A STUDY ON THE FACTORS INFLUENCING THE SUCCESS OF STATISTICAL PROCESS CONTROL (SPC) PROJECTS IN ELECTRICAL AND ELECTRONICS FIRMS

by

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Research report in partial fulfillment of the requirements for the degree of Master of Business Administration in University Science Malaysia

Mid June 2007

Specially dedicated to:

To my loving mother and

To Vikash Nutan Shah to get well soon…

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ABSTRAK

Kajian ini mengkaji faktor-faktor utama yang mempengaruhi kejayaan pelaksanaan Kawalan Proses Statistik (SPC) di firma-firma elektrik dan elektronik di sekitar kawasan perindustrian Pulau Pinang and Kulim. Hubung-kait di antara pembolehubah pengantara dengan perubahan budaya turut dikaji. Borang soal-selidik diedarkan kepada responden kajian melalui Jabatan Sumber Manusia dan Jabatan Kualiti di syarikat-syarikat pemilikan Jepun, Amerika, Eropah serta Malaysia. Kaedah persampelan bertujuan digunakan bagi mengumpul data daripada mereka yang pernah terlibat dalam pelaksanaan dan pengamalan projek-projek SPC. Sejumlah 160 borang soal-selidik diedarkan untuk pengumpulan data. Analisa faktor dan kebolehpercayaan dijalankan bagi memastikan kesahihan data yang dikumpul. Analisa regresi dan regresi berhirarki dijalankan bagi memastikan faktor paling signifikan dalam mempengaruhi kejayaan projek-projek SPC daripada sejumlah 103 balasan yang diterima. Keputusan analisis memperihalkan bahawa peranan Jabatan Kualiti and Komunikasi adalah faktor yang paling utama dalam kejayaan projek-projek SPC di firma elektrik dan elektronik. Jabatan Kualiti perlu memainkan peranan penting dalam pelaksanaan projek SPC dengan menyediakan kemuduahan latihan atau sebagai perunding. Walau bagaimanapun, komunikasi utuh diperlukan bagi perbincangan di antara ahli-ahli untuk tujuan berkongsi pengetahuan SPC. Di samping itu juga, interaksi di antara pembolehubah pengantara menandakan kerja berkumpulan ada hubungan pentingnya dalam kejayaan sebarang projek SPC. Penglibatan semua ahli berkaitan proses, daripada para operator sehinggalah para pengurus, kumpulan pengeluaran and jaminan kualiti harus berkerjasama bagi mengekalkan kemampuan dan kestabilan proses.

ABSTRACT

This study examines the key factors influencing success of implementing Statistical Process Control (SPC) in Electrical and Electronics firms in Penang and Kulim Industrial area. The relationship between the moderating variable, culture change is also being studied. Questionnaire was distributed to the respondents by the Human Resource department and Quality Assurance department in each selected Japanese, American, European and Malaysian ownership of companies. Purposive sampling method was used to collect the data from those who have experience in implementing and practicing SPC projects. Total of 160 questionnaires were distributed. It is done to prevent any noise factor in the data. Factor analysis and reliability analysis were performed to confirm the reliability of the data. Regression analysis and Hierarchical Regression analysis were performed to determine the most significant factor influencing the success of SPC projects base on 103 responses received. The results revealed that Role of Quality Department and Communication are directly influencing the Success of SPC Projects in the Electrical and Electronics firms. Quality department is required to guide the process with SPC and being like a consultant in the process. However, communication is required to discuss among the members and also to share SPC knowledge among them. Besides this, the interaction between the moderating variable indicates that Teamwork have a significant relationship with the Success of SPC Projects in Electrical and Electronics firms. Where it requires all the process related members from operators to mangers, production and quality assurance group to work as a team to maintain the process capability and stability.

