesian manufacturing organisations' engagement in a strategic alliances may have a positive association with their internal business process-related performance.

H_{4c}: There is a positive relationship between a manufacturing firm's engagement in a strategic alliance and its internal business process-related performance.

4.2.4.4. Strategic Alliance and Learning and innovation-related Performance

Performance with respect to learning and innovation is defined in terms of three items. These items are: the number of new products launched, the number of new patents and the time taken to market new products (see Hoque, 2000; Kaplan and Norton, 1992). In recent years, manufacturers and distributors have come to rely increasingly on strategic alliances. Along with the development of technology and changes in customer tastes and needs, product life cycle is becoming increasingly short. For example, the product life cycle of manufactures of personal computers, software packages, and other seasonal products such as clothes are very short. To compete in such markets, manufacturers have to innovate products rapidly (Weng, 1999). Therefore, research and development (R&D) becomes one of the most important factors for success in manufacturing organisations. Hagerdoorn and Narula (1996) suggest that among other benefits, a strategic alliance promotes joint development agreements, joint research programmes, cross licensing and R & D among alliance partners. Through strategic alliances, risk and costs associated with new product development can be shared, more effective use can be made of manufacturing facilities and production capabilities, and technology and knowledge can be transferred among the alliance partners (Whipple & Frankel, 2000).

Engagement in a strategic alliance generates benefits for new product development. For example, Hamel, (1991); Inkpen & Crossan (1995); Teece & Pisano (1994) suggest that companies may engage in alliances with the primary goal of learning from partners, as the alliance partners are expected to give access to each others skills and capabilities. Grant & Baden-Fuller (1995) also argue that through the learning process, alliance partners are able to speed up their capability development and minimize exposure to technological uncertainties by acquiring and exploiting knowledge developed by other partner(s). Consider, for example, the benefits derived from strategic alliances by Japanese manufacturers in the automotive industry. Since the early 1980s, Japanese cars have dominated the world automotive market, while increase in demand for European and American cars has been slow. One of the reasons for the success of Japanese car manufacturers is their engagement in a strategic alliances, which have helped them take advantage of sophisticated automotive technology, design changes and innovation (Carr, 1999). Consider also, the case of the alliance between Seat, a Spanish car manufacturer, and Volkswagen (VW). Before engaging in the alliance, Seat had limited capabilities in relation to R&D and new product and process development. Seat was uncompetitive; it needed to improve its product range, reduce its costs and improve product quality. Starting from 1982, when Seat and Volkswagen (VW) entered into a strategic alliance, it became successful. In 1990, Seat launched Toledo, a combination of VW platform with Mediterranean design and since then Seat has continued to aggressively launch new products (e.g. in 1991 Ibiza new style was released, followed by Cordoba in 1992; Inca in 1995, Alhambra in 1996, Aros and New Toledo, in 1998) (Alvarez & Gonzales, 1999).

However, the relevant literature indicates that the success of strategic alliances with respect to learning and innovation-related performance is less than 50%. Mowery et al. (1996), for example, report that a strategic alliance does not always improve learning process optimally. If one of the partners in the alliance is technologically stronger than the other, the stronger or the "teacher firm" does not learn much from the weaker or "student firm". This is perhaps why Whipple & Frankel (2000) suggest that all parties in a strategic alliance ought to be compatible and they should compliment each other for the alliance to be successful. This indicates some strategic alliances improve the learning process, while the others may not. Inkpen & Crossan (1998) also reports that a strategic alliance may fail to improve learning processes, as one of the partners may have limited incentive to share its knowledge. Similarly, Schill et al (1994) suggest that if there is development of a dependent relationship (because of the weaker partner's limited knowledge), the weaker partner may not learn as expected and it may prevent the alliance from increasing pace of new products and processes innovations. "Student firms" may be dependent on their "teacher firms", and might not have enough awareness to react quickly to the market force and may imitate their "teacher firms'" products, instead of developing their own initiatives (Nakamura et al. 1996). The other reason for failure of strategic alliances, is the weaker partner's strategy of absorbing "teacher firms'" core capabilities (Nakamura et. al., 1996). For example, although Rover entered in an alliance with Honda, Rover failed to continue improving its new product innovation, as Rover did not exploit Honda's core capabilities. Rover spent too much time designing key components, such as engines, regardless of the fact that Honda already designed better engines, and therefore, did not take advantage of opportunities offered via their strategic alliance. As a result, Rover did not have new models ready to use the engines on time (Alvarez & Gonzales, 1999).

Other factors, such as management capabilities, managerial experiences and environmental turbulence have also played a significant role in the success of strategic alliances (Li & Atuahene-Gima, 2001). For example, Li & Atuahene-Gima (2001) investigate the effect of strategic alliances in relation to product development in 300 Chinese companies. China is a transitional economy, so it poses severe resource, management and other challenges for companies. Surprisingly, the study reveals that product innovation is low, yet engagement in a strategic alliances is common. A plausible explanation for this finding is that organisations in China may lack experience or have managerial and other problems that obstruct the benefits of such alliances (see also, Nee, 1992; Peng & Heath, 1996; Xin & Pearce, 1996). McGee et al (1995), for instance, argue that the success of a strategic alliance depends on the prior experience of the alliance partners' management teams. Smith & Barclay (1997) also suggest that a strategic alliance may fail in improving performance, because the alliance companies do not fully understand how to manage or maintain the relationship. This problem may result from a lack of resources.

Besides innovation of new products, manufacturers also have to market their products promptly; otherwise competitors may take over the market. For example, Sullivan (1995) reports that a PC division of one major manufacturer lost $1billion in one year, due to demand underestimation and hence, could not market the product on time during Christmas sales season. Marketing capability is an important infrastructure, which supports product innovation and development (Brouther et al., 1995; Reijnders and Verhallen's, 1996). Alliances between manufacturers and distribution channels help manufacturers to market their products effectively without putting too much effort into promoting their products (McGee et al., 1995; Shan, 1990).

Indonesia is a developing country, where manufacturing organisations are the backbone of the economy. The Indonesian government supports and facilitates Indonesian manufacturing companies in improving their production (Investment coordination board, 1999). Due to competition in global markets, manufacturing companies have to design new products. Companies have to continuously renew their products, as product life cycle is very short. To solve these problems, strategic alliances among manufacturing and other firms in Indonesia are a critical strategy. Such alliances can help companies adapt to new technology and to learn new technology from others (Boeker, 1989; Chandler & Hanks, 1994). Based on the discussion above, it is posited that engagement in strategic alliances by manufacturing firms in Indonesia is positively associated with their learning and innovation related performance.

H_{4d}: There is a positive relationship between a manufacturing firm's engagement in strategic alliance and its learning and innovation related performance.

4.2.5. Managerial Use of Information Technology and Organisational Performance.

Information technology, which consists of communication technology (as discussed earlier) may enhance organisational (business unit) performance (Dickens, 1992; Bititici, 1997; Kagan, 2000, Housedshel & Watson, 1987; Booth, 2000). Information technology in terms of communication networks (Intranet, Internet, e-mail, voice mail, and other telecommunication facilities such as net-phone, videoconference, net meeting) may help the organisation to integrate its business from supplier to customer; from one division to another division; from one region to another; and get data on real-time basis for planning, controlling, and decision making (Dickens, 1992; Karake, 1992).

Globalisation has changed customers' demand. High quality products, competitive prices, quick responses, speedy delivery and a high reliability of both products and after-sale services are required by today's customers (Kaplan & Norton, 1996; Lynch & Cross, 1991, Wyle, 2000). In other words, global competition has forced demand for faster and better customer services. Suppliers, on the other hand, also have more bargaining power, as they have more opportunities to sell their products to different manufacturers/customers. In the process, globalisation has intensified the need for fast and accurate information, which requires organisations to have a suitable communication network. Communication among managers within an organisation can be highly effective through electronic mail, net-phone, net meeting and videoconference. Reduced cost and increasing quality of communication are examples of the benefits of a communication network (Galbraith, 1977; Mintzberg, 1983; Thompson, 1966; Targowski, 2004).

Andersen (2001) finds that managerial use of information technology, such as Intranet and Internet, to enhance an organisation's internal and external communication, improves the organisation's performance. The use of information technology is positively associated with organisational performance due to improved strategic spare-parts, better coordination of strategic actions and facilitation of learning processes. Andersen (2001) also suggests that the use of information technology has a positive relationship with innovation and profitability. The reason for this is that the use of Intranet and Internet increases the speed of internal and external communication, with lower costs and increased profitability and sales growth.

From the discussion above, it can be argued that the use of an appropriate communication networks enable organisations to improve communication between various functional areas of the organisation, leading to improved performance through employee, customer and suppliers' satisfaction (see also Kagan, 2000). However, none of the studies, let alone any similar study in Indonesia, examines the relationship between managerial use of information technology and organisational performance, including financial performance, customer-related performance, internal business process-related performance and learning and innovation-related performance. This study attempts to examine these relationships in Indonesian manufacturing organisations.

4.2.5.1. Managerial Use of Information Technology and Financial Performance.

In the era of globalisation, the ability to offer customised products with short lead-time, is becoming a huge area of competitive differentiation among manufacturers. Manufacturers have to coordinate their inventory to always be available to produce products based on the demand (Narasimhan & Das, 1999). In typical manufacturing operations, the flow of raw materials is one of the most important factors, as it determines production speed. The number of parts used in production can be up to thousands of items. These parts are usually purchased from suppliers on the basis of price, quality and delivery time. To keep the production process running smoothly, the material and spare parts procurement must be equipped with timely, valuable information on parts and their suppliers (Soliman & Youssef, 2003). A good communication network is required to keep the information flow smooth.

Conventionally, information flowed through mail, telephones, and faxes. However, mail takes time to reach its destination, while telephone and facsimile can sometimes be costly, especially if the vendors are in different locations (e.g. out of town or overseas). Unlike telephone, Internet and Intranet have the facility to transmit graphs and pictures and material specifications within a few seconds. Therefore, Internet reduces communication time and costs, as it decreases the use of mail, telephone and facsimile. Internet and Intranet are beneficial as they can be used to gather and present information on a real-time basis (Andersen, 2001). By sending on-time information to suppliers, materials can be expected to arrive in the factory on time.

With a fast information flow, inventory, as well as production reports, can be prepared and made available on a real-time basis, which facilitates monitoring production process and spare-parts effectiveness (Andersen, 2001). For example, real-time information on inventories may enable a manager to make accurate decision when buying stock, and as a result there may not be resource shortage or build up, which consequently affects company financial performance (Tullo, 2000). Similarly Badiru (1990) and Siebeneicher (1987) explain that by using information networks, marketing departments may be able to inform the production department of product demands and at the same time, this information may signal the production department to change its production schedule and avoid stock build up. Also, the production department can then inform the purchasing department of its production schedule , which can in turn inform suppliers when to send raw materials. This integration helps companies save costs.

Since Internet and Intranet transmit information on a real time basis, businesses are aggressively adopting Internet because they want to cut costs, reduce order processing time, and improve information flow (The inaugural report from Forester Research's Business Trade & Technology Strategies service, 1997). As discussed above, the Internet has reduced the number of letters, phone calls and faxes around the globe. Previously, purchasing documents were sent through the mail, but now the internet can deliver such documents in minutes, to both the supplier and at the same time, provide access to other departments within the organisation. Intranet also decreases the duplication of paper work, as well as reduce the feedback lead–time (Haywood, 1999). This reduction in time and costs in the whole manufacturing chain enables companies to gain competitive advantages in pricing their products. Internet also helps companies search for the best-priced quality materials and spare parts, thus helping companies to find cost effective materials and spare parts for their operations.

Links with suppliers or supply chains do not only make production processes run smoothly, but also help manufacturers reduce costs in production, selling and delivering the products to customers. For example, the Cisco manufacturer operates 37 factories and each of these factories is linked to Cisco via the Internet. Cisco monitors its partners through Internet and as its partners perform 90% of the assembly of component and they even do 55% of the final assembly. Cisco networking is geared up to end-customers without a Cisco employee ever touching the product. Cisco's supply chain fulfils more than half of these orders and Cisco save about US$500 to US$800 million per year by not operating its own manufacturing facilities. Furthermore, 80% of Cisco product orders are now placed via Internet, translating to US$45 million in business per day (Mike, 2000).

The use of information technology is also beneficial to manufacturers' and customers' relationships. Advertisements on the web, for instance, help manufacturers reduce advertisement expenses and other sales costs (e.g. sales person costs), as Internet allows sales personnel to concentrate on proactively managing customers' accounts, rather than serving solely as information providers and order takers (Soliman & Yousef, 2003). For instance, today Cisco receives in excess of 80% percent of new orders through Internet and resolves more than 80% of its customer-related issues via self-service mechanisms. Cisco has saved hundreds of million of dollars in sales costs, as it has been able to reduce its marketing expenses and redistribute contact centre personnel into revenue generating jobs or functions (Goldenberg, 2004).

Since Internet and Intranet can help companies to send information with minimal effort and cost, and instant arrival, it is a significant factor in rivalling competition, because it leads to shorter delivery cycle time and lower costs. Indonesia is an archipelago country with 1300 islands over a distance equivalent to the length of the USA. Communication by telephone and fax within the country and overseas is dear, while communication by mail is not only expensive, but also time consuming; it takes at least a week to reach the destination (Investment Coordination Board, 1999). Therefore, managerial use of information technology in Indonesian manufacturing organisations is likely to help companies save on communication costs. Further, as Indonesia is one of the Pacific Rim countries, where Western companies establish or jointly cooperate with manufacturing organisations, they have to market their products overseas and throughout the country. Following this trend, Naisbitt (1982) predicted that from 2000, the Pacific Rim would be the primary production area of big Western corporations, which means there may be many business units of multinational enterprises spread throughout the Pacific Rim. Internet helps these organisations to reach their customers and sell their products easily. All of these benefits from managerial use of information technology ultimately may improve a manufacturing company's financial performance. The hypothesis below summarises the discussion:

H_{5a}: There is a positive relationship between managerial use of information technology and a manufacturing organisation's financial performance.

4.2.5.2 Managerial Use of Information Technology and Customer-Related Performance.

Manufacturers have been struggling to meet customer demand and needs, because they change rapidly. Further, in highly competitive environments, manufacturers have to customise their products; otherwise their competitors may take over the market. (Narasimhan & Das, 1999). More than two-thirds (68 percent) of industrial buyers have experienced increasing needs for customised products or components over the past few years (Andel, 2002). In section 4.2.3, it is discussed that adoption of manufacturing automation allows manufacturers to customise their products, as automation is flexible and produces products rapidly. As the production process in automated manufacturing plants can be switched easily to modify products or to produce another similar product, automation can also help companies to meet customer demand (Attaran, 1989, Willis & Sullivan, 1984). However, relevant literature indicates that adoption of manufacturing automation mainly improves performance at plant or factory level; it needs a communication network to transmit the information from the production departments to other departments, so that the company can gain the optimal benefits from automation. Information technology (e.g.

Intranet, Internet, and videoconference) facilitates sharing of information rapidly and accurately among stakeholders, for very little cost (Andersen, 2001). Communication networks allow an organisation to have online information, which is important for decision-making and critical to compete in current markets. For example, in a highly competitive market, customer's needs and tastes, and competitors' products change unexpectedly. With Intranet or Internet, marketing departments are able to inform production departments of the demand trend for a particular product(s) and the production departments are then able to adjust their production to meet customers' changed tastes and needs (Narasimhan & Das, 1999).

Further, in the free market competition, a change in competitor's price may be unanticipated. Accounting departments need to supply marketing departments with online information about how far prices can be reduced to compete with competitors'. . For instance, the communication network can help marketing staff to respond quickly to customer queries (e.g. for product availability, product quality and also product price) (Willis and Sullivan, 1984). In addition, when responding to customers' needs, the coordination between production and marketing departments is important as it helps companies produce only products which are in demand, and offer them at competitive prices.

In addition, in today's globalization era, the competition is high. Customers do not only demand products at competitive prices but also of high quality. Further, customers demand the products to be delivered with minimum lead-time. Manufacturers need to have good who supply high quality materials with on time delivery, so that the production can be done on time (McGee et al, 1995; Shan, 1990). As discussed in section 4.2.4.2, a manufacturing firm's engagement in a strategic alliance with suppliers may not improve product or service quality unless there is a close collaboration and coordination between the firm and the alliance member suppliers. To strengthen the collaboration, the company needs a good communication network, which can effectively facilitate communication with suppliers. Internet helps allied manufacturers and supplier share and exchange information. For example, when a manufacturer changes its product design, the supplier at the same time must know how to support the change and gets the appropriate materials or spare parts for supply (Stucky, 1983).

Online communication of information is not only important for coordination and cooperation among internal parties, it is also important for aligning external parties, such as customers. In highly competitive environments, the drivers of manufacturing success are customers' needs and time. Time is the major source of competitive advantage and competitive pressures. Further, due to free market competition and globalization, there are no geographical barriers to selling products. Manufacturers have to find an effective and less expensive way to expand its market share and give opportunity to customers, in any part of the globe, to buy its products. Electronic advertisement of products on the web has become a trend, as it costs less, yet also increases ease of access to customers. Advertiser's may offer their products and provide information about their products on line as well as offer additional benefits to consumers also. Therefore, customers are able to search all the products and get all the product information details online.

By advertising products on the web, manufacturers enhance opportunities for their customers for trial and actual purchase of a product. For example, Land's End clothing company allow customers to provide physical information about themselves and use the information to see an image of how an item would actually look on them. Similarly, music, movie, and games sites allow consumer to sample the content prior to purchasing (Baker & Lutz, 2000).

This interactive advertisement allows customers to put order and pay through the Internet. Also the electronic advertisement can help customers and manufacturers get and give response faster than if it were done through the traditional way by phone, fax or mail. Customers do not need to stay on the phone line to get a response for customer services, instead they can click the interactive online communication network on the manufacturer's web site or send email to the manufacturer's customer service cell (Mike, 2000). Further, the manufacturer can respond to any customer's questions and complaints right away using the network (Faber et al, 2004).

The communication network can satisfy customers. Companies, which use Internet are able to reach customers or be reached by customers and sales through the Internet, a new effective tool to survive the competition. Internet has become an important source for consumer information through electronic advertising (Interactive Advertising Bureau, 2003). Online trade is likely to expand globally and the prediction is that it will grow from US $550 billion in 2001 to US$6.9 trillion in 2004 (Feo, 2001). Most organisations may gain benefits from online trade. For example, General Electric, a manufacturer of electrical and telecommunication products, sold US$500 million worth of products online in 2001 from among 250,000 products (Feo, 2001). Another example is Cisco, which in 1996 introduced an online order system for customers called Connect online; it allows customers to place orders right into the company's internal system. Under the system, customers' orders can be seen by Cisco sales personnel almost immediately. With this system, Cisco grows with fewer people, less lines down but it is able to ship the products right away to customers (Elliott, 1997). Given that 80% of Cisco product orders are now placed via Internet, it translates to US$45 million in business per day (Mike, 2000).

The discussion above suggests that information technology has the potential to improve companies' customer satisfaction and increase market share. The use of information technology such as Internet and Intranet in Indonesia can also help Indonesian manufacturing organisations to satisfy their customers as well as increase their market share. Due to cheap labour and investment cost, Indonesia now is one of the countries where Western companies produce their products, and many local manufacturing companies hold the license for manufacturing well known brand products (such as Polo Ralph Lauren, Christian Dior, Boss), which can be marketed around the world at cheaper prices (Naisbitt, J. 1996). For example, in US stores we often find Christian Dior products, which are made in Indonesia. The head quarters of these manufacturing companies need to continuously monitor the quality as well as timely delivery of the products. Information technology helps these companies to enhance the communication between the manufactures and their headquarters, therefore, reports can be sent on time and the spare-parts can be done properly. Information technology can also help Indonesian manufacturers to broaden their markets by putting the products online. Following the discussion, it is argued that managerial use of information technology in Indonesian manufacturing companies is likely to improve their customer-related performance.

H_{5b}: There is a positive relationship between managerial use of information technology and customer-related performance.

4.2.5.3. Managerial Use of Information Technology and Internal Business Process-Related Performance.

Today's business competition forces manufacturers to increase their efficiency. Without increasing their efficiency, they may not survive in the turbulent competition, as inefficiency results in increased price, reduced profit and reduced financial ability to continue the business. Efficiency can be identified from how efficient is the use of labour, materials and capacity for production. It can be also observed from the ratio of defective products to good products and other wastes such as scrap loss (Hoque & James, 2000; Ono, 1998). Many organisations do not realise that their information system can be bureaucratic, which creates non-value added activities and costs. For example, duplication of paper works, inspection of incoming raw materials, long approval procedures for raw material purchases are examples of inefficiency (Ono, 1998). Managers often face the dilemma that on one hand they have to protect company's asset by creating systems and procedures (e.g purchasing or selling procedure), while on the other hand they have to increase efficiency by reducing non-value added activities such as raw materials inspection.

One way to increase efficiency without compromising the company's asset protection is to build up a long-term relationship with its upstream and down stream parties such as suppliers and customers (Mia & Winata, 2003). Further, as an alliance with suppliers includes the specification and quality standard of raw materials or spare parts, manufacturers can eliminate the incoming materials inspection as the alliance member suppliers will deliver materials that are up to the company's standard (Baumgartner et al, 2001). Further, an alliance with suppliers can help manufacturing companies smooth their production and reduce manufacturing lead-time, as the suppliers can send the materials on time based on production schedule (Mia, 2000). High quality of raw materials leads to defect-free products and reduces rework of materials and labour costs. To keep up with good quality raw materials and spare-parts availability, manufacturers need to coordinate with their suppliers, and having a good communication network is essential for this (Mia, 2000; Mia & Winata, 2003). Information technology, such as Internet and Intranet, help managers within an organisation to effectively communicate with suppliers and share and exchange information on a real time basis (Andersen, 2001).

Internet increases organisational efficiency and creates opportunity to take advantage of their core competencies. Similarly, Intranet is also useful to integrate the departments within an organisation. For example, through

Intranet, the production department can send its production schedule to purchasing department and then the purchasing department has access to the warehouse to check the inventory availability. Purchasing departments can inform the suppliers to send the materials including quantity, quality and time of delivery. In the mean time suppliers can also have access to production departments and keep informed when the material is needed. Communications through Internet and Intranet are also efficient, as the technology reduces use of telephone, facsimile and mail (Haywood, 1999). Using information technology, information can be sent anywhere in the world electronically. Therefore, the use of information technology with supplier alliance members, by manufacturing organisations, may result in multiple savings as it increases employee efficiency by reducing purchasing personnel (e.g., for approval process, putting order, and negotiating better contract pricing). Information technology can also help companies leverage existing contracts more effectively, decrease maverick buying practice and reduce duplication of paper work, while increasing accuracy (Weil, 2000). Weil reports that a supplier alliance which is supported by information technology can increase labour efficiency buy 15%, decrease order cycle by 10% and increase accuracy of supply by 5%.

Other studies show that use of manufacturing automation and managerial use of information technology can also help a manufacturing company to reduce wastes, such as manufacturing lead-time (Attaran, 1989). However, manufacturing automation needs support from suppliers (Attaran, 1989; Meredith, 1987). Manufacturing automation can decrease wastes, defective production and manufacturing lead-time if it has supply of quality raw materials in time (Meredith, 1987; Gupta and Somer, 1989). Communication and collaboration with suppliers to send materials in the right quantity, quality and time, is the factor behind automation's success (Feraro et al 1988; Synder and Eliott, 1988; Siebeneicher 1987; Van Houten, 1998). For example, IBM (one of the biggest computer manufacturers) reports that after tightening its supplier alliance using information technology, within five years, it saved US$4.2. billion in material acquisition, reduced its delivery cycle time by 55%, improved inventory turn over by 44%, and achieved a 24% overall logistic cost reduction (Howell, 2000).

Following the discussion above, it is arguable that managerial use of information technology helps coordination and integration of departments and divisions within an organisation. Soliman (1997) argues that coordination and integration of various departments within an organisation, result in reduction of scraps and reworks, improvement in communication between the various parts of the organisation, improvement of vendors' selection methods, reduction in supply lead time of materials, reduction in manufacturing costs, and reduction in inventory levels. Therefore, efficiency of materials, labour, and production facilities increase.

Indonesian manufacturing organisations may have alliances with their suppliers, which are located throughout the Indonesian islands as well as overseas. Due to high competition, Indonesian manufacturers do not only have to be concerned with their product quality, but also have to consider their internal business process efficiency. Consequently, the manufacturers need to control the whole production process, sales and delivery by cutting out the middlemen. Indonesian manufacturing companies have been trying to improve their labour and material efficiency by implementing manufacturing automation (Investment Coordination Board, 1999). However, the manufacturing technology may not improve the organisations' internal process efficiency, as it may only improve the productivity at factory level. It needs integration of various departments within the company as well as external parties such as suppliers (Gupta and Somer, 1989). Managerial use of information technology may help internal and external parties to communicate and be integrated (Andersen, 2001). Integration through fast communication is also very important to improve internal process efficiency, as it synchronises the departments within the company. Further, the tight link between manufacturers and suppliers through the use of information technology makes it effective to control the efficiency and makes manufacturing agile (Freeland, 1980; Shapiro, 1977; Hayes & Wheelwright, 1979; Hayes & Wheelwright, 1979). Since information technology, in terms of Internet, Intranet and videoconferencing, transmit information rapidly without any delay and therefore improve communication, collaboration between supplier alliance member organisations and internal operations. The technology may help Indonesian manufacturing organisations improve their internal business process-related performance. The hypothesis below formally presents the discussion:

H_{5c}: There is a positive relationship between managerial use of information technology and internal business process-related performance of a manufacturing organisation.

4.2.5.4. Managerial use of Information Technology and Learning and Innovation Related-Performance.

As discussed in section 4.2.3.4, because of the development of technology and the increase in competition, product life cycle becomes short, and customers needs, tastes and demand change rapidly. Further, many customers are no longer satisfied with mass produced goods and they demand customization and on time delivery of innovative products (Andel, 2002). Manufacturers operating in such a market have to keep monitoring the changing market and accommodate the changes into their products and services. Besides, manufacturers have to innovate products that meet customers' demand, and also must be profitable (Patuwo and Hu, 1998; Vokurka et al, 1998). A manufacturing company is an innovator when it has a high frequency of new product launches, obtains new patents, and takes relatively short lead-time to market new products (Hoque and James, 2000). Manufacturers nowadays have challenges to introduce new products continuously.

To expedite innovation, today's manufacturing companies look for manufacturing automation having flexibility that allows the users of the automation to adjust the machine to produce other products (Blois, 1986). Besides the automation also improves efficiency as reduced labour costs, reduced defective products, standardised product quality, reduced manufacturing lead-time make the products profitable (Attaran, 1989; Hayes & Jaikumar, 1991, Sommers & Gupta, 1991; Poo, 1990). However automation alone, may not help a company to learn and innovate new products. It needs integration among departments within the organisation to support learning and innovation (Feraro et al, 1988). For example, production managers need information from marketing managers about market trends for the product, customers' demand and the price that customers are willing to pay. The information brings production and R&D departments together to design the product. Once the product design is finished and the prototype is accomplished, all the manufacturing information for the product must be sent to the accounting department for costing, profit margin and price calculation. If the margin is under the company's expectation, the accounting department sends the information back to the production and R&D departments, and asks for adjustment to the design. In the meantime, the marketing managers monitor the progress of the new product design. During product designing, other departments such as maintenance, purchasing and personnel get involved, as they have to settle the production infrastructure, such as machine adjustment, spare part and raw materials availability, and skilled labour availability. This process of learning and innovation is repeated for each new product and the process can take time to accomplish the design, production and launch the product (Hansen & Mowen, 1997).

However, previous research reveals that not all new products generate profit (Hollingum, 2000). Profit requires tight integration, collaboration and cooperation from all departments within an organisation. Internet helps companies to integrate and increase the collaboration and cooperation among the departments (Andersen, 2001). Using information technology, such as Internet and Intranet, departments are able to share and exchange information effectively (Tullo, 2000). For example, by using information technology, the R&D department is able to transmit the design, graphs and all other details of the design to other departments. Further, when R&D is designing the product, the marketing department can monitor whether the design, including the product's features, are aligned with potential customers' needs, tastes and demand. Meanwhile, purchasing departments can have access to information and find out what kind of materials will be needed for the new product and start a search for suppliers of the materials and spare parts (Haywood, 1999).

Using information technology, all meetings and discussions about learning and innovation processes explained above, can be held without all parties coming to the same place. Videoconferencing can help the process of meetings and discussion to be fast, cheap and effective. Without this information technology, new product developments can take more time and may not satisfy the customers' needs and tastes. As a consequence, new product development could be a waste of scarce resources (Andersen, 2001; Mollenauer, 1991).

The extant literature contains evidence on the success of information technology in improving learning and innovation of new products and processes. For example, Cummins Engine Co., one of the largest manufacturer of diesel engines, designs new products in about sixty different locations around the world and products are manufactured in about 30 locations. The company adopted manufacturing automation, including computer-aided design (CAD). There are 18 different CAD systems. However, because the company has 750 workstations and because every department tries to optimize its own capacity, separate product design units created difficulties in integrating the product design. There was no appropriate information network to facilitate sharing information. Frequently, decisions had to be made based on insufficient information, or a lot of time and energy had to be spent in recreating information, resulting in delays and performance shortcomings. To solve the problem, Cummins set up an information network and soon after that, Cummins improved its departments' integration and took advantage of business opportunities to improve its product innovation (Hollingum, 2000).

Managerial use of information technology improves integration, collaboration and cooperation internally within, and externally to, an organisation. Collaboration and cooperation with suppliers can help a company to expedite production of a new product if necessary, as collaboration with suppliers will keep the materials and spare parts available on time. As a result the company is able to market the new product rapidly and create opportunities for new markets and compete with its competitors. Researches of Business Trade & Technology Strategies service (1997) reports that a total of 30% of Internet users in the survey stated that Internet usage resulted in new business opportunities and 43% stated that it has increased productivity. Consider, for example, the case of information technology, such as Internet and Intranet usage by Rover. Rover has a tight competition with Mercedes and BMW, and therefore it has to continuously come up with new product designs. The pressure of automobile manufacturing is the large number of prototypes, which is a necessary step in conventional design to production. The production of Rover is 60-70% outsourced and there are about 90 suppliers supporting the production. To move up to a new market and to compete with its rivals, Rover has to have fast new product innovation and launch it quickly, before its rivals come up with their new products. Rover links its design engineering and production department, as well as its suppliers and marketing channels. In design state, Rover involves all department managers within the company, as well as suppliers and purchasing agents. Rover starts this new system for its product called Rover 75. To improve product quality and production speed, Rover implements robots for Rover 74 production. There are many robots used for manufacturing and using robots are not as simple as using manufacturing machines. There are about 169 robot tools and guns to be chosen for the right purposes. Since the use of robots are complicated, the production department is equipped with an Intranet tool library, from which robot tools and guns can be selected for use for particular purposes and locations. This library not only improves working speed and accuracy, but also improves the next product design process. All the processes of using tools and guns are recorded electronically by information technology, and the record can be used for the coming product's design. Rover overcomes many potential problems, before any prototypes are built, and saves a great amount of money. Besides, since the design and production of Rover 75 is carried out electronically, the parts of Rover 75 are fitted perfectly at all the attachment points (Hollingum, 2000).

