SELECTION AND IMPLEMENTATION OF QUALITY CONTROL AND IMPROVEMENT INITIATIVES: CASE STUDIES OF TWO MALAYSIAN MANUFACTURING COMPANIES

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A project report submitted in partial fulfilment of the requirement for the award of the Degree of Master of Mechanical Engineering

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For my beloved family
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Muhammad Aqeeq Hazim Bin Khairul Anhar
ACKNOWLEDGEMENTS

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ABSTRACT

Quality Control and Improvement Initiatives (QCII) refer herein to approaches, systems, tools and/or techniques and included, for example: Statistical Process Control (SPC), Six Sigma, Design of Experiment (DOE), Failure Mode and Effect Analysis (FMEA) and Acceptance Sampling. Unfortunately, there is a relatively lack of guidance available to organisations on how to select and implement appropriate QCII according to the context. In addition, very limited study has been found on the selection and implementation of multiple QCII in Malaysian manufacturing companies. The objectives of this study are to (1) identify the main QCII currently being used by the case companies, (2) investigate the processes involved in selecting and implementing multiple QCII, and (3) propose a framework for selecting and implementing QCII. Research approach used is case study, involving two Malaysian manufacturing companies. Main data collection method used is interview. The main QCII currently being implemented by the case companies are Quality Improvement Team, 8D Problem Solving Technique, Quality Gates, Failure Mode and Effect Analysis, Process Control Plan and Work Instruction. Based on case study data and literature review, a framework for selecting and implementing QCII has been developed. The framework summarises six main steps for selecting and implementing QCII which involved: (1) Diagnose current situation and performance, (2) Identify area(s) for improvement, (3) Identify and understand relevant QCII, (4) Select appropriate QCII, (5) Implement the QCII, and (6) Monitor progress and evaluate performance.
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CHAPTER 1

INTRODUCTION

1.1 Introduction to the chapter

This chapter explains the background of study, problem statement, objectives, scopes and importance of the case study.

1.2 Background of the Study

The pressure from globalisation has made manufacturing organisations moving towards three major competitive arenas: quality, cost, and responsiveness. Quality is a universal value and has become a global issue. In order to survive and be able to provide customers with good products, manufacturing organisations are required to ensure that their processes are continuously monitored and product qualities are improved. Manufacturing organisation applies various quality control techniques to improve the quality of the process by reducing its variability. A range of techniques are available to control and improve product or process quality. These include Seven Statistical Process Control (SPC) tools, Acceptance Sampling, Quality Function
Deployment (QFD), Failure Mode and Effects Analysis (FMEA), Six Sigma, and Design of Experiments (DoE).

A few companies continue to emphasize only the inspection aspect of quality control, whereas inspection is actually one useful element in an overall quality system who stated by (Stephen, 2000). The quality control of company is very important because of being the strategy that can bring:

i. Better quality as well as at incoming materials, production and assembly parts until the finish goods before outgoing and delivery.

ii. Better quality in term of saving cost or cheap with good quality due to apply continuous improvement.

ii. Better providing the customer satisfaction, creating greater markets and thus reducing overall cost resulting from improved quality is a reasonable measure of the correctness of its application.

Key competitive business strategies include both achieving lower cost and adding value through differentiation (Porter, 1980). Quality improvement is one important way in which competitive performance may be achieved. Through this strategy, if defects are eliminated or minimized, the cost of production due to waste will decrease. Organisations are facing problems in selecting appropriate improvement initiatives due to a plethora of initiatives currently available in the market (Hendra, 2010, Thawesaengskulthai, 2010). Improvement initiative refers herein to approaches systems, tool and/or technique and include, for example: Six Sigma, Lean, Business Process Reengineering, ISO9001, and benchmarking (Van der Wiele, Van Iwaarden, Dale & William, 2007).

1.3 Problem Statement

There is a myriad of initiatives that can be used to control and improve quality in the production, such as Statistical Process Control (SPC), Acceptance Sampling, ISO9001, Failure Mode and Effect Analysis (FMEA) and Benchmarking. Unfortunately, there is a lack of clear understanding by people regarding why, where and how to implement the initiatives. One reason may be due to lack of knowledge in the field of quality control. Lack of disclosure and review of quality control will
cause this problem to continue happening. Strong knowledge of quality control will facilitate a manufacturing company to determine the appropriate quality control initiatives for every critical process. In addition, the implementation of the quality control initiatives can be done in a better way. To address this issue, this project aims to investigate the selection and implementation of Quality Control and Improvement Initiatives (QCII) in Malaysia manufacturing companies.