Chapter 1

INTRODUCTION

1.1 Introduction

In today's manufacturing and service industry, customer is highly demanding and consistently increasing their demand for high quality products and services with low costs. To meet the customer's demand and request coupled with increase in competitive advantage, a company should focus on their process/products consistently with high level of quality. Total Quality Management (TQM), a management philosophy used widely in today's organization, will guide the management or the organization by endorsing culture and attitude to continuously improve the quality level of the product/service. One of the powerful tools or technique used to reduce the variation in the process in daily basis in TQM framework is Statistical Process Control (SPC), which is used to control, manage, improve and analyze by eliminating the special variation causes such as measurement error, wear of the tools, operator error, gauge and repetitive reliability and so on (Antony and Mason, 2001).

Statistical Process Control is an application of statistical tool and techniques in any environment to manufacture a product or service with most economical way or concept. According to Herrman (2002), by practicing SPC, it increases customer satisfaction for long term deal, less investment on finish product inspection as well as

reduction in rework cost which eventually increase the production rate. A successful application of SPC requires a unification of planning skills, engineering skills, management skills, statistical skills and communication skills (Antony, 2000). This study is therefore, attempts to explain the most significant factors that influence the successful SPC implementations in an organization.

1.2 Background

Statistical process control (SPC) is a tool used in Total Quality Management by an organization or a firm. It can be used either in manufacturing or service-based industries. In detail, using the correct and relevant statistical methods or tools allows SPC to manage, monitor, maintain and improve the performance of a process.

In Antony and Taner (2003), it has been commented in today's manufacturing and service industry, SPC fail to perform and the reason behind the failure that is being highlighted is lack of understanding of the techniques and usage of SPC in the organization. Failure to do so, will result the organization to receive more customer claims, customer feedbacks, product recalls, product rework, scrap rate decrease in manpower, decrease in profit margin and so on (Little, 2001). Once the organization receives more customer claims, increase in product reworks and scrap rate, which indicates their process is not in stable. Thus, the firm or company is processing more and more defects which eventually reduce the quality of the product or the quality of service.

According to Ribeiro and Cabral (1999), the failure of SPC can be due to wrong interpretation or using incorrect SPC methodology by the organization. Many organizations accept SPC as a tool to plot graphs and as a presentation material for customer satisfaction during customer audits. However the SPC charts are used to alert the responsible person about the condition of the process, but it will not explain what the problem is, in the process, causing the sudden change in the process stability. Oakland (1999) mentioned that most of the western organizations are using SPC to satisfy their customer's requirement. He further explains when the firms are having such concept in SPC; they are blind with the benefits of SPC. They are eventually going to overspend their financial resources for product rework (Herrman, 2002).

This study presents the factors influencing success of Statistical Process Control in Electric and Electronic firms' at northern region of Malaysia. The firms referred to this study are Multi National Corporations from American, European, Japanese and Local companies which have collaboration with American Firms or other European firms. It is being suspected that culture in Malaysia is indirectly influencing the success of SPC projects. It is also hoped that this study will beneficial for the local companies in Malaysia to successfully practice SPC to profit their organization and to their respective customers not to satisfy the customers as mentioned by Oakland (1999). One of the reasons the study was perused was to highlight the local companies as well Multi National Companies in Malaysia the importance of Statistical Process Control, which has the full control on the entire process capability, which also drives the organization to continuous improvement.

project to be implemented and practiced in an organization (Stepanov and Laansoo, 2004). Culture mainly referred to the attitude of the employees in the organization. Attitude of the employee usually leads to the culture change to adapt a new phenomenon or practice enforced by the top management in the firm. The employees should be highly motivated and willing to accept the challenges to successfully practice SPC project which requires very tedious applications in the organization and firm.

Given this situation as above, the benefits gain by the organization by practicing SPC and identifying the critical success factors of SPC projects, coupled with culture influence in the success of SPC project is an interesting study to be focused on in today's manufacturing and service industry in Malaysia.

1.4 Research Objectives

This study is undertaken to investigate the critical success factors influencing SPC in Penang and Kulim electrical and electronic firms. In general, the study will look at the following objectives:

i) To examine whether the success of SPC projects is influenced by the critical factors.

ii) To examine the level of SPC understanding in the firms.

iii) To examine the level of SPC tools and techniques practiced in the firms.

iv) To examine the successful SPC projects conducted in the firms.

