INTERNETWORKED MANUFACTURING : THE FUTURE TREND IN MALAYSIA

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ABSTRACT

Malaysia is going towards industrialization country, which emphasizes on knowledge worker as stated in Vision 2020. Information-based organization will required in the future in order to compete globally. The encouragement by government in information technology (IT) should be taken seriously by manufacturing companies in order to become excellence. In other words, IT adoption in manufacturing process can support customer-driven emphasize by many manufacturers. They are engaged in assessing ways in which their productivity, product quality and operations can be improved. Most manufacturers recognize that IT adoption can affect the companies' ability to compete in producing a higher quality of products.

The paper presents the future trend of ISO 9000 certified manufacturing companies in Malaysia on utilizing the computer network in their operation. From the analysis, we determine these manufacturing companies are going towards implementing a collaborative process which involves using of Internet, intranets, extranets and other network to link the workstations of engineers and other specialist with their colleagues at the other locations. This situation will not only increase the speed of information flows, but also overcome the barrier of time, cost and location. Analysis showed, the Windows-based operating system (e.g. Windows NT, Lotus Smart Suite (Notes), UNIX and Windows 2000) dominates many manufacturing companies. Other manufacturing software such as ERP, Control Systems, MS Office 2000, CAD, and MRP will be widely used by them. These software need to be supported by powerful machines such as microcomputer, visual database and ATM switching in order to make the production operation become more effective and efficient. These peripherals demanded to be connected among companies either through Direct Link or Intranet Base/Internet Hookup. Most of the connection to the major network is through leased line.

INTRODUCTION

In general, manufacturing companies in Malaysia are moving positively towards the adoption of information technology (IT). IT in manufacturing sector is found to contribute significantly towards productivity increases, especially in effective decision making and reducing the cycle time of a particular process. The manufacturing sectors are still expected to spearhead Malaysia's growth in the future. This could be achieved by enhancing their productivity through upgrading of skills and advancement in education of workers, adopting better management techniques and systems, acquiring new technology as well as effective and efficient applications of IT in processes and systems. IT is aid for industries in Malaysia in order to gain a sustainable competitive advantage.

In this context IT refers to hardware, software, telecommunications, database management and other information processing technologies used in computer based information systems. Furthermore, the concept of internetworked manufacturing means a manufacturer that uses the internet, intranets, extranets and other computer networks to support electronic commerce and other business processes, managerial decision making, and team and workgroup collaboration within the organization and among its customers, suppliers and other business partners.

Advances in IT have meant that powerful methods of planning and control are increasingly available to small and medium-sized batch manufacturing companies (Howard, Kochhar & Dilworth, 1999). IT in general, affects internal corporate activities and provides a source of competitive advantage in the marketplace (Wilson & Vlosky, 1998). Many researchers found that IT has become essential in order to gain a competitive advantage (Porter, 1985; Porter & Miller, 1985). Harris (1995) stated that IT is becoming closely integrated with the management and operation of present-day manufacturing and IT is playing an increasingly strategic role in manufacturing organizations. He also add that this evolution underscores the need for planning for effective and efficient acquisition, assimilation, and utilization of information technology in manufacturing organizations.

In order to upgrade the management and operational relationship, the use of network technology become the choice of many manufacturing companies. The Internet and Internet-like networks inside the company (intranet), between companies and its trading partner (extranets) and other types of networks have become the primary IT infrastructure of many manufacturing companies (Kalakota & Whinston, 1996). These networks enable the companies to exchange data and documents, collaboratively in design-

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factor to consider in order to improve the products and services performance. To our knowledge, in the research that has attempted to outline manufacturing process content, the tendency has been to focus on specific improvement techniques, such as just-in-time (JIT), material requirement planning (MRP) or total quality management (TQM) etc. (Gunasekaran, 1998; Engstrom, Jonsson, & Medbo, 1999).