Mike (2000) reports that Cisco links its product design to production floor, cost control, suppliers and customers. Steps from prototyping, design change, quality testing and execution become workflows in which information is shared with alliance partners to create the right design in a shorter time frame. The use of information technology increases speed of innovation and shortens time to market new products, through collaboration with suppliers and customers. Cisco finds that by sharing information through the use of information technology, time for each step, from prototyping to production, decreases by more than a week. Document packaging, which used to be done manually, taking two days, is assembled automatically in few minutes. The result is that the time to market new products decreases by 25% and generates US$100 million contribution to revenue. Cisco uses information technology to communicate with its suppliers and the technology helps Cisco share wealth of information (e.g., shop floor data, demand change, engineering system interlock and replenishment of inventory). The close link between Cisco and its suppliers provides efficiencies through cumulative learning, enabling Cisco to stay close to product development, as its major suppliers can quickly and effectively adjust their manufacturing capacity, based on demand volume for products.

The real life business examples discussed in this section are examples of the communication, integration and trust required by companies in today's Internet economy. Indonesia has transformed from an agriculture-based economy to an industry-based economy; now manufacturing companies form the backbone of Indonesia's export commodities. To compete with other countries (such as Vietnam, China, Thailand, India and Malaysia), Indonesian manufacturers have to keep renewing their products (Investment Coordination Board, 1999). Learning process is an important step in developing new products and competing with manufacturers from other countries. Managerial use of information technology may help Indonesian manufacturers to track and learn about new products and new technology by searching the Internet. Internet may also help Indonesian manufacturers to search the potential suppliers around the globe and link their operation with the suppliers. Further, Internet may also help the manufacturers to market their products faster and cheaper. With the use of information technology, the manufacturers may be able to offer their products on the web and give opportunities to the customers from any part of the world to learn about their products and place orders and pay for purchases electronically. Like Cummins Co; Rover, and Cisco, Intranet may also help Indonesian manufacturers link and share information with all the departments internal to the organisations and help managers to keep innovating their products. Hence, it is argued that the use of information technology by Indonesian manufacturing companies may help them improve their organisational learning and innovation-related performance. The hypothesis below formally presents the argument:

H_{5d}: There is a positive relationship between managerial use of information technology and learning and innovation-related performance of a manufacturing organisation.

4.3. Chapter Summary

This chapter presents the discussion on development of hypotheses (14 in total) for empirical tests. An extensive review of the relevant literature was conducted for this purpose. The discussion refers to the findings and suggestions of relevant previous research for development of each of the hypotheses. The next chapter presents the methodology used to conduct the study in the sample manufacturing organisations in Indonesia.

RESEARCH METHOD

5

5.0. Introduction

This chapter describes the research methods used in this study. Section 1 of the chapter presents the rationale for the questionnaire survey and personal interviews used in the study, followed by section two, describing the selection of the sample. Section three describes the managers who participated in the study, while section four explains the instruments used for measurement of the variables in the study. This section also presents the results of reliability and validity tests undertaken on each of the instruments. Section five describes the procedures followed for data collection. Finally, section six presents an overall summary of the chapter and introduces the next chapter.

5.1. Rationale for the Research Methods.

Following the concept of multi-method of research, this study collected the data using the questionnaire survey and personal interviews with business unit managers in the sample manufacturing organisations operating in Java Island, Indonesia. The reasons for using the multi-method of research (including the questionnaire survey method and personal interviews) in this study were as follows:

(a). The multi-method of research approach minimizes (if not eliminates) the survey method bias and enhances the validity of data collected (Page & Meyer, 2000). Consequently, this method builds the researcher's confidence in the results. Sometimes the questionnaire method does not (i) fully cover the issues underpinning the research or generate detailed answers to the questions, and (ii) provide detailed or in-depth information that helps correctly explain the results and make discussions informative.

(b). Through the discussion between the researcher and the selected respondents during personal interviews, the researcher can gain an understanding and first-hand knowledge of the elements or factors related to the research issues. Thus, the interview method complements the survey method that uses questionnaire.

5.2. Sample Selection

As the first step in data collection for the research, a list of the manufacturing organisations that operate in Java Island, Indonesia was obtained from Online Indonesian Data Centre of Industry and Trading Department 2000. Second, the companies in the list were ranked from the largest to the smallest using sales revenue and 1000 large companies were selected starting from the top of the list, having sales revenue from 25 billion Rupiah and above. From among the 1000 large companies, 450 companies were selected at random. Only large companies were selected because such companies have more resources to afford the investment in manufacturing automation and modern information technology. These companies represent the following industries:

Table 5.1: The Sample distribution

	Type of Industry	Number	Percentage
1	Adhesive	4	3.85%
2	Automotive and allied products	6	5.77%
3	Beverages	5	4.81%
4	Cement	5	4.81%
5	Chemical and allied products	6	5.77%
6	Electric and electronics equipment	4	3.85%
7	Fabricated metal products	7	6.73%
8	Food processing	6	5.77%
9	Furniture	6	5.77%
10	Garments	5	4.81%
11	Glass and applied products	4	3.85%
12	Herbal/ traditional medicine	5	4.81%
13	Home appliance	3	2.88%
14	Metal manufacture	4	3.85%
15	Paper and pulp	3	2.88%
16	Pharmaceutical	4	3.85%
17	Photographic equipment	4	3.85%
18	Plastic products	5	4.81%
19	Stone and clay products	5	4.81%
20	Textile products	7	6.73%
21	Tobacco manufacturers	6	5.77%
	Total	104	100%

A random sampling was chosen because Page & Meyer (2000) suggest that random sample is the best method of sample selection for its high level of accuracy and also for high validity of the results yielded by the sample. It also generates an effective sample size that is greater than the actual sample.

5.3. The Participants

Initially, a letter was written to the managing director (MD) or an equivalent senior executive of each of the selected companies in the sample. The letter explained the purpose of the study, asked the MD to nominate one general manager in charge of a business unit (henceforth, BU manager) to take part in the study and solicited the executives permission to contact the nominated BU managers. For purposes of this study, a business unit is defined as a profit centre, which carries out the usual business activities, including manufacturing and selling products (Mia, 2000). A sample of the questions used for the data collection was attached to the MDs' letter. Within four weeks of posting the letter, the MDs were contacted by telephone, asking if they would nominate their BU managers to participate. In total, 160 BU managers were nominated by 160 MDs, who supplied the BU managers' names and addresses. Subsequently, each of the nominated BU managers were sent a package that contained (i) a personal letter explaining the purpose of the study, the potential benefit of the study, and an assurance of confidentiality of their responses, (ii) a copy of the questionnaire and (iii) a self-addressed stamped envelope for returning the completed questionnaire direct to the researcher. The letter to the managers also explained that the questionnaire would not ask for any sensitive and current financial information and all the information collected would be treated as strictly confidential. Forty-four BU managers refused to participate in the study and 12 letters were returned without any explanation. In total, 113 responses were received, of which 104 questionnaires were fully completed. Thus, the final sample used for data analysis was 104. The response rate was 65% (104/160 times 100%).

Though the response rate was relatively low, the sample size was effective. Page & Meyer (2000) explain that the rule of thumb is at least four sample elements for every variable included in the study. The model of the current study includes four variables: (i) adoption of manufacturing automation, (ii) engagement in a strategic alliance, (iii) managerial use of information technology, and (iv)organisational performance. Even if we treat the four aspects of organisational performance (financial, customer, internal business process, and learning and innovation) as separate variables, the actual sample size is more than adequate, as per the above rule of thumb.

To acquire an in depth understanding of the effect adoption of manufacturing automation, engagement in a strategic alliance, and managerial use of information technology have on organisational performance, interviews were conducted with nine selected BU managers. These managers were selected at random from among the BU managers who completed and returned the questionnaire.

5. 4. Measurement of the Variables

Pre-established instruments were used to measure the variables. In some cases, some wording of the instruments were modified (adjusted) to suit the objective of the study and to make the instruments applicable to Indonesian environments. The questionnaire was presented to the respondents, both in English and in Bahasa Indonesia, for completion. A professional translator was used to check the translation of the questionnaire from English to Indonesian.

5.4.1. Pilot Testing of the Questionnaire

Three steps were undertaken in pilot testing each instrument in the questionnaire. First, the adapted English version of the questionnaire was checked by a group of ten academics in Australia to ensure that the instruments' original meaning and thrust of the measurement remained intact. The questionnaire was revised using the feedback obtained from the academics. Second, a group of 8 academics from three Indonesian universities, who were experienced in conducting research using questionnaire and knowledgeable in both English and Bahasa Indonesia, checked the questionnaire to ensure that the translated version of the questionnaire correctly mirrored its English version in meaning. Again, the questionnaire (translated version) was revised using the feedback from the eight academics. Finally, a pilot test of the revised questionnaire (both the English and Bahasa Indonesia version) involving 10 BU managers was carried out to ensure that the instruments measuring the variables were clear, comprehensive, and relevant. The final version of the questionnaire incorporated the managers' feedback/suggestions for improvements. The 10 managers who participated in the pilot test were not included in the sample of the study.

5.4.2. Reliability and Validity Test of the Measurement Instruments

The reliability and validity of measures are taken in this study to reflect the level of confidence in the results yielded by the measures. For purposes of this study, reliability of the instrument measuring a variable is defined as the consistency of the items in the instrument. Thus reliability addresses the extent to which the measure (or response) of a variable is dependable, or free of error (Banker & Potter, 1993). The reliability of all the instruments for this study has been assessed using the Cronbach (1951) alpha coefficient (Banker & Potter, 1993). Alpha coefficient ranges in value from 0 to 1 and may be used to describe the reliability of factors extracted from multi-point formatted questionnaires or scales (i.e., rating scale: 1 = poor or low, 5 = excellent or high). The higher the score, the more reliable the generated scale is. Nunnally and Bernstein (1994, p. 265) have indicated 0.7 to be an acceptable reliability coefficient for exploratory study. However, lower alpha coefficients sometimes are used in the literature.

The instruments measuring the variables in the study were evaluated for content validity and construct validity (Page & Meyer, 2000). An instrument's content validity is defined in terms of the extent to which its items for the investigated variable provide adequate coverage of the investigative questions (Cooper and Schindler, 2003; Page & Meyer, 2000). The content validity of the instruments for the current study is considered to have been fulfilled by using the pre-established instruments. Construct validity is concerned with how well the variables are selected and defined with regard to the construct being measured (Page & Meyer, 2000). The construct validity for all the variables in the current study has been assessed by factor analysis. An instrument is valid if the eigenvalue of the factors is greater than 1. Further if the items in the instrument loaded on a single factor with an eigenvalue greater than 1, it indicates that the instrument has a uni-dimensional character, (Page & Meyer, 2000). The greater the loading, the stronger is the validity of the measure for the variable concerned. Loadings in excess of 0.70 are considered excellent, 0.60 very good, 0.55 good, 0.45 fair, and 0.32 poor (Comrey & Lee, 1992). The results of the reliability and validity assessment for each of the variables in the current study are presented and discussed below.

5.4.3. Adoption of Manufacturing Automation.

As discussed earlier in chapter 3 of this thesis, manufacturing automation was defined following Jonsson (2000) as a computer-aided design (CAD), computer-aided manufacturing (CAM), computer-aided process planning (CAPP), Flexible Manufacturing System (FMS), and automated material handling (AMH) (see, also, Tonkay, 1990; Weiermair, 1990; Wyle, 2000). The extent of adoption of manufacturing automation was measured on a 5-point Likert scale ranging from low adoption to high adoption. On the scale, 1 represents low adoption and 5 represents high adoption. The instrument consisted of five items or questions referring to the extent to which the following computerised manufacturing system are used in the sample organisations. The participant BU managers were asked to respond to each of the five items (questions) by indicating the extent of adoption of computerized equipment in their company's production process. The instrument was adapted from Jonsson (2000) and had to go through each of the three steps of pilot testing discussed above. Kotha & Swamidass (2000) was followed to explain the meaning of each manufacturing automation technical term in the instrument. The participants in the study were asked to respond to each of the following questions:

Please indicate the extent to which the following production functions (activities) are computerised (automated) in your organisation:

1. Product Design (Computer Aided Design/CAD)
2. Product Manufacturing (Computer Aided Manufacturer/ CAM)
3. Process Planning (Computer Aided Process Planning/ CAPP)
4. Flexible Manufacturing System (FMS)
5. Automated Material Handling (AMH)

Appendix A, Section B presents the instrument. As mentioned earlier in this section, the instrument has been subjected to the reliability and validity test below. It can be observed from Table 5.2 that the Cronbach (1951) alpha coefficient for the instrument in the current study is 0.81 indicating a satisfactory reliability level for the instrument (Nunnally and Bernstein, 1994, p. 265).

Table 5.2: The Instrument Measuring the Extent of Adoption of Manufacturing Automation. Reliability Analysis – Scale Alpha Correlation Matrix

	CAD	**CAM**	**CAPP**	**FMS**	**AMH**
CAD	1.0000				
CAM	.1710	1.000			
CAPP	.2383	.6621	1.0000		
FMS	.2687	.5446	.5819	1.0000	
AMH	.2390	.5729	.5716	.7699	1.000

N of Cases = 103.0
Reliability Coefficients 5 items
Reliability coefficient - Alpha = .8111

The construct validity of the instrument has been assessed using factor analysis. The factor loadings for the items in the instrument, the eigenvalue, and the variance explained are presented in Table 5.3.

Table 5. 3: The Instrument Measuring the Extent of Adoption of Manufacturing Automation. Construct validity test: Component Matrix Factor Analysis

Product design (CAD)	0.634
Product manufacturing (CAM)	0.766
Process Planning (CAPP)	0.795
Flexible Manufacturing System (FMS)	0.848
Automated material handling	0.871

Extraction Method: Principal Component Analysis. 1 (one) component extracted. The eigenvalue = 3.097. Variance explained, 61.9 percent.

The orthogonal rotated factor analysis results reveal that all items in the instrument fall into one factor and the eigenvalue is greater than 1, which indicate that the instrument is uni-dimensional. The overall score for adoption of manufacturing automation has been computed by averaging the BU managers' response to each of the five items in the instrument. Table 5.4 presents the mean, standard deviation, theoretical range, and the actual range for the scores for the variable.

Table 5. 4: The Descriptive Statistics

Variable	Mean	Me-dian	Actual range		Theoretical range	
			Min	Max	Min	Max
Manufacturing automation	1.92	1.80	1	4	1	5
Strategic alliance	2.49	2.50	1	4	1	5
Information Technology	2.85	3.07	1.2	4.6	1	5
Financial Performance	3.0	3.00	1.5	4.25	1	5
Customer –Related Performance	3.4	3.50	1.75	4.5	1	5
Internal Business Process-Related Performance	2.9	3.00	1	4.75	1	5
Learning and innovation-Related Performance	3.0	3.00	1.8	4.4	1	5

5.4.4 Engagement in a Strategic Alliance

For the purposes of this study, strategic alliance is defined as a cooperative and mutual agreement between autonomous organisations with a view to improving competitive advantage and long-term profitable value for all the cooperating parties; nonetheless, the agreement may or may not involve cross-partner equity investments (Jarillo, 1988; James, 1985; Miles & Snow, 1986). The extent of engagement in a strategic alliance was measured on a 5-point Likert scale, ranging from strongly disagree (low alliance) to strongly agree (high alliance). On the scale, 1 represented low alliance and 5 represented high alliance. The instrument consisted of four items referring to the extent of agreement between the respondent manager's firm and its alliance member companies in developing, producing and marketing the products. The BU managers (respondents) were asked to respond to each of the four items (questions) indicating the extent to which their companies had a mutual agreement or business network with their company's allied partners. Following were the items in the instrument:

1. My company has entered into cooperation/agreements with other firms to produce the products.
2. My company collaborates with other firms to market the products.
3. My company's alliance partners provide my company support services (such as providing maintenance, training, administration and data processing, etc).
4. My company has established cooperative agreements with other firms and institutions for R&D.

Appendix A, Section C presents this instrument. The instrument was adapted from Bucklin and Sengupta (1993) and had to go through the three steps of pilot testing discussed above. This instrument also was used by Li & Atuhene-Gena (2001). Just like the instrument measuring adoption of manufacturing automation, the instrument measuring engagement in a strategic alliance has been subjected to the reliability and validity test below. It can be observed from Table 5.5 that the Cronbach (1951) alpha coefficient is 0.81, indicating a satisfactory reliability level for the instrument (Nunnally and Bernstein, 1994, p. 265).

Table 5. 5: The Instrument Measuring Engagement in a Strategic Alliance. Reliability analysis – Scale Alpha: Correlation Matrix

	Produce parts/ products	Market the products	Support services	R&D
Produce parts/ products	1.0000			
Market the products	.5481	1.0000		
Support services	.6154	.6227	1.0000	
R&D	.4258	.4243	.4747	1.0000

N of Cases = 101.0
Reliability Coefficients 4 items
Reliability coefficient - Alpha = .8113

An orthogonal rotated factor analysis of the items in the instrument for the study has been carried out to assess the instrument's construct validity. Results presented in Table 5.6 show that each of the four items in the instrument loads on a single factor, indicating that the measure is uni-dimensional. The factor loading, eigenvalue and the percentage of variance explained are presented in Table 5.6.

Table 5.6: The Instrument Measuring Engagement in a Strategic Alliance. Validity test: Component Matrix Factor Analysis

Produce parts/products	.815
Market the products	.817
Support services	.859
R& D	.703

Extraction Method: Principal Component Analysis.
1 component extracted, Eigenvalue = 2.56, percentage of variance explained = 64.

The results reveal that the instrument meets the criteria of reliability and validity. The overall score for engagement in a strategic alliance has been computed by averaging the BU managers' response to each of the four items in the instrument. Table 5.4 presents the mean, standard deviation, theoretical range, and the actual range of the scores for the variable.

5.4.5 Information Technology

This study focuses on managerial use of information technology, such as Intranet, Internet, and visual communication including videoconference, and net-meeting (Forouzan, 2001). Therefore, measurement of this variable involved the extent of managerial use of information technology such as Intranet, Internet, and visual communication (Andersen, 2001; Byrd et al, 2000; Reichert et al, 1998). The managerial use of information technology is for gathering, processing and sharing information among managers for decision- making.

The extent of managers' use of information technology was assessed on a 5-point Likert scale ranging from 1 (not at all) to 5 (always). The instrument consisted of five items referring to the extent of managers' use of information technology. The BU managers (respondents) were asked to respond to each of the five items (questions) indicating the extent to which managers within their business unit use information technology. Following are the five items in the instrument, that was adapted from Andersen (2001):

1. To what extent do managers in your organisation use electronic mail (by Intranet), to communicate with different people across the organisation?
2. To what extent do managers in your organisation access information and data from other parts of the organisation via the computer network (Intranet)?
3. To what extent do managers in your organisation use electronic mail (Intranet) to exchange information with manufacturing, engineering, and other functional areas?
4. To what extent do managers in your organisation use the Internet or similar external data networks to obtain work related information?
5. To what extent do managers in your organisation use the Internet or other data interface to communicate with customers, suppliers, and other parties?

Appendix A, Section D presents the instrument. The instrument was adapted from Andersen (2001) and had to go through the three steps of pilot testing discussed above. Similar to the measurement instruments for manufacturing automation and strategic alliance, the measurement instrument for information technology was subjected to a reliability and validity test as described below. Tables 5.7 and 5.8 present the results of Cronbach alpha reliability, and construct validity test of the instrument for the current study. It can be observed from Table 5.7 that the Cronbach (1951) alpha coefficient is 0.91 indicating a satisfactory reliability level for the instrument (Nunnally and Bernstein, 1994, p. 265). Similarly, the results presented in Table 5.8 reveal that each of the five items in the instrument loads on a single factor indicating a uni-dimensionality character of the instrument. The eigenvalue for the factor is 3.74, and it explains almost 75 percent of the variance.

Table 5.7: The Instrument Measuring Managers' Use of Information Technology. Reliability analysis – Scale Alpha Correlation Matrix

	Electronic mail	Electronic accessing info and data	Electronic exchange of information	Internet use for work.	Internet use for external parties
Electronic mail	1.000				
Electronic access of info and data	.7673	1.000			
Electronic exchange of information	.7565	.8373	1.000		
Internet usage for work.	.5105	.5598	.4197	1.000	
Internet usage for external parties	.7992	.8328	.8062	.4447	1.000

N of Cases = 103.0
Reliability Coefficients 5 items
Reliability coefficient - Alpha = .9116

Table 5.8: The Instrument Measuring Managers' Use of Information Technology. Validity Test: Component Matrix Factor Analysis

Electronic mail	.935
Electronic access to information and data	.901
Electronic exchange of information	.644
Internet use for work.	.915
Internet use for external parties	.897

Extraction method: Principal Component Analysis, One component extracted.
Eigenvalue = 3.742, variance explained = 74.80 percent.

The results above indicate that the instrument meets the criteria for reliability and validity. The overall score for the managers' use of information technology is computed by averaging the BU managers' response to each of the five items in the instrument. Table 5.4 presents the mean, standard deviation, theoretical range, and the actual range of the scores for the variable.

5.4.6 Organisational Performance.

Organisational performance, defined in this study as business unit performance, is measured following the balanced scorecard concept advocated by Kaplan and Norton (1992). The balanced scorecard concept advocates four perspectives of performance measures: financial, customer, learning and innovation, and internal business process. Appendix A, Section E presents the instrument measuring the performance. Similar to all other variables in the study as discussed above, the performance measurement scale also had to go through each of the three steps of pilot testing before it was used for data collection.

5.4.6.1. Financial performance

Following Kaplan and Norton (1996) and other researchers above, this study defines organisational (business unit's) financial performance in terms of return on investment (ROI), operating income and sales growth. ROI is measured as the net income before tax over total asset (Hansen & Mowen, 1997). Operating income of a business unit (or an organisation) is measured as the difference between the unit's net sales (total sales less returns) and operating expense (cost of goods sold less selling and administrative expenses) (Warren, et al 1996), while sales growth is measured in terms of the percentage increase in the organisation's current period's sales relative to its previous period's sales (Hansen & Mowen, 1997).

Respondents were asked to indicate on a 5-point Likert scale their BU's financial performance relative to their BU's competitor performance for the year prior to this study. On the scale, 1 represents below average and five represents above average. The BU's financial performance measure includes the following items:

1. Return on Investment (ROI)
2. Operating income.
3. Sales growth.

As mentioned earlier in this section, the instrument has been subjected to a reliability and validity test. It can be observed from Table 5.9 that the

Cronbach (1951) alpha coefficient is 0.6433 indicating a satisfactory reliability level for the instrument (Nunnally and Bernstein (1994, p. 265). Confirmatory factor analysis is used to test the validity of the instrument. Table 5.10 shows that all three items in the instrument are loaded on a single factor with the eigenvalue of 1.752 and explaining more than 58% of the variance in financial performance. These results show that the instrument meet the reliability and validity criteria.

Table 5.9: The Instrument Measuring Financial Performance.
Reliability analysis – Scale Alpha
Correlation Matrix

	ROI	**Operating income**	**Sales growth**
ROI	1.0000		
Operating income	.3641	1.0000	
Sales growth	.4197	.3424	1.0000

N of Cases = 101.
Reliability Coefficients 3 items.
Reliability coefficient - Alpha = 0.6433.

Table 5.10 The Instrument Measuring Financial Performance.Validity Test: Component matrix factor analysis

Sales growth	0.786
ROI	0.733
Operating income	0.773

Extraction Method: Principal Component Analysis
1 (one) component extracted
Eigen value = 1.752, explaining more than 58% of the variance in the BUs' financial performance.

The overall score for the financial performance is computed by averaging the BU managers' response to each of the three items in the instrument. Table 5.4 presents the mean, standard deviation, theoretical range, and the actual range of the scores for the variable.

5.4.6.2 Customer-Related Performance

In this study performance relating to the customer perspective is defined in terms of on-time delivery, number of customer complaints, market share, cycle time from order to delivery, customer response time, and warranty repair cost. Therefore the measurement instrument for this variable includes the following items :

1. On-time delivery of orders.
2. Number of customer complaints.
3. Market share,
4. Cycle time from order to delivery,
5. Customer response time
6. Warranty repair cost

The BU managers were asked to indicate, on the scale, their business unit's customer – related performance relative to that of the competitor. On the scale, 1 represents below average and five represents above average performance. Originally there were eight items in Hoque & James (2000) scale. They were: survey of customer satisfaction, number of customer complaints, market share, percentage of shipments returned due to poor quality, on-time delivery, warranty repair cost, customer response time and cycle time from order to delivery. The pilot study resulted in dropping two items from the scale as those two items were found by BU managers in the pilot test confusing and overlapping with the other items. Specifically, the BU managers suggested that the term "survey of customer satisfaction" was not clear to them because, logically, customer satisfaction was also the expression of the other seven items (number of customer complains; on time delivery, warranty repair, customer response time, etc). In addition, the managers also found the item "percent shipments returned due to poor quality" might be mixed with "warranty repair cost". Following the recommendation of the BU managers who participated in the pilot test, the items " percentage of shipment" and "survey of customer satisfaction" were removed from the scale.

As mentioned earlier in this section, the instrument has been subjected to a reliability and validity test. It can be observed from Table 5.11 that the Cronbach (1951) alpha coefficient for the instrument in this study is 0.82 indicating a satisfactory reliability level for the instrument (Nunnally and Bernstein (1994, p. 265). Table 5.12 shows that the confirmatory factor analysis of the data for validity test of the instrument in this study extracted a single factor with the eigenvalue of 3.205 and explaining more than 53% of the variance in the customer-related performance. These result shows that the instrument meet the reliability and validity criteria.

Table 5.11: The Instrument Measuring BU's Customer-Related Performance. Reliability analysis – Scale Alpha Correlation Matrix

	On time delivery	No. of customer complaints	Market share	Cycle time from order to delivery	Customer response time	Warranty repair cost
On time delivery	1.000					
No. of customer complaints	0.4231	1.000				
Market share	0.3329	0.4090	1.000			
Cycle time from order to delivery	0.2242	0.6276	0.6694	1.000		
Customer response time	0.5515	0.5872	0.5179	0.4197	1.000	
Warranty repair cost	0.3369	0.3896	0.3217	0.3300	0.3907	1.000

N of cases = 96.0
Reliability Coefficients 4 items
Reliability coefficient - Alpha = 0.8223

Table 5.12: The Instrument Measuring BU's Customer-Related Performance. Validity Test: Component Matrix Factor Analysis

On time delivery	0.638
Number of customer complaint	0.800
Market share	0.753
Cycle time from order to delivery	0.764
Customer response time	0.802
Warranty repair cost	0.605

Extraction Method: Principal Component Analysis
1 (one) component extracted
Eigenvalue = 3.205, percentage of variance explained = 53%.

The overall score for customer – related performance is computed by averaging the BU managers' response to each of the five items in the instrument. Table 5.4 presents the mean, standard deviation, theoretical range and the actual range of the scores for the variable.

5.4.6.3 Internal Business Process-Related Performance

Performance with respect to a BU's internal business process-related performance is defined and measured in terms of efficiency in using labour and material, ratio of good output to total output, materials scrap loss and manufacturing lead-time (see Hoque, 2000; Kaplan and Norton, 1992). The instrument measuring the variable was adapted from Hoque and James (2000) and the specific items consisting the instrument are:

1. Labor efficiency variance.
2. Material efficiency variance
3. Ratio of good output
4. Manufacturing lead time
5. Rate of material scrap loss

The BU managers were asked to respond to each of the above items on a 5-point Likert – scale. On the scale, 1 represents below average performance and 5 represents above average performance. Like all other measurement instruments in this study, this instrument also had to pass the three steps of pilot testing before it was used for the data collection.

The measurement instrument was also subjected to a reliability and validity test. It can be observed from Table 5.13 that the Cronbach (1951) alpha coefficient is 0.79 indicating a satisfactory reliability level for the instrument (Nunnally and Bernstein (1994, p. 265). The confirmatory factor analysis of the data for validity test of the instrument in this study extracted a single factor having the Eigenvalue of 2.722 and explaining more than 54% of the variance in the internal business process-related performance. The results presented in Table 5.14, therefore, reveal that it is a uni-dimensional instrument measuring the BUs' internal process-related performance in this study.

Table 5.13: The Instrument Measuring The BUs' Internal Process-Related Performance. Reliability Analysis – Scale Alpha. Correlation Matrix

	Labour efficiency variance	Ratio of good output	Manufacturing lead time	Material efficiency variance	Rate of material scrap loss
Labour efficiency variance	1.0000				
Ratio of good output	.5869	1.0000			
Manufacturing lead time	.5033	.4404	1.0000		
Material efficiency variance	.3359	.2369	.3853	1.0000	
Rate of material scrap loss	.5470	.3638	.2732	.6072	1.0000

N of cases = 103.0
Reliability Coefficients 5 items
Reliability coefficient - Alpha = .7891.

Table 5.14 : The Instrument Measuring the BUs' Internal Process-Related Performance. Validity Test: Component

Labour efficiency variance	.823
Ratio of good output	.714
Manufacturing lead time	.697
Material efficiency variance	.684
Rate of material scrap loss	.764

Extraction Method: Principal Component Analysis
1 (one) component extracted
Eigenvalue = 2.722, percentage of variance explained = 54%.

The results above show that the instrument meets the criteria for reliability and validity. The overall score for internal business process-related performance is computed by averaging the BU managers' response to each of the five items in the instrument. Table 5.4 presents the mean, standard deviation, theoretical range, and the actual range for the scores for the variable.

5.4.6.4 BUs' performance related to learning and innovation

For purposes of this study, a business unit's performance with respect to learning and innovation is defined in terms of: number of new product launches, number of new patents, and time to market new product (see Hoque, 2000; Kaplan and Norton, 1992). The BU managers were asked to respond to each of the three items on a 5-point Likert scale indicating their BU's learning and innovation – related performance in comparison to that of the competing firm(s). Just like all of the other measurement instruments in this study, this instrument also had to go through each of the three steps of pilot testing before it was used for the data collection.

As mentioned earlier in this section, the instrument was subjected to a reliability and validity test. It can be observed from Table 5.15 that the Cronbach (1951) alpha coefficient is 0.71 indicating a satisfactory reliability level for the instrument (Nunnally and Bernstein (1994, p. 265). The confirmatory factor analysis of the data for validity test of the instrument in this study has extracted a single factor having the eigenvalue of 1.90 and explaining more than 63% of the variance in the learning and innovation-related performance. The results presented in Table 5.16, therefore, reveal that it is a uni-dimensional instrument measuring the BUs' learning and innovation-related performance in this study.

Table 5.15: The Instrument Measuring BUs' Learning and Innovation-Related Performance. Reliability Analysis – Scale Alpha Correlation Matrix

	No. of new product launches	**No. of new patents**	**Time to market new product**
No. of new product launches	1.000		
No. of new patents	.6446	1.000	
Time to market new product	.3635	.3095	1.000

N of cases = 103.0
Reliability Coefficients 3 items
Cronbach Alpha = .71

Table 5.16 : The Instrument Measuring BUs' Learning and Innovation-Related Performance. Validity Test: Component Matrix Factor Analysis

No. of new product launches	.871
No. of new patents	.849
Time to market new product	.646

Extraction Method: Principal Component Analysis
1 (one) component extracted
The eigenvalue = 1.90 percentage of variance explained = 63%.