1.3 Problem statement

Past studies have shown or highlight us, many firms focusing on Statistical Process Control (SPC) mainly to reduce defect rates, operator errors and variability cause found in the process. Even though SPC is a proven problem-solving tool in manufacturing and service industry, there are organizations, which fail to establish and implement SPC in their respective organization due to lack of top management commitment, ignorance by the employees for continuous improvement and due to customer's request (Antony, 2000). It is because most of the SPC projects fail in the initial stage of implementation due to the reasons highlighted above by Antony, (2000). Similarly, Nasirin et al. (2001) have studied on the failure factors in the Malaysian context; however, their study was looking on IS (information system) projects. They have identified factors such as corporate leadership, goals/deliverables, skills, deviation from timetables and management practices influence the failure of projects.

However, in Antony et al. (2003), they found that the extent of critical success factors of SPC are positively increased the quality performance. This study, however, believed that there is a gap in the literature about critical success factors for SPC in the context of the success of the SPC project itself. Furthermore, this study argued that the success of SPC is heavily dependent on the cultures in the organizations. Based on this gap in the literature, a detailed investigation on the critical success factors for SPC and how cultural change play a role in moderating the relationships is therefore necessary (will be further discussed in the following paragraphs).

This study specially examines certain factors that influence the success of the SPC projects in an firms practicing SPC. Where as, practicing SPC in the firms is after the successful implementation of SPC in the organization (please refer to Figure 2.1), where proper SPC tools and techniques is being used and by trained personals. The study point out, though most organizations start to practice SPC to achieve success, but they are frequently exposed to the factors which may cause their project to delay or fail at the end. SPC able to capitulate a poor performing processes but when it did not succumb the expected results, it will be classified as a failure. Nevertheless, understanding the key elements of the success of SPC would be beneficial to the organization. Instead focusing on the failure of the SPC in an organization the organization or the management should focus on the factor influencing the success of SPC such as Top management commitment, SPC knowledge, proper and easy communication between members and teamwork in the organization (Gupta, 2002), so that they could align themselves and work towards to it. One of the main success of SPC in the organization is to gain customer satisfaction, to reduce the defect rates and to increase process capability and stability. Further more, properly used SPC tools and technique will motivate the companies to apply six sigma and enhance their quality level towards zero defect.

Despite of technology and system introduction in Malaysia from Multi National Cooperation, there is another factor which is lacking for a new system and technology to be fully utilized here (Gates, 1998), which is the culture implanted by the locals in the Multi National Cooperation. Organization culture is a crucial factor in influencing SPC

v) To examine the benefits of practicing SPC projects in the firms.

vi) To examine if the level of cultural change moderates the relationship.

1.5 Research Questions

As mentioned above, the study will be focused on confining the key success factors of SPC projects in firms. This study attempts to answer the following questions:

i) Is the success of SPC projects is influenced by the critical factors?

ii) Do the firms have understandings on SPC?

iii) Do the firms practice SPC tools and techniques?

iv) Do the firms sustain successful SPC projects?

v) Do the firms benefit by practicing SPC projects?

vi) What are the most significant factors that influence the success of SPC projects?

vii) Is the level of cultural change moderates the relationship?

1.6 The significance of the study

This study is expected to facilitate the academicians and practitioners to enhance their research or to practice SPC in their respective firm. On top of that, this study may institute a base of success theory for sustaining SPC in a firm. It may highlight the key factors, which are required by the management and the organization to enhance in

statistical process control concept. Below are some of the reasons why this success factor of SPC is significant to the SPC practitioners, firms and management:

(i) To augment the success

This study will motivate and propose a guideline to the firms and management to concentrate on the significance factor which has been highlighted in this research. So that, less time is required and well practice is being conducted in the organization (Gupta, 2000).

(ii) To develop SPC skills and knowledge among the practitioners

This research will help the practitioners to gauge their SPC knowledge and their involvement in successful projects. This will highlight the management to select the appropriate team to maintain and improve the current process by practicing SPC (Antony, et. al, 2000).