Others like manufacturing planning and conrol (MPC) is also a system that have been established for some time as being central to the success of modern manufacturing companies (Howard, Kochhar & Dilworth, 1999). Hsu (1999) said that Prabhaker et al. (1995) note that advanced IT, particularly for manufacturing such as FMS, CIM, GDSS and CAD allows an organization to integrate manufacturing with other department. Orr and Sohal (1999) mentioned that in a study by Orr and Waldron (1997), it was found that approaches such as Quality Function Deployment were used to facilitate the use of advanced manufacturing technology which subsequently shortened the time lag between product development and full scale manufacturing. Roberts and Wood (1997) tend to see the data and information flow in manufacturing process itself. Also, they tend to see the use of technological advance, the comparison of the effectiveness and efficiency of using IT compared to manual operating. Hsu (1999) also mentioned that Rockart and Short (1991) stressed that IT is capable of generating inter functional coordination in solving conflicts among departments.

Roberts and Wood (1997) argued that information system (IS) has been a factor in order to gain competitive advantage by start up manufacturing companies. The money spent in IS is an investment to compete against their rivals in that industry. The link between IT and competitive advantage could be seen in many literatures (Robert & Wood, 1997; Kim & Lee, 1996). Kim and Lee (1996) also relate the utilization of IT to the process improvement. On the other hand, Ho (1996) argued that if manufacturers do not consider about organizational design alternatives and business process reengineering while implemented IT, IT would become their competitive burden. Researcher also stated that in pursuit of a world class manufacturer, an evolutionary process is necessary for manufacturing organization in IT implementation. Learning organization is contended to be the driving force in each stage to exploit IT for the competitive advantage. Orr (1999) in paper said that the correct manufacturing technologies could provide the organization with considerable operational and competitive benefits. However, Ho (1996) mentioned that rapid advances in the various components of IT have resulted in continuous improvement in price-performance ratio in recent years.

Through readings, researchers realized that many literatures did not address specifically the use of network technology in manufacturing activity whether internally or externally. Furthermore, the studies in this field still lack a cohesive foundation on utilizing IT to improve manufacturing process.

RESEARCH OBJECTIVES

The aim of this research is to identify the status of IT adoption in manufacturing, including methods of adoption, investment in IT, and types of software used by them. Also, to interrogate the future trend of ISO 9000 certified manufacturing companies in Malaysia on utilizing the network technologies in their operation within and between companies.

METHODOLOGY

The study design targeted several sources for data collection, including a written survey, and semi-structured one-on-one interviews, providing both qualitative and quantitative data for analyses. The questionnaire that adapted from Shahrum, Sharipah, Engku, Kamran, Sabri & Zurni (1996) was used to examine the adoption of IT in manufacturing. Mail questionnaires were developed and mailed to 302 companies throughout Malaysia. Pre-addressed, self-addressed postage paid envelopes and personally signed cover letters were included with the survey. Three weeks after the initial mailing, a second mailing was conducted. After lag of three weeks, follow-up phone calls, facsimile, and electronic mail were made to known companies that had not responded to previous mailing. Furthermore, semi-structured interviews were developed based on a list of questions designed in order to see the future trend of internetworked manufacturing in Malaysia. It was conducted with Management Information System (MIS) manager in order to get a better understanding on to what extent are IT services provided in manufacturing.

A sample frame identified 302 companies that certified to MS ISO 9000 series by SIRIM Berhad using proportionate stratified random sampling method. This sampling size is used with the intention to investigate a manufacturing process of a high quality manufacturer from different types of manufacturing companies. The classification of company is referring to Vastag, Kasarda & Boone (1994) and Corbett (1998). The researchers have modified the classification to suite to Malaysian type of manufacturing companies that based on the product characteristics.

The classifications are; computers, electronic and electrical components; machinery and metal parts; pharmaceutical and cosmetics; wood products and furniture; chemical and petroleum products; textiles, clothing and footwear; food products, beverage and tobaccos; transport equipment; other equipment and technical tools.

RESULTS

Response Rate

Of the 302 questionnaire distributed, a total of 128 were completed and returned (42.7% response rate). This considerable response was generated by the mailing, using facsimile, semi-structured interviews and electronic mail.