The results above show that the instrument meets the criteria for reliability and validity. The overall score for learning and innovation-related performance is computed by averaging the BU managers' response to each of the five items in the instrument. Table 5.4 presents the mean, standard deviation, theoretical range, and the actual range of the scores for the variable.

5.5. Chapter Summary

This chapter discusses the reliability and validity of the instruments used to measure the variables in the study. It has reported the results for alpha reliability coefficients computed for each of the different instruments. The chapter has also reported the results for factor analysis carried out on each of the measures. The results reveal that all of the measures are unidimensional and meet the criteria for reliability and validity. The next chapter explains the path analysis technique used to analyse the data for the study, explains data screening and presents the results.

DATA ANALYSIS AND THE RESULTS

6

6.0. Introduction

This chapter presents the data analysis procedure and the results. The technique of path analysis is used to analyse the data for the study. Section 6.1 provides an explanation for the path analysis technique. It also describes the advantages and limitations of the technique. Section 6.2 explains the assumptions underpinning the path analysis technique, including the assumptions for regression analysis; this is because path analysis is a form of regression analysis. The section then presents the results of testing each of the above-mentioned assumptions for the study. Section 6.3 presents the results of the data analysis for each of the hypotheses formulated in chapter 4 of the thesis. Following the presentation of the results, this section also provides an explanation for the results for each hypothesis. Section 6.4 presents the summary of the results obtained for each of the hypotheses tested. Finally, section 6.5 summarizes the chapter and briefly introduces the next chapter.

6.1. Data Analysis: The Path Analysis Technique.

As mentioned above, path analysis technique was used to analyse the data to test the hypothesised relationships between the variables in the model (Figure 6.0) of the study. The path analysis technique is a statistical

method for investigating direct and indirect relationships between an independent variable and a dependant variable in the model of a study. Alternative definitions for the technique are available in the relevant literature. Pedhazur (1982), for instance, explains path analysis as a method of studying patterns of relationships among variables. Asher (1976) defines path analysis as a technique for selecting those variables that are potential determinants of an effect or relationship, and then attempting to isolate the separate contributions to the effect made by each predictor variable. Again, Wrights (1934, p. 193) suggests that
"...the method of path coefficients is not intended to accomplish task of deducing causal relations from the values of the correlation coefficients. It is intended to combine the quantitative information given by the correlations with such qualitative information as may be at hand on causal relations to give a quantitative interpretation".

A major advantage of the path analysis technique is its capability of determining the direct and indirect aspects of a relationship between a predictor variable and an outcome variable in a research model (Asher 1976). As a pattern of interpretation, path analysis makes explicit the rationale for a set of regression calculations (Mia, 1984). Duncan (1966, p. 5), for instance, argues:

The great merit of the path scheme, then, is that it makes the assumptions explicit and tends to force the discussion to be at least internally consistent, so that mutually incompatible assumptions are not introduced surreptitiously into different parts of an argument.

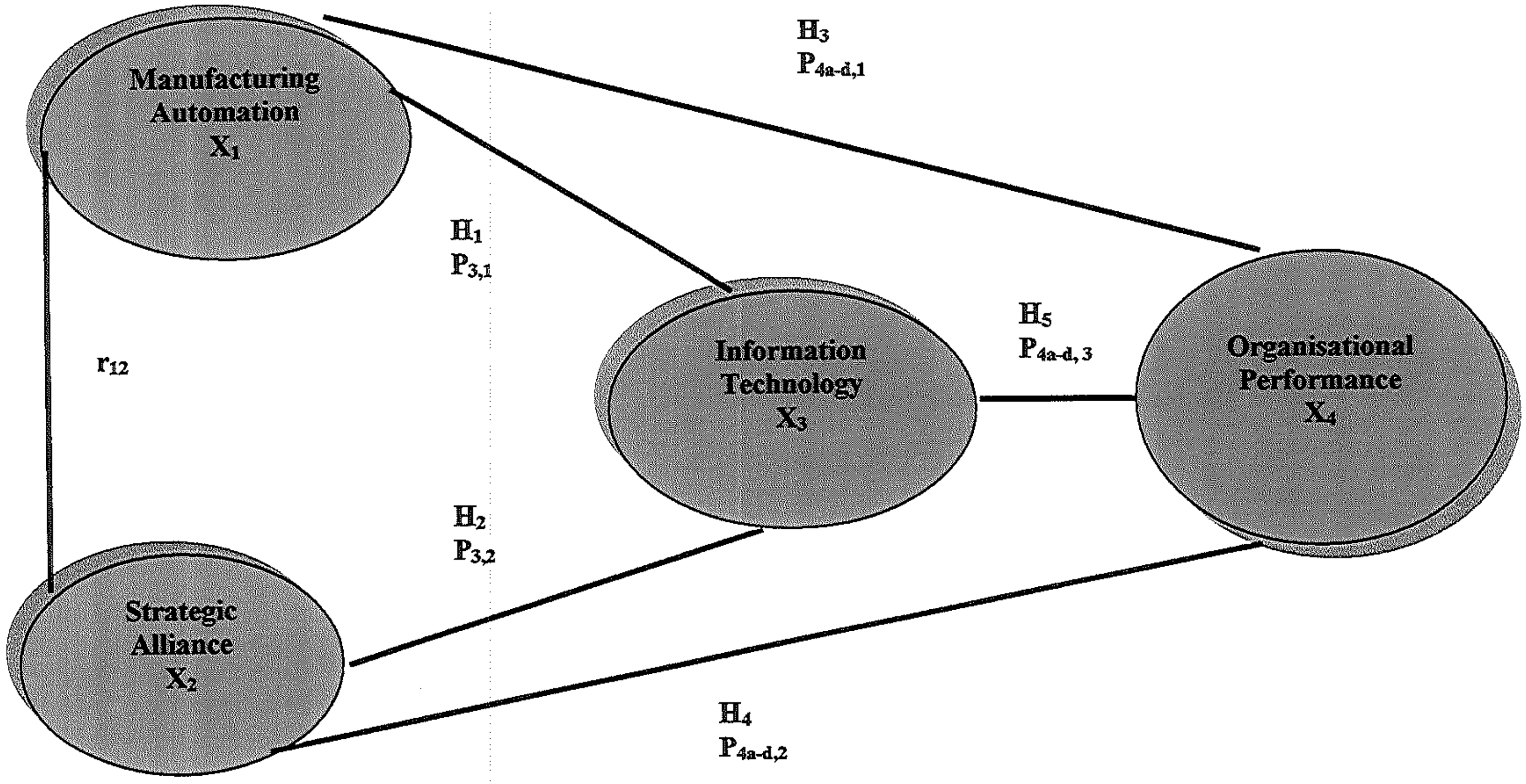
The method can also identify existence of the unanalysed aspect(s) as well as spurious aspect(s) of the relationship. The unanalysed aspect of a relationship exists due to correlated factors (causes), and the spurious aspect of the relationship exists due to common factors (causes) between the variables in the relationship (Pedhazur, 1982; Brownell, 1983; Mia, 1984). By evaluating the direct and indirect influences of the independent variable(s) in a relationship, the researcher can have a better understanding of the relationship between the independent variable(s) and the dependent variable(s). Path analysis technique also enables the correlation between any two variables to be decomposed into a sum of simple (direct) and compound (indirect) paths. Path diagram is a useful device to visualize graphically the pattern of the relationships among the variables in a model. However, the path analysis technique suffers from a particular limitation in that it does not account for the interaction effect (if any) of the exogenous or independent variables on the endogenous or dependent variables in the model. This limitation is highlighted in chapter 7 under the limitations section.

The path analysis technique is considered most suitable for analysing data for the current study as it aims to identify:

Direct effect of the exogenous variables (adoption of manufacturing automation, engagement in a strategic alliance, and managerial use of information technology) on a manufacturing firm's performance, and the indirect effect of manufacturing automation and a strategic alliance on the firm's performance via information technology.

A path model contains exogenous and endogenous variables. An exogenous variable in a path model is a variable whose variability is determined by factors or causes outside the model. Therefore, no effort is made to explain the variability of an exogenous variable or its relationship with other exogenous variable(s) in the model. On the other hand, an endogenous variable is one whose variation is explained by exogenous variables or other endogenous variables in the model (Pedhazur, 1982). For example, in Figure 6.0 (the model of the current study), X_1 and X_2 are the exogenous variables because no other variable(s) in the model accounts for variability in these variables. However, X_3 is an endogenous variable in the model as its variability is accounted for by the exogenous factors (X_1 and X_2). Furthermore, X_3 (the endogenous variable) joins the exogenous factors (X_1 and X_2) in explaining the variability in X_4, the ultimate dependent (endogenous) variable in the model.

Figure 6.0 The Model of the Study



An endogenous variable can be treated as dependent variable in one set of variables and it may also be conceived as an independent variable in relation to other set of variables in the model. In Figure 6.0, the model of the study, variable X_1 and X_2 are exogenous variables. Researchers do not attempt to find a relationship between exogenous variables (Pedhazur, 1982; Asher, 1976). However, X_3 and X_4 in the above model are endogenous variables. The path diagram shows that X_1 and X_2 are the independent (exogenous) variables influencing X_3 (the dependent or endogenous) variable, and then X_3 is taken as an independent variable along with the other two independent variables (X_1 and X_2) influencing the ultimate dependent (endogenous) variable (X_4) in the model. The correlation (r_{12}) between the exogenous variables (X_1 and X_2) in the model is depicted by a line, thus indicating the assumption that these variables are independent of each other, therefore the correlation (in this case, r_{12}) remains unanalyzed (Asher, 1976; Mia, 1984; Pedhazur, 1982).

Technically, path analysis is a conventional multiple regression technique (Pedhazur, 1982; Mia, 1984). The difference in this case is that, the multiple regressions (for path analysis) are carried out step- by -step following the numbers of the dependent variables in the model. For example, to test the model in Figure 6.0 above, multiple regressions will be run twice. First, the dependent variable (X_3) is regressed against the exogenous variables X_1 and X_2. Second, X_4 (the ultimate dependent variable in the model) is regressed against X_1, X_2 and X_3. In calculating the path coefficient, each endogenous (dependent) variable in a path model is represented by an equation consisting of the exogenous (independent) variables, which are assumed to explain variability in the dependent variable in the equation. And, the term 'residual' is used for the other variables that are not under consideration (i.e., not included in the equation) but are assumed to explain some variability in the dependent variable. In the model R_i ($_i$ = u and v) is used to term the residual variable. For each independent variable in the equation there is a path coefficient indicating the amount of expected change that occurs in the dependent variable as a result of a unit change in the independent variable. In the equation, X_i stands for the variables that are included in the equations (6.1) and (6.2) below and R_i stands for the exogenous variable(s), which are not included in the equation. The term P_{ij} represents a path coefficient or β (a standardized regression coefficient) where 'i' indicates the effect (on the dependent variable) and 'j' indicates the cause (the independent variable). The coefficient indicates the direct effect of an independent variable on a relevant (hypothesized) dependent variable in the model. For instance, in equation (6.1) below, the path coefficient P_{31} indicates the direct effect of the independent variable (X_1) on the dependent variable (X_3).

Equation (6.1) below is used to test hypotheses H_1 and H_2. Similarly, equation (6.2) is used to test hypotheses H_3, H_4, and H_5 in the model shown in Figure 6.0.

$$X_3 = P_{31}X_1 + P_{32} X_2 + P_{3u}R_u \qquad (6.1)$$

$$X_4 = P_{41}X_1 + P_{42} X_2 + P_{43} X_3 + P_{4v}R_v \qquad (6.2)$$

In equation (6.1) above, X_3 is the managerial use of information technology (the dependent variable), X_1 is the adoption of manufacturing automation and X_2 is the engagement in strategic alliance (both are the independent variables). In the equation, P_{31} is the direct effect (relationship) of X_1 on X_3 and P_{32} is the direct effect (relationship) of X_2 on X_3. Similarly, R_u in equation (6.1) stands for the unanalysed (residuals) effect on X_3 of the independent variables that are not included in the equation. Similarly, in equation (6.2), X_4 is the organisational performance (the ultimate dependent variable in the current study), X_1 is the adoption of manufacturing automation, X_2 is the engagement in strategic alliance, and X_3 is the managerial use of information technology (the independent variables). In the equation, P_{41} is the direct effect (relationship) of X_1 on X_3 and P_{42} is the direct effect (relationship) of X_2 on X_3. In this case, R_v stands for the unanalysed (residual) effect on X_4 of the independent variables not included in the equation.

Recall, since organisational performance in the current study is assessed following the balanced scorecard approach that includes four perspectives – (a) financial, (b) customer, (c) internal business process, and (d) learning and innovation. Equation (6.2) is presented in the following four separate equations; one for each of the above perspectives of organisational performance.

$$X_{4a} = P_{4a1} X_1 + P_{4a2} X_2 + + P_{4a3} X_3 + P_{4av} R_{av} \quad (6.21)$$

$$X_{4b} = P_{4b1} X_1 + P_{4b2} X_2 + + P_{4b3} X_3 + P_{4bv} R_{bv} \quad (6.22)$$

$$X_{4c} = P_{4c1} X_1 + P_{4c2} X_2 + + P_{4c3} X_3 + P_{4cv} R_{cv} \quad (6.23)$$

$$X_{4d} = P_{4d1} X_1 + P_{4d2} X_2 + + P_{4d3} X_3 + P_{4dv} R_{dv} \quad (6.24)$$

In the equations above, X_{4a} stands for financial performance, X_{4b} stands for customer-related performance, X_{4c} stands for internal business process-related performance, and X_{4d} stands for learning and innovation-related performance of an organisation. In the equation (6.21), P_{4a1}, P_{4a2}, and P_{4a3} are the path coefficients for the direct relationships between the financial performance (X_{4a}) and adoption of manufacturing automation (X_1), engagement in strategic alliance (X_2), and managerial use of information technology (X_3) respectively. The path coefficient (P_{4av}) is the unanalysed relationship between exogenous variables (R_{av}) not included in the model (the equation). In the equation (6.22), P_{4b1}, P_{4b2}, and P_{4b3} are the path coefficients for the direct relationships between the customer-related performance (X_{4b}) and adoption of manufacturing automation (X_1), engagement in strategic alliance (X_2), and managerial use of the information technology (X_3) respectively. The path coefficient (P_{4bv}) is the unanalysed relationship between exogenous variables (R_{bv}) not included in the model (the equation). In the equation (6.23), P_{4c1}, P_{4c2}, and P_{4c3} are the path coefficients for the direct relationships between the internal business process-related performance (X_{4c}) and adoption of manufacturing automation (X_1), engagement in strategic alliance (X_2), and managerial use of the information technology (X_3) respectively. The path coefficient (P_{4cv}) is the unanalysed relationship between exogenous variables (R_{cv}) not included in the model (the equation). Finally, in the equation (6.24), P_{4d1}, P_{4d2}, and P_{4d3} are the path coefficients for the direct relationships between the learning and innovation-related performance (X_{4d}) and adoption of manufacturing automation (X_1), engagement in strategic alliance (X_2), and managerial use of the information technology (X_3) respectively. The path coefficient (P_{4dv}) is the unanalysed relationship between exogenous variables (R_{dv}) not included in the model (the equation).

There are two techniques available for obtaining solutions to the P_{ij}s. Technique (1) is the instrumental variable procedures (Stokes, 1974), and technique (2) is partial multiple regression. Technique one requires multiplying equations by suitable instruments, taking expected values, and solving the equations. In a particular equation, suitable instruments are the explanatory variables, which are assumed to be uncorrelated with the residual variable for that equation (see, also Mia, 1984). In equation 6.1, for example, the suitable instruments are variables X_1 and X_2. Solutions to the two path coefficients in equation 6.1 above can be obtained as follows (see Pedhazur, 1982). For this purpose, first we need to decompose the correlation between X_1 and X_3 or (r_{13}), and between X_2 and X_3 or (r_{23}) in the above equation as shown below.

$X_3 = P_{31}X_1 + P_{32} X_2 + P3uRu$ (6. 1).

Multiplying the equation (6.1) by X_1 and assuming[3] that the variables are expressed in standard form, we get:

$X_1X_3 = P_{31}X_1 X_1 + P_{32} X_1X_2 + P_{3u}R_uX_1$ (6. 11).

Or, $r_{13} = P_{31} + P_{32}r_{12} + P_{3u}R_uX_1$ (6.12).

Or, $r_{13} = P_{31} + P_{32}r_{12}$ (6.13).

So, the correlation between X_1 and X_2 consists of (or is decomposed into) direct effect (P_{31}) and unanalysed effect[4] ($P_{32}r_{12}$).

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[3] For detailed discussion of this assumption underlying path analysis, see Pedhazur (1982, p.582).

[4] The effect ($P_{31}r_{12}$) is unanalysed as it includes the correlated cause (r_{12}). For detail discussion, see Pedhazur (1982, p.588).

Similarly, multiplying the equation (6.1) by X_2, we get:

$r_{23} = P_{31}\, r_{12} + P_{32} + P_{3u}R_uX_1$ (6.14).

Or, $r_{23} = P_{31}\, r_{12} + P_{32}$ (6.15).

So, again we find that the correlation between X_2 and X_3 consists of (or is decomposed into) direct effect (P_{32}) and an unanalyzed effect ($P_{31}r_{12}$).

We can decompose the correlation between X_1 and X_4 (i.e., r_{14}), X_2 and X_4 (i.e., r_{24}), and between X_3 and X_4 (i.e., r_{34}) in equation (6.2) following the same technique applied in equations (6.11 to 6.15) as presented below.

$X_4 = P_{41}X_1 + P_{42}\, X_2 + P_{43}\, X_3 + P_3vRv$ (6. 2).

Multiplying the equation (6.2) by X_1, we get:

$X_1X_4 = P_{41}X_1\, X_1 + P_{42}\, X_1X_2 + P_{43}\, X_1X_3 + P3_vR_vX_1$ (6. 21).

Or, $r_{14} = P_{41} + P_{42}r_{12} + P_{43}r_{13} + P_{3v}R_vX_1$ (6.22).

Or, $r_{14} = P_{41} + P_{42}r_{12} + P_{43}\,(P_{31} + P_{32}r_{12})$, substituting the value for (r_{13}) in equation (6.13) above (6.23).

Or, $r_{14} = P_{41} + P_{42}r_{12} + P_{43}P_{31} + P_{43}P_{32}r_{12}$ (6.24).

Therefore, we get r_{14} consisting of direct effect (P_{41}) plus indirect effect ($P_{43}P_{31}$), and unanalysed effect ($P_{42}r_{12} + P_{43}P_{32}r_{12}$).

Multiplying the equation (6.2) by X_2, we get:

$X_2X_4 = P_{41}X_1\, X_2 + P_{42}\, X_2X_2 + P_{43}\, X_2X_3 + P_{3v}R_vX_2$ (6. 21).

Or, $r_{24} = P_{41}r_{12} + P_{42} + P_{43}r_{23} + P_{3v}R_vX_2$ (6.22).

Or, $r_{24} = P_{42} + P_{41}r_{12} + P_{43}\,(P_{31}r_{12} + P_{32})$, substituting the value for (r_{23}) in equation (6.15) above (6.23).

Or, $r_{24} = P_{42} + P_{41}r_{12} + P_{43}P_{31}\, r_{12} + P_{43}P_{32}$ (6.24).

Therefore, we get r_{24} consisting of the direct effect (P_{42}) plus indirect effect ($P_{43}P_{32}$), and the unanalysed effect ($P_{41}r_{12} + P_{43}P_{31}r_{12}$).

Multiplying the equation (6.2) by X_3, we get:

$X_3X_4 = P_{41}X_1 X_3 + P_{42} X_2X_3 + P_{43} X_3X_3 + P_{3v}R_vX_3$ (6. 25).

Or, $r_{34} = P_{41}r_{13} + P_{42}r_{23} + P_{43} + P_{4v}R_vX_3$ (6.26).

Or, $r_{34} = P_{43} + P_{41}(P_{31} + P_{32}r_{12}) + P_{42} (P_{31}r_{12} + P_{32})$, substituting the value for (r_{13}) and (r_{23}) from equations (6.12) and (6.15) respectively (6.27).

Or, $r_{34} = P_{43} + P_{41}P_{31} + P_{41}P_{32}r_{12} + P_{42}P_{31} r_{12} + P_{42}P_{32}$ (6.28).

Therefore, we get r_{34} consisting of the direct effect (P_{43}) plus the spurious effects ($P_{31}P_{41}$), ($P_{42}P_{32}$), ($P_{41}P_{32}r_{12} + P_{42}P_{31}r_{12}$). The decompositions of the correlations (r_{14a}, r_{24a} and r_{34a}) are presented in Appendix B.

Also, using the substitution method (see Pedhazur, 1982, p.94), we get:

$P_{31} = (r_{13} - P_{32}r_{12})/ (1 - r^2_{13})$ (6.16), and

$P_{32} = (r_{23} - P_{31}r_{12})/ (1 - r^2_{13})$ (6.17).

Solution to the other path coefficients in the model can be obtained in a similar way (see Mia, 1984).

Using the same technique above, the solutions to the path coefficients in equation 6.2 can be obtained in a similar way).

Alternatively, the second technique (the partial multiple regression) can be used. This technique regresses an endogenous (dependent) variable only on those explanatory/ exogenous variables in the model that have a direct link with it (Mia, 1984; Pedhazur, 1982). Thus using the partial multiple regression technique, the equation for the model (Figure 6.0) can be written as:

$X_3 = \beta_{1.2}X_1 + \beta_{2.1}X_2 + P_{3u}R_u$ (6.18).

$X_4 = \beta_{1.23}X_1 + \beta_{2.31}X_2 + \beta_{3.12}X_3 + P_{4v}R_v$. (6.19).

And the residual path coefficients (P_{iks}) can be estimated as (see Mia, 1984):

$$P_{ik} = \sqrt{1 - R^2_e},$$

Where R^2_e is the squared multiple correlation coefficient of the equations (6.1) and (6.2). Thus,

$$P_{3u} = \sqrt{1 - R^2_u},$$

$$P_{3v} = \sqrt{1 - R^2_v},$$

Since exogenous variables are assumed to be dependent on variables not included in the model, and are therefore represented by a residual term only, it is assumed that the residuals in equations (6.1) and (6.2) are not correlated with the variables in the equation in which they appear, nor with any of the variables preceding it in the model (Pedhazur, 1982). Under such conditions, the solution for the path coefficient takes the form of ordinary least squares solutions for the *β's* (standardised regression coefficients)

As discussed above, the advantage of the path analysis techniques is an ability to find the direct and the indirect effect of exogenous variables on the endogenous variables in the model. The total effect (the effect coefficient, EC) on endogenous (dependent) variables in the model can be estimated as: $EC_i = (DE + IE)$, where EC_i is the total effect on the dependent variable i, DE is the direct effect, and IE is the indirect effect of the explanatory variables of that particular dependent variable (Pedhazur, 1982). For example, the total effect of adoption of manufacturing automation (X_1) and engagement in strategic alliance (X_2) on managerial use of the information technology (X_3) can be obtained from equations 6.13 and 6.15 on page 7 above.

The computation is as below:

$EC_3 = P_{31} + P_{32}$

The remainder of the effects (i e $P_{32}r_{12}$, and $P_{31}r_{12}$) in those equations, are left out as these terms include r_{12}, the unanalysed (UE) causes. The sum of direct effects (DE) and the indirect effects (IE) is EC, or the total effect (Pedhazur, 1982, p. 589). Using equations $EC_3 = P_{31} + P_{32}$, the total effect on the four perspectives of organisational performance ($X_{4a}, X_{4b}, X_{4c}, X_{4d}$) in the model can be computed as:

$EC_{4a} = P_{4a1}+P_{4a2}+P_{4a3}+P_{4a3}P_{31}+P_{4a3}P_{4a2}$, for financial performance.

$EC_{4b} = P_{4b1}+P_{4b2}+P_{4b3}+P_{4b3}P_{31}+P_{4b3}P_{4b2}$, For customer-related performance.

$EC_{4c} = P_{4c1}+P_{4c2}+P_{4c3}+P_{4c3}P_{31}+P_{4c3}P_{4c2}$, for internal business process-related performance.

$EC_{4c} = P_{4c1}+P_{4c2}+P_{4c3}+P_{4c3}P_{31}+P_{4c3}P_{4c2}$, for learning and innovation-related performance.

P_{41}; P_{42}; P_{43} are the direct effects of (X_1), (X_2) and (X_3) on (X_4) while $P_{43}P_{31}$ and $P_{43}P_{42}$ are the indirect effects of that relationship. As discussed earlier, the spurious effects and the unanalysed effects are not included in the calculation of EC_i above. By comparing the effect coefficient, it can be known which exogenous variable has more effect on the endogenous variable (Pedhazur, 1982).

6.2. The Assumptions of Path Analysis and Relevant Data Screening.

There are five assumptions that underlie the application of path analysis (Pedhazur, 1982). They are:

The relationships among the variables in the model are linear and additive. As a result curvilinear, multiplicative or interaction relationships are excluded from the analysis.

Each residual (e.g., P_{3u}, P_{3v} mentioned in the earlier section) is not correlated with the variables that precede it in the model. Thus for example in figure 6.0 it is assumed that (P_{3u}) is not correlated with variables x_1 and x_2, and (P_{3v}) is not correlated with X_1, X_2, and X_3. It can be implied that the residuals are not correlated among themselves or (P_{3u}) is not correlated with (P_{3v}).

There is one-way causal flow in the system, that is reciprocal causation between variables is ruled out.

The variables are measured on an interval scale.
The variables are measured without error.

Given the above assumptions and also because path analysis is technically the conventional multiple regression, the same assumptions that apply to multiple regression, also apply to the path analysis technique (Pedhazur, 1982). Coakes and Steed (2001) suggest four assumptions to be observed in regression analysis. These are:

First, the ratio of cases to independent variables (IVs);
Second, absence of outliers among the (IVs) and dependent variables (DVs);

Third, absence of multicollinearity and singularity among the (IVs);
Fourth, presence of normality, linearity, homoscedasticity, and independence of residuals of the variables in the model.

Since manual calculation for technique one (mentioned on page 6) may be fairly tedious, time consuming and prone to error, this study uses technique two (regression analysis). Before analysing the data, the following checks/tests were conducted to ensure that the data were suitable for regression analysis.

6.2.1. Ratio of Cases to Independent Variables.

Tabachnick & Fidel (2001) explain "that the cases to independent variables ratio has to be substantial or else the solution will be perfect and meaningless. With more IV's than cases, one can find a regression solution that completely predicts the DV for each case, but only as artefact of the cases-to-IV ratio". In other words, the sample size of a study should be large enough to satisfy the requirement. The required sample size for a study depends at least on an alpha level, and number of IVs. The simple rule of thumb is that the sample size for a multiple regression method of analysis is at least 50 + (8 times the number of IVs). This rule of thumb assumes that the alpha is 0.05 or lower. Coakes and Steed (2001) suggest that the minimum sample size for a standard regression analysis using SPSS is ideally five times the number of independent variables (IVs). The current study involves three independent variables: adoption of manufacturing automation (X_1), engagement in strategic alliance (X_2) and managerial use of the information technology ((X_3). Therefore, according to the simple rule of thumb discussed above, the sample size for the study should be 50 + (8 x 3) = 74 cases and 5 x 3 = 15 cases (according to Coakes and Steed, 2001). Since the actual sample size in the study is 104, the simple rule of thumb and Coakes and Steed's (2001) requirements are met.

6.2.2. Absence of Outliers Among the Independent Variables (IVs) and the Dependent Variables (DVs).

Tabachnick and Fidel (2001) reports that extreme cases (outliers) have an important impact on the regression solution, and also affect the precision of estimation of the regression weights, which ultimately lead to the wrong analysis. Screening for outliers can be performed through a residual analysis after an initial regression run. In the case of regression analysis, Tabachnick and Fidel (2001) suggest that the search for multivariate outliers should also be done. The regression analysis using SPSS detects the multivariate outliers by searching the leverage and or Mahalanobis distance; though Rousseenuw & van Zomeren (1990) indicate that these methods may not be reliable. However, alternative methods are computationally challenging and currently unavailable in a statistical package. Therefore, multivariate outliers are best detected through Mahalanobis distance (Tabachnik & Fidel, 2001, p.69). Tabachnick and Fidel (2001) explain that Mahalanobis distance can be evaluated for each case by using the critical Chi- square (x^2) value for leverage at alpha level (0.001). If the Mahalanobis distance is more than the critical (x^2) value, the outliers are assumed to be present.

For the current study, the relationships among adoption of manufacturing automation, engagement in a strategic alliance and managerial use of information technology (the IVs) and organisational performance (the DV), the Z score or the critical x^2 value (df 1; alpha 0.001) was found to be 10.828 (Tabachnick and Fidel, 2001, p. 933). The results of the analysis reveal that for the relationships among adoption of manufacturing automation, engagement in a strategic alliance and managerial use of information technology, the Mahalanobis distances were between 0.017-8.211, much smaller than the critical x^2 value. Therefore, the results reveal that there is no outlier in the relationships. Besides, for the relationships of the four aspects of organisational performance (financial, customer, internal business process and learning and innovation) with adoption of manufacturing automation, engagement in strategic alliance, and managerial use of the information technology, the z score (df 2; alpha 0.001) was 13.816. The results of the analysis reveal that the range of Mahalanobis distances are between 0.323 – 8.766, again much smaller than the critical x^2 value, indicating that there is no outlier in the relationships.

6.2.3. Absence of Multicollinearity and Singularity Among the Independent Variables.

Tabachnick & Fidel (2001) explain that multicollinearity and singularity among the IVs in a regression model are problems with correlation. Multicollinearity occurs when variables are too highly correlated (0.90 and above) while singularity occurs when variables are redundant or measures the same thing (i.e., one of the variables being measured is a combination of two or more of the other variables in the model). In a regression model, a bivariate correlation of 0.90 or above indicates the existence of redundant variables or multicollinearity in the model (Tabachnick & Fidel, 2001, p 83). Including redundant variable(s) in the same analysis (equation or model) will inflate the size of error terms, which actually weaken the analysis. Tabachnick & Fidel (2001) warn not to include the variables with bivariate correlation more than 0.70 in the same equation or model. SPSS has incorporated collinearity diagnostics proposed by Belsey, Kuh, and Welsch (1980) in which a conditioning index and Variance Proportions associated with each variable are produced. Condition index is a measure of tightness or dependency of one variable on the others. A high condition index is associated with variance inflation in the standard error of the parameter estimate for a variable. A collinearity problem occurs when the condition index is greater than 30 for a given dimension, coupled with at least two variance of proportions for individual variable is greater than 0.50. The collinearity of the data in this study is tested by using bivariate correlation matrix and collinearity diagnostic which is produced by SPSS. The results presented in the Table 6.1 to 6.3 indicate no evidence of multicollinearity problem among the variables in the model. There is no condition index approaching to 30 and no dimension (row) has more than one Variance Proportion greater than 0.50. The data is analyzed using ANOVA and multiple regression. SPSS 10.1 version is used to test the assumption of the regression.