On top of it, this study is very much significant in Malaysian context. It has been a motivation for this study to be carried out as up to now no study have been to done to analyze the relation between our Malaysian cultures with the internationally recognized SPC practices implementation. SPC is rarely implemented by organization as it requires high skill and deep understanding on this tool. In Malaysia, this tool is practiced by the Multi National Companies, as they were imposed with SPC earlier in their parent company. This study even highlights the level or the culture change influencing the success of SPC projects.

1.7 Definition of Key Terms

In order to ease the study, several key technical terms and general terms are defined as follow:-

Statistical Process Control – Is a statistical tool from TQM (Total Quality Management), which is used effectively in controlling a process or product variation to reduce the defect occurrence and to increase quality of the product, service and process (Antony, 2000).

Success of SPC Project – Success of SPC project in an organization is measured by the completion of the project or achieving the target which was set to reduce the defect rate, cost or time and the benefits they have achieved (Rungasamy et al, 2002).

Commitment of Top Management – Is the involvement by the top management in the SPC project by giving their full support for the completion of the project and to show up the importance and benefits of SPC to the organization (Antony and Taner, 2003).

Employees Participation and Education – Is the commitment given by the team members and other members in the organization during the implementation stages and their enhancement in SPC through trainings and sharing of the member's experiences (Antony et al, 2000).

Role of Quality Department – Is the association of the quality department in the company which drives the SPC projects to the success by monitoring and highlighting the variation caused by the SPC charts (Dogdur et al., 1997).

Characteristic of the SPC Project – Is the criteria of the project in an organization. Where duration, cost, manpower resources, and risk of the project is being calculated, coupled with the appropriate charts and adequate techniques and rules of SPC being followed and practiced in the process (Antony et al., 2000).

Statistical and Engineering Skills – Is more to the engineers or middle management who able to select the right charts for the suitability of the variable and the ability to analyze the trend of the process and defect occurrence which captured in the chart. On top of that, it also measures the ability to select the critical process, introducing adequate SPC software and hardware and adequate training on the measurement systems (Antony and Taner, 2003).

Teamwork – Is the collaboration and involvement by communicating between team leaders, corporate management, and team members shown by the team members and other members in the respective process or organization and also the involvement of knowledgeable person in SPC projects, coupled with frequent meetings with team members which lead to success the SPC project (Does and Trip, 1997).

Communication – Is the effectiveness of the message deliverance, updates and follow-up of the projects to the members as well as the other participants in the organization (Philip, 2003).

Culture Change – Is the transformation of an organization to accept, protest or boycott and resist to new concept or practices of SPC in an organization (Rungasamy et al, 2002).

1.8 Chapters Organization

The following chapters of this study are organized into; Chapter 2 covers the literature review of this project by discussing about the factors involved and also the basic understanding on Quality, continues improvement and Statistical Process Control, together with theoretical framework and hypothesis generation. Chapter 3 describes the questionnaire design, data collection method and statistical analysis used. Subsequently, Chapter 4 presents the results of the statistical analyses from the collected data. Finally. Chapter 5 concludes the discussions, limitations of this study, as well as the suggestion for future research.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

This chapter further elaborates the key terms defined in previous chapter. The core of the chapter is, to intricate the factors involved in the success of SPC projects in the firms. Together, this chapter envelops the theoretical framework and hypothesis of the study. To understand further about SPC and its usage, it is being required to comprehend the origin of it. Hence, the chapter inaugurate with quality.

2.2 Quality

In Garvin (1984), he illustrates performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality as the attributes of quality. Where as in Crosby (1979), defines quality as a conformance to requirements or specification. Lundvall and Juran (1974) defined Quality as fitness for use. Since manufacturing and service factors are into quality, so the definition of Quality has been re-defined by Mitra (2004) in his text defining, quality of a product or service is the fitness of the product or service for meeting or exceeding its intended use as required by the customer.

