

**CRITICAL SUCCESS FACTORS IN  
TECHNOLOGY FORECASTING ACTIVITIES**

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*"Thanks to God for creating me and sending me to your beautiful world that is full of lights and excitement".*

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## RELATED PUBLICATIONS

Salleh Yahya & Nur Nadia Yong Abdullah (2006). Critical success factors and human capital in technology forecasting. In the Proceedings of IAMOT 2006: 15<sup>th</sup> International Conference on Management of Technology, East Meets West. Beijing, China, May 22 – 26, 2006.

Salleh Yahya & Nur Nadia Yong Abdullah (2006). Critical human factors for the success of technology forecasting implementation. In the Proceedings of International Conference on Technology Management (ICTM 2006), Kuala Lumpur, December 4-5, 2006.

## ABSTRACT

The implementation of technology forecasting is important in technology acquisition and adoption process. Past studies have demonstrated that the success of implementing technology forecasting depends on various factors that involve throughout the implementation process. However, none of the studies have reported on the critical factors of technology forecasting. Therefore, this study has been carried out with the research target to explore the critical factors of technology forecasting. To achieve the research target, three research objectives were identified: 1) to determine the current technology forecasting profile among manufacturing organizations, 2) to explore experts' opinion on the critical success factors that highly influence the application and performance of technology forecasting and 3) to develop strategies with emphasis on human resource approaches to manage and enhance the critical factors. A survey was conducted among manufacturing companies that deploy technology in the companies' operations. Data were collected from the return of 118 usable mailed questionnaires. The findings through descriptive analysis depicted that the characteristics of the companies surveyed are the root cause of the low level of technology forecasting application. Further, the results of factor analysis and simple linear regression analysis showed that human factors are the critical factors in technology forecasting activities as compared to other factors. These human factors are found directly related to human and the surrounding of humans in the organizations. The overall findings suggest that organizations should provide more training on qualitative technology forecasting techniques to increase the level of technology forecasting application. Additionally, qualitative techniques also promote innovation and research and development (R&D) activities. To increase the organizations' R&D capabilities, organizations have the alternative to outsource or collaborate with universities or research institutions. In managing and enhancing the human factors identified, strategies such as training and education, effective performance appraisal, reward and recognition and practice of technology forecasting culture are important considerations and are recommended for organizations. The important implication of this study is that organizations must ensure critical human factors are in a satisfactory condition for better performance of technology forecasting activities while non-human factors are needed as it is the pre-requisite for application of technology forecasting. The harmonious collaboration of both factors would improve the implementation

process towards production of successful forecasts. This study ends with contributions to the theoretical and practical aspect of technology forecasting, extensions from current study and the limitations of the study.



## ABSTRAK

### **FAKTOR-FAKTOR PENENTU KEJAYAAN DALAM AKTIVITI-AKTIVITI PERLUNJURAN TEKNOLOGI**

Pelaksanaan perlunjuran teknologi adalah penting di dalam proses perolehan dan penerapan teknologi. Kajian-kajian terdahulu menunjukkan bahawa kejayaan melaksanakan perlunjuran teknologi bergantung kepada pelbagai faktor sepanjang proses pelaksanaan. Sungguhpun begitu, tidak ada kajian-kajian yang menunjukkan tentang faktor-faktor penentu di dalam perlunjuran teknologi. Justeru itu, kajian ini dijalankan dengan sasaran kajian untuk mengenalpasti faktor-faktor penentu di dalam perlunjuran teknologi. Bagi mencapai sasaran kajian, tiga objektif kajian telah dikenalpasti: 1) mengenalpasti profil terkini perlunjuran teknologi di kalangan organisasi pembuatan, 2) mengkaji pandangan pakar terhadap faktor-faktor penentu kejayaan yang sangat mempengaruhi aplikasi dan prestasi perlunjuran teknologi dan 3) membangunkan strategi-strategi dengan menggunakan pendekatan sumber manusia untuk mengurus dan mempertingkatkan keberkesanan faktor-faktor penentu yang dikenalpasti. Kajian ini telah dijalankan di kalangan organisasi-organisasi pembuatan yang menggunakan teknologi di dalam operasi organisasi. Data telah dikumpul melalui 118 borang soal selidik yang dikembalikan. Hasil daripada analisis deskriptif menunjukkan ciri-ciri organisasi tersebut adalah punca aplikasi perlunjuran teknologi berada pada tahap yang rendah. Seterusnya, hasil daripada analisis faktor dan analisis regresi linear menunjukkan bahawa faktor-faktor berteraskan manusia adalah faktor penentu kejayaan dalam aktiviti perlunjuran teknologi berbanding dengan faktor-faktor lain. Faktor-faktor berteraskan manusia ini didapati berkaitan dengan manusia secara langsung dan keadaan sekeliling manusia di dalam organisasi. Keseluruhan hasil kajian mencadangkan supaya organisasi memberi lebih latihan mengenai penggunaan teknik kualitatif dalam perlunjuran teknologi untuk meningkatkan tahap aplikasi perlunjuran teknologi. Tambahan pula, teknik kualitatif juga membantu merangsang aktiviti inovasi dan kegiatan penyelidikan dan pembangunan. Untuk meningkatkan keupayaan dalam kegiatan penyelidikan dan pembangunan, organisasi secara alternatifnya boleh membuat perolehan luaran atau usahasama dengan universiti-universiti atau institusi-institusi penyelidikan. Dalam mengurus dan mempertingkatkan keberkesanan faktor-faktor berteraskan