Table 6.1: The Correlations Between Adoption of manufacturing automation and Engagement in strategic alliance Dependent variable: Information Technology

		Manufacturing automation	**Strategic alliance**
Manufacturing automation	Pearson Correlation Sig (2-tailed) N	1	
Strategic alliance	Pearson Correlation Sig (2-tailed) N	.288**	1

** Significant at the 0.01 level (2 tailed), n = 101.

The table presenting correlation matrix between adoption of manufacturing automation and engagement in a strategic alliance shows that there is no multicoleanirity between those two variables as the coefficient was only 0.288, which was much below 0.9.

Table 6.2: Multiollinearity diagnostic[a]

Variance proportion							
Mo-del	**Di-mension**	**Eigen-value**	**Condition index**	**Constant**	**Manufacturing automation**	**Strategic alliance**	**Information technology**
	1	3.738	1.000	0.01	0.01	0.01	0.01
	2	0.119	5.604	0.04	0.38	0.55	0.06
	3	0.80	6.838	0.60	0.30	0.42	0.07
	4	0.63	7.703	0.35	0.31	0.02	0.86

[a]Dependent variable: Financial performance.

Table 6.3 :
Correlation Matrix Between Adoption of Manufacturing Automation, Engagement in a Strategic Alliance and Managerial Use of Information Technology

		Manufacturing automation	**Strategic alliance**	**Information technology**
Manufacturing automation	Pearson Correlation Sig (2-tailed) N	1		
Strategic alliance	Pearson Correlation Sig (2- tailed) N	0.344**	1	
Information technology	Pearson Correlation Sig (2- tailed) N	0.564**	0.356**	1

** Correlation I significant at the 0.01 level (2-tailed).

The results presented in Table 6.3 indicate that the correlation between adoption of manufacturing automation and engagement in a strategic alliance is much below 0.9. Similarly the correlation between manufacturing automation and information technology, and between strategic alliance and information technology are also much below 0.9. Thus, there is no multicoleanirity between these three independent variables.

6.2.4. The Existence of Normality, Linearity, Homoscedasticity, and Independence of Residuals of the Variables.

6.2.4.1. Normality.

Normality of a variable is assessed by either statistical or graphical methods. The components of normality are skewness and kurtosis. Skewness has to do with the symmetry of the distribution; a skewed variable is a variable whose mean is not in the centre of the distribution. Kurtosis has to do with the peakness of a distribution; a distribution is either too peak or too flat. When a distribution is normal, the values of skewness and kurtosis are zero (Tabachnik & Fidel, 2001; Page & Meyer, 2000). If there is a positive skewness, there is a pileup of cases to the left and the right tail is too long. With a negative skewness, there is a pileup of cases to the right and the left tail is too long. Kurtosis values above zero indicate a distribution that is too peaked with a short tail and kurtosis values below zero indicate a distribution is too flat. However, in a large sample, a variable with significant skewness often does not deviate from normality to make a substantive difference in the analysis. In other words, with large samples, the significance level of skewness is not important, as well as the visual appearance of the distribution. Watermark, (1976, in Tabachnik & Fidel, 2001, p 74-75) suggests that underestimation of variance associated with positive kurtosis disappear with sample of 100 or more cases, while negative kurtosis will disappear with 200 or more cases. Tabachnick & Fidel (2001) also suggest that, though the conventional (0.01 or 0.001) alpha levels are used to evaluate the significance of skewness and kurtosis with small and moderate samples, if the sample is large, the standard error for both skewness and kurtosis decreases. Tabachnick and Fidel (2001, p. 67) explain that the normality can be seen from the standardised score of skewness and kurtosis. Standardised score is obtained from Skewness score divided by its standard error. If the standardized score is in excess of 3.29 ($p > 0.001$, two tailed test), there is a potential outlier and it may create the abnormality in the distribution. For this study, the results presented in Table 6.4 reveal that there is no standardized score more than 3.29 for any of the variables in the model. Therefore, the distributions of the cases based on standardized score are considered normal.

Table 6.4: Descriptive statistics

Variable	Mean	Median	Std . devi-ation	Skeweness	Std. Error of Skeweness	Kurtosis	Std. Error of kurtosis	Standardized score Skeweness	Standardized score Kurtosis
Manufacturing automation	1.92	1.80	0.90	0.64	0.24	-0.80	0.47	1.21	-2.67
Strategic alliance	2.49	2.50	1.08	0.19	0.24	0.48	4.00	0.80	0.12
Information technology	2.85	3.07	1.14	-0.03	0.23	-1.26	0.24	2.69	1.69
Financial performance	3.0	3.00	0.65	-0.71	0.23	0.47	3.25	-3.00	-1.08
Customer–related performance	3.4	3.50	0.60	-0.59	0.23	0.47	3.25	-2.49	-0.14
Internal business process-related performance	2.9	3.00	0.77	-0.55	0.23	0.47	3.75	-2.33	-1.60
Learning and innovation-related performance	3.0	3.00	0.67	0.19	0.23	0.47	3.00	0.81	0.16

No of cases : 104 cases.

In regression analysis, the test for normality of the distribution of a variable is performed by screening the residuals. The residual scatterplots (Coakes & Steed, 2001; Tabachnik & Fidel, 2001). Coakes & Steed (2001) explain that if the sample is from a normal distribution, then the cases in the normal P-P plot of regression standardized residual fall more or less in a straight line. It means that the differences between the obtained and predicted dependent variable scores are normally distributed. From the figure 6.1 to 6.5 it is evident that the assumptions of the normality are upheld. Since the residuals are normally distributed, it is not necessary to screen the individual variables for normality (Tabachnik & Fidel, 2001, p 77).

Figure 6.1: Normality Test for The Regression of Adoption of Manufacturing Automation, Engagement in a Strategic Alliance and Managerial Use of Information Technology

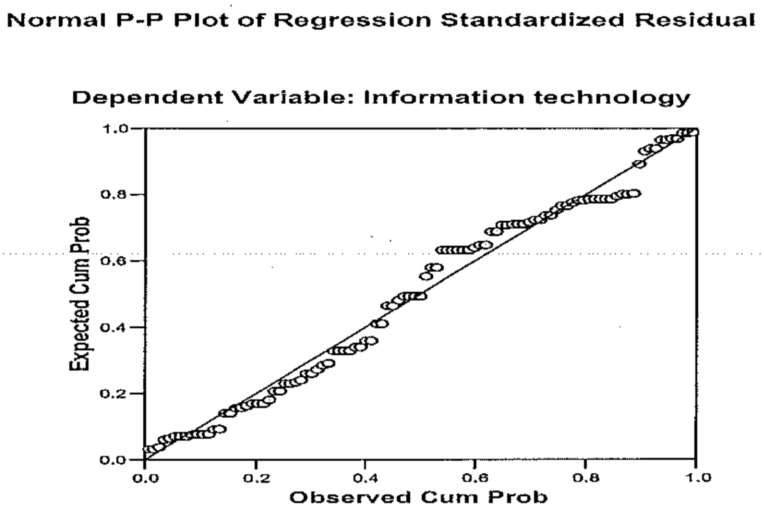


Figure 6.2: Normality Test for The Regression of Adoption of Manufacturing Automation, Engagement in a Strategic Alliance, Managerial Use of Information Technology, and Financial Performance

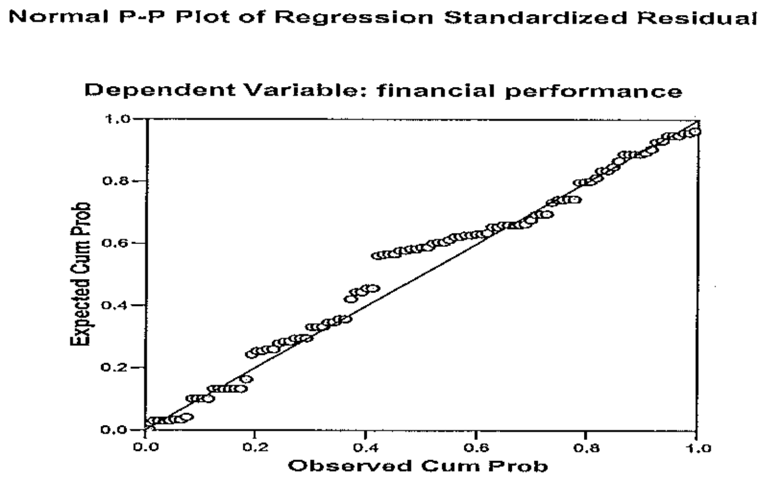


Figure 6.3: Normality Test for The Regression of Adoption of Manufacturing Automation, Engagement in a Strategic Alliance, Managerial Use of Information Technology, and Customer-Related Performance

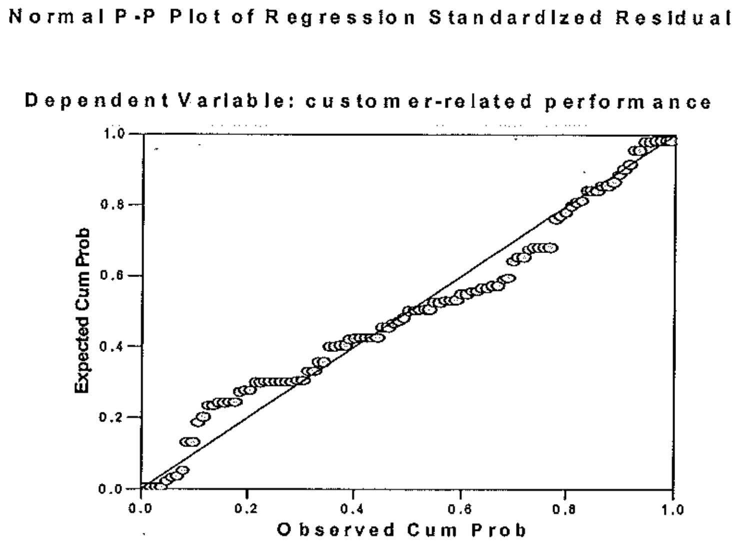


Figure 6.4: Normality Test for the Regression of Adoption of Manufacturing Automation, Engagement in a Strategic Alliance, Managerial Use of Information Technology, and Internal Business Process-Related Performance

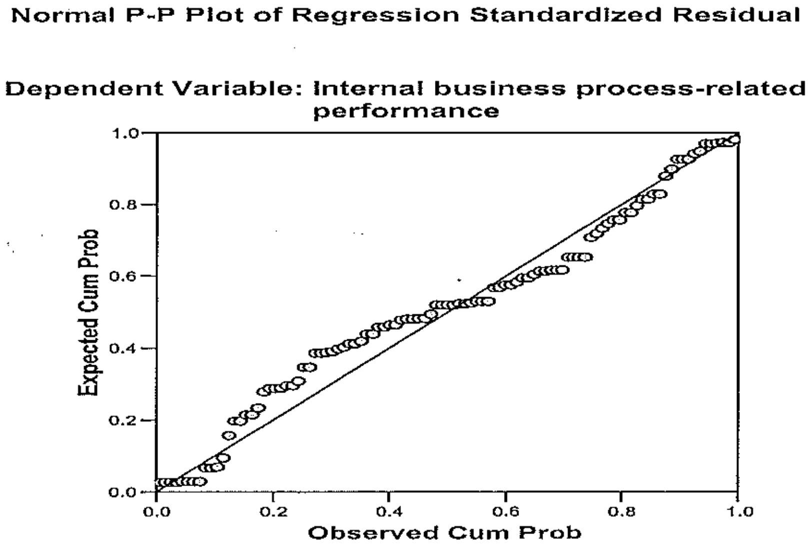
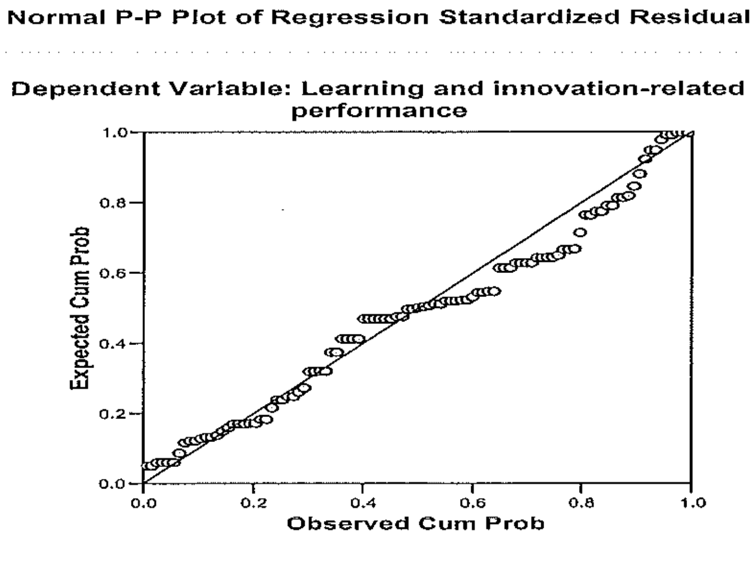


Figure 6.5: Normality Test for The Regression of Adoption of Manufacturing Automation, Engagement in a Strategic Alliance, Managerial Use of Information Technology and Learning and Innovation-Related Performance



6.2.4.2. Linearity

Coakes & Steed (2001) report that scatter diagram can be used to test the normality, linearity, homoscedasticity, and independence of residuals. The normality plot in figure 6.6 shows that the cases are relatively lined up along the diagonal, so it can be assumed that the residuals have a linear relationship with the predicted dependent variable scores, and that the variance of the residuals is the same for all predicted scores. From the residual scatterplots (Figure 6.6 to 6.10) it can be observed that there is no clear relationship between the residual and the predicted values. They are consistent with the assumption of linearity and the residuals are independent (Coakes & Steed, 2001, p. 172). Moreover, as homoscedasticity is related to the assumption of the normality, and since the assumption of normality of the data in this study is met, the relationships between variables can be assumed to be homoscedastic (Tabachnik & Fidel, 2001, p. 79)

Figure 6.6: Scatter Plot of Information Technology

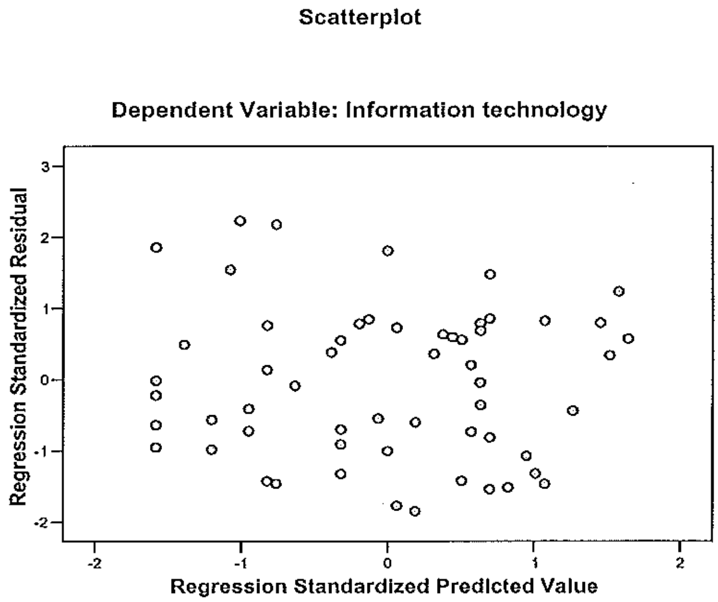


Figure 6.7: Scatter Plot of Financial Performance

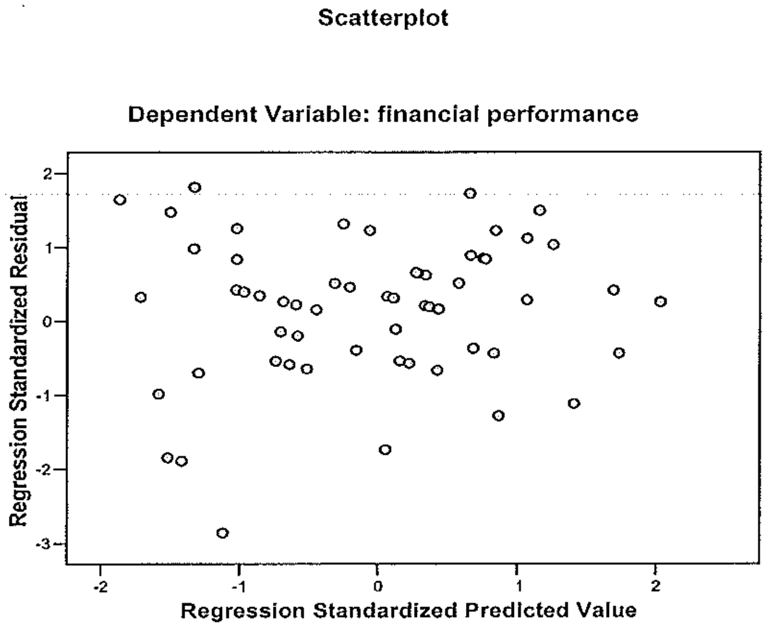


Figure 6.8: Scatter Plot of Customer-Related Performance

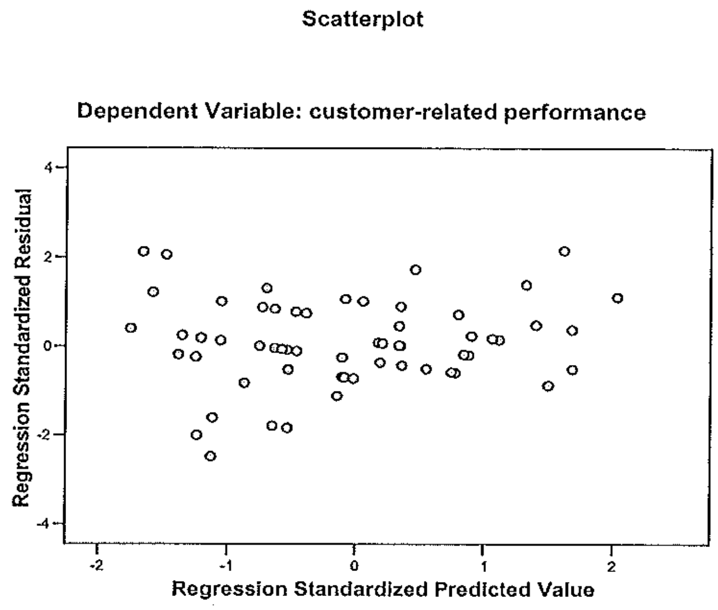


Figure 6.9: Scatter Plot of Internal Business Process-Related Performance

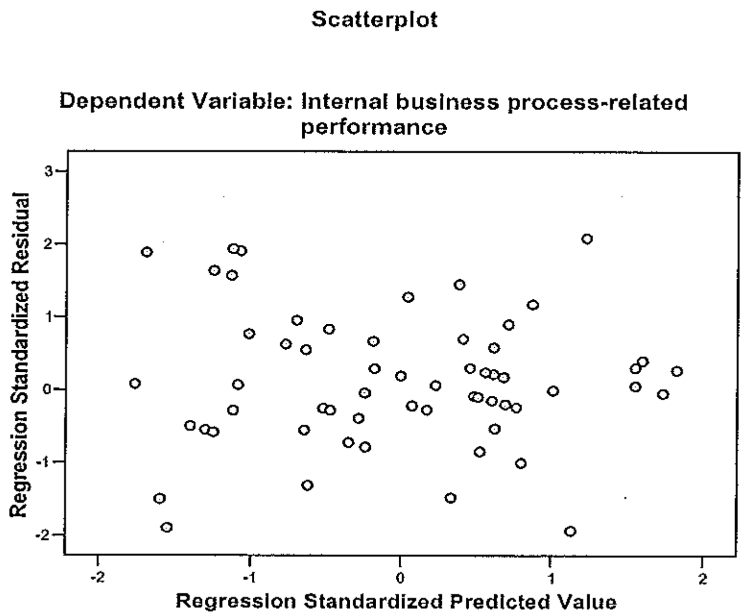
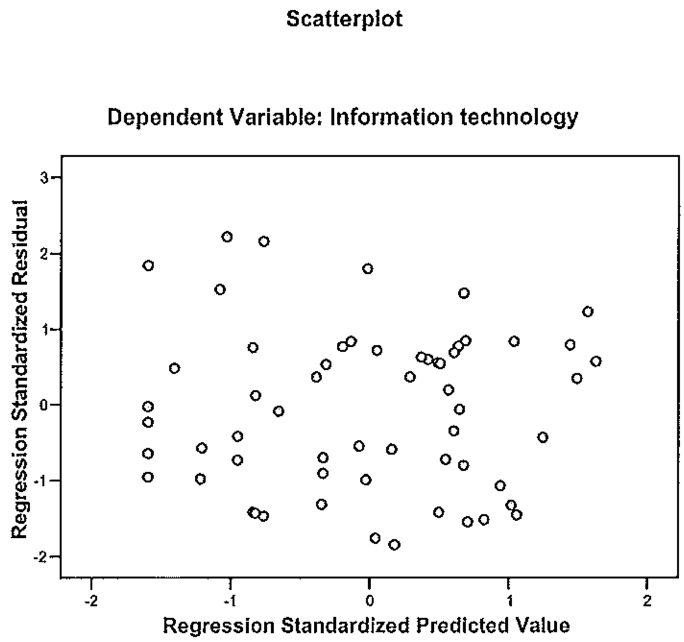


Figure 6.10: Scatter Plot of Learning and Innovation-Related Performance



6. 3. RESULTS

Table 6.5 below presents the mean, standard deviation, and measure of skewness and kurtosis obtained for the variables of interest in this research. Pearson product moment correlation among the variables (i.e., the results of a preliminary analysis of the data) are presented in Table 6.6 for each of the four perspectives of organisational performance – financial, customer, internal business process, and learning and innovation. The results reveal that the correlation between variables in the model of the study are far below 0.90 level, therefore, it is concluded that multicollinearity does not exist between any of the variables (see Tabachnic and Fidell, 2001).

Table 6.5. Descriptive Statistics for Variables in the Model

Variable	Mean	Median	Std . dev.	Skeweness	Kurtosis
Manufacturing automation	1.92	1.80	0.90	0.64	-0.80
Strategic alliance	2.49	2.50	1.08	0.19	0.48
Information technology	2.85	3.07	1.14	-0.03	-1.26
Financial performance	3.03	3.00	0.65	-0.71	0.47
Customer-related performance	3.42	3.50	0.60	-0.59	0.47
Internal business process – related performance	2.87	3.00	0.77	-0.55	0.47
Learning and innovation - performance	3.08	3.00	0.67	0.19	0.47

No of cases: 104 cases.

Table 6.6.: Pearson Correlations Between Variables in the Model

	Manufacturing Automation X_1	Strategic Alliance X_2	Information Technology X_3	Financial Performance X_{4a}	Customer – related Perf. X_{4b}	Int. process – related Perf. X_{4c}	Learning and Innov. – related Perf. X_{4dd}
Manufacturing automation (X_1)	1						
Strategic alliance (X_2)	.344** (0.001)	1					
Information technology (X_3)	0.564**	0.356**	1				
Financial performance (X_{4a})	0.285**	0.303**	0.381**	1			
Customer - related performance (X_{4b})	0.337**	0.074**	0.346**	0.485**	1		
Internal process related performance (X_{4c})	0.401**	0.358**	0.388**	0.465**	0.231**	1	
Learning and innovation related performance (X_{4d})	0.439**	0.227**	0.569**	0.617**	0.587**	0.286**	1

Number of cases: n=104. * = significant at $p<0.05$, and ** = $p<0.01$ (2-tailed).

6. 3. 1. The Relationships Between Adoption of Manufacturing Automation, Engagement in a Strategic Alliance and Managerial Use of Information Technology. Test of Hypotheses H_1 and H_2.

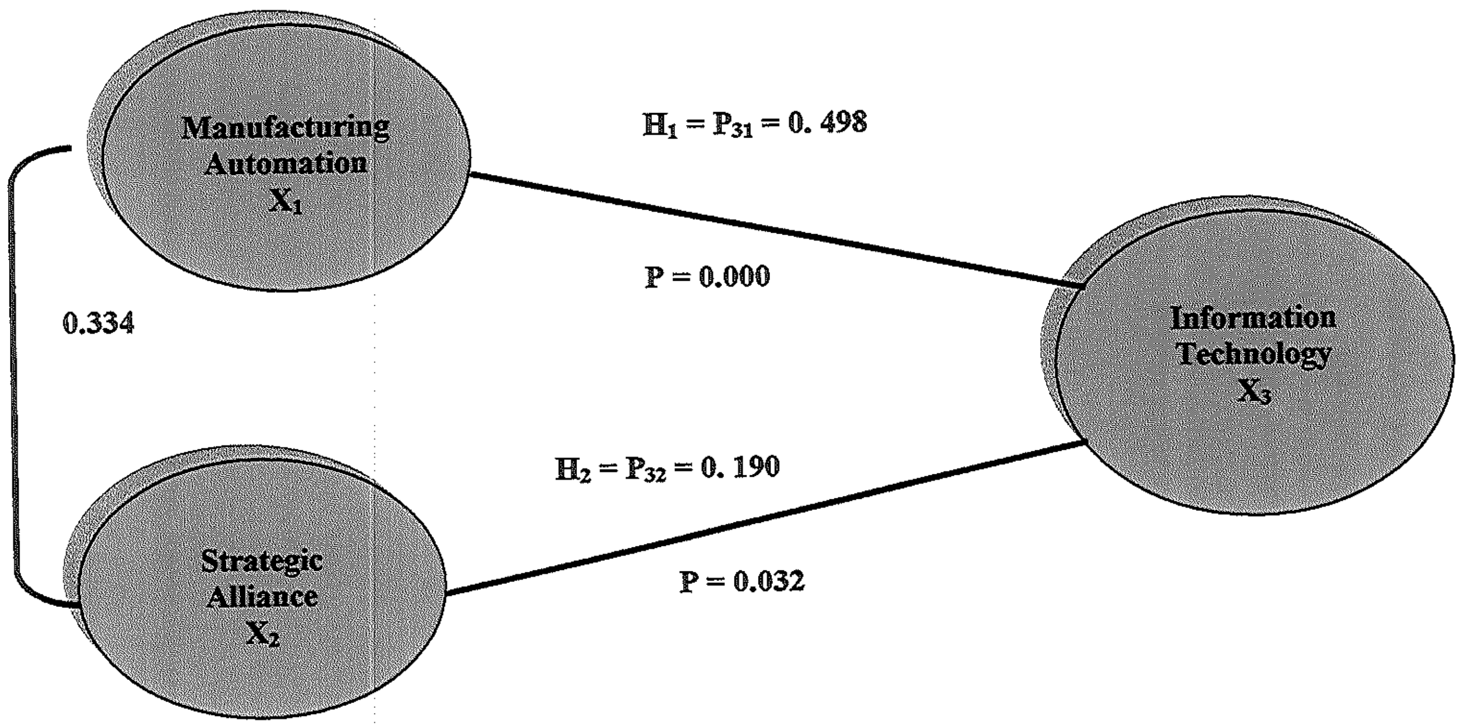
In sections 4.2.1. and 4.2.2 of chapter 4, the discussion of the relationships between a manufacturing firm's adoption of manufacturing automation (X_1), engagement in a strategic alliance (X_2), and managerial use of managerial use of the information technology (X_3) is summarised in hypotheses one (H_1) and two (H_2). Figure 6.11 graphically presents the relationships. Hypothesis H_1 predicts that there is a positive association between manufacturing firms' adoption of manufacturing automation and its managers' use of information technology. Similarly, hypothesis H_2 predicts that there is a positive relationship between manufacturing firms' engagement in a strategic alliance and its managerial use of information technology. The hypotheses are tested using equation (6.1) below.

$$X_3 = P_{31}X_1 + P_{32}X_2 + P_{3u}R_u \qquad (6.\ 1)$$

where

X_3 = Managerial Use of information technology (IT);
X_2 = Engagement in a strategic alliance;
X_1 = Adoption of manufacturing automation; and
R_u = Residual.

Figure 6.11: The Relationships Between Managers' Use of Information Technology (X_3), Engagement in a Strategic Alliance (X_2), and Adoption of Manufacturing Automation (X_1)



The results of the test are presented in Table 6.7. It can be observed from the table that both of the path (standardized regression) coefficients (P_{31}) and (P_{32}) are significant ($p<0.001$, and $p<0.032$ respectively) and positively indicate that, as the extent of a manufacturing firm's adoption of manufacturing automation and engagement in a strategic alliance increase, the managers' use of information technology also increases. The model explains 34.7% (adjusted $R^2 = 0.347$, $F_{(2, 97)} = 25.815$, $p < 0.001$) of the variance in the managers' use of information technology. The results reveal that as the extent of a manufacturing firm's adoption of manufacturing automation and engagement in a strategic alliance increase, managers in the firm tend to make a greater use of information technology. The results also reveal that though both adoption of manufacturing automation and engagement in a strategic alliance have significant and positive effect on managers' use of information technology, the magnitude of the path coefficients for adoption of manufacturing automation (P_{31}) and engagement in a strategic alliance (P_{32}) and their significance level (see Table 6.8) indicate that adoption of automation compared to engagement in a strategic alliance has a greater effect on the managers' use of information technology.

Table 6.7.: The Results of Regressing Managerial Use of Information Technology (X_3) Against Adoption of Manufacturing Automation (X_1) and Engagement in a Strategic Alliance (X_2). The Test of H_1 and H_2.

$$X_3 = P_{31}X_1 + P_{32} X_2 + P_{3u}R_u$$

Hypothesis	Path Coefficients	Explanatory variables	β	T-statistic	P <
H_1	P_{31}	Manufacturing automation (X_1)	0.498	5.725	0.001
H_2	P_{32}	Strategic alliance (X_2)	0.190	2.178	0.032

Adjusted R^2=0.347, $F_{(2,97)} = 25.815$, $p < 0.000$.
Dependent variable: managerial use of information technology .