2.3 · Total Quality Management

Antony and Mason (2000) illustrates total quality management is a combination of quality and management, and there are no specific definition for TQM. Antony and Mason (2000) refers to Madu (1998) TQM definition, which defines, TQM as an organization-wide quality program to continuously improve products and services delivered to customers by developing supportive organizational culture and implementing statistical and management tools. Where, TQM should be a company-wide policy to continuously improve products and services (Antony and Mason, 2000). In addition of that, Jabnoun and Serdani (2005) referring to Dean and Bowen (1994), introducing components of TQM as continues improvement, customer satisfaction and teamwork. Where as, Dowe et al. (1999) highlighting the components of TQM are employee's commitment, shared vision and customer focus. This shows the definition of TQM varies and it is very broad (Antony and Mason, 2000). TQM is also a process that collects the right employees in a team from the organization, which breaks the boundaries and makes changes in the organization and firm. TQM will assist in problem identifying, results productivity improvement. In addition of that, continues improvement is the heart of the TQM (Smith, 1999).

2.4 Continues Improvement

To perform continues improvement certain tools and techniques are required. Generally seven QC tools are used as tools and techniques for continuous improvement (McQuater, et al., 1995). McQuater, et al. (1995) defines tools and techniques as skills, practical way and mechanisms which could be applied to any tasks that contribute positive results and improvement. The seven QC tools as cause and effect diagram, pareto analysis, relationship diagram, control charts, histograms and flowcharts. David and Richard (2003) gave few more examples and the definition of these tools according to the situation. They further add on the tools list with five why analysis, brainstorming, flow chart, pie-chart, scatter diagram and check sheet which respectively explained in Ishikawa (1982). The benefits of these tools and techniques as illustrated by McQuater, et al. (1995) are monitoring and evaluating a process, awareness of quality and commitment of the organization and team for continuous improvement. Bare in mind all the tools and techniques are only suitable for specific tasks only. David and Richard (2003) support this, from their observation, their students prefer to use control charts during their practical situation analysis. It is because the control charts highlights the best data and gives the best analysis of information. Yan Xu (2001) elaborates the traditional QC tool has limitations and can be only used when there is a quality problem in today's industry. Where as, control charts like Shewhart control chart (now known as SPC) more widely used in the industries due to its process control capability.

2.5 Statistical Process Control

Antony and Mason (2000) discuss SPC has statistical technique used to control processes and to reduce the variation in the processes, which is the key aspect to quality improvement. Antony and Mason (2000) support this concept by referring to Dale (1999). SPC is generally accepted to control and manage (the management) a process (manufacturing or service) through the usage of statistical methods. Antony and Mason (2000) further define the process variations as special causes and common causes. Special causes are the variation not inherent in the process and can be rectified easily. Examples for special causes are machine tool wear, errors in measurement and operator error. The failure magnitude is rather high for this cause. Common causes are the variations inherent in the process and affect the products or the services directly. Examples of the common causes are humidity fluctuations, temperature fluctuations and raw material variations. SPC is a tool which distinguishes between the common and special causes of the variation and it used to alert the management about the abnormality of the process. SPC should be practiced willingly by the organization and requires high motivation and not for customer satisfaction (Dogdu et al, 1997).

2.6 The Need and Benefits of SPC

Antony and Mason (2000) explain very well the need and benefits of SPC. Inspection-based quality control was the control used to inspect the final products or the service quality before prevention measure. It is costly, time-consuming, unreliable and

inefficient. Moreover inspection-based quality is not a value-added quality method for continues improvement because it is not leading to the root-cause of a problem. Prevention measure is required to analyze the root cause to prevent reoccurrence. SPC is able to highlight abnormalities in the processes and prevent the abnormalities from reoccurrence. Typical benefits gained by practicing SPC would be reduction in wasted efforts and costs, improved operation information, common understanding among the management and operators, better consistency of process output, and understanding each process well by dividing the causes in common cause and special cause. Where as, Does et al., (1997) adds on the needs and benefits of SPC as an alteration from detection to prevention, a new way delegating tasks and responsibilities to lower level of an organization, establishing capability of any process and reducing variation in a process. The benefits are financial gain, better communication with the customers, suppliers which relates to delivery performance and productability, statistical-orientated organization where decisions are made based on data and responsibility in the organization increases as performance of the process is measured. Topping by Hewson et al., (1996), highlights the most of the companies who implements SPC able to locate the problems in the process easily which reduced their scrap rate, reduced their product recall and improved their customer satisfaction.