manusia, strategi-strategi seperti latihan dan pendidikan, penilaian prestasi yang efektif, ganjaran dan pengiktirafan dan amalan budaya perlunjuran teknologi adalah penting dan disarankan kepada organisasi untuk dilaksanakan. Implikasi utama kajian ini adalah organisasi mesti memastikan faktor-faktor berteraskan manusia berada di dalam keadaan yang memuaskan demi meningkatkan prestasi perlunjuran teknologi manakala faktor-faktor berteraskan bukan manusia adalah diperlukan untuk membolehkan perlunjuran teknologi diaplikasikan. Keharmonian daripada gabungan kedua-dua faktor akan membantu proses pelaksanaan ke arah pengeluaran perlunjuran yang berjaya. Kajian ini diakhiri dengan sumbangan kajian dari aspek teoritikal dan praktikal, cadangan kajian akan datang dan limitasi kajian.

## CHAPTER I

### INTRODUCTION

#### 1.1 The Importance of Technology Forecasting in Industrialization Process

According to Porter (1985), in the dynamic business environment, technology is the new core competency needed by organizations to win competition especially in manufacturing organizations. Schlie (1996) and Shenhar and Adler (1996) added that the most suitable choice and well-integrated of technology to perform the value chain activities would ensure higher output in a shorter period with lower costs, better performance and would add to the competitive advantage of the organizations. Furthermore, in a recent research done by Heim and Compton (2000), it is found that manufacturing organizations that aspire to be of world class would need to acquire ten generic principles and technology is one of them.

Knowing the importance of technology to increase survivability, Malaysian Government has thoroughly designed and implemented many strategies in increasing the usage of technology among the various industries in Malaysia. One of the rigorous efforts undertaken by the Government is none other than the blueprint of Vision 2020 as announced by former 4<sup>th</sup> Prime Minister of Malaysia, Tun Dr. Mahathir Mohamad. Through Vision 2020, the Government is expected to embrace Malaysia to be a fully developed country that has an



economy, which are highly competitive, dynamic, robust and resilient (Office of the Prime Minister of Malaysia, 2006).

To foster the process of Malaysia to become a developed country, it requires the industries to apply high technology in its operation. High technology application inside organizations would accordingly increase the technology capability of the industries and to continue its competitiveness in globalize and challenging market. Within this context, the Malaysian Government has been putting manufacturing industry or manufacturing organizations in the centre of attention. Various initiatives have been taken substantially and are still on going to provide future direction for manufacturing industry in terms of increasing the use of technology in its operation and to ensure manufacturing organizations is fit to adopt or create higher technology through research and development.