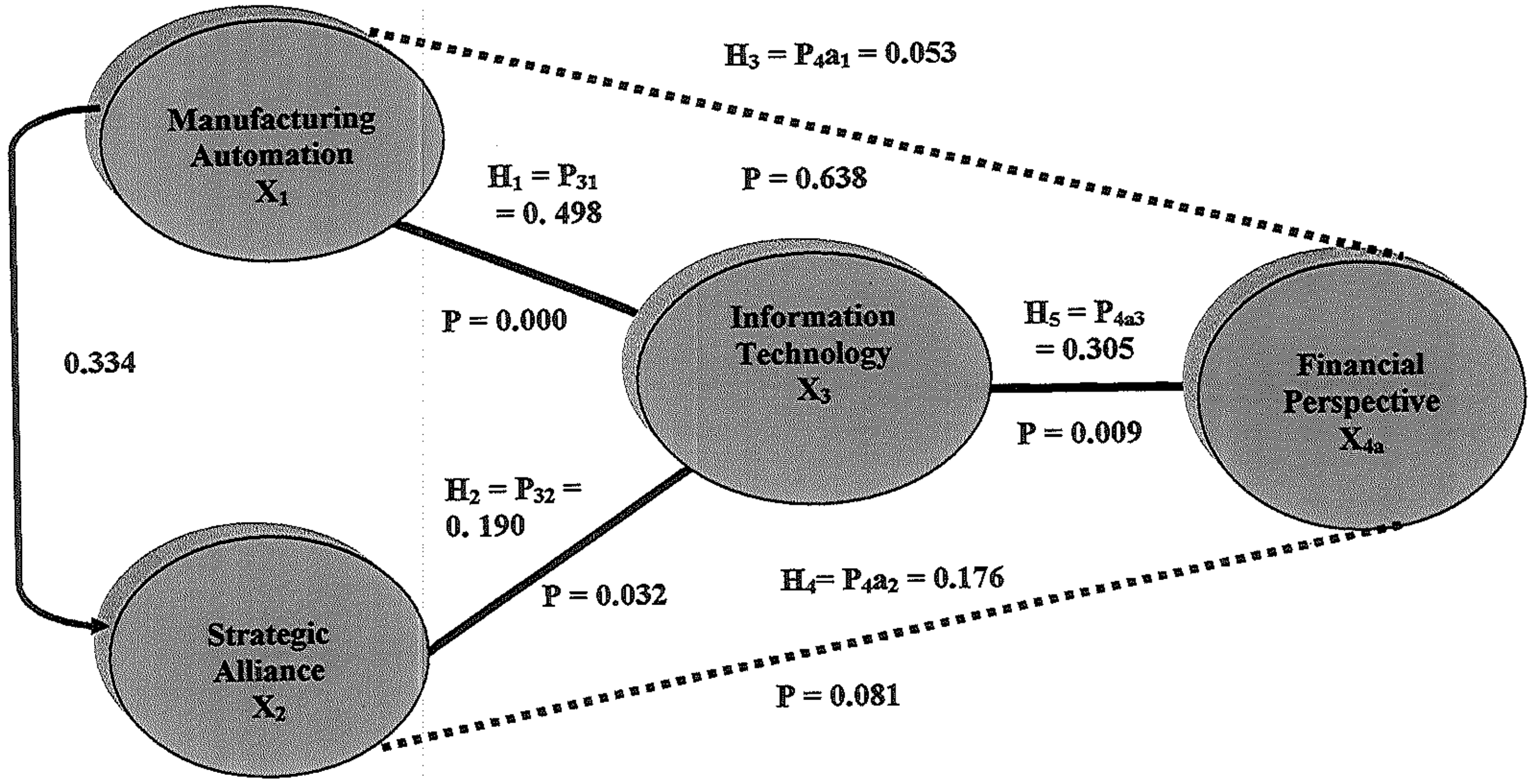
6. 3. 2. The Relationships Between Adoption of Manufacturing Automation, Engagement in a Strategic Alliance, Managers' Use of Information Technology and Organisational Performance. Test of Hypotheses H_3, H_4 and H_5.

Just like in the cases of hypotheses H_1 and H_2, sections 4.2.3. to 4.2.5 in chapter 4 contains the discussion on the relationships between adoption of manufacturing automation (X_1) and organisational performance (X_4), engagement in a strategic alliance (X_2) and organisational performance (X_4), and managerial use of information technology (X_3) and organisational performance (X_4), which are summarised in hypotheses (H_3, H_4, and H_5 respectively). However, as the current study investigates organisational performance with respect to four different perspectives – (a) financial, (b) customer, (c) internal business process, and (d) learning and innovation, the above relationships have been discussed separately for each perspective of the performance. To make it easier for the reader to follow, the discussion on the relationship of a particular predictor variable with a particular aspect of the performance is organised by the respective hypothesis as below.

6.3.2a. The Relationships Between Adoption of Manufacturing Automation, Engagement in a Strategic Alliance, Managers' Use of Information Technology and a Manufacturing Organisation's Financial Performance. Test of Hypotheses H_{3a}, H_{4a} and H_{5a}.

Hypothesis H_{3a} and H_{4a} summarize the discussion on the relationships between a manufacturing firm's adoption of manufacturing automation (X_1), engagement in a strategic alliance (X_2), and financial performance (X_{4a}) in the model. Similarly, hypothesis H_{5a} summarizes the discussion on the relationship between a manufacturing firm's manager's use of information technology (X_3) and financial performance (X_{4a}). These relationships can be observed in Figure 6.12.

Figure 6. 12. The Relationships Between Adoption of Manufacturing Automation (X_1), Engagement in a Strategic alliance (X_2), Managers' Use of Information Technology (X_3) and Financial Performance of a Manufacturing Firm (X_{4a}).



Hypotheses H_{3a}, H_{4a}, and H_{5a} predict that there is a positive relationship between a manufacturing firm's financial performance and its adoption of manufacturing automation, engagement in a strategic alliance, and managerial use of information technology respectively. The hypotheses are tested using the equation (6. 2) below.

$$\mathbf{X_{4a} = P_{4a1}X_1 + P_{4a2}\,X_2 + P_{4a3}\,X_3 + P_{4v}R_v} \qquad (6.\,2.)$$

where

X_{4a} = Financial performance of a manufacturing firm;

X_3 = Managerial use of information technology;

X_2 = Engagement in a strategic alliance;

X_1 = Adoption of manufacturing automation; and

R_v = Residual.

The results presented in Table 6.8 reveal that the effect of managerial use of information technology on a manufacturing firm's financial performance is significant ($P_{4a3} = 0.305 = p < 0.01$) and positive, indicating that the managers' increasing use of information technology is positively associated with improved financial performance of the firm. Bartol (1983) suggests that a path coefficient of the magnitude of 0.06 or greater is meaningful. Following Bartol's (1983) criterion, the relationship ($P_{4a2} = 0.176$) between engagement in a strategic alliance (X_2) and financial performance (X_{4a}) is considered meaningful and significant ($p < 0.08$), although it is lower than the conventional level. Note, the model accounts for 19% (adjusted $R^2 = 0.19$, $F_{(3,96)}$, = 7.484, p<0 001) of the variance in financial performance. These results support hypothesis H_{5a} and hypothesis H_{4a}. However, the effect (P_{4a1}) of adoption of manufacturing automation (X_1) on financial performance (X_{4a}) is not significant, therefore, hypotheses H_{3a} is not supported.

Table 6. 8.: The Results of Regressing a Manufacturing Firm's Financial Performance (X_{4a}) Against Managerial Use of Information Technology (X_3), Engagement in a Strategic Alliance (X_2), and Adoption of Manufacturing Automation (X_1). The Test of H_{3a}, H_{4a}, and H_{5a}.

$$X_{4a} = P_{4a1}X_1 + P_{4a2} X_2 + P_{4a3} X_3 + P_{4va}R_v$$

Hypo-thesis	Path Coefficient	Explanatory variables	B	T-statistic	P
H_{3a}	P_{4a1}	Manufacturing Automation (X_1)	.053	0.472	0.638
H_{4a}	P_{4a2}	Strategic Alliance (X_2)	.176	1.764	0.081
H_{5a}	P_{4a3}	Information Technology (X_3)	0.305	2.680	0.009

Adjusted R^2=0.190, F (3,96) = 7.484, $p < 0.001$
Dependent Variable: Financial Performance.

Using the above results, the total effects of adoption of manufacturing automation, engagement in a strategic alliance and managerial use of information technology on financial performance can be computed as below (for further discussion, see Pedhazur, 1982):

The total effect of adoption of manufacturing automation (X_1) on financial performance (X_{4a}).

The indirect effect through managerial use of information technology

$= P_{31} * P_{4a3}$	= 0.498*0305 =	0.152
The direct effect	$= P_{4a1}$	<u>0.053</u>
Total effect	$= P_{4a1} + (P_{31} * P_{4a3}) =$	0.205

The total effect of engagement in a strategic alliance (X_2) on financial performance (X_{4a}).

The indirect effect through managerial use of information technology

$= P_{32} * P_{4a3}$	= 0.19*0.305 =	0.060
The direct effect	$= P_{4a1}$	<u>0.180</u>
Total effect	$= P_{4a1} + (P_{31} * P_{4a3}) =$	0.240

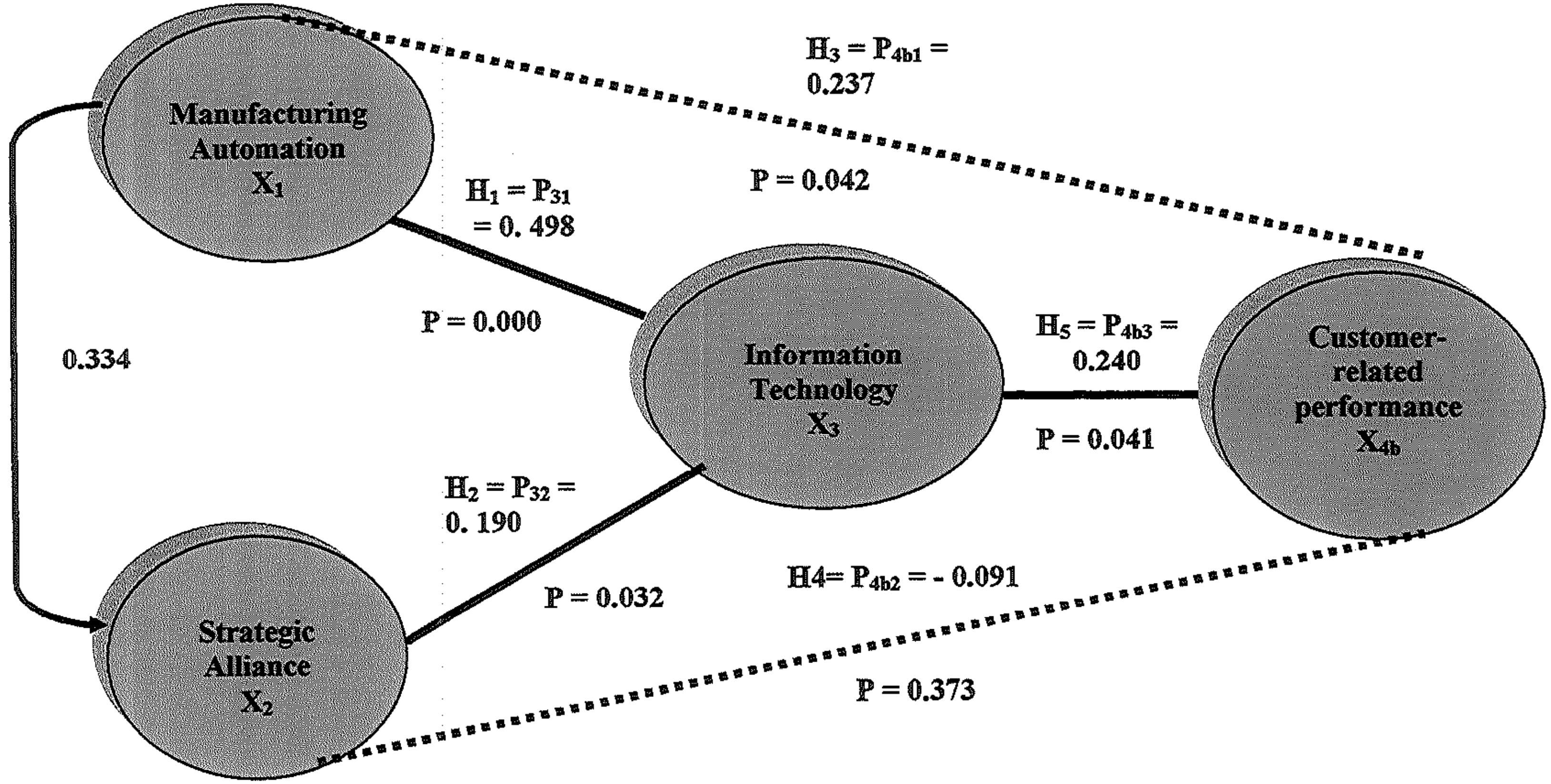
The results indicate that although the direct effect (P_{4a1}) of adoption of manufacturing automation on financial performance (X_{4a}) is not significant, it has a relatively strong indirect effect (0.152) on the organisations' financial performance (X_{4a}). The indirect effect (via managerial use of information technology is, indeed, greater than that of engagement in a strategic alliance (X_2).

These results also indicate that engagement in a strategic alliance (X_2) has a relatively strong direct effect (P_{4a2}=0.176) on financial performance and its indirect effect (0.06) is meaningful also (Bartol, 1983).

6. 3. 2b. The Relationships Between Adoption of Manufacturing Automation, Engagement in a Strategic Alliance, Managers' Use of Information Technology and a Manufacturing Organisation's Customer-Related Performance. Test of Hypotheses H_{3b}, H_{4b} and H_{5b}.

Hypothesis H_{3b}, H_{4b} and H_{5b} summarize the discussion in chapter 4 on the relationships between a manufacturing organisation's adoption of manufacturing automation (X_1), engagement in a strategic alliance (X_2) and managerial use of information technology (X_3) and its customer-related performance (X_{4b}). These relationships can be observed in Figure 6.13. Hypotheses H_{3b}, H_{4b}, and H_{5b} predict that there is a positive relationship between a manufacturing organisation's customer-related performance (X_{4b}) and the extent of its adoption of manufacturing automation (X_1), engagement in a strategic alliance (X_2), and managerial use of information technology (X_3) respectively.

Figure 6.13. The Relationships Between Adoption of Manufacturing Automation (X_1), Engagement in a Strategic Alliance (X_2), Managers' Use of Information Technology (X_3) and Customer-Related Performance of a Manufacturing Organisation (X_{4b}).



The hypotheses are tested using the equation below:

$$\mathbf{X_{4b} = P_{4b1}X_1 + P_{4b2}\,X_2 + P_{4b3}\,X_3 + P_{4vb}R_v} \qquad \mathbf{(6.\,3).}$$

where

X_{4b} = Customer-related performance of a manufacturing organisation;

X_3 = Managerial use of information technology;

X_2 = Engagement in a strategic alliance;

X_1 = Adoption of manufacturing automation; and

R_v = Residual.

The results presented in Table 6. 9 reveal that the effect ($P_{4b3} = 0.240$) of managerial use of information technology (X_3) is significant, ($p < 0.04$) and positive, indicating that the managers' use of information technology is positively associated with manufacturing organisations' customer-related performance ($\mathbf{X_{4b}}$). Similarly, the effect ($P_{4b1} = 0.240$) of adoption of manufacturing automation (X_1) on the customer-related performance (X_{4b}) is significant ($p<0.\ 04$) and positive, therefore, indicating that increasing automation improves a manufacturing firm's customer-related performance. The effect ($P_{4b2} = -\ 0.09$) of engagement in a strategic alliance (X_2) is not significant, but meaningful (Bartol, 1983). These results support hypotheses H_{3b} and H_{5b}, but not H_{4b}. The model accounts for 15.6% (adjusted $R^2 = 0.156$, $F_{(3,96)}, = 5.935$, $p< 001$) of the variance in the customer-related performance.

Table 6.9: The Results of Regressing a Manufacturing Firm's Customer-Related Performance (X_{4b}) Against Managerial Use of Information Technology (X_3), Engagement in a Strategic Alliance (X_2) and Adoption of Manufacturing Automation (X_1). The Test of H_{3b}, H_{4b}, and H_{5b}.

$$X_{4b} = P_{4b1}X_1 + P_{4b2}X_2 + P_{4b3}X_3 + P_{4vb}R_v$$

Hypo thesis	**Path Coefficient**	**Explanatory variables**	***B***	**T-statistic**	***P***
$H3_b$	$P_{4b\,1}$	Manufacturing automation (X_1)	0.237	2.064	0.042
$H5_b$	P_{4b3}	Information technology (X_3)	0.240	2.071	0.041
$H4_b$	P_{4b2}	Strategic alliance (X_2)	- 0.091	-0.895	0.373

Adjusted R^2=0.156, F (3,96) = 5.935, p <= 0.001
Dependent Variable: Customer-related performance (X_{4b}).

Using the results, the total effect of adoption of manufacturing automation (X_1) on customer-related performance can be computed as:

The indirect effect through managerial use of information technology.

$= P_{31} * P_{4b3}$	= 0.498*0.24 =	0.120
The direct effect	$= P_{4b1} =$	<u>0.370</u>
Total effect	$= P_{4b1} + (P_{31} * P_{4b3}) =$	0.357

Similarly, the total effect of engagement in a strategic alliance on customer-related performance is:

The indirect effect through managerial use of information technology

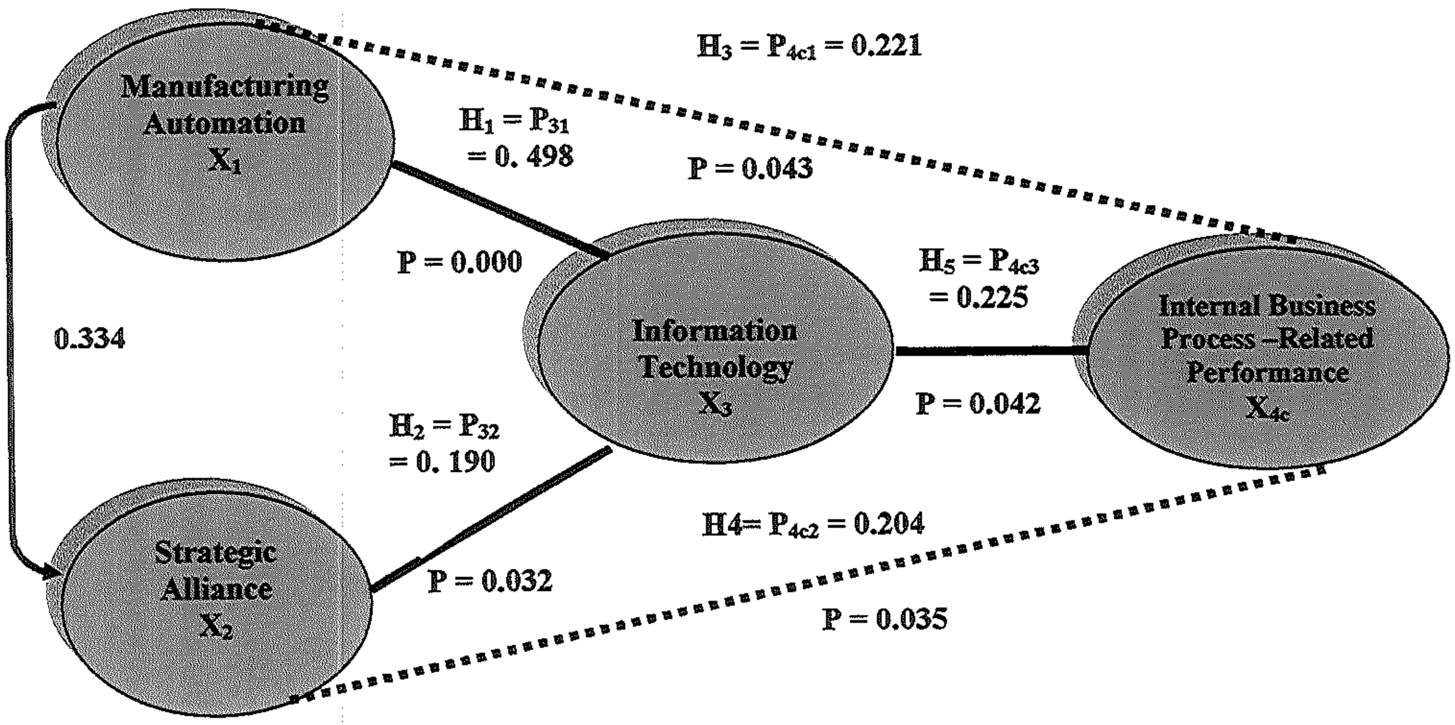
$= P_{32} * P_{4b3}$	= 0.190*-0 24=	0.045
The direct effect	$= P_{4b2}$	-0.091
Total effect	$= P_{4b2} + (P_{32} * P_{4b3}) =$	-0.046

The total effect, as calculated above, reveals that a manufacturing firm's engagement in strategic alliance (just like adoption of manufacturing automation) is directly and indirectly associated with the firm's customer–related performance.

6. 3. 2c.The Relationships Between a Manufacturing Firm's Adoption of Manufacturing Automation, Engagement in a Strategic Alliance, Managers' Use of Information Technology and its Internal Business Process-Related Performance. Test of Hypotheses H_{3c}, H_{4c}, H_{5c}.

Hypothesis H_{3c}, H_{4c} and H_{5c} summarize the discussion on the relationships between a manufacturing firm's adoption of manufacturing automation (X_1), engagement in a strategic alliance (X_2), managerial use of information technology (X_3) and its internal business process-related performance. These relationships can be observed in Figure 6.14. Hypotheses H_{3c}, H_{4c}, and H_{5c} predict that there is a positive relationship between a manufacturing firm's internal business process-related performance and the extent of its adoption of manufacturing automation, engagement in a strategic alliance, and managerial use of information technology.

Figure 6.14. The Relationships Between a Manufacturing Firm's Internal Business Process-Related Performance (X_{4c}) and its Managers' Use of Information Technology (X_3), Engagement in a Strategic Alliance (X_2) and Adoption of Manufacturing Automation (X_1).



The equation (6. 4) below is used to test these hypotheses:

$$X_{4c} = P_{4c1}X_1 + P_{4c2} X_2 + P_{4c3} X_3 + P_{4vc}R_v \qquad (6.4)$$

where

X_{4c} = Internal business process-related performance of a manufacturing firm;

X_3 = Managerial use of information technology;

X_2 = Engagement in a strategic alliance;

X_1 = Adoption of manufacturing automation; and

R_v = Residual.

Table 6.10: The Results of Regressing a Manufacturing Firm's Internal Business Process–Related Performance (X_{4c}) Against Managerial Use of Information Technology (X_3), Engagement in a Strategic Alliance (X_2) and Adoption of Manufacturing Automation (X_1). The Test of Hypotheses H_{3c}, H_{4c}, and H_{5c}.

$$X_{4c} = P_{4c1}X_1 + P_{4c2} X_2 + P_{4c3} X_3 + P_{4vc}R_v$$

Hypothesis	**Path Coefficient**	**Explanatory variables**	β	**T-statistic**	**P**
$H3_c$	P_{4c1}	Manufacturing Automation (X_1)	0.221	2.051	0.043
$H5_c$	P_{4c3}	Information Technology (X_3)	0.225	2.065	0.042
$H4_c$	P_{4c2}	Strategic Alliance (X_2)	0.204	2.133	0.035

Adjusted R^2 =0.236, F (3,96) = 11.202, p = 0.001
Dependent Variable: Internal business process related performance.

The results presented in Table 6.10 reveal that the relationship (P_{4c1}) between adoption of manufacturing automation (X_1) and internal business process-related performance (X_{4c}), and the relationship (P_{4c2}) between engagement in a strategic alliance (X_2) and internal business process -

related performance (X_{4c}) are significant and positive. Similarly, the relationship (P_{4c3}) between managerial use of information technology (X_3) and internal business process-related performance (X_{4c}) is also significant and positive. Thus, these results support hypotheses H_{3c}, H_{4c} and H_{5c}. The model accounts for almost 24% (adjusted $R^2 = 0.236$, $F_{(3,96)}$, = 11.202, p< 001) of the variance in the internal process -related performance of the organisations.

Using the results above, the total effect of adoption of manufacturing automation on internal business process – related performance is computed as below:

The indirect effect through information technology

$= P_{31}P_{4c3}$	$= 0.498*0.225$	0.112
The direct effect	$= P_{4c1}$	0.221
Total effect	$= P_{4c1} + (P_{31}*P_{4c.3}) =$	0.333

Total effect of engagement in a strategic alliance to internal business process - related performance:

The indirect effect through managerial use of information technology

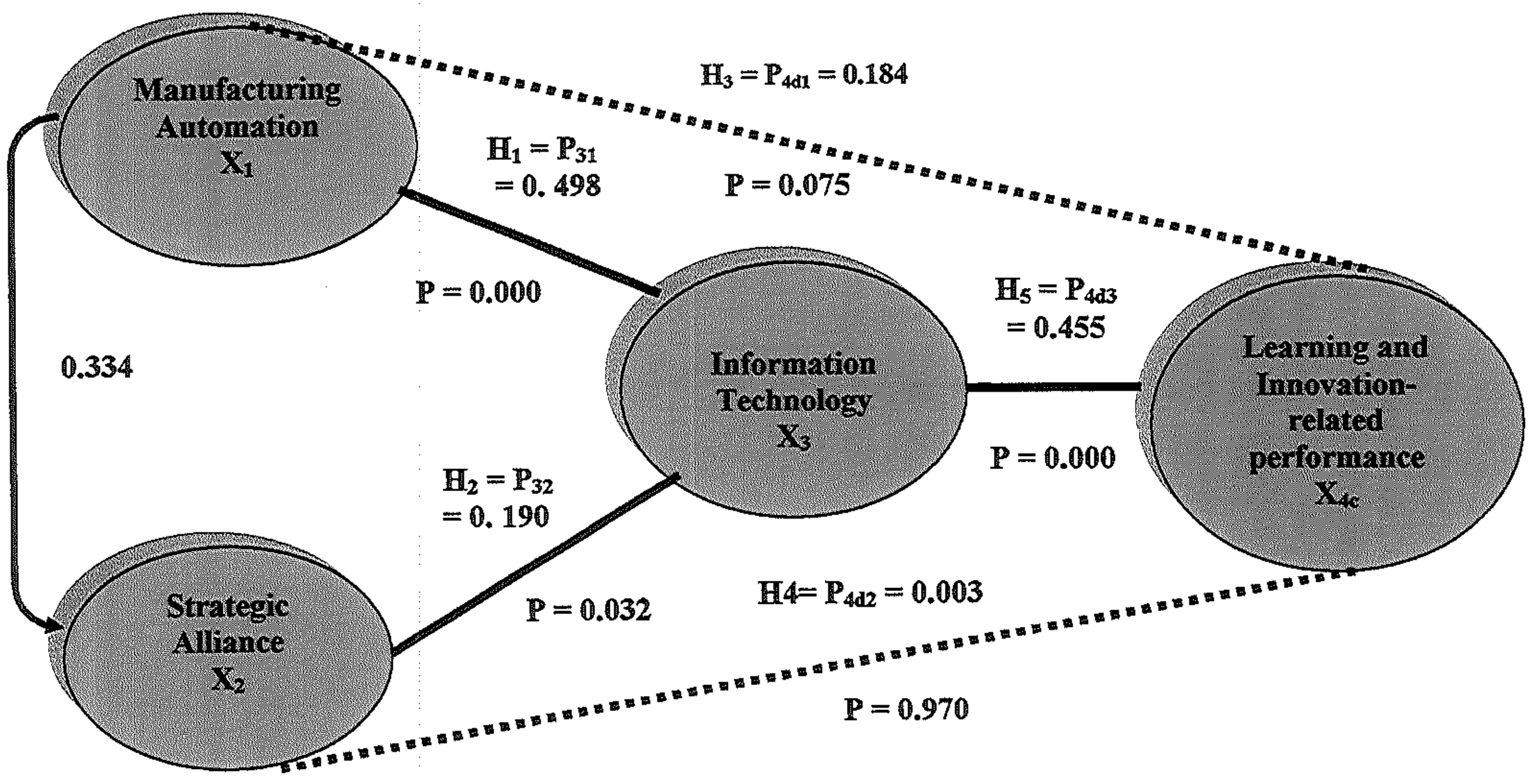
$= P_{32}*P_{4c3}$	$= 0.190*225$	$= 0.043$
The direct effect	$= P_{4c2}$	$= 0.204$
Total effect	$P_{4c2} + (P_{32}*P_{4c3})$	$= 0.247$

The total effect as calculated above indicate that both adoption of manufacturing automation and engagement in a strategic alliance have a sizeable total effect on a manufacturing firm's internal business process-related performance.

6.3.2d. The Relationships Between a Manufacturing Firm's Adoption of Manufacturing Automation, Engagement in a Strategic Alliance, Managers' Use of Information Technology and its Learning and Innovation-Related Performance. Test of Hypotheses H_{3d}, H_{4d}, H_{5d}

Finally, Hypothesis H_{3d}, H_{4d} and H_{5d} summarize the discussions on the relationship between a manufacturing firm's adoption of manufacturing automation, engagement in a strategic alliance, managerial use of information technology and its the learning and innovation-related performance. These relationships can be observed in Figure 6. 15.

Figure 6.15. The Relationships Between a Manufacturing Firm's Learning and Innovation-Related Performance (X_{4d}) and its Managers' Use of Information Technology (X_3), Engagement in a Strategic Alliance (X_2) and Adoption of Manufacturing Automation (X_1).



Hypotheses H_{3d}, H_{4d}, and H_{5d} predict that there is a positive relationship between a manufacturing firm's learning and innovation-related performance and the extent of its adoption of manufacturing automation, engagement in a strategic alliance and managers' use of information technology. The hypotheses are tested using the regression equation (6. 5) below:

$$X_{4d} = P_{4d1}X_1 + P_{4d2} X_2 + P_{4d3} X_3 + P_{4vd}R_v \qquad (6.5)$$

Where

X_{4d} = Learning and innovation -related performance of a manufacturing firm;

X_3 = Managerial use of information technology;

X_2 = Engagement in a strategic alliance;

X_1 = Adoption of manufacturing automation; and

R_v = Residual.

Table 6.11: The Results of Regressing a Manufacturing Firm's Learning and Innovation – Related Performance (X_{4d}) Against Managerial Use of Information Technology (X_3), Engagement in aStrategic Alliance (X_2) and Adoption of Manufacturing Automation (X_1). The Test of Hypotheses H_{3d}, H_{4d}, and H_{5d}

$$X_{4d} = P_{4d1}X_1 + P_{4c2} X_2 + P_{4d3} X_3 + P_{4vd}R_v$$

Hypo thesis	Path Coefficient	Explanatory variables	β	T-statistic	P
H_{3d}	$P_{4d\,1}$	Manufacturing Automation (X_1)	0.184	1.798	0.075
H_{5d}	P_{4d3}	Information technology (X_3)	0.455	4.417	0.000
H_{4d}	P_{4d2}	Strategic alliance (X_2)	0.003	0.038	0.970

Adjusted R^2=0.315, F (3,96) = 16.184, p = 0.001

Dependent Variable: Learning and innovation related – performance.

The results presented in Table 6.11 reveal that the relationship (P_{4d3}) between information technology (X_3) and learning and innovation-related performance of an organisation is significant and positive (β = 0.455, p<0.001) supporting hypothesis H_{5d}. While, the relationship between adoption of manufacturing automation (X_1) and learning and innovation-related performance (X_{4d}) is positive and significant (β = 0.184, p<0.075), therefore reasonably supporting hypothesis H_{3d}, the relationship (P_{4d2}) between engagement in a strategic alliance (X_2) and learning and innovation-related performance is not significant, so hypothesis H_{4d} is not supported. The model accounts for 31.5% (adjusted R^2 = 0.315, $F_{(3,96)}$, = 16.19, p< 001) of the variance in the learning and innovation - related performance:

Using the results above, the total effect of adoption of manufacturing automation on learning and innovation-related performance can be calculated as below:

The indirect effect through managerial use of information technology

= P_{31}*P_{4d3}	= 0.498*0.455	0.227
The direct effect	=P_{4d1}	<u>0.184</u>
Total effect	= P_{4b1} +(P_{31}*P_{4d3})	0.411

Total effect of engagement in a strategic alliance to learning and innovation-related performance:

The indirect effect through managerial use of information technology

$= P_{32} * P4_{d3}$	$= 0.190 * 455 =$	0.086
The direct effect	$= P_{4d2}$	<u>0.003</u>
Total effect	$= P_{4c2} + (P_{32} . x\ P_{4d\,3})$	0.089

The total effectcalculated above reveal that adoption of manufacturing automation strongly influences a manufacturing firm's learning and innovation-related performance. The results also reveal that indirect influence of engagement in a strategic alliance of a manufacturing firm on its learning and innovation–related performance is meaningful (Bartol, 1983).