Profile of Respondents Companies

Table 1: State/Location of Companies

	Frequency	Percent (%)
Kedah	36	28.1
Penang	28	21.9
Selangor	21	16.4
Johor	10	7.8
Perak	8	6.3
Missing value	7	5.5
Kuala Lumpur	5	3.9
Negeri Sembilan	3	2.3
Pahang	3	2.3
Melaka	2	1.6
Perlis	2	1.6
Kelantan	1	.8
Sabah	1	.8
Terengganu	1	.8
Total	128	100.0

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Of the companies who responded to this survey, a total of 28.1% is currently located at Kedah, 21.9% located at Penang, followed by Selangor (16.4%). Other companies located at Johor (7.8%), Perak (6.3%), Kuala Lumpur (3.9%), Negeri Sembilan (2.3%), Pahang (2.3%), Melaka (1.6%), Perlis (1.6%), Kelantan (0.8%), Sabah (0.8%), and Terengganu (0.8%). However, there is 5.5% of the respondents do not provided information needed.

Table 2: Type of manufacturing

	Frequency	Percent (%)
Other	45	35.2
Computers, electronic and electrical components	37	28.9
Transport equipment	11	8.6
Chemical and petroleum products	10	7.8
Machinery and metal parts	9	7.0
Food products, beverage and tobacco	4	3.1
Other equipment and technical tools	3	2.3
Wood products and furniture	2	1.6
Missing value	7	5.5
Total	128	100.0

The distribution of respondent is heavily weighted as other category of manufacturing company type (35.2%) and computer, electronic, and electrical components (28.9%). Followed by transport equipment manufacturing type (8.6%), then chemical and petroleum products (7.8%), machinery and metal parts (7.0%), food products, beverage and tobacco (3.1%), other equipment and technical tools (2.3%). Finally, wood products and furniture company type (1.6%). However, there were no answers received from 5.5% of respondents.

Table 3: Certfication ti ISO 9000 Series Model

	Frequency	Percent (%)
ISO 9002	100	78.1
ISO 9001	19	14.8
ISO 9003	1	.8
Missing value	8	6.3
Total	128	100.0

When asked about the certification they obtained, majority of respondents were qualified to ISO 9002 model (78.1%) certification, whereas 14.8% of respondents qualified to ISO 9001 model certification and just 0.8% of the respondents qualified to ISO 9003 model certification.

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Table 4: Status of Using Computer Services Currently

	Frequency	Percent (%)
Yes	123	96.1
No	1	.8
Missing value	4	3.1
Total	128	100.0

Part 2 of the questionnaire was designed to elicit information on the status of IT adoption among those manufacturing companies. This meant that this part of the questionnaire was only applicable to 123 of 128 respondent company. As Table 4 illustrates, the majority (96.1%) of the respondents was using computer services currently. Nonetheless, only 0.8% of the respondents was not using it. However, there is no response obtained from 3.1% of the respondents regarding to this question.

Table 5 : Methods of Adoption IT

	Frequency	Percent (%)
Own Computer :		
Yes	117	91.4
No	7	5.5
Missing value	4	3.1
Total	128	100
Lease Computer :		
Yes	8	6.3
No	116	90.6
Missing value	4	3.1
Total	128	100
Hire other Companies or individuals :		
Yes	4	3.1
No	123	96.1
Missing value	1	0.8
Total	128	100

Table 4: Status of Using Computer Services Currently

	Frequency	Percent (%)
Yes	98	76.6
No	24	18.8
Missing value	6	4.7
Total	128	100.0

Many of respondents stated that their computers were networked (76.6%), since 18.8% stated that their computers were not networked. Despite, there was no answer gain from 4.7% of the respondents.

Table 8 : Total up-to-date Expenditure on Computers in Ringgit Malaysia (RM)

	Frequency	Percent (%)
Less than 100, 000	8	6.3
100,000 to 500,000	18	14.0
501,000 to 1,000,000	29	22.7
More than 1,000,000	21	16.4
Missing value	52	40.6

For this question, majority of the respondents kept it as confidential to disclose to the public (40.6%). There are 22.7% of the respondents invested around RM501,000 to RM1,000,000 for computers including purchasing, leasing of computers, and hiring of companies or individuals. Followed by those who expense around RM100,000 to RM500,000 (14.0%), followed by those who expense more than RM1,000,000 (16.4%). Finally, there was 6.3% of the respondents who invest less than RM100,000 for their computers.