To date, three Industrial Master Plans have been implemented with the concerns to push non-resource based manufacturing activities up the value-added chains to create competitiveness by emphasizing on utilization of high technology. Recently, the Malaysian Government has implemented National Mission which works as the framework for the planning and implementation of the country's developmental policies towards achieving the goals of Vision 2020 and the launched of Ninth Malaysia Plan on March 31, 2006. The new Malaysia Plan will continue the endeavour of the previous Malaysia Plan. Performance of manufacturing industry is expected to become more robust, dynamic and competitive and projected to grow by an average rate of 6.7% annually during the Ninth Malaysia Plan (Abdullah, 2006; The Star Online, 2006).

However, increasing the usage of technology at the manufacturing organizations level would not be easy without the financial assistance from the Malaysian Government. A strong financial status is a key enabler for applying technology. Thus, during the recent announcement of Ninth Malaysia Plan, the Government has initiated more funds such as Strategic Investment Fund, the Automotive Development Fund, the Industrial Restructuring Fund, the Automation Fund and specific funds for the manufacturing sectors (Abdullah, 2006).

A few of technology related divisions and agencies have been set up by the Government which are dedicated to increase the adoption of technology in manufacturing industry in Malaysia. Under Ministry of Science, Technology and Innovation (MOSTI), Science and Technology Division has been established. This division has introduced Intensification of Research in Priority Areas (IRPA), a research grant scheme to encourage R&D activities for research organizations and institutions of higher education in the public sector. Another agency, MIMOS Berhad is specializing in research and development on information and communication technology (ICT) and microelectronics. SIRIM Berhad, on the other hand, would be the prime mover in industrial research and development while Malaysian Technology Development Corporation Sdn. Bhd. (MTDC) would focus on commercialising research results of universities and research institutions, identifying and transferring emerging and strategic technologies for adoption by industries.

Aside from the above agencies, to encourage high and emerging technology application by the manufacturing organizations, Malaysian Industry-Government Group for High Technology (MIGHT) was established which is responsible in studies on Government's policies in shaping national technology competitiveness. The main concern of MIGHT is on high technology industry development and support research priorities and human capital development through its various funding (Ministry of Science, Technology and Innovation, 2006).

As continuous efforts to facilitate commercialisation and application of technology among private sector, the Malaysian Government has introduced Technology Development Programme (TDP) grant scheme. Under the TDP, three distinct grant schemes were introduced and called 1) Technology Acquisition Fund (TAF): to provide partial grants to assist private sector in developing its technology capability, 2) Commercialisation of R&D Fund (CRDF): to provide partial grants up to 50 percent or 70 percent for commercialisation of feasible R&D projects and 3) Technology Acquisition Fund for Women (TAF-W): designed for women entrepreneur to enable technology development among women entrepreneur (Malaysian Technology Development Corporation, 2006).



Towards the second half of the vision, under the Ninth Malaysia Plan, the Government will expand the capacity of Kulim High Technology Park, establish the Sarawak Technology Park and Perak Technology Park, and develop another 20 industrial and small and medium enterprises park around the country. Aside from building technology parks, the Government will improve the infrastructure in existing industrial areas and develop several industrial clusters in Penang, Kedah, Pahang and Terengganu (Abdullah, 2006).

Looking towards the future of Malaysia in the industrialization process, the utmost important issue is not that manufacturing organizations need to keep up with the technological advances rather it is for these technical organizations to acquire the right technology at the right time. Hence, it is important to stress here that manufacturing organizations need to engage in technology forecasting as technology forecasting is an alternative to get the right technology possible. An effective technology forecasting implementation would produce a good forecast that provide quality input for decision makers in acquiring the right and appropriate technology possible for organizations to perform efficiently and effectively.

## **1.2 Problem Statements**

As depicted in Figure 1.1, given the importance of technology forecasting and the need to embrace the right technology, attention throughout the implementation of technology forecasting activities is crucial. The implementation of a successful technology forecasting activities is influenced by various factors that are involved throughout the implementation process. As each factor differs in the degree of influence on the application and performance of technology forecasting activities, therefore, exploration among the various factors to identify the critical success factors (CSF) is urgently needed.