6. 4. Summary of the results

As explained in chapter four, following the extant literature and anecdotal evidence, fourteen hypotheses were developed for the study. The discussion in chapter five explains (a) the sample of the Indonesian manufacturing firms that participated in the study, and (b) the data collection procedure. Section 3 of this chapter presents and explains the results of testing each of the fourteen hypotheses. Table 6.12 below presents the summary of the results.

Table 6. 12. Summary of the results testing the hypotheses

Hypothesis number	Hypotheses	Results
H_1	There is a positive association between a manufacturing organisation's extent of adoption of manufacturing automation and managerial use of information technology	Supported
H_2	There is a positive relationship between the extent of a manufacturing organisation's engagement in a strategic alliance and managerial use of information technology.	Supported
H_{3a}	There is a positive relationship between a manufacturing organisation's extent of adoption of manufacturing automation and its financial performance.	Not supported
H_{3b}	There is a positive relationship between a manufacturing organisation's extent of adoption of manufacturing automation and its customer-related performance	Supported
H_{3c}	There is a positive relationship between a manufacturing organisation's extent of adoption of manufacturing automation and its internal business process-related performance.	Supported
H_{3d}	There is a positive relationship between a manufacturing organisation's extent of adoption of manufacturing automation and its learning and innovation related performance.	Not Supported
H_{4a}	There is a positive relationship between the extent of a manufacturing organisation's engagement in a strategic alliance and its financial persformance.	Not Supported
H_{4b}	There is a positive relationship between the extent of a manufacturing organisation's engagement in a strategic alliance and its customer –related performance	Not Supported
H_{4c}	There is a positive relationship between the extent of a manufacturing organisation's engagement in a strategic alliance and its	Supported

	internal business process-related performance.	
H_{4d}	There is a positive relationship between the extent of a manufacturing organisation's engagement in a strategic alliance and its learning and innovation-related performance.	Not Supported
H_{5a}	There is a positive relationship between a manufacturing organisation's managerial use of information technology and its financial performance.	Supported
H_{5b}	There is a positive relationship between a manufacturing organisation's managerial use of information technology and its customer - related performance	Supported
H_{5c}	There is a positive relationship between a manufacturing organisation's managerial use of information technology and its internal business process- related performance.	Supported
H_{5d}	There is a positive relationship between a manufacturing organisation's managerial use of information technology and its learning and innovation-related performance	Supported

6.5. Chapter Summary

Section 1 of this chapter explains the technique of path analysis, its merits and demerits, as well as its suitability for the current study. Section 2 of the chapter provides an overview of the various aspects of data screening and presents the results of screening the data for this study. The results of testing each of the fourteen hypotheses are presented in section 3 of the chapter, which also provides an explanation of the results. Finally, in section 4, the summary of the results for testing each of the hypotheses is presented. The next chapter, chapter 7, discusses the results, highlights the limitations to the study and explains the implications of the empirical results for theory development and practice.

DISCUSSION, IMPLICATIONS, LIMITATIONS, AND CONCLUSION

7

7.0. Introduction

This chapter discusses the results presented for each of the hypotheses in chapter six. The discussion proceeds as follows. First, section 7.1 presents each hypothesis and makes a statement on whether the hypothesis is supported or not. Then an interpretation of the results is provided for the hypothesis. Second, the section explains how the results support/extend the previous research relevant to this study. Third, the results for the hypotheses relating to each of the endogenous (dependent) variables in the model (Figure 3.1) of the study are further explained using the information collected during the personal interviews with the ten business unit managers. These managers agreed to be interviewed after collection of the data using the questionnaire. The endogenous (dependent) variables are managerial use of information technology and firm performance including financial performance, customer-related performance, internal business process-related performance, and learning and innovation-related performance in the model (see, Figure 3.1). As explained in chapter 5, the business unit managers were personally interviewed after the questionnaire survey was completed. Section 7.2 discusses the implications of the study and section 7.3 explains the limitations to the study. Finally, section 7.4 presents the conclusion.

7.1. Discussion of the Results.

7.1.1. Managerial Use of Information Technology.

7.1.1.1. Hypothesis 1.

As discussed in section 4.2.1 of chapter four that hypothesis H_1 proposes that there is a positive association between a manufacturing organisation's extent of adoption of manufacturing automation and managerial use of information technology. The results presented in Table 6.7 in chapter 6, indicate that managerial use of information technology in a manufacturing firm is positively and significantly associated with the firm's extent of adoption of manufacturing automation. Therefore, hypothesis H_1 is supported.

An interpretation of the results is that, as the extent of adoption of manufacturing automation in a manufacturing firm increases, managerial use of information technology, such as Internet and Intranet in the organisation, also increases. This is because managers' use of information technology helps them to share and exchange information among themselves, monitor daily production, marketing and other functions and make decisions based on real time information (Attaran, 1989; Meredith, 1987). The use of information technology also helps the managers integrate different departments or functions within the organisation, thereby making adoption of manufacturing automation beneficial to improve productivity and other aspects of performance of the organisation (Blois, 1986; Bowers, 1990). Since the adoption of manufacturing automation increases productivity, as the system can operate 24 hours without interruption, it is important that production managers are able to monitor the daily operation online. For example, it is important that production managers have online access to necessary information to monitor and control production costs, so that productivity increases do not lead to undesirable increases in costs (e.g. raw material cost, overhead cost) (Hoque, 2000). Besides, the managers need to have online access to information to monitor finished goods inventories, so that the increase in productivity does not lead to inventory build up. Indeed, an inventory build up may wipe out the benefits of adoption of manufacturing automation, due to additional costs associated with extra inventory. Similarly, managers have to monitor inventory of necessary raw materials and spare parts so that production process can run as smoothly as required. Nemetz & Fry (1988), for example, report that adoption of manufacturing automation does not automatically increase productivity, as it depends on the availability of raw materials and spare-parts. Managers' use of information technology can help them effectively monitor and manage production and other related functions to maximise benefits of manufacturing automation adoption.

The results extend Hoque (2000), who argues that adoption of manufacturing automation increases managerial use of cost information. However, Hoque (2000) conceptualises and measures manufacturing automation in terms of CAD and CAM and ignores the other important attributes of manufacturing automation, such as computer aided process planning (CAPP), flexible manufacturing systems (FMS), and automated material handling (AMH). Moreover, although Hoque (2000) investigates the impact of adoption of manufacturing automation on managerial use of cost information, the study ignores the role of information technology in gathering and making the cost information available to the managers for monitoring the company's operation. The results also extend Blois (1986) and Bowers (1990), who argue in favour of the importance of integrating manufacturing automation with the other functional areas like marketing, human resource management and finance in an organisation. Also, like Hoque (2000), these researchers ignore the role of managers' use of information technology in supporting an integration of the different functional areas in an organisation. The current study supports Attaran (1989); Nemetz & Fry (1988); and Meredith (1987) who suggest that managers' use of information technology helps them get on time information to monitor and control their company's daily operations.

7.1.1.2. Hypothesis 2.

Recall from section 4.2.2 of chapter 4, hypothesis H_2, which proposes that there is a positive relationship between the extent of a manufacturing organisation's engagement in a strategic alliance and managerial use of information technology. The results presented in Table 6.7 in chapter 6 reveal that managerial use of information technology is positively and significantly associated with a manufacturing firm's engagement in a strategic alliance, therefore hypothesis H_2 is supported.

An interpretation of the results is that as the extent of a manufacturing organisation's engagement in a strategic alliance increases, managers in the organisation make more use of information technology. A reason for this is that information technology is able to quickly transmit information and helps the managers get instant access to information, exchange and share the information among themselves and with other stakeholders, both internal and external to the organisation (Fulk & DeSantics, 1995; Galbraith, 1994, Haywood, 1999, Huber, 1990; Kaplan & Norton, 1996). Managers' use of information enables them build up cooperation, collaboration and integration among alliance member firms (Suter, 1999; Papazoglou et al, 2000). Managers of an alliance member organisation, by using information technology, can facilitate distribution of workflow among the alliance members, arrangement of delivery of orders (for materials, spare parts, products) to the appropriate organisational sites or facilities, tracking the status/progress of activities and coordination of smooth and timely flow of information among all alliance members.

Manufacturers, through their strategic alliances, gain the benefit of getting quality materials and spare parts, marketing their products effectively and expediting innovation of new products (Bucklin & Sengupta (1993). However, Harrigan (1998) reports that about 70 percent of strategic alliances fail to maintain the relationship among alliance member firms, due to lack of collaboration and trust among the members (Brouthers et al, 1995; Smith and Barclay, 1997). Alliance member firms need to have close communication among themselves, which enables them to exchange and use real time information (Shrader, 2001). Such close communication eliminates communication gaps and enhances cooperation and collaboration among alliance member firms (Adobor, 2002; Buckley & Casson,1988; Whipple & Frankel, 2000).

This study supports Papazoglou, et. al (2000) and Steensma. & Corley (2000) who argue that managerial use of information technology by an alliance member firm is relatively high, as it enhances collaboration and cooperation among the alliance organisations. Further, the results support Balakkrishnan et al (1999), who review the literature on the role of information technology used by managers in manufacturing organisations, which are members of a strategic alliance. Balakrishnan et al conclude that such organisations would make a high use of information technology, as it is essential to improve communication, collaboration and integration.

7.1.1.3. Interviews with Managers

The above interpretations of the results for hypotheses one and two above are further supported by the information collected through the personal interviews with the selected business unit managers. Consider, for example, the interview with the manager in charge of a DVD and VCD manufacturer in Java Island in Indonesia. The firm adopted a fully automated manufacturing system about three years prior to this study and have been producing to order. The manager indicated that because of the firm's adoption of manufacturing automation, the manager's use of information technology, such as Internet and Intranet, has become critical. Since the head office, including marketing office of the firm, is about 2 hours drive away from the manufacturing plant, the company installed a communication network to link its head office and factory to optimise utilisation of the automation.

The managers said that during the 1990s, managers in the company used radio communication to link the factory with the head office and other departments. The factory used to send disks to head office, containing production data for production report and cost control. However, when the company introduced the fully automated manufacturing technology to the production system, which increased productivity by more than twenty times, radio communication and exchange of disks were no longer effective. The speed of the reporting system had become misaligned with the speed of the production of goods. The accounting department had a lot of difficulties controlling and monitoring the inventory, as well as with preparing production reports. Further, design prints, which came from customers to the marketing department in head office, had to be sent by facsimile to the factory. But, facsimile transmission quite often did not send a clear picture of the design and oral communication through radio was frequently distorted and confusing. Since the adoption of manufacturing automation resulted in high-speed continuous production of a large volume of products, the plant managers needed to send on-time, accurate production data to the head office for production report and cost control. So, the company installed an information network (Intranet and Internet) for communication, not only between the head office and plants, but also among departments within the company and other external parties.

According to the manager, since the installation of the information technology (network), accounting departments have been able to produce daily production reports. Consequently, information and reports on cost control, inventory control and product availability have become available online, and are therefore effective. Further, the manager said that net meetings and videoconferences (using the information technology) among managers within the organisation, as well as with external stakeholders, have helped the company to optimise utilisation of their automated manufacturing facility.

The interview data supports the study's statistical results that managerial use of information technology enhances integration of departments within the organisation, as well as communication with stakeholders outside. Besides, it is evident from the interviews that managerial use of information technology assists managers in monitoring their organisation's daily operations.

The interviews with the manager of a decorated glass and plate manufacturer reveal that, when the company adopted manufacturing automation about five years ago, its managers needed to use Internet and Intranet to optimize its production and fulfil its customer orders. This company also produces its products to orders. Its marketing managers are never in the office, as they move around the globe to promote their company's products in different exhibitions. Therefore, most of the customers' orders come during the exhibition period. These orders, including the pictures and details, are sent directly from exhibitions overseas (mostly) through the Internet, to its marketing department, which then makes the orders ready for delivery to customers, usually within two weeks. The marketing managers use Intranet to send the orders from the marketing department to the production plant, to manufacture the orders.

The manager also explained that, though the automated manufacturing facility is expected to improve productivity and product quality, it depends on the reliability of suppliers. Managers' use of the Internet enhances communication between the suppliers and the managers, as the information can be transmitted on timely basis. During the interview, the manager explained that adoption of manufacturing automation increased the speed of the plant's productivity, and use of information technology (such as Internet and Intranet) helps the purchasing managers to effectively communicate with suppliers. Use of information technology also enables the company's suppliers to have online access to its inventory and production schedule, and therefore, they can supply the necessary materials and spare-parts on time.

During the interview with the manager in charge of a bulb manufacturing company, the manager revealed that the company's manufacturing process is automated and continuous. The boiler must not stop operating, as it is costly to turn on and off the machine. The production process has to continue producing 24 hours per day, therefore, the raw materials and spare-parts have to be available on demand. Most of the suppliers of the company are in China, Vietnam and other countries. Communication with those suppliers must be on time, fast and accurate, therefore, the use of the Internet is crucial. These interview results support the statistical results of the study that managerial use of information technology in a manufacturing firm increases with the firm's adoption of manufacturing automation, and its engagement in a strategic alliance for close communication between the firm and its alliance partners, including suppliers and customers.

An interpretation of these results is that, successful adoption of manufacturing automation and engagement in a strategic alliances improves a manufacturing firms' performance, but is also affected by other factors; managerial use of information technology is one of them. For example, availability of the production data and cost information, the internal integration among managers, as well as collaboration among alliance partners, must exist along with adoption of manufacturing automation and engagement in a strategic alliance. Information technology having the capability to instantly transmit, allow sharing and gathering of information, is an important infrastructure to support a firm's adoption of manufacturing automation and engagement in a strategic alliance.

7.1.2. Financial Performance

7.1.2.1. Hypothesis 3_a

Hypothesis 3_a in section 4.2.3.1 in chapter four, proposes that there is a positive relationship between a manufacturing organisation's extent of adoption of manufacturing automation and its financial performance. The results presented in Table 6.8 in chapter 6 indicate that a manufacturing firm's financial performance is not associated with the firm's adoption of manufacturing automation, therefore the hypothesis is not supported.

A plausible interpretation of the results is that from the early 1990s to now, Indonesia has been experiencing frequent political instabilities and labour union problems (Kwik, 1996). During the period, many firms in the country's manufacturing industry adopted manufacturing automation in order to avoid the problems of labour unrest. Consequently, it is arguable that the adoption of manufacturing automation in Indonesia has been based on more political considerations (like labour unrest) rather than economic reasons. Moreover, the adopter firms might have considered only the production efficiency, rather than the costs associated with adoption of automation. This is perhaps a reason why many companies that adopted manufacturing automation in Indonesia appear to capture only the technical benefits (e.g., increased production) of the system. The production becomes faster as the machines are able to produce quickly and run 24 hours a day without any interruption. However, though the productivity has been high, the companies may have failed to improve their financial performance probably because of the high depreciation costs, high interest costs due to high interest rates in the country, raw materials shortage, finished goods inventory build up, and the high cost of training. Personal interviews with managers of the selected business units reveal that in many cases, after the adoption of manufacturing automation, the adopter firms realised that other expenses like high employee training costs, technical expertise costs, depreciation costs and other costs, like interest, increased unexpectedly.

In addition, Indonesia has a large population providing an adequate workforce; therefore the wage rate in the country is relatively low. As a result, the decrease in labour costs due to adoption of manufacturing automation may not have been significant enough to improve financial performance. Besides, the on going tax exemption offered by the Indonesian Government for importation of production equipment might have motivated many manufacturing organisations in Indonesia to adopt automation, without proper cost and benefit evaluation. Therefore, though the adoption of manufacturing automation in Indonesia may improve productivity, it may not improve the firms' financial performance.

The results support Zhao & Co (1997) who study the impact of manufacturing automation in Singapore and report that the economic justification for manufacturing automation adoption is not applicable to organisations, which operate in a country where wage rates are relatively low. The results of this study also support Wong and Ngin (1997), who report that adoption of manufacturing automation in Singapore does not have any relationship with financial performance, as the labour saving is not significant enough to result in financial improvements. Further, results of this study are consistent with Vrakking (1989) and Dimitrov (1990) who conduct a comparative study of the impact of manufacturing automation adoption on financial performance in the US and UK and find no significant result. This study extends Boyer et al (1996), who study the effect of investment in manufacturing automation on firm performance in terms of sales growth, return on sales and earning growth; they found no relationship between the investment and the dependent variables. Unlike the current study, which covers multiple manufacturing industries, Boyer et al conducted their study only on the metal industry in the USA. Therefore, the current study extends Boyer et al (1996) findings into other industries.

7.1.2.2. Hypothesis 4_a

Chapter four, section 4.2.4.1, presents hypothesis 4_a proposing that there is a positive relationship between the extent of a manufacturing organisation's engagement in a strategic alliance and its financial performance. The results presented in Table 6.8 in chapter 6, indicate that a manufacturing firm's financial performance is not associated with its engagement in a strategic alliance, therefore, the hypothesis is not supported.

A reason for the insignificant result may be because of the collectivist characteristic of Indonesian society. The relevant literature (Hofstede; 1981, 1994; Koentjaraningrat, 1975) suggests that a firm's engagement in a strategic alliance in a collectivist society, such as in Indonesia, is a rather common business trait. Consequently, the alliance by itself may not result in a competitive advantage, leading to a better financial performance. More specifically, a manufacturing firm's engagement in a strategic alliance in such business environment, may not help the firm improve its financial performance, as the company may not be able to obtain cheaper raw materials or spare parts than its competitors. Also, the company may not be able to sell its products or services at a better price than its competitors, as the competitors also engage in similar allianced with suppliers, marketing channels and customers. Engagement in a strategic alliance is expected to create a competitive advantage for a particular manufacturer when there is a relatively strong relationship of the manufacturer with its alliance member firms. Such a strong relationship may be able to create a barrier for competitors to achieve sales growth and increase profitability (Bucklin & Sengupta, 1993). Some previous studies also reveal that strategic alliances do not always improve financial performance, as maintenance of a good relationship between the alliance member firms is difficult due to lack of close communication, collaboration and cooperation between them (Adobor, 2002; Buckley & Casson, 1988; Whipple & Frankel, 2000).

Success of a strategic alliance also needs trust among the alliance partner organisations and managerial skill and experience in teamwork (see Peng & Heath, 1996; Li and Atuahene-Gima, 2001). Li and Atuahene-Gima (2001), for instance, suggest that failure of gaining benefits from a strategic alliance occurs because the alliance member firms do not have enough teamwork experience and, therefore, synergy and collaboration are not realized. Similarly, Bruner et al (1992), Sabel (1993), and Shrader (2001) report that to maintain a strategic alliance, trust and close communication among the alliance partners are critical to prevent a communication gap. A communication gap creates suspicions among the alliance partners, and as a result, synergistic effects of strategic alliances remain unachieved (Berryman,1998; Papazoglou et al, 2000). It may be that strategic alliances of the Indonesian manufacturing firms (in the sample) suffer from a lack of trust and close cooperation, collaboration and communication.

This study empirically supports Bucklin and Sengupta (1993), and Papazoglou et al (2000) who argue that a firm's engagement in a strategic alliance may not be directly associated with the firm's financial performance, because there may be other variables (like managers' use of information technology) mediating the relationship. This study also supports Shrader (2001), who reports that there is no direct relationship between a firm's engagement in a strategic alliance and its performance in terms of sales growth, and market share, perhaps because there are other factors influencing the relationship.

7.1.2.3. Hypothesis 5a

Hypothesis 5a in section 4.2.5.1 of chapter four proposes that there is a positive relationship between managerial use of information technology and financial performance of a manufacturing firm. The results presented in Table 6.8 of chapter 6 indicate that the hypothesised relationship between financial performance and managerial use of information technology is positive and significant, therefore, the hypothesis is supported.

An interpretation of the results is that managerial use of the information technology, in terms of Internet and Intranet, is beneficial for a firm as the technology can be used to gather and present information on real-time basis. The capability of the technology improves a company's financial performance, as it can help the company to monitor daily operations, control cost, promote sales, and facilitate accurate and fast decision making (Andersen, 2001). Managers in a manufacturing firm have to monitor daily operations including inventory level. A failure to monitor inventory may result in inventory build up, leading to increased operating expenses (e.g. inventory carrying cost) or shortage of inventory, leading to loss of sales and market share. In other words, managers have to be able to minimise the inventory build up (or shortage), hence working capital tied up in the inventory. However, on the other hand, managers have to coordinate inventory to be always readily available to produce based on demand (Narasimhan & Das, 1999). Consequently, the timing of purchasing raw materials is one of the critical factors in a manufacturing firm, as it determines the production speed.

An effective inventory management of a manufacturing firm needs close communication and timely information sharing with its suppliers, so that the suppliers are able to deliver the required materials and spare parts on time (Soliman & Youssef, 2003). The information technology can play a significant role in making inventory and cost reports available on a real-time basis, and help managers to monitor the production process effectively (Andersen, 2001). For example, real-time information on inventory may enable a purchasing manager in the firm to make accurate decision in buying inventory, consequently, there may not be inventory shortage or inventory build up, which ultimately affects the firm's financial performance (Tullo, 2000).

Information technology, in terms of Internet and Intranet, has the facility to instantly transmit graphs and pictures (such as material specifications) at low cost, therefore, the technology reduces communication costs (Andersen, 2001). Information technology is also beneficial to marketing activities. For example, the use of websites helps manufacturers to reduce advertisement expenses and other sales costs, such as sales person costs, billing and order taking costs. Internet also helps companies to search for the best raw material and price, quality materials and spare-parts, as well as the best suppliers, thus manufacturers would be able to reduce their raw materials and spare-parts costs (Soliman & Yousef, 2003). The reduction in time and costs throughout the manufacturing chain enables companies to gain competitive advantages, as they can reduce their sales price without sacrificing profit, therefore they become more competitive.

The results of this study empirically support Andersen (2001) and Andersen & Segars (2001) who argue that the use of information technology facilitates decision-making processes and improve organisational performance, in terms of profitability and sales growth. The results of the current study also support Balakkrishnan et al (1999), who after reviewing the literature on the role of information technology, argue that managerial use of technology improves financial performance through reducing inventory carrying cost, communication costs, and inventory physical movement costs.

An interpretation of this result is that information technology mediates the relationship between financial performance and manufacturing automation, and strategic alliance. Therefore, it is argued that the relationships between a manufacturing firm's financial performance and its adoption of manufacturing automation, and engagement in strategic alliance are mediated by managerial use of information technology. In other words, adoption of manufacturing automation and engagement in strategic alliance affects manufacturing firms' financial performance through the use of information technology. Adoption of manufacturing automation may not improve manufacturing firms' financial performance unless the adoption is supported by the use of information technology. Similarly, engagement in strategic alliance may not improve manufacturing firms' financial performance unless the alliance is supported by the use of information technology, which is needed to strengthen collaboration, cooperation, and trust among the alliance member firms. As explained above, having a strong alliance with suppliers, build up or shortage of inventory of a manufacturing firm can be eliminated as the availability of raw materials and spare parts can be assured.

7.1.2.4. Interviews with Managers.

The above interpretations of the results for hypotheses 3a, 4a and 5a above are further supported by the information collected through the face to face interviews with the selected business unit managers. During the interviews, some of the managers said that many manufacturing companies that implemented manufacturing automation in Indonesia capture only the technical benefits (such as increased production) of the automation. Although manufacturing automation helps companies to avoid labour union problems and therefore the production becomes faster as the machines are able to produce quickly and run 24 hours without interruption, manufacturing companies in Indonesia fail to improve their financial performance because of the high depreciation costs, high interest rates, raw material shortage, finish goods inventory build up, and high cost of employee training. In many cases, after manufacturing automation adoption, the adopter firms realise that other expenses like high labour training cost, technical expertise costs, and depreciation cost increase unexpectedly.

For example, the interview with a packaging company manager revealed that though manufacturing automation increased the company's productivity and efficiency, the automation cost too much hitting hard the company's profit. High labour turnover due to the political and social turbulence in the Country resulted in high training costs for workers and other employees. In another interview at a traditional herbs/ medicine company, the manager said that manufacturing automation adoption did not improve the company's financial performance because of the low labour costs in Indonesia, consequently manufacturing automation did not generate a significant manufacturing cost saving. Besides, the high speed production by manufacturing automation created inventory build up, as the products could not be sold as quickly as they were produced. The manager commented:

"production manager always try to maximise utilisation of the machines' capacity without considering how far the market can absorb the products. It seems there is not enough integration between marketing department and production department. We solve the production problem, but we create another problem in marketing area".

The views expressed by the managers during the interviews are consistent with the statistical result of this study that adoption of manufacturing automation does not directly improve a manufacturing company's financial performance unless the automation is supported by managerial use of information technology. Similarly, a manufacturing company's engagement in strategic alliance also is unlikely to be beneficial to the organisation's financial performance unless the alliance is supported by managerial use of information technology. During the interviews, three managers from three selected manufacturing organisations explained that an alliance with suppliers does not always improve financial performance, as manufacturing companies do not always get a better price from their suppliers. This is because the competition among the manufacturing companies in Indonesia is very tight giving the suppliers more bargaining power than that of the buyers. Suppliers do not reduce their prices, as other buyers are willing to buy with a better price. Also due to the unstable political situation in Indonesia, raw material prices fluctuate, so the suppliers normally do not like to enter into a long -term contract. This type of situation occurs especially when a manufacturing company needs specific materials that usually have quite fluctuating price (e.g. timber). Such an unreliable condition forces manufacturing companies to build up their own inventory, as a result, huge working capital is tied up in the inventory and costs increase. Further, alliance with overseas suppliers create different problem for manufacturing companies due to political instability, Rupiah value (the Indonesian currency), has been falling, thus imported materials have become very expensive.

The only way to minimise these problems is to keep monitoring the price and keep communicating with suppliers, and make fast and accurate purchasing decisions. Moreover, because Indonesia as a country is spread over a huge area and the islands are separated by water, the alliance partners are usually at a great distance from each other; and communication and postal services among provinces and islands of the Country are often time consuming and expensive. This difficulty makes it imperative for manufacturing firms in the Country to use information technology for successful and timely communication with their alliance partners. Consider for example the joint licensing arrangement between Walt Disney in USA and the Decorated Glass Company in Indonesia, which has been successfully operating for the last 7 years because of the company's high use of Internet by the companies. During the interviews, the manager of the Decorated Glass Company explained that sending (pictures, graph, product designs) and meeting between two managers from two different countries have been done using information technology. The use of telephone and facsimile are reduced as it is costly and has limited functions.

A close relationship with supplier alliance member firms also needs high use of information technology because a quick information transmission helps managers avoid production and delivery delays, therefore, reduce wastes and costs. An alliance with customers also increases the need for the use of information technology. Customers at any time can search a company's product and make purchase decision, which means that the manufacturers can complete their sales transaction anytime with small costs.

The discussions during the interviews with the managers in the selected manufacturing firms provide supports for the statistical results of the study that a manufacturing firm's adoption of manufacturing automation and engagement in strategic alliance are unlikely to directly help improve financial performance.

7.1.3. Customer-Related Performance

7.1.3.1. Hypothesis 3b

Hypothesis 3b in section 4.2.3.2 of chapter four proposes that there is a positive relationship between a manufacturing organisation's adoption of manufacturing automation and its customer- related performance. The results presented in Table 6.9 in chapter 6 indicate that customer-related performance is positively associated with the firm's adoption of manufacturing automation, therefore, the hypothesis is supported.

Manufacturing automation generates technical benefits to production as it standardises product quality and reduce production time. Fast production of goods helps a manufacturer to fulfil its customer's demand. Besides, the capability of manufacturing automation to standardise product quality reduces product defect and customer complaints (Boyer et al, 1996). Because the automated manufacturing system is flexible, manufacturers are able to produce modified existing products or develop new products, which are aligned with customers' taste and needs. Besides with manufacturing automation, manufacturers are able to quickly produce in small batch, therefore, come up with the best response to their customer's needs by offering broader product range including new products thereby increase their market share. Production precision and shorter production time of manufacturing automation also help manufacturers meet their customers' demand dead line without increasing labour cost (such as overtime cost) (see Meredith, 1987; Dean and Snell, 1991; Parthasarthy and Sethi, 1992).

Customer satisfaction is likely to improve as the products are of high quality, they are delivered on time and at competitive price.

This study extends Boyer et al (1996), who studies the relationship between the firms' investment in manufacturing automation and their performance in terms of sales growth, return on sales and earnings growth. Boyer et al did not investigate the impact of a manufacturing firms' adoption of manufacturing automation and its non-financial performance related to customer, internal business process, and learning and innovation; this study does.

7.1.3.2. Hypothesis 4b

Chapter four, in section 4.2.4.2, presents hypothesis 4b, which proposes that there is a positive relationship between a manufacturing firm's engagement in a strategic alliance and its customer-related performance. The results presented in Table 6.9 in chapter 6 indicate that customer-related performance is not directly affected by a manufacturing firm's engagement in strategic alliance, therefore hypothesis 4_b is not supported.

The relevant literature indicates that strategic alliance may enhance the alliance member companies' access to new markets, increased resource availability, and help the companies adapt to environmental uncertainty (Astley & Foomburn, 1983; Bucklin & Sengupta, 1993; Shrader, 2001; Steensma & Corley, 2000). However, trust and commitment among the alliance member firms are critical for building and maintaining the alliance (Fichman & Levinthal, 1991; Gambetta, 1988; Abodor, 2002). An absence of trust and commitment among the alliance partners may create barrier for alliance partners to continue the cooperation (Collinson, 2000). Adobor (2002), Whipple & Frankel (2000), for instance argue that trust and commitment among alliance partners are critical for the alliance to improve customer satisfactions, market share, promotes cooperation and speeds up negotiations (se also Jarillo, 1988; Buckley & Casson, 1988; Dwyer, Schurr & Oh, 1987; Reve, 1990). Besides, communication also an important factor as it allows the alliance member firms exchange information useful for building a close relationship and trust and cooperation among them (Buckley & Casson, 1988).

There are two possible reasons why strategic alliance does not have a direct relationship with customer-related performance in the current study. Firstly, because Indonesia is a vast country consisting of island, which are spread over a huge area and the islands are separated by water. As a result, a manufacturing firm's alliance partners are usually at a great distance from each other even within the Country let alone outside; and communication and postal services among provinces and islands of the Country are time consuming and expensive. Because of these difficulties, trust, commitment and collaborations among the alliance partners may not be strong in the absence of managerial use of information technology. Another plausible explanation for the results is the Indonesian Society, which is characterised by a relatively high level of collectivism. In such a society, engagement in strategic alliance among the manufacturing firms may be a common factor. Consequently, being a member of only a strategic alliance in Indonesia may not result in a company's better customer-related performance unless (Hofstede; 1981, 1994; Koentjaraningrat, 1975). Since strategic alliance in the current study has the same mean and median (see Table 6.4), it is arguable that the level of the alliance among the sample firms is more or less similar.