Selden (1999) highlights that by implementing and practicing SPC it able to improve the sales of a company. He further illustrates that SPC can be fully explored in service industry to benefit the company financially. By knowing the normal and abnormal data, Lipke, (2002) suggests reengineering can be done to improve the process

performance. This further explains that the related personal in-charge of the process able to understand fully the process and take control of the process (Hewson et al., 1996). Bamford and Greatbanks (2003) add on, by knowing the principle of the SPC tool and its implication in the process, it will allow the owner of the process and related members in the process to take charge of the process. Data entering and data capturing is the most important part in SPC (Antony et al., 2000). Any error in data registering, it may lead to wrong definition of a problem or leads the process to an abnormal cause. Harrison and Drury, (2002) supports that by providing adequate SPC charts to the operator, will make them more convenient to use the charts and able to minimize the error generated by them during plotting the graph or registering the data in the software. By using the statistical principles and techniques of SPC, one can focus their manufacturing process into more economical concept of manufacturing. By doing so, they are able to increase product uniformity, plant operation rate, production rate, customer satisfaction, positive return of their investment. It also able to reduce the rework cost, material waste, and product recalls (Herrman, 2002). Generally most of the authors, mentions by implementing and practicing SPC in the organization and firms, will lead to the organization and firm's profitability by improving the quality of the product by controlling the process. By failing to do, the organization will be in treat financially, unable to get customer's trust and business due to the increase of the defect rate, and the engineers and operators will be spending more time in reworking the product rather than increasing the quality of the process and product (Herman, 2002).

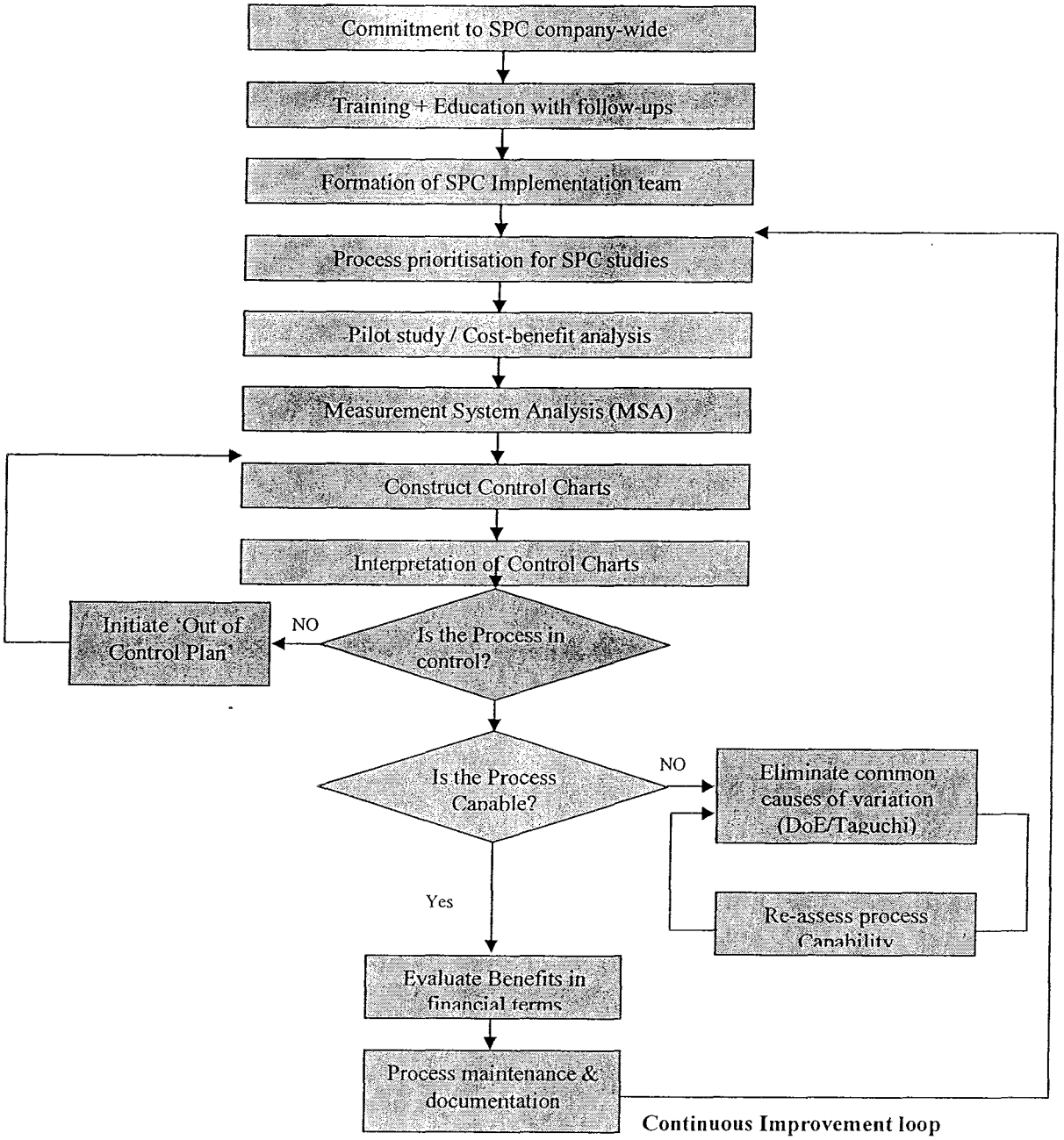
2.7 Problems Encountered During Implementation SPC