Table 9 : Type(s) of Software Used

	Frequency	Percent (%)
Word Processing:		
Yes	105	82.0
No	18	14.1
Missing value	5	3.9
Total	128	100
Spreadsheet:		
Yes	103	80.5
No	20	15.6
Missing value	5	3.9
Total	128	100
Database:		
Yes	91	71.1
No	32	25.0
Missing value	5	3.9
Total	128	100
Statistical Packages:		
Yes	62	48.4
No	61	47.7
Missing value	5	3.9
Total	128	100
Customized Packages:		
Yes	72	56.3
No	51	39.8
Missing value	5	3.9
Total	128	100
Others:		
Yes	84	65.6
No	39	30.5
Missing value	5	3.9
Total	128	100

It would appear that a large number of companies surveyed use much software. As Table 9 indicates, within the companies survey to find out the most popular software used by them, most of them (82%) used word processing, while 80.5% operated spreadsheet. There are 71.1% of the respondents

used database, followed by 65.6% that utilized other software. Moreover, the percentage of respondents who operated customized packages was 56.3%, Finally, they are 48.4% of the respondents used statistical packages.

Future Trend of Internetworked Manufacturing

In order to determine the extent of IT adoption, respondents companies were asked to provide information for future use.

Table 10 : Aplication Software

	Frequency	Percent (%)
ERP	39	30.5
Control Syste m	27	21.1
MS Office 2000	15	11.7
CAD	14	10.9
MRP syste m	10	7.8
Othe r	7	5.5
QUPTA	3	2.3
Y2K Compliance	3	2.3
ETP	3	2.3
SQL 7	3	2.3
SAPR3	3	2.3
SEM	1	.8
Total	12 8	100.0

Table 10, presents the information provides about the application software search by manufacturing companies. Many respondents search for Enter- prise Resource Planning (ERP) that is 30.5%. There are 21.1% of the re- spondents stated they preferred to have control systems such as data, docu- ment and quality assurance control systems. Whereas, 11.7% of the re- spondents stated that they want Microsoft Office 2000. Another 10.9% reported that their need is product design application software such as Com- puter Aided Design (CAD). They are 7.8% of the respondents search for MRP systems for the future, whereas 5.5% stated other application software including Fidelio version 6.11 or the latest version, Norton Utilities, and Web Site for ISO 140001. For application software like QUPTA, Y2K Com- pliance, ETP, SQL7, and SAPR3, they are 3% of the respondents respec- tively, needed that application. Only 1% seeks for SEM.

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Table 11 : Typ(s) of Hardware Needed

	Frequency	Percent (%)
Computer:		
PC/ Server/ Microcomputer	56	43.8
Minicomputer	39	30.5
Missing value	33	25.8
Total	128	100
Database :		
Visual	82	64.1
Object Oriented	46	35.9
Total	128	100
Switching:		
ATM	82	64.1
Cisco Switching Technology	46	35.9
Total	128	100

Table 11, describes the types of hardware needed for respondents companies including computer, database, and switching. For computer, most of them (43.8%) needed Personal Computer including server and Microcomputer. Considering that, another 30.5% respondents stated that they need Mini-computer. However, they are 25.8% of the respondents do not response to the question asked. In addition, for database hardware, it found that 64.1% of the respondents search for visual hardware. Another 35.9% of them seek for object oriented database. While for switching hardware, a large amount of respondents (64.1%) mentioned about ATM switching hardware; whereas, 35.9% of them seek for Cisco Switching Technology.

Table 12 : Software System

	Frequency	Percent (%)
Windows NT	65	50.8
Lotus Smart Suite (notes)	25	19.5
UNIX	21	16.4
Windows 2000	7	5.5
Other	6	4.7
Novell Version 4.11	4	3.1
Total	128	100.0

Table 13 : Network

	Frequency	Percent (%)
Intranet	44	34.4
Internet	25	19.5
E-Commerce/ E-Business	22	17.2
LAN	16	12.5
Other	9	7.0
Missing Value	8	6.3
Remote Access	4	3.1
Total	128	100.0

For the software systems that report by *Table 12*, most of the respondents (50.8%) seek for Windows NT, another 19.5% search for Lotus Smart Suite (Notes). Whereas, there is 16.4% of the respondents anticipate having UNIX. Another 5.5% search for Windows 2000, and other software system that will be demanded by the respondents (4.7%) including ISO 9000 series software, interactive software, and shareware. Only 3.1% of the respondents will inquire Novell Version 4.11 or the latest version in the future.