This study empirically supports Balakrishnan et al (1999), who argue that close communication among the member firms of a strategic alliance is required to maintain cooperation and collaboration among the firms. This study extends Shrader (2001) who reports no relationship between the firms' engagement in strategic alliance and their performance. Shrader (2001) argues that there are other factors moderating the relationship. Shrader assesses the performance only in terms of sales growth, market share, R&D intensity and advertising intensity; the study does not investigate the effect of a strategic alliance on customer-related performance. The current study does.

7.1.3.3. Hypothesis 5b

Recall, section 4.2.5.2 of chapter four presents hypothesis 5b, which proposes that there is a positive relationship between information technology use and customer-related performance. The results presented in Table 6.9 in chapter 6 indicate that managerial use of information technology improves a company's customer-related performance, thus the hypothesis is supported.

Information technology such as communication network (e.g. Intranet, Internet, and videoconference) rapidly transmits and highly facilitates sharing of information among all stakeholders and managers within an organisation (Andersen, 2001). The technology allows an organisation to have access to on-line information, which is important for decision making and to compete in the market. For example, in highly competitive market, customer needs and tastes as well as competitors' product ranges change rapidly. To adapt to the changes, managers must keep monitoring the change and make fast and accurate decisions to face the change. With Intranet and Internet, marketing departments can remain informed and up to date about the trend in demand for the products, customer expectations, as well as competitors' products and package deal. Thus, marketing managers may be able to make right decisions to compete with the competitors. Besides, marketing managers through Intranet may inform the production managers to adjust or modify the designs of the existing products to meet the customers' changing tastes and needs (Narasimhan & Das, 1999).

Besides, in the highly competitive environment, prices of certain products change unexpectedly. For example, the prices of timber, gold, tobacco, steel and other mining and agricultural products are very volatile in Indonesia and therefore marketing managers must keep monitoring the prices and transfer this information to accounting department, so that accounting department can always have a contact with marketing department and inform marketing managers how far the selling price can be reduced (Willis and Sullivan, 1984).

In addition, information technology is also important for purchasing managers to monitor the price changes especially for those materials, which have fluctuating demand, therefore, price. Managerial use of information technology by purchasing managers helps them make quick purchasing decisions. Besides, a coordination between production and marketing managers through information sharing is also important to respond customers' needs; it helps companies to produce products, which are on demand and sell at competitive price. Customers do not only demand products at competitive price, but they also look for high quality products and high quality services. For instance, since customers demand delivery of high quality products on time and to satisfy such demands, manufacturers need to have reliable suppliers to supply high quality materials on time (McGee et al, 1995; Shan, 1990). Managerial use of information technology helps manufacturer and supplier alliance members to share and exchange information for mutual benefits. If a supplier know the production schedule or new product design of a manufacturer's production schedule, the supplier can send the manufacturer the appropriate materials and/or spare parts in right quantity and at the right time (Stucky, 1983).

The results of this study extend Andersen (2001), who argues that managerial use of information technology enhances organisations' communication and positively influence their performance as the use of information technology helps managers making their strategic decisions and better coordinate strategic actions. However Andersen investigates the organisational performance in terms of profitability and sales growth only. This study extends Andersen & Segar (2001), who investigate the performance effect of managers' use of information technology in textile and apparel industry in USA. Andersen & Segar test the effect of managerial use of information technology on financial performance, while the current study investigates the effect on financial as well as non-financial performance related to customer, internal business process and learning and innovation. The results indicate that managerial use of information technology plays an important role in manufacturing firm's successful adoption of manufacturing automation, its engagement in strategic alliance and improvement in customer-related performance.

7.1.3.4. Interviews with Managers

The above interpretations of the results for hypotheses 3b, 4b and 5b above are further supported by the information collected through the face to face interviews with the selected business unit managers. During the interviews, the selected managers explained that manufacturing operations are often overwhelmed with constantly changing priorities, demand do not align with forecast, late deliveries, product specification problems, capacity imbalance, material flow interruptions. All these factors constrain operational capabilities and result in unpredictable performance. Therefore, manufacturers have to anticipate these changes and have to have a way to solve those problems. It is argued here that managerial use of information technology in an answer to the problem.

Consider, for example, the comments of a furniture company manager that communication is the most important factor in running the business, especially because most of furniture production is based on export job orders. Timber supply is the critical factor for the production, so the supply must be maintained. Since the lead-time for raw materials order to delivery to factory is normally long, a furniture manufacturer has to have a close communication with timber suppliers, so that good quality timber can arrive at factory on time. Lack of communication with suppliers may delay the production resulting in a longer production cycle time and ultimately the company's failure to meet the delivery deadline. Besides, availability and price of timber are generally very volatile causing difficulties for the furniture manufacturers to maintain their raw material (timber) stock for production. The manager commented: "the most important raw material of our products is timber. We get the timber from plantations, which are located in different islands in eastern part of Indonesia, such as Sumatra, Kalimantan and Sulawesi. Use of Internet helps us to communicate with our suppliers. The price of timber is very unpredictable. The best way to get good price from suppliers is to keep communicating with them. We never think our time to communicate with our suppliers is a waste. Chatting with them through Internet helps us to be close to our suppliers and because of that we are always on their priority list to get good quality timber with the best price".

The manager of the furniture company also explained that close communication and sharing of information with suppliers helps us and the suppliers understand and trust each other. According to the manager, having trust in suppliers by giving them access to the company's production plan and schedule has increased our suppliers' involvement in the Company and as a result they have a great willingness to support the Company as they feel part of the team. Furthermore, as most customers of furniture companies are overseas, communication through Internet is the cheapest and fastest way to interact with the customers. The technology has a capability to store a lot of emails, which can be sent and received without worrying about the time difference. The manager further said that discussions with customers are done using the technology, including sending design, graph and pictures of the desired furniture.

Similarly the interview with the manager of a large garment manufacturing firm in Java revealed that the Company has one hundred fourteen distribution channels. The manager said that all of the channels are run by the Company's alliance member firms and the use of Internet helps the managers of the alliance member companies to communicate with each other. Communication using information technology is done 24 hours and time difference does not interfere, as the technology such as e-mail stores huge amount of information. Besides, the Company, having joint licensing with European companies to produce garments, continuously exchange information on garment designs and patterns using the technology, thereby ensures production and delivery of the goods to the customers' satisfaction.

The interviews described above support the statistical result that managerial use of information technology enhances communication internally and externally to improve customer- related performance.

7.1.4. Internal Business Process-Related Performance

7.1.4.1. Hypothesis 3c

Recall, hypothesis 3c in section 4.2.3.3 of chapter four proposes that there is a positive relationship between a manufacturing organisation's extent of adoption of manufacturing automation and its internal business process-related performance. The results presented in Table 6.10 in chapter 6 reveal that internal business process-related performance is directly and positively associated with adoption of manufacturing automation, therefore, hypothesis 3_c is supported.

An interpretation of the results is that adoption of manufacturing automation increases material and labour efficiencies as the automation reduces defective production. Robinson et al (1990) report that most automated manufacturing systems have detector devices, which are able to inspect automatically the defective products in early stage and repair or scrap the defective products, thereby reduce rework and waste (Attaran, 1989; Beaumont & Schroder, 1997). The automated system usually gives early warnings of machine problems, therefore, helps avoid machine downtime. The automatic defective product inspection and repair capacity of the system reduces number of production stops and production loss resulting in minimisation of production slack such as labour downtime (Meredith, 1987). In return, as manufacturing automation can automatically and timely detect the defective product, it is expected to minimise production costs and decrease manufacturing lead- time (Yamashina and Mizuyama, 1998). Manufacturing automation also reduces labour requirement's as the production tasks are mostly done by machines, therefore, the system can increase productivity and improve labour and material efficiency (Dimitrov,1990; Ebel, 1992; Hayes & Jaikumar, 1991; Willis & Sullivan, 1984; Zummato and O'Connor, 1992).

This study extends Boyer et al (1996) and Dean & Snell (1996). Boyer et al (1996) examine the relationship between adoption of manufacturing automation and organisational performance (on-time delivery, inventory management, employee productivity, equipment utilization, production lead-time and scrap minimization). Boyer et al study is conducted exclusively in metal industry. Similarly Dean and Snell (1996) examine the relationship of manufacturing automation with organisational performance only within the metal industry. Therefore, the external validity of the results of both of the studies is limited to the metal industry only. Moreover, both of these studies ignored the role of a manufacturer's engagement in strategic alliance and managerial use of information technology in the model. Since the current study was conducted in 21 different manufacturing industries, its results are expected to have a wider external validity. Moreover, this study investigates the role of a manufacturer's engagement in strategic alliance and managerial use of information technology along with adoption of manufacturing automation therefore its model is comprehensive and extends Boyer et al (1996) and Dean & Snell (1996).

7.1.4.2. Hypothesis 4c

Recall, section 4.2.4.3 of chapter four presents hypothesis 4c which proposes that there is a positive relationship between a manufacturing firm's engagement in strategic alliance and its internal business process-related performance. The results the results presented in Table 6.10 in chapter 6 indicate that internal business process–related performance is positively and significantly associated with engagement in strategic alliance, so the hypothesis is supported.

An interpretation of the results is that a firm's engagement in strategic alliance is a critical success factor for the firm as it increases the firm's business process efficiency (Forrest, 1990; Lee & Mulford, 1990; Powel et al, 1996). This is because engagement in strategic alliance with suppliers, for example, enables a manufacturer get on time supply of quality materials and spare parts, which help the manufacturer respond quickly to necessary production changes as well as shrink manufacturing lead-time. Further, having desired quality raw materials and spare parts, manufacturers are able to reduce or eliminate production delays and defective products. Availability of quality raw materials and spare parts also help the firms avoid rework and production stoppage. Further, having a close alliance with its suppliers, a firm can eliminate raw materials and spare parts inspection and the related costs. These benefits from alliance ultimately increase raw material and labour efficiency as well as shorten production lead-time. Similarly, having the alliance with customers also help a manufacturing firm improve its product and service quality through early recognition of the changes in customer tastes and demand, thereby increase its efficiency by producing the products, which are in demand and avoid wastes (e.g., excess processing, transport and stock) (Baumgartner et al, 2001; Ono ,1998).

The results of the study support Klunk and Rose (2000) and Sundra (2000). Klunk and Rose report that by engaging in strategic alliance, the Exide Electronics Manufacturing Company in USA is successful in significantly increasing its production process efficiency by reducing defects in its components manufactured. Sundra (2000) also report a similar success of Lockheed Martin Aeronautics, USA in improving the Company's production process efficiency (see also, Powel et al, 1996; Forrest, 1990; Lee & Mulford, 1990). The current study extends Klunk and Rose (2000) and Sundra (2000) because these studies examine the relationship between a firm's engagement in a strategic alliance and its process efficiency but ignore the role of the firm's adoption of manufacturing automation and managerial use of information technology in the model. Since the current study investigates the role of a manufacturer's adoption of manufacturing automation and managerial use of information technology along with that of strategic alliance, its model is comprehensive and extends Klunk and Rose (2000) and Sundra (2000).

7.1.4.3. Hypothesis 5c

Hypothesis 5c (Section 4.2.5.3, chapter four) proposes that there is a positive relationship between managerial use of information technology and a manufacturing firm's internal business process-related performance. The results presented in Table 6.10 in chapter 6 support the hypothesis, as the relationship is significant and positive.

An interpretation of the results is that managerial use of information technology is an important factor, which enhances the effect of manufacturing automation and strategic alliance on internal business process-related performance. Managerial use of information technology can help a manufacturer to establish close collaborations and cooperation with its alliance partners and ensure reliable supply of raw materials and spare parts, therefore, rework of defective products consuming additional labour and materials can be avoided (Andersen & Segar, 2001).

Information technology such as Internet, Intranet and video conferencing help managers to work efficiently in terms of time, personnel, and cost. For example, the sharing of information between production managers and suppliers through Intranet can help manufacturing companies reduce purchasing personnel (for approval process, putting order, and negotiating better contract pricing). Information technology also helps companies to leverage existing contracts more effectively, decrease unplanned or ad hoc purchase and reduce duplicate paper works while increasing accuracy (Weil, 2000).

The results also show that information technology enhances the performance effect of manufacturing automation adoption and strategic alliance engagement. The association between the internal business process-related performance and manufacturing automation, strategic alliance, and information technology is significant and positive which means that a manufacturing firm's adoption of manufacturing automation and its engagement in strategic alliance have both a direct effect, and an indirect effect through its managers' use of information technology on its internal business process-related performance. Information technology, by facilitating instant transmission, exchange and sharing of information, integrates different departments within a manufacturing company and thereby improves the company's performance. For example the integration between production department and purchasing department helps production managers manage productions smoothly. Besides information technology helps a manufacturing firm have close collaboration and cooperation with its alliance partner organisations, and as a result gain the benefits of getting reliable supply of raw materials and spare parts, which in turn, minimize rework of defective products and the related costs.

The results support Howell (2000), Gupta and Somer (1989) and Meredith (1987). Howell (2000) reports that IBM, having a close communication and cooperation with its alliance partners through use of information technology, is successful in making significant improvement in its internal business process efficiency. Gupta and Somer (1989), Meredith (1987) argue that with the support from information technology, manufacturing automation can significantly improve the internal business process efficiency. This study extends Howell (2000), Gupta and Somer (1989) and Maredith (1987). These studies ignore the role of a firm's adoption of manufacturing automation and its engagement in a strategic alliance together with managerial use of information technology. The current study does so. It investigates the role of a manufacturing firm's adoption of the automation and managerial use of information technology along with that of strategic alliance, therefore, its model is comprehensive and extends these studies.

7.1.4.4. Interviews with Managers

The above interpretations of the results for hypotheses 3c, 4c and 5c above are further supported by the information collected through the face to face interviews with the selected business unit managers. For instance, during the interview with the manager of a DVD and VCD manufacturer, it became clear that adoption of manufacturing automation resulted in high production efficiency. According to the manager, defective products in the firm used to be detected by employees using audio or video test machines before manufacturing automation was adopted. For this purpose, thousands of product units had to be tested which took weeks to finish. But, with the automated manufacturing system, the defective products are automatically detected, dropped from production process and crushed before a further processing is done, thereby saving the testing time, labour and material costs. Moreover, the automated manufacturing system recycles the defective products, therefore reduces material costs also.

An interview with the manager of a Take Away plastic container manufacturer also disclosed that adoption of manufacturing automation by his company significantly saves plastic loss, as the defective products are scrapped and reused in production. The manager said: "Before, there were many mistakes done by our workers, they could not cut the shape of the containers perfectly… it was not straight and the size of each container was not standard. With the automatic machines, the plastic sheets are heated, shaped and cut perfectly, and the ones, which are not perfect, can be reheated into melted plastic and reshaped. So we reduce the defective products and since then material waste has been reduced by 100%".
Similarly, the interview with the manager of a traditional herbs manufacturer revealed that the automated packaging system adopted by the company helps the company save time to weigh the herbs, fill up and seal the paper packages, so the labour requirement is reduced. Further, before the adoption of manufacturing automation, all raw herbs used to be sorted out manually which was subject to many unavoidable errors. But, adoption of manufacturing automation eliminated the errors, therefore defective products. Consequently, adoption of manufacturing automation resulted in

the reduction in labour hours and materials loss, thereby, improving process efficiency. As the manager commented: "our production machines sort, dry and weigh and send the herbs to the blending machine automatically. The blended herbs are put in the package automatically. No human hands are involved; very hygienic".

In addition, the manager of the herbs manufacturing company, during the interview, explained that his company's alliance with the maintenance services companies is more beneficial than managing the services by his company. This is because, the maintenance services companies carry out routine maintenance, which helps the herbs manufacturing company reduce defective products, save materials and most importantly help the company keep up to date and adapt with the changing technology and improve its competitive advantage. The manager said: "we are not engineer or technology experts; we have an alliance with production technology companies, which check our machine and renew our production machine technology routinely. So we are never technologically left behind". Further, the manager also explained that use of information technology helps his company to communicate and coordinate their marketing channels, which are located around the globe.

7.1.5. Learning and Innovation -Related Performance

7.1.5.1. Hypothesis 3d

Recall, hypothesis 3d in section 4.2.3.4 of chapter four proposes that a manufacturing firm's adoption of manufacturing automation is positively associated with the firm's learning and innovation-related performance. However the results presented in Table 6.11 in chapter 6 reveal that learning and innovation-related performance of a manufacturing firm is not associated with the firm's adoption of manufacturing automation, therefore, the hypothesis is not supported.

An interpretation of the results is that in the competitive environment, product life cycle becomes very short and manufacturers need to keep monitoring the trend in products' demand, customer needs, and competitors' products. Manufacturers also need to respond to varying levels of market demand and changing customer tastes and requirements, take advantage of technological innovations and rapidly changing competitive conditions. Without monitoring the changing environment, adoption of manufacturing automation may not mean anything, as the manufacturer may not optimise the flexibility of the automation. Worse, the firm may keep producing products, which are not in demand. It is imperative that manufacturing firms realise that technology itself does not help them become innovative. Product learning and innovation comes from the results of product observation, research and creation. It needs to have a broad vision and knowledge to bring the company to the height of learning and innovation. Therefore, departments including production, R&D, and marketing need to be well integrated and coordinated to promote innovation. Marketing department has to keep observing the new trend in the product demand and must share the information with production and R& D departments. Coordination and communication among these departments are critical, as these three departments have to work closely for new product development. The results indicate that success of a firm's adoption of manufacturing automation in improving its learning and innovation is dependent on managerial use of information technology, which acts as a mediator in the relationship. In other words, the relationship between adoption of manufacturing automation and learning and innovation-related performance is not direct, rather it is indirect via managerial use of information technology.

The results empirically extend Boyer et al (1996) and Vokurka et al (1998), who investigate the impact of only a firm's adoption of manufacturing automation on its profitability, not on other aspects of organisational performance. The current study investigates the above relationship with the financial as well as non-financial performance including the customer, internal business process, and learning and innovation-related performance. Moreover, unlike Boyer et al (1996) and Vokurka et al (1998), the current study investigates the relationship incorporating the role of strategic alliance and the use of information technology, therefore, offering a more comprehensive understanding of the relationship.

7.1.5.2. Hypothesis 4d

Recall, section 4.2.4.4 of chapter four presents hypothesis 4d proposing that there is a positive relationship between a manufacturing firm's engagement in strategic alliance and its learning and innovation-related performance. The results show that the firm's engagement in strategic alliance and its learning and innovation-related performance is not associated. So, Hypothesis 4d is not supported.

An interpretation of the results is that a manufacturing firm's learning and innovation-related performance may not improve just because of the firm's engagement in strategic alliance; a close collaboration among the alliance partner firms is critical for the alliance to attain synergy of the alliance. Understanding, trust and close communication among strategic alliance partner organisations are important factors to maintain the alliance and to gain benefits from the alliance for learning and innovation (Balakrsihnan et al, 1999; Nee, 1992; Patuwo and Hu, 1998; Peng & Heath, 1996; Xin & Pearce, 1996). It is essential to have a clear understanding, trust and close communication among a strategic alliance partners for the alliance to be successful in improving learning and innovation-related performance (see. Grant & Baden-Fuller, 1995; Mowery et al., 1996; Whipple & Frankel, 2000). For example, a manufacturing firm's alliance with marketing firms can help the manufacturer understand more clearly the trend in product demand in response to customer tastes and needs provided there is trust and close communication among the alliance member firms (Hamel, 1991; Inkpen & Crossan, 1995; Teece & Pisano, 1994). Such an alliance can help manufactures innovate new products, which are in trend and market it timely; in the process, create a competitive advantage.

The results support Li & Atuahene-Gima (2001) who report that, strategic alliance among companies in China is not positively related to product innovation. The explanation provided by Li & Atuahene-Gima (2001) is that the relationship among the alliance partner companies was not congenial due to difficulties among the alliance members' management. However, Li & Atuahene-Gima do not incorporate the role of information technology in this study. The result also support Balakrishnan et al (1999), who argue that the role of information technology and strategic alliance is important to support new product development, i.e., innovation.

7.1.5.3. Hypothesis 5d

Recall, hypothesis 5d in section 4.2.5.4 of chapter four proposes that there is a positive relationship between managerial use of information technology and a manufacturing firm's learning and innovation-related performance. The results presented in Table 6.11 in chapter 6 indicate that learning and innovation-related performance is positive and significantly associated with the use of information technology, therefore the hypothesis is supported.

An interpretation of the results is that integration among departments within an organisation is of paramount importance for improving learning and innovation-related performance (Feraro et al, 1988). Consider, for instance the scenario that in a manufacturing firm, the marketing manager informs the production manager about the new trend in demand for a product. The information brings the production, marketing, R & D, finance, purchasing and personnel departments together to work on the design and manufacturing of the new product. This process of learning and innovation is repeated for each new product development and the process can take time to accomplish the design, produce and launch the product (see Hansen & Mowen, 1997). For this purpose, transmission of information to relevant parties must be timely, so that the process of new product development is fast. Andersen (2001) and Tullo (2000) argue that information technology helps companies to integrate and increase the collaboration and cooperation among the departments. Using information technology, such as Internet and Intranet, marketing department may have an access to monitor the new product's features, which are aligned with the potential customers' needs, tastes and demand. Information technology also makes it easy for marketing department to evaluate the product design, graph and all other details and transmit them to production department instantly. The use of information technology also helps production managers to have close communication and cooperation with suppliers and get appropriate materials at the right time (McGee et al, 1995; Shan, 1990). Further, using information technology, meetings and discussions about the new product development process explained above can be done without all parties coming to the same place, therefore, the decision process becomes faster. Video conferencing can help the process of meetings and discussion fast, cheap and effective. Without the use of information technology, the new product developments can be slow and costly, as all department managers have to come to a certain place at the same time (Mollenauer, 1991; Andersen, 2001).

The results empirically extend Andersen & Segar (2001) who find that the use of information technology enhances communication for decision making and improves financial performance in the textile and apparel industry, USA. An interpretation of the results indicates that the application of manufacturing automation and the engagement in a strategic alliance may improve learning and innovation-related performance via managerial use of information technology. The flexibility offered by manufacturing automation alone may not help a manufacturer to be innovative, unless the manufacturer understands the trend in the product demand. Therefore, a manufacturer needs to monitor the product trend and as information technology enables its users to access information around the globe, a manufacturer can easily search and monitor the development of new products, technology and change in customer taste. Information technology also gives access to all parties within a company to share and exchange information, therefore, other departments such as marketing department can help production departments remain informed about the new product trends. Product design can be effective as all parties within and outside the company can get involved easily through the use of information technology. For example, the use of Internet or Intranet can help R& D to transmit to production and marketing departments graphs and all details of the plan within minutes. All meetings and discussions can be held through Internet and videoconference, which is more efficient and effective. Finally, close communication with alliances such as distribution channels, suppliers and R&D through the use of information technology is not only cheaper but also faster.

7.1.5.4. Interviews with Managers

The above interpretations offered for the results for hypotheses 3d, 4d and 5d are further explained by using the information collected during the interviews with the managers in the selected business units. The managers during the interviews expressed the view that manufacturing automation alone may not make companies innovative. Brilliant ideas based on market research or customer preferences together with the trend of technology can help a company to be innovative.

During the interview with the manager of a garments manufacturing firm, the manager explained that manufacturing automation helps garments design and production as it is easy to switch the system to produce different products within the same category. Further, an alliance with other companies such as delivery alliance can help a manufacturer to effectively market its products, while an alliance or joint licensing with an R&D company or a company selling other brand can result in knowledge and technology transfer leading to new learning and innovation.

The interview with the manager of a home appliance manufacturer revealed that information technology and strategic alliance support the firm's product development. The technology and design of home appliances change rapidly. Customer tastes and needs change overtime along with technology development. The manager said that when the design of a new product is done, it is sent to marketing, purchasing and production departments, which then search internal and global data bases for similar product designs, compatible components, suitable processes, and available suppliers of inputs as well as alternative machines. All of these functional departments must be working together, frequent meetings have to be held. The use of information technology saves the managers' time as they can participate in meetings from their desks. R&D contacts help modify the design and develop the prototype of the product(s), while contact with marketing agency support marketing research.

7.2. Implication of the Results of the Study

7.2.1. Research Implications.

In terms of research, the results of the study indicate that managerial use of information technology is an important factor mediating the relationship between a manufacturing firm's adoption of manufacturing automation and engagement in strategic alliance in improving its performance. The results also indicate that managerial use of information technology is significantly and positively associated with the financial and other attributes of organisational performance (including customer, internal business process, and learning and innovation) of the manufacturing firms participated in the study. Therefore, the results suggest that the role of managerial use of information technology should be taken into account in future research examining the effect of firm's adoption of manufacturing automation, engagement in strategic alliance and similar other variables on organisational performance.

The results reveal that managerial use of information technology (including Internet, Intranet and Videoconference) mediates the effect of a firm's adoption of manufacturing automation on the firm's performance. This is because the use of the technology facilitates a manufacturing firm's integration, coordination and cooperation of departments, which in turn improves organisational performance (financial performance, customer-related performance, internal business process-related performance, and learning and innovation -related performance).

Managerial use of information technology is also an important variable mediating the relationship between a manufacturing firm's engagement in strategic alliance and its performance because the use of information technology engenders close communication, clear understanding and trust among strategic alliance partner organisations, thereby improves organisational performance.

7.2.2. Implications for Practice.

In terms of practice, the results of the study have implications for the selection of infrastructure to support a firm's adoption of manufacturing automation and engagement in strategic alliance, and also for organisational performance. The study suggests that the adoption of manufacturing automation itself may not always improve various aspects of performance of a manufacturing firm. Adoption of manufacturing automation does not directly affect the firm's financial performance and also the learning and innovation-related performance. Similarly, engagement in strategic alliance also does not directly affect the firm's financial performance, customer-related performance, and learning and innovation–related performance. The results of the study reveal that managerial use of information technology acts as a mediator in the above relationships. In other words, the results indicate that to gain the benefits of a manufacturing firm's adoption of manufacturing automation, managerial use of information technology is needed for communication and sharing information among managers of different departments (including production, marketing, R&D, HRM, and purchasing) within a firm and also with parties external to the firm. For instance, sharing of information between a manufacturing firm's production and marketing departments support close communication and collaboration between the two departments, therefore, the production department can timely adjust production activities in response to the market demand. Through managerial use of information technology including Internet, Intranet and videoconference, a manufacturing firm can speed up the information sharing with its alliance partners and, as a result, can avoid inventory build up as well as idle machine's capacity. This is because, since information technology can instantly transmit necessary information, the alliance partners (e.g., R&D, suppliers, and distributors) are able to respond to the manufacturing firm's need in the right time. Besides, because of its capability to simultaneously transmit to all relevant parties pictures, designs, graphs and group discussions, information technology enables manufacturers to improve their performance including financial, customer, internal business process, and learning and innovation.

Therefore, it is argued that Indonesian manufacturing firms would benefit from facilitating managerial use of information technology simultaneously with adoption of manufacturing automation and engagement in a strategic alliance to improve their performance. The discussion in 7.1.3-6 of this chapter of the thesis would suggest that a manufacturing firm's lack of attention to managerial use of information technology may lead to suboptimal benefits from investment in adoption of manufacturing automation and engagement in strategic alliance.

7.3. Limitation of the Study and Further Research

Similar to other field studies, this study also suffers from several limitations. These are:

First, although companies representing 19 different industries participated in the study, all of them are manufacturing companies. Therefore, the results may be manufacturing industry specific, so caution is necessary to generalise the results to other industries. Testing the model of the study in service organisations such as hospitality and banking and finance industry may be beneficial.

Second, this study does not consider the time lag between a firm's adoption of manufacturing automation and realisation of the desired benefits. Since a firm's desired level of adoption of manufacturing automation may continue over a number of years due to high capital investment specially in Indonesia, it is possible that adoption of the automation in the Country may take some time to generate the desired benefits. Therefore, it is possible that companies which were adopting the automation at the time of the data collection for the current study may not have realized appreciable returns from their investment in the automation (Meredith & Vineyard, 1993). A longitudinal study may find results, which are different from those reported in this study.

Third, this study does not consider the different types of strategic alliance that a manufacturing firm can engage in. The extant literature suggests that strategic alliance may be of vertical or horizontal form. A vertical alliance focuses on supplier-manufacturer-distributor relationships (Bucklin and

Sengupta 1993; Foest, 1990; Harrigan, 1985; 1986; 1988; Andersen & Narus 1984; 1990; Anderson & Weitz, 1992). On the other hand, a horizontal alliance focuses on the relationship between similar firms within the same industry. Strategic alliance may also include network with strategic departments or institutions such as government departments, and other business organisations. Further, strategic alliance may also be internal and external. Internal strategic alliance is between a manufacturer and its stakeholders, for instance companies, which are under the same ownership or under the control of one head office. External strategic alliance is between a manufacturer and other companies, which are under different ownership. Future research on the relationship between a manufacturing firm's performance and its engagement in different types of strategic alliance, adoption of manufacturing automation, and managerial use of information technology is needed to understand if different types of strategic alliance has differential effect on the relationships (Becket-Camarata et al, 1998; Lorange et al., 1992).

7.4. Conclusion

From the discussion above, it can be concluded that:

First, Managerial use of information technology is associated with the extent of a manufacturing firm's adoption of manufacturing automation as the adoption of the automation needs high integration among departments within a company as well as outside the company.

Second, Managerial use of information technology is also affected by the extent of a manufacturing firm's engagement in strategic alliance, as the success of the alliance is depended on close communication, collaboration and trust among the alliance partners.

Third, managerial use of information technology is required for the success of a firm's adoption of manufacturing automation in its performance. This is because the use of the technology mediates the above relationship with its capability to instantly transmit information, facilitate sharing of information among department managers within the firm as well as strengthen and increase collaboration, cooperation, and understanding with alliance partners.

Fourth, managerial use of information technology acts as a mediator in the relationship between a manufacturing firm's customer-related performance and its adoption of manufacturing automation, and its engagement in strategic alliance. Communication, collaboration and cooperation with supplier alliance through the use of information technology also ensures that the manufacturer get good quality raw materials and spare parts and therefore it can produce high quality products and provide high quality services to its customers. A strong relationship with a supplier alliance partners enables manufacturing companies to improve their product and service quality. The use of information technology also helps manufacturers distribute their products quickly in response to their customer needs.

Fifth, a manufacturing firm's engagement in strategic alliance, supported by managerial use of information technology, not only provides good quality raw materials and spare parts, but it also reduces defective products as manufacturing system processes good quality raw materials and is supported with good spare parts which arrive at the factory on time. By reducing the defective products, manufacturing lead-time can be reduced or eliminated and internal business process–related performance is improved.

Sixth, the flexibility offered by an automated manufacturing system alone may not help a manufacturer's innovative efforts, unless the manufacturer understands the trend in the product demand. Therefore, a manufacturer's adoption of the automation needs to be supported by managerial use of information technology to monitor the products' demand trend and access to information around the globe on development of new products, new technology and customer tastes.

APPENDIX A.

QUESTIONNAIRE

..... January, 2002

Mr..............
....
Dear ....,

I am an academic staff, Faculty of Economics, Satya Wacana Christian University, and Partner, HLB Hadori & rekan International Accounting Firm. Currently, I am doing my PhD in accounting under the supervision of Dr. Hadori Yunus, the Managing Partner of HLB Hadori & rekan and Professor Lokman Mia, Professor of Accounting, Griffith University, Australia. In my PhD research, I am particularly interested to find out why application of manufacturing automation, performance management and information technology is successful in improving performance in some organisations but not in others.