Basically it is not an easy task to implement SPC in an organization. Antony and Mason (2000), Antony, et al. (2000) and Antony and Taner (2003) illustrates the key factors contributing to the failures of SPC not to be implemented in the organization; lack of training and education on SPC, management commitment on providing relevant resources of SPC, employee understanding on benefits of SPC, lack of knowledge on which product or process to be measured or monitored using SPC and inadequate measuring systems for SPC which contributes to the failure to be implemented in an organization or firms. In addition to that, Greg and Chad (2006) adds, most of the management focus on the volume control not the economic control. Some of them fail to sustain because they miss to use the right tools in SPC. Dogdu et al. (1997) highlights choosing the wrong critical parameter in the earlier stage will mislead the measurement and data analysis, lack of previous data which eliminates the history of the process condition, data not stored electronically, poor employee commitment in collecting data which results poor data collection and poor analysis results, employee turnover where the knowledgeable employee leaves the job and training is required for the new employee and to understand the process, and lack of motivation to the employees. Harrison and Drury (2002), mention that the data is not being monitored and has not been recorded correctly, thus leads the process to a different cause. Krumweide and Sheu (1996) have highlighted the main practical problem faced in the small organization which is the difficulties in obtaining the funds for SPC training.

2.8 Key success factors of implementing SPC

In the recent study by Antony and Taner (2003), they have classified success factors of SPC into four main characters. They are management skills, engineering skills, statistical skills and teamwork. Initially Antony et al. (2000) and Antony and Mason (2000) focused main ten ingredients of success of implementing SPC in an organization. They are management commitment and support, training and education for SPC, teamwork, process prioritization and definition, selection of appropriate quality characteristics (or process variables), defining the measurement system, selection of control charts, culture change, use of pilot study and use of computers and software packages. Figure 2.1 illustrates the normal practice of implementing SPC in the organization as justified by Antony et al. (2000).

Figure 2.1: **Flowchart of implementing SPC in an organization.**



Antony and Taner (2003), which was the latest study done on factors influencing in SPC implementation in an organization. Implementation of SPC referred by Antony and Taner (2003), is the beginning stage or the initial stage of the implementing SPC for

the first time in the organization as shown in Figure 2.1. In their study, they were less focusing on role of quality department, communication, characteristics of SPC projects and culture in the organization but strongly supported by Herrman (2002). So in this study, these variables are given importance and the factors are regrouped in-line with the Malaysian, electric and electronic manufacturing environment.