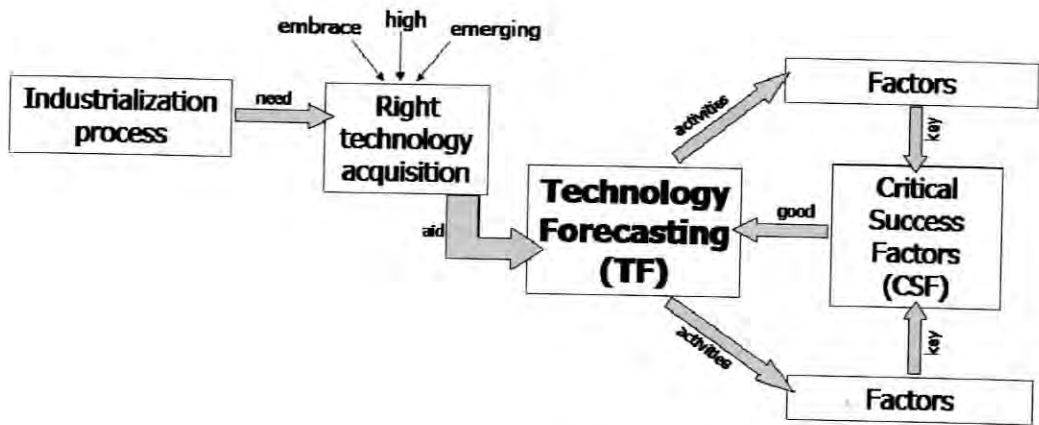


Figure 1.1 The importance of technology forecasting and critical success factors of technology forecasting

CSF are elements identified in an organization and when the CSF are properly sustained, maintained or managed, they can have significant impact in the success of an organization competing in a particular industry (Leidecker & Bruno, 1984). Thus, the concern to identify the CSF of technology forecasting are because when organizations formally identified the CSF of technology forecasting activities, management can then plan strategic ways to manage and administer the CSF in ensuring the process of technology forecasting is effectively implemented. Eventually, it would improve the application and performance of the technology forecasting. Forecasters would be able to produce good forecasts as input for decision makers in deciding on the right technology to be adopted.

In addition, so far, through researching past literatures, it is observed that many past researches have identified factors that help to improve the hard factors in the application of technology forecasting rather than studies which focus on the ways to enhance the technology forecasting activities (Porter, 1999) especially in identifying the CSF that would significantly influence the implementation of technology forecasting activities. Without proper exploration to identify the CSF, it will hamper the quality of the forecast produced and ultimately, right technology will not be adopted.

Another issue is that forecasting is a human activity usually carried out by several individuals within an organization (Bretschneider & Gorr, 1989). However, many studies have

reported that human is the main cause of failure in many new technological developments in organizations (Rasmussen, 1982; Eberts & Salvendy, 1986; Goulielmos & Tzannatos, 1997; Mital & Pennathur, 2004). The failure occurred, as organizations did not carefully consider the human elements from the early phase of planning till the execution. Employees or users, for instance, did not receive appropriate briefing and training at certain stages of implementation or even worst, briefing and training is given after new technology was being fully implemented. Only when defects occurred, organizations started to take actions. Rationally, organizations shall be proactive to eliminate unwanted losses since there is already a big capital invested for technological development purposes that are supposedly resulted in fruitful outcomes.

Aside from the above issues, in today's knowledge-based organizations, it requires new ways in managing knowledge workers and so does the human resource management approaches as compared to non-knowledge organizations. Thus, this requires human resource functions to adapt to the current knowledge organizations needs. For example, Salleh and Goh (2002) have identified that towards becoming a knowledge organization, organizations need to focus on training and development that develops individuals' capabilities on achieving quality, creativity, leadership and problem solving. The design of a compensation and reward system should be on promoting group performance, knowledge sharing and innovative thinking whereas the performance appraisal, on the other hand, should be able to provide input and evaluate the individuals' practices towards knowledge organizations. Hence, appropriate human resource management approaches should also be implemented to manage and enhance the soft factors or human factors that are important in the technology forecasting activities too.

From the above scenario that has been put forth, the following questions need to be addressed:-

- 1) What are the current technology forecasting practices among manufacturing organizations?
- 2) What are the critical success factors of technology forecasting?
- 3) How to manage and enhance the critical success factors whilst improving the application and performance?



### **1.3 Objectives of the Study**

The following objectives are drawn to solve the research problems identified:-

- 1) To determine the current technology forecasting profile among manufacturing organizations.
- 2) To explore experts' opinion on the critical success factors that highly influence the application and performance of technology forecasting.
- 3) To develop strategies with emphasis on human resource approaches to manage and enhance the critical factors whilst improving the application and performance of technology forecasting activities in manufacturing organizations.