The trend of the network needed was asked to the respondents and their responses are presented in Table 13. Most of the respondents stated that they search for Intranet (34.4%). Another 19.5% of the respondents need to have Internet that included leased line, website, telecommunication IP, and linking PC. Whereas, there is 17.2% of the respondents seek for Electronic Commerce or Electronic Business. Another 12.5% of the respondents require Local Area Network (LAN) such as Ethernet, and direct link for the future. They are 7.0% of the respondents stated other in their answer that included WAN for example. However, they are no answer received from 6.3% respondents. Finally, 3.1% of the respondents stated about remote access.

CONCLUSION

The manufacturers tend to utilize application software that can help them to control their manufacturing process better. The ERP systems, MRP systems and control systems (such as inventory control, document control, and quality assurance) for example can provides a good monitoring capabilities. Furthermore, manufacturers who also observe the benefits they could gain by

using CAD. Where, they could identify the buyer requirement identifications better where buyers could look at new designs in 3D models. The use of CAD produced a number of operational benefits including enhanced accuracy of the production drawings.

As stated in the results, microcomputers remain the most popular type of computer being used. Furthermore, the visual database is popular by the manufacturer to acquire in the future. This is because of its flexibility and easy to use. The visual databases also provide the user with its functionality which is not available in the operational database. In switching technologies, the ATM switching is looked as a technology that allow multimedia applications to work on it effectively. Comparing to other switching technologies, ATM can transfer the data that cut into the cell format faster from one point to the other point. Furthermore, ATM switching can work with any type of cables that use networking.

Windows NT will be increasingly search in the future because apart from its powerful functionality, Windows NT is also the network operating systems that can support any type of hardware and application software. The easy to use and user friendly environment make NT the choice of IT practitioner. Apart of supporting the conventional network environment, NT also used to support web-based network environment that is widely developed now. Another software that widely used in manufacturing industry now is Lotus Smart Suite. Lotus Smart Suite provide the user with collaborative work management tools which include scheduling, project management, workflow systems, knowledge management tools, electronic communication tools and electronic conferencing tools. This functionality is widely used in manufacturing industry in order to improve the effectiveness of the business process.

One positive trend is that most systems are now linked in a networked. Intranet will be necessity in order to ensure that inter-organizations information will be more accessible to the workers. Besides, the future trend on the worldwide communications network, known as the Internet, will permit individuals to exchange and share information from around the globe. The development of network such as LAN, MAN, Intranet and Extranet, the organizations significantly can improve its productivity by reducing the cost of labor, transport, time and other resources. By using network such as extranet, the manfacturer can link its intranet to the intranet of its customer, suppliers and other business partners. Extranet provide significant business value by facilitating and strengthening the business relationships of the organization with its customers and suppliers, establishing enterprise collaboration systems and utilizing groupware tools for internetworked manufacturer.

MANAGERIAL RECOMMENDATIONS

Effective adoption of IT in organizational become an important managerial concern. As mentioned earlier, IT is becoming closely integrated with the management and operation of present day manufacturing. In addition, IT is most likely to be used in enhancing manufacturing process and controlling manufacturing operations. It can also create additional advantages, including lower costs, quick response to customer's requirement, increased productivity and product differentiation. IT that could give companies' new tools and weapons to be ahead of their competitors. Therefore, to ensure that the manufacturer can obtain benefits from IT, workers should know how to utilize it in their job. The management should provide training to workers and create an IT-organization culture. By doing this, workers will be motivated and the probability of their work productivity increase is high. Furthermore, this environment will lead this organization towards knowledge-based organization, where the knowledge is use as a strategic tool to gain and sustain competitive advantage.

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