Further to my telephone conversation with you on ...., I like to sincerely thank you for agreeing to participate in my study. Your participation in the study requires only to complete the attached questionnaire which should not take more than 30 to 40 minutes. Please complete the questionnaire without discussing your responses with anyone. It is essential for the purpose of the study to have your own opinion.

The information that I am gathering will be used only for the research purposes. I assure you that under no circumstances will your responses be made available to anyone. You will not be individually identified in my PhD thesis. To further ensure this confidentiality, your name does not appear anywhere in the questionnaire.

I appreciate very much your help.

Yours sincerely,

Lanita Winata

SEKSION A : JENIS INDUSTRI

SECTION A: TYPE OF INDUSTRY

Jenis industri

You may write or tick your answer here ↓

Type of industry

Jenis industri dari perusahaan anda adalah:

Your company's type of industry is:

Otomobil dan produk terkait		Automotive and allied products
Elektrik dan peralatan elektrik		Electric and electronics equipment
Semen		Cement
Kimia dan produk terkait		Chemical and allied products
Barang barang konsumsi		Consumer goods
Manufaktur tembakau		Tobacco manufacturers
Makanan dan minuman		Food and beverage
Kayu dan produk papan		Lumber and wood products
Kain dan perlengkapannya		Apparel and other textile products
Jamu/ minuman tradisional		Herbal/ traditional medicine
Produk metal		Fabricated metal products
Farmasi		Pharmaceutical
Plastic dan produk dari gelas		Plastic and glass products
Lainnya (silahkan jekaskan)……………………		Other (please specify)……………

Please tick your answers here

Rata rata perputaran penjualan perusahaan anda adalah:	**2001**	**2000**	**1999**	**Your company's approximate sales turnover was**
Kurang dari Rp. 25 milyar				Less than Rp. 25.billion
Di atas Rp. 25 milyar - Rp. 30 milyar.				Above Rp. 25. billion - Rp. 30 billion.
Di atas Rp. 30 milyar - Rp. 35 milyar.				Above Rp. 30 billion - Rp. 35 billion
Di atas Rp. 35 milyar - Rp. 40 milyar.				Above Rp. 35 billion - Rp. 40 billion
Di atas Rp. 40 milyar.				Above Rp. 40 billion

SEKSION B: OTOMASI

Banyak perusahaan pada akhir akhir ini menanamkan modalnya pada otomasi manufaktur. Otomasi ini berkisar dari mulai perancangan produk, perencanaan dan pengendalian, proses produksi sampai dengan perakitan. Silahkan mengidentifikasi seberapa jauh proses produksi di organisasi anda menggunakan jenis jenis otomasi berikut di bawah ini:

Please circle your answers below

SECTION B: AUTOMATION

Many companies worldwide have undertaken major manufacturing automations defined in terms of computer-controlled manufacturing equipment. These automations are ranging from product design, planning and control, process, and assembly. Please indicate the extent to which the following computerised manufacturing system are used in your organisation

	Low				High	
Perancangan produk (misalnya penggunaan Computer Aided Design/ CAD atau suatu alat computer untuk menggambar, merancang suatu suku cadang, menganalisa atau merancang suatu suku cadang atau produk)	1	2	3	4	5	Product design (e.g. the use of Computer Aided Design/CAD or a computerised device for drawing and designing parts or products and for analysis and testing of designed parts or products).

Manufaktur produk (misalnya penggunaan Computer Aided manufacturer/ CAM atau sekelompok mesin produksi yang saling berkomunikasi melalui komputer	1	2	3	4	5	Product manufacturing (e.g. the use of Computer Aided Manufacturing/ CAM or a form of automation where computers communicate work instructions directly to the manufacturing machinery)
Proses perencanaan (misalnya penggunaan Computer-Aided Process Planning /CAPP atau sekelompok komputer untuk merancang produk dan menghubungkan perancangan ini dengan rencana produksi, seperti pemilihan mesin, alat, produksi dan jadwal produksi)	1	2	3	4	5	Proses planning (e.g. the use of Computer- Aided Process Planning or CAPP or a series of computers for designing the products and link the design to the production planning, such as machine selection, tool selection, and production route)

Flexible Manufacturing Systems of FMS (Sekelompok mesin produksi otomatis yang saling bekerja sama tetapi tidak mempunyai komunikasi langsung dengan kelompok mesin yang lainnya)	1	2	3	4	5	Flexible Manufacturing Systems or FMS (A group of automated production machines that work together but have no direct communication with other machines and systems outside their group).
Pengelolaan material otomatis (termasuk pendistribusian secara otomatis, alur bahan baku secara otomatis, pemindahan bahan baku secara otomatis dan penyimpanan secara otomatis)	1	2	3	4	5	Automated Material Handling (including automated distribution, automated material flow, automated material handling and automated storage)

SEKSION C : STRATEGIK ALLIANSI

Alliansi strategic didefinisikan sebagai kerjasama yang mengikat dan memberikan keuntungan timbal balik antar organisasi organisasi yang terikat di dalam perjanjian . Kerja sama ini ditujukan untuk memberikan keuntungan jangka panjang bagi semua pihak terkait. Perjanjian ini tidak selalu merupakan pengikatan kepemilkan Silahkan tunjukkan sampai seberapa jauh perusahaan anda mempunyai kerjasama timbal balik dengan perusahaan perusahaan lain

Please circle your answers below

↓

SECTION C: STRATEGIC ALLIANCE

Strategic alliance was defined as a cooperative and mutual agreement between autonomous organisations with a view to improving competitive advantage and long-term profitable value for all the cooperating parties; nonetheless, the agreement may or may not involve cross-partner equity investments. Please indicate the extent to which your company has a mutual agreement or business network with other companies.

	Strongly disagree				**Strongly agree**	
Perusahaan saya bekerjasama dengan perusahaan lain untuk memproduksi produk perusahaan saya.	1	2	3	4	5	My company has entered into cooperative agreements with other firms to produce the products
Perusahaan alliansi saya memberikan dukungan jasa (seperti pemeliharaan, pelatihan dan pemerosesan data)	1	2	3	4	5	My company's alliance partners provided my company support services (such as providing maintenance, training, administration and data processing)
Perusahaan saya bekerja sama dengan perusahaan lain untuk melakukan penelitian dan pengembangan produk perusahaan saya.	1	2	3	4	5	My company has established cooperative agreements with other firms and institutions for R&D.

SEKSION D : PENGGUNAAN INFORMASI TEKNOLOGI

Sesi ini tentang penggunaan informasi teknologi (IT) sebagai alat komunikasi oleh perusahaan. It yang dimaksudkan adalah intranet, internet dan video conferencing. Silahkan tunjukkan sampai seberapa jauh manager manager anda menggunakan informasi teknologi.

Please circle the answers below

↓

SECTION D: THE USAGE OF INFORMATION TECHNOLOGY

This section is concerned with use of information technology (IT) for managerial purposes. IT includes intranet, internet and videoconference. Please indicate the extent of your managers' use of information technology

	Not at all				**Always**	
Seberapa jauh perusahaan anda menggunakan e-mail untuk meningkatkan komunikasi deng personil personil di dalam organisasi.	1	2	3	4	5	To what extent do the managers in your organisation use electronic mail (by Intranet), to communicate with different people across the organisation?

Seberapa jauh perusahaan anda menggunakan jaringan internal (intranet) untuk mengakses informasi dan data dari bagian bagian lain di perusahaan.	1	2	3	4	5	To what extent do the managers in your organisation access information, and data from other parts of the firm via the computer network (Intranet)?
Seberapa jauh perusahaan anda menggunakan email (melalui intranet) untuk saling mengirimkan informasi ke bagian manufaktur, engineering dan bagian bagian fungsional yang lain.	1	2	3	4	5	To what extent do the managers in your organisation use electronic mail (by Intranet) to exchange information with manufacturing, engineering, and other functional areas?
Seberapa jauh manajer manajer anda mendapatkan infomasi dengan menggunakan internet atau jaringan data eksternal yang serupa	1	2	3	4	5	To what extent do the managers in your organisation use the Internet or similar external data networks to obtain work related information?
Seberapa jauh manajer manajer anda menggunakan internet atau data interface lain untuk berkomunikasi dengan pelanggan, pemasok dan pihak pihak lainnya.	1	2	3	4	5	To what extent do the managers in your organisation use the Internet or other data interface to communicate with customers, suppliers, and other parties?

SEKSION E: PERFORMANSI PERUSAHAAN

Please circle the answers below

SECTION E: ORGANISATIONAL PERFORMANCE

Dibandingkan dengan pesaing pesaing perusahaan anda, tunjukkan rata rata pertumbuhan performansi perusahaan anda selama tiga tahun terakhir

Please indicate the average growth of your company's performance relative to your competitors for the last three years in terms of:

	Below Average				**Above average**	
Waktu merespon pelanggan	1	2	3	4	5	Customer response time
Siklus waktu dari pesanan sampai dengan pengantaran barang	1	2	3	4	5	Cycle time from order to delivery
Selisih efisiensi tenaga kerja	1	2	3	4	5	Labor efficiency variance
Tenggang waktu proses manufaktur	1	2	3	4	5	Manufacturing lead time
Pangsa pasar	1	2	3	4	5	Market share
Selisih efisiensi bahan baku	1	2	3	4	5	Material efficiency variance
Jumlah paten baru	1	2	3	4	5	No. of new patents
Jumlah peluncuran produk baru	1	2	3	4	5	No. of new product launches
Jumlah keluhan pelanggan	1	2	3	4	5	Number of customer complaints
Ketepatan pengiriman barang yang dipesan	1	2	3	4	5	On-time delivery of orders

	Below Average				**Above average**	
Laba operasi	1	2	3	4	5	Operating income
Tingkat kerugian disebabkan oleh bahan baku yang tersisa	1	2	3	4	5	Rate of material scrap loss
Rasio produk yang bagus dibanding yang yang rusak	1	2	3	4	5	Ratio of good output
Perputaran investasi (laba : total investasi)	1	2	3	4	5	Return on Investment (income divided by total investment)
Pertumbuhan penjualan	1	2	3	4	5	Sales growth
Waktu untuk memasarkan produk baru	1	2	3	4	5	Time to market new product
Biaya perbaikan di dalam masa garansi	1	2	3	4	5	Warranty repair cost

APPENDIX B
COMPUTATION OF PATH COEFFICIENTS

Information Technology

The decomposition of the correlations between (X_3), i.e., managers' usage of information technology for communication (ITC) and the extent of manufacturing automation (X_1), and strategic alliance (X_2) can be worked out as follows.

$X_3 = P_{31}X_1 + P_{32} X_2 + P3uRu$

(1)

Multiplying the equation (1) by X_1, we get:

(2).

$X_1X_3 = P_{31}X_1 X_1 + P_{32} X_1X_2 + P_{3u}R_uX_1$

(3).

Or, $r_{13} = P_{31} + P_{32}r_{12} + P_{3u}R_uX_1$

(4).

Or, $r_{13} = P_{31} + P_{32}r_{12}$

(5).

Similarly, Multiplying the equation (1) by X_2, we get:

$r_{23} = P_{31} r_{12} + P_{32} + P_{3u}R_uX_1$

(6).

Or, $r_{23} = P_{31} r_{12} + P_{32}$

(7).

For financial performance.

Decomposition of the correlation between X_1 and X_{4a} (i.e., r_{14a}), X_2 and X_{4a} (i.e., r_{24a}), and between X_3 and X_{4a} (i.e., r_{34a}) following the same technique applied in equations (3 to 7) above.

$X_{4a} = P_{4a1}X_1 + P_{4a2} X_2 + P_{4a3} X_3 + P_{3a}vRv$ (8).

Or, $X_1X_{4a} = P_{4a1}X_1 X_1 + P_{4a2} X_1X_2 + P_{4a3} X1X3 + P3a_vR_vX1$ (9).

Or, $r_{14a} = P_{4a1} + P_{4a2}r_{12} + P_{4a3}r_{13} + P_{3av}R_vX_1$ (10).

Or, $r_{14a} = P_{4a1} + P_{4a2}r_{12} + P_{4a3} (P_{31} + P_{32}r_{12})$, substituting the value for (r_{13}) in equation (5) above (11).

Or, $r_{14a} = P_{4a1} + P_{4a2}r_{12} + P_{4a3}P_{31} + P_{4a3}P_{32}r_{12}$ (12).

Therefore, we get r_{14a} consisting of the direct effect (P_{4a1}), the indirect effect ($P_{4a3}P_{31}$), and the unanalysed effect ($P_{4a2}r_{12}$), and ($P_{4a3}P_{32}r_{12}$).

Multiplying the equation (8) by X_2, we get:

$X_2X_{4a} = P_{4a1}X_1 X_2 + P_{4a2} X_2X_2 + P_{4a3} X_2X_3 + P_{3av}R_vX_2$ (13).

Or, $r_{24a} = P_{4a1}r_{12} + P_{4a2} + P_{4a3}r_{23} + P_{3av}R_vX_2$ (14).

Or, $r_{24a} = P_{4a2} + P_{4a1}r_{12} + P_{4a3} (P_{31}r_{12} + P_{32})$, substituting the value for (r_{23}) in equation (7) above (15).

Or, $r_{24a} = P_{4a2} + P_{4a1}r_{12} + P_{4a3}P_{31} r_{12} + P_{4a3}P_{32}$ (16).

Therefore, we get r_{24a} consisting of the direct effect (P_{4a2}), the indirect effect ($P_{4a3}P_{32}$), and the unanalysed effect ($P_{4a1}r_{12} + P_{4a3}P_{31}r_{12}$).

Multiplying the equation (8) by X_3, we get:

$X_3X_{4a} = P_{4a1}X_1\ X_3 + P_{4a2}\ X_2X_3 + P_{4a3}\ X_3X_3 + P_{3av}R_vX_3$ (17).

Or, $r_{34a} = P_{4a1}r_{13} + P_{4a2}r_{23} + P_{4a3} + P_{4av}R_vX_3$ (18).

Or, $r_{34a} = P_{4a3} + P_{4a1}(P_{31} + P_{32}r_{12}) + P_{4a2}\ (P_{31}r_{12} + P_{32})$, substituting the value for (r_{23}) in equation (7) above (19).

Or, $r_{34a} = P_{4a3} + P_{4a1}P_{31} + P_{4a1}P_{32}r_{12} + P_{4a2}P_{31}\ r_{12} + P_{4a2}P_{32}$ (20).

Therefore, we get r_{34a} consisting of the direct effect (P_{4a3}) and the spurious effects ($P_{31}P_{4a1}$), ($P_{4a2}P_{32}$), ($P_{4a1}P_{32}r_{12} + P_{4a2}P_{31}r_{12}$).

For non- financial performance.

1. **Customer-related performance (X_{4b}).**

Decomposition of the correlation between X_1 and X_{4b} (i.e., r_{14b}), X_2 and X_{4b} (i.e., r_{24b}), and between X_3 and X_{4b} (i.e., r_{34b}) following the same technique applied in equations (3 to 5) above.

$X_{4b} = P_{4b1}X_1 + P_{4b2}\ X_2 + P_{4b3}\ X_3 + P_{3b}vRv$ (21).

Multiplying the equation (21) by X_1, we get:

$X_1X_{4b} = P_{4b1}X_1\ X_1 + P_{4b2}\ X_1X_2 + P_{4b3}\ X1X3 + P3b_vR_vX1$ (22).

Or, $r_{14b} = P_{4b1} + P_{4b2}r_{12} + P_{4b3}r_{13} + P_{3bv}R_vX_1$ (23).

Or, $r_{14b} = P_{4b1} + P_{4b2}r_{12} + P_{4b3}\ (P_{31} + P_{32}r_{12})$, substituting the value for (r_{13}) in equation (5) above (24).

Or, $r_{14b} = P_{4b1} + P_{4b2}r_{12} + P_{4b3}P_{31} + P_{4b3}P_{32}r_{12}$ (25).

Therefore, we get r_{14b} consisting of the direct effect (P_{4b1}), the indirect effect ($P_{4b3}P_{31}$), and the unanalysed effect ($P_{4b2}r_{12} + P_{4b3}P_{32}r_{12}$).

Multiplying the equation (21) by X_2, we get:

$X_2X_{4b} = P_{4b1}X_1 X_2 + P_{4b2} X_2X_2 + P_{4b3} X_2X_3 + P_{3bv}R_vX_2$ (26).

Or, $r_{24b} = P_{4b1}r_{12} + P_{4b2} + P_{4b3}r_{23} + P_{3bv}R_vX_2$ (27).

Or, $r_{24b} = P_{4b2} + P_{4b1}r_{12} + P_{4b3} (P_{31}r_{12} + P_{32})$, substituting the value for (r_{23}) in equation (7) above (28).

Or, $r_{24b} = P_{4b2} + P_{4b1}r_{12} + P_{4b3}P_{31} r_{12} + P_{4b3}P_{32}$ (29).

Therefore, we get r_{24b} consisting of the direct effect (P_{4b2}), the indirect effect ($P_{4b3}P_{32}$), and the unanalysed effect ($P_{4b1}r_{12} + P_{4b3}P_{31}r_{12}$).

Multiplying the equation (21) by X_3, we get:

$X_3X_{4b} = P_{4b1}X_1 X_3 + P_{4b2} X_2X_3 + P_{4b3} X_3X_3 + P_{3bv}R_vX_3$ (30).

Or, $r_{34b} = P_{4b1}r_{13} + P_{4b2}r_{23} + P_{4b3} + P_{4bv}R_vX_3$ (31).

Or, $r_{34b} = P_{4b3} + P_{4b1}(P_{31} + P_{32}r_{12}) + P_{4b2} (P_{31}r_{12} + P_{32})$, substituting the value for (r_{23}) in equation (7) above (32).

Or, $r_{34b} = P_{4b3} + P_{4b1}P_{31} + P_{4b1}P_{32}r_{12} + P_{4b2}P_{31} r_{12} + P_{4b2}P_{32}$ (33).

Therefore, we get r_{34b} consisting of the direct effect (P_{4b3}) and the spurious effects ($P_{31}P_{4b1}$), ($P_{4b2}P_{32}$), ($P_{4b1}P_{32}r_{12} + P_{4b2}P_{31}r_{12}$).

2. Internal business process-related performance (X_{4c}).

Decomposition of the correlation between X_1 and X_{4c} (i.e., r_{14c}), X_2 and X_{4c} (i.e., r_{24c}), and between X_3 and X_{4c} (i.e., r_{34c}) following the same technique applied in equations (3 to 7) above.

$X_{4c} = P_{4c1}X_1 + P_{4c2}X_2 + P_{4c3}X_3 + P_{3c}vRv$ (34).

Multiplying the equation (34) by X_1, we get:

$X_1X_{4c} = P_{4c1}X_1X_1 + P_{4c2}X_1X_2 + P_{4c3}X1X3 + P3c_vR_vX1$ (35).

Or, $r_{14c} = P_{4c1} + P_{4c2}r_{12} + P_{4c3}r_{13} + P_{3cv}R_vX_1$ (36).

Or, $r_{14c} = P_{4c1} + P_{4c2}r_{12} + P_{4c3}(P_{31} + P_{32}r_{12})$, substituting the value for (r_{13}) in equation (5) above (37).

Or, $r_{14c} = P_{4c1} + P_{4c2}r_{12} + P_{4c3}P_{31} + P_{4c3}P_{32}r_{12}$ (38).

Therefore, we get r_{14c} consisting of the direct effect (P_{4c1}), the indirect effect ($P_{4c3}P_{31}$), and the unanalysed effect ($P_{4c2}r_{12} + P_{4c3}P_{32}r_{12}$).

Multiplying the equation (34) by X_2, we get:

$X_2X_{4c} = P_{4c1}X_1X_2 + P_{4c2}X_2X_2 + P_{4c3}X_2X_3 + P_{3cv}R_vX_2$ (39).

Or, $r_{24c} = P_{4c1}r_{12} + P_{4c2} + P_{4c3}r_{23} + P_{3cv}R_vX_2$ (40).

Or, $r_{24c} = P_{4c2} + P_{4c1}r_{12} + P_{4c3}(P_{31}r_{12} + P_{32})$, substituting the value for (r_{23}) in equation (7) above (41).

Or, $r_{24b} = P_{4b2} + P_{4b1}r_{12} + P_{4b3}P_{31}r_{12} + P_{4b3}P_{32}$ (42).

Therefore, we get r_{24b} consisting of the direct effect (P_{4b2}), the indirect effect ($P_{4b3}P_{32}$), and the unanalysed effect ($P_{4b1}r_{12} + P_{4b3}P_{31}r_{12}$).

Multiplying the equation (34) by X_3, we get:

$X_3X_{4c} = P_{4c1}X_1X_3 + P_{4c2}X_2X_3 + P_{4c3}X_3X_3 + P_{3cv}R_vX_3$ (43).

Or, $r_{34c} = P_{4c1}r_{13} + P_{4c2}r_{23} + P_{4c3} + P_{4cv}R_vX_3$ (44).

Or, $r_{34c} = P_{4c3} + P_{4c1}(P_{31} + P_{32}r_{12}) + P_{4c2}(P_{31}r_{12} + P_{32})$, substituting the value for (r_{23}) in equation (7) above (45).

Or, $r_{34c} = P_{4c3} + P_{4c1}P_{31} + P_{4c1}P_{32}r_{12} + P_{4c2}P_{31}r_{12} + P_{4c2}P_{32}$ (46).

Therefore, we get r_{34b} consisting of the direct effect (P_{4c3}) and the spurious effects ($P_{31}P_{4c1}$), ($P_{4c2}P_{32}$), ($P_{4c1}P_{32}r_{12} + P_{4c2}P_{31}r_{12}$).

3. Learning and innovation-related performance (X_{4d}).

Decomposition of the correlation between X_1 and X_{4d} (i.e., r_{14d}), X_2 and X_{4d} (i.e., r_{24d}), and between X_3 and X_{4d} (i.e., r_{34d}) following the same technique applied in equations (3 to 7) in Chapter 6.

$X_{4d} = P_{4d1}X_1 + P_{4d2} X_2 + P_{4d3} X_3 + P_{3d}vRv$ (47).

Multiplying the equation (47) by X_1, we get:

$X_1X_{4d} = P_{4d1}X_1 X_1 + P_{4d2} X_1X_2 + P_{4d3} X1X3 + P3d_vR_vX1$ (48).

Or, $r_{14d} = P_{4d1} + P_{4d2}r_{12} + P_{4d3}r_{13} + P_{3dv}R_vX_1$ (49).

Or, $r_{14d} = P_{4d1} + P_{4d2}r_{12} + P_{4d3} (P_{31} + P_{32}r_{12})$, substituting the value for (r_{13}) in equation (5) above (50).

Or, $r_{14d} = P_{4d1} + P_{4d2}r_{12} + P_{4d3}P_{31} + P_{4d3}P_{32}r_{12}$ (51).

Therefore, we get r_{14b} consisting of the direct effect (P_{4d1}), the indirect effect ($P_{4d3}P_{31}$), and the unanalysed effect ($P_{4d2}r_{12} + P_{4d3}P_{32}r_{12}$).

Multiplying the equation (47) by X_2, we get:

$X_2X_{4d} = P_{4d1}X_1 X_2 + P_{4d2} X_2X_2 + P_{4d3} X_2X_3 + P_{3dv}R_vX_2$ (52).

Or, $r_{24d} = P_{4d1}r_{12} + P_{4d2} + P_{4d3}r_{23} + P_{3dv}R_vX_2$ (53).

Or, $r_{24d} = P_{4d2} + P_{4d1}r_{12} + P_{4d3} (P_{31}r_{12} + P_{32})$, substituting the value for (r_{23}) in equation (7) above (54).

Or, $r_{24d} = P_{4d2} + P_{4d1}r_{12} + P_{4d3}P_{31} r_{12} + P_{4d3}P_{32}$ (55).

Therefore, we get r_{24d} consisting of the direct effect (P_{4d2}), the indirect effect ($P_{4d3}P_{32}$), and the unanalysed effect ($P_{4d1}r_{12} + P_{4d3}P_{31}r_{12}$).

Multiplying the equation (47) by X_3, we get:

$X_3X_{4d} = P_{4d1}X_1\ X_3 + P_{4d2}\ X_2X_3 + P_{4d3}\ X_3X_3 + P_{3dv}R_vX_3$ (56).

Or, $r_{34d} = P_{4d1}r_{13} + P_{4d2}r_{23} + P_{4d3} + P_{4dv}R_vX_3$ (57).

Or, $r_{34d} = P_{4d3} + P_{4d1}(P_{31} + P_{32}r_{12}) + P_{4d2}\ (P_{31}r_{12} + P_{32})$, substituting the value for (r_{23}) in equation (7) above (58).

Or, $r_{34d} = P_{4d3} + P_{4d1}P_{31} + P_{4d1}P_{32}r_{12} + P_{4d2}P_{31}\ r_{12} + P_{4d2}P_{32}$ (59).

Therefore, we get r_{34d} consisting of the direct effect (P_{4d3}) and the spurious effects ($P_{31}P_{4d1}$), ($P_{4d2}P_{32}$), ($P_{4d1}P_{32}r_{12} + P_{4d2}P_{31}r_{12}$).

APPENDIX C

INTERVIEW RESULTS

Inter view number	Type of products	Type of MA	What are the motivations of having MA?	Do you get benefits from MA's implementation?	Does IT supports MA?	Does your company engage SA?	Do IT , SA , and MA compliment each other?
1	CD,VCD, DVD	Integrated flow from raw material to finishing	productivity, quality and avoid labour union problems	MA does not reduce the operating cost, but improve productivity and product quality	yes. It helps us to monitor the daily operation	We have up stream and down stream subsidiaries	Yes, MA speeds up the production, IT helps us to transmit bulk of production data and SA helps us to maintain the product quality, raw material availability and reduce production and marketing costs

Note:

MA = Manufacturing automation
SA = Strategic Alliance
IT = Information technology.

Inter view number	Type of products	Type of MA	What are the motivations of having MA?	Do you get benefits from MA's implementation?	Does IT supports MA?	Does your company engage SA?	Do IT , SA , and MA compliment each other?
2	Packaging	Integrated from raw material to finishing	productivity, quality and avoid labour union problems	MA reduces the operating cost and improve productivity and product quality	Actually IT could increase department's integration and reduce the conflict between marketing and production managers, which ultimately help to reduce the inventory build up. Unfortunately we don't use IT effectively	Yes, we have an alliance with overseas marketing companies . It helps us to sell our product with less marketing cost. But our alliances with local suppliers do not gain much as our suppliers are not reliable.	No. Only MA improves our productivity and product quality . For the rest, we have to pay more money to support the automation

Inter view number	Type of products	Type of MA	What are the motivations of having MA?	Do you get benefits from MA's implementation?	Does IT supports MA?	Does your company engage SA?	Do IT , SA , and MA compliment each other?
3	Garment	CAD, FMS	productivity, quality and avoid labour union problems	Automation increase our productivity and product quality but it does not reduce the production cost. Labor cost is much chepar than the cost of the automation, but by having automation we have less problems with labour union. We are happy.	Certainly. We have six factories and all of our customers are overseas. IT provides cheap and fast communication therfore our automation never be idle	Yes, joint licensing with well known brand such as Arrow, Polo Ralph Lauren, Christian Dior and other European products	Yes, our SA with distributors generates huge benefits for our company. Our production machines produce high quality products and IT helps us to communicate with managers in different plant sites as well as our distributors.

Inter view number	Type of products	Type of MA	What are the motivations of having MA?	Do you get benefits from MA's implementation?	Does IT supports MA?	Does your company engage SA?	Do IT , SA , and MA compliment each other?
4	traditional medicine/ herbs	Integrated from raw material to packaging	Avoid labour union problems	By using machine our products become more hygenic. No human touch. The productivity has been increasing and we have less deffect products.	Yes, IT increases the flow of communication among the departments	Not always. We have contract with certain suppliers so we can be sure that we will get the raw materials. However, some suppliers do not want to have a contract. E.g. suppliers of clove, pepper and other expensive spices are reluctant to have binding contract.	yes they do. It helps us to monitor the price of herbs.

5	Take away containers, disposal plates, bowls	Integrated from raw material to packaging	Avoid labour union problems	The productivity increases and no defect product.. No material scrap as the scrap can be reheated and reshaped.	Not really. We don't use a lot of information technology. We still use telephone and facsimile	Yes. We have alliances with customers and suppliers	SA helps us to maximise our production machines' utilization

Inter view number	Type of products	Type of MA	What are the motivations of having MA?	Do you get benefits from MA's implementation?	Does IT supports MA?	Does your company engage SA?	Do IT, SA , and MA compliment each other?
6	Furniture	Integrated from raw material to packaging	productivity , quality and avoid labour union problems	Automation only can be used for cutting and grinding. However, it improve our product quality as the shape of the furnitures are standardised	Yes, IT helps managers to utilise manufacturing automation	Yes, especially with suppliers	yes, IT helps managers to receive orders from overseas as well as communicate well with their suppliers. Having good communication with suppliers, managers can get good price and good quality of wood

Inter view number	Type of products	Type of MA	What are the motivations of having MA?	Do you get benefits from MA's implementation?	Does IT supports MA?	Does your company engage SA?	Do IT , SA , and MA compliment each other?
7	Bulb	Integrated from raw material to bulb before putting the wire	productivity , quality and avoid labour union problems	We reduce our production time as the raw material can be transferred to the boiler automatically and the output can be sent to the tables directly. We reduce the labour requirement. But the cost oF the automation is very expensive. It hits our profit.	Yes, It enhances the communication between factory and head office, which is located at different town (the distance is about 10 hours drive)	Yes, we have brand alliance with American bulb Company and also with overseas glass suppliers	Yes, MA helps us to speed up the production, reduce labour union problems . IT speeds up the communication with less cost and SA maintains the raw material availability as the turbo bolier must not stop operating. Our plant operates 24 hours

Inter view number	Type of products	Type of MA	What are the motivations of having MA?	Do you get benefits from MA's implementation?	Does IT supports MA?	Does your company engage SA?	Do IT , SA , and MA compliment each other?
8	Home appliances	Integrated from raw material to packaging	productivity , quality and avoid labour union problems	Certainly manufacturing automation improve our productivity and product quality and of course improve our operating profit	Yes. IT helps us to communicate with head office and other departments	Yes. Sure we have brand alliance with overseas companies. All the components of our products are imported from overseas.	Yes. Without IT, we may not be able to maximise our manufacturing automation
9	decorated glass and plates	Integrated from raw material to finising	productivity , quality and avoid labour union problems	Yes, it is a great help to have an manufcturing automation. I do not to worry about labor strikes anymore. Our productivity and product quality is very good.	yes. It help us to send orders to head office	We have a sticker company (as a subsidiary) and we have alliances with glass and plates company. We just put the sticker . Besides we have joint licensing with Walt Disney, USA.	Yes, MA speeds up the production and improves product quality. IT helps us to transmit orders from overseas to head office and from marketing department to production department and SA helps us to maintain the product quality, raw material availability and reduce production costs .

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