From the literature review it is found most of the literature were focused on the implementation and these similar factors are predicted to be significantly influencing the success of practicing the SPC projects in an organization such as Commitment of Top Management, Employees Participation and Education, Statistical and Engineering Skills, Role of Quality Department, Communication, Characteristics of SPC Projects, Teamwork and Culture Change. The details of the variables are explained in the sub sections as below:

2.8.1 Commitment of top management

The concept (variation reduction) and the benefits as well as the usage of the SPC should be understood by the higher management first before implementing it. It is very important to have the management commitment and the management should highlight the importance of SPC in the organization, or else it is tough to achieve co-ordination from the employees. Sufficient budget and adequate resources should be arranged by the management to prepare themselves for continues improvement of product and process quality. The management should have motivation level to absorb any resistance during the change over which involves organization culture and implement know-how concept

among the employees (Antony, et al. (2000)). It consists of company wide commitment and training and education. A company wide commitment defines as the commitment by the organization from the higher management to the operators. The organization should clearly state the objective as well as their goal on implementing and practicing SPC in their organization. Rungasamy, et al. (2002) mentions, the selection of the process should be the key process and statistically and technically critical.

Process prioritization will funnel the management to identify the critical process and allocate proper manpower and economic resources for continuous improvement. The selected process should be further studied by defining the relationship with other operations, such as upstream and downstream from the selected process, process elements (machine, method, materials, people and environment), which continuously affect one another. Clearly, defined Ishikawa diagram and flow charts are able to elaborate the relationships well. On top of that Kaye and Anderson (1998) illustrate that continues support and commitment from management will effectively increase the quality level in an organization.

2.8.2 Employees participation and education:

Higher management training should be carried out first and then followed by the middle management and to the floor operators. The training should consist of rectifying and developing control chart, interpretation of control chart and successful case studies of SPC. Training should be carried in long-term basis not short-term basis, which allows the employees to understand SPC concept in detail, and able to rectify and discuss the

problem faced by themselves during the implantation period with other team members in training. This will reduce the efficiency of SPC usage and the employees may not able to absorb the overall benefits from it (Antony, et al. (2000)). Basically training and education should create awareness to the employees who involved in the SPC projects and to other employees as well and encourages the employees to keenly involve quality improvement and continues improvement activities in firms (Rungasamy et al (2002)).

Krumwiede and Sheu (1996) argue that all the employees should understand the benefits of SPC and its function in quality improvement and in their respective job. Thus training should be conducted formally for the management and informally to the operators to deliver the SPC concepts and decision making. Frequent meeting with the team members and the participating operators will increase the awareness of SPC projects by sharing the SPC projects among them and the achievement and action should be taken on certain conditions will accelerates the training and education (Strevmer (1996)). On top of that management should able to explain statistically the development of the process. This will further enhance the understanding of the concepts and principals of SPC among the participants (Jabnoun and Sedrani (2005)).

2.8.3 Role of quality department

Foster et al. (2002) emphasizes that knowledge on Quality, if followed by adequate application will certainly prove beneficial in process improvements. The authors further affirm that teamwork and proper leadership techniques will certainly enhance employee participation and customer satisfaction. Smith (1999) promotes the

TQM (Total Quality Management) concept and has concluded in agreement with Foster et al. (2002) that teamwork is a critical element in improvements of any process. Smith (1999) takes one step further and highlights the importance of getting the right people involved from various departments and to ensure they are empowered to make changes. He believes that, this will even optimize and simplify the processes. Furthermore, in today's quality management system it has been mistaken by its' philosophy and theory (Does et al, (1997)). In actual fact, the system is an architect of the organization, which touches core values of organizational culture. Hence, affects every process that is executed in the organization. Understanding of Quality Management and its components are essential in process optimization, especially where Statistical Process Control is involved. Adequate awareness at all levels; together with some Human Resource skills will certainly boost the organization to a higher plane.

Khoo and Tan (2002) explains that quality department should prepare for new changes, should focus customer driven goals or more to customer satisfaction, should lead and to involve every members in the firm to participate in quality related activities and create awareness among them. Where as, Dogdur et al. (1997) explains quality department should take lead in process and guide the related responsible process engineer to take charge of the process. Quality department should also act as a consultant and guide the process members when there is any abnormality or critical situation taken place in the process.