### **1.4 Significance of the Research**

One way to increase the capability of having the right technology is through the implementation of technology forecasting. Technology forecasting is a people activity. Hence, there is an urgency to examine the critical factors that would critically affect the technology forecasting activities. Thus, the most significance of this study is to obtain experts' opinion on factors that are critical to implement better technology forecasting project which has not been conducted before in past studies. The opinions obtained are further affirmed through inferential statistic and analysis. The results of this process would close the literature gaps on ways to improve the technology forecasting implementation as reported by Porter (1999). In his paper, Porter claimed that many researches from the technology forecasting field in the past did not address measures to enhance the technology forecasting implementation.

When the CSF are derived from experts' opinion, it serves as a guideline and tool to develop measures in better managing and enhancing the CSF. The results of this study revealed that the soft elements in the organizations is the main influencer when implementing technology forecasting activities. The findings are consistent with Bretschneider and Gorr

(1989) that have recognised technology forecasting activities are human activities whereas Rice (1997) affirmed that forecasting is the results of a complex behavioural process. The successful implementation of technology forecasting activities requires the interaction of several individuals within the organizations and ways in which an organization's environment, culture, and process interact throughout the implementation process. Therefore, it is suitable to consider human resource practices when developing measures to manage and enhance the soft elements of technology forecasting. The measures developed have utilised training and education and other human resource practices such as performance appraisal, reward and recognition. Eventually, through effective management of the CSF, it would ease the adoption of technology forecasting project.

As a result of better management of the CSF that influence the forecasting process, technology forecasters would eventually be able to produce a better and more accurate forecast that would assist decision makers in making quality decisions. Quality decisions are very important for strategic technology planning. Quality decisions transforms into strategic technology plan and when the strategic technology plan is closely linked to the innovation activities, this helps in harmonizing the organizations' core competencies that include technology and its human capital. Moreover, this provides means to achieve competitive advantages that will eventually reduces threats from competitors and will strengthen the organizations' position in the market and industry as a whole.

Beside that, in the knowledge era, more and more manufacturing organizations are slowly progressing into learning manufacturing organizations. Technology forecasting is one of the major useful tools that would assist manufacturing organizations in becoming a learning organization. Therefore, the findings of this study would assist the practitioners to improve their technology forecast activities and smoothly transferring into a learning organization.

Overall, it is hoped that the study could assist and contribute to the success of adopting and implementing technology forecasting activities among indigenous manufacturing organizations. Finally, this study could serve as the grounds of further research in the area of technology forecasting and management of technology involving human capital and human resource management or human resource development.



## 1.5 Conceptual and Operational Definition of Terms

### (i) Technology

Technology is not just machinery. Technology is also a set of means created by people to enhance human performance to accomplish a purpose or a task beyond human capability (Sumath & Sumanth, 1996; Wyk, 1996). On the other hand, Khalil (2000) defined technology as all the knowledge, products, processes, tools, methods and systems employed in creation of goods or in providing services or the way we do things to achieve objective.

Technology can be divided into three interdependent, codetermining, and equally important components that are hardware, software and brainware. Hardware is the physical structure and logical layout of the equipment or machinery to carry out the required tasks. Software is the knowledge of how to use the hardware to carry out the required tasks. Brainware or know-why is the reasons for using the technology in a particular way (Zeleny, 1986). On top of all three components, there exist an independent components that involves in all level of technological achievements namely know-how which is the learned or acquired knowledge of or technical skills regarding how to do things well that resulted from experience, transfer of knowledge or hand-on practice (Khalil, 2000). Know-how varies widely in the extent and validity from company to company and from industry to industry (Heim & Compton, 2000).

In this research, technology is defined as hardware, software, brainware and know-how, which are unique to individual organization. They constitute the collective knowledge and technical capabilities of the organization, including its people, equipment, and systems (Khalil, 2000).

### (ii) Manufacturing organizations

Heim and Compton (2000) defined manufacturing as an organization that deals with a complex combination of disciplines and technology, reflecting management attitudes and philosophies, organizational issues, and the influences of an