1.4 Objectives of Study

The objectives of this study are:

i. Identify the main QCII currently being used by the case companies.

ii. Investigate the processes involved in selecting and implementing the QCII.

iii. Propose a framework for selecting and implementing the QCII.

1.5 Scopes of Study

The scopes of this study are:

i. These studies are being carried out at two selected manufacturing companies.

ii. Data are collected through interviews, document review, and observation focussing on three main QCII implemented in the case companies.

1.6 Importance of Study

The importance area of study for selection improvement initiatives due to the following main reasons:
i. Previous literature have highlighted the importance of selecting the right initiative for a given contact or situation, such as Basu (2004), Francis (2010), Hendra (2010), and Rigby and Bilodeau (2005). Selection processes will help organisations doing the right things (Mohammad, 2012).

ii. Help Malaysian manufacturing companies to select and implement appropriate quality control and improvement initiatives.

iii. To enrich the pool of case study materials and finding related to the selection and implementation of quality control and improvement initiatives.

1.7 Outline of the Study

There are five chapters in this thesis. The first chapter represents the background, aims, objectives, scopes and importance of the research. Chapter 2 describes the literature review on what has been highlighted by the previous researchers on the QCII. Chapter 3 explains the research design and methodology being used. This chapter will briefly explain on the research design, research procedures, and data collection methods. Chapter 4 discusses the results and findings from the research. Chapter 5 concludes the findings related to the aims and the objectives. It also comprises the limitation of the research, and also the suggestion for future research.
CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to the chapter

This chapter reviews the relevant literature and provides background which underpins this research. It contains with definition of quality, overview of quality control and quality improvement, quality control and improvement initiatives and previous study related to quality control and improvement initiatives. Finally, it concluded with a conclusion for this chapter.

2.2 Definition of Quality

Quality can be defined as fulfilling specification or customer requirement. A product is said to be high in quality if it is functioning as expected and reliable. Quality is a universal value and has become a global issue. Manufacturing organisations are required to ensure that their processes are continuously monitored and product qualities are improved in order to survive and be able to provide customers with good products. By the ways, one of the most important tasks in any quality program is to understand and evaluate the needs or expectations of the customer and then
provide products and services that meet or exceed those needs or expectations (Basu, 2004).

Quality is a significant element of production or services in keeping the customers satisfied. There are different definitions and competing views of the term quality by different people and the common element of the business definitions is that the quality of a product or service refers to the perception of the degree to which the product or service meets the customer's expectations. Crosby, (1979) defined quality as the conformance to requirements or specifications and also suggested that to manage quality adequately; it must be able to be measured. ISO 9000: (2000) (cited in Vorley and Tickle, 2001) defined quality as the degree to which a set of inherent characteristics fulfill requirements. Thus, the essential factors to Quality is quality must be measurable, quality must be based on customer needs, quality should be able to be edified with function ability and interchange ability (Mitra, 1998).

Three aspects are usually associated with the definition of quality: quality of design, quality of conformance and quality of performance. Quality of design deals with the stringent conditions that the product or service must minimally process to satisfy the requirements of the customer. It implies that the product or service must be designed to meet at least minimally the needs of the consumer (Mitra, 1998).

Quality of conformance implies that the manufactured product or the service rendered must meet the standards selected in the design phase. With respect to the manufacturing sector, this phase is concerned with the degree to which quality is controlled from the procurement of raw material to the shipment of finished goods (Mitra, 1998).

Quality of performance is concerned with how well the product functions or service performs when put to use. It measures the degree to which the product or service satisfies the customer. This is the final test of product or service acceptance always lies with the customers (Mitra, 1998).

2.3 Overview of Quality Control

Quality control is a conventional way that businesses have used to manage quality. Quality control is concerned with checking and reviewing work that has been done.
This is mainly done by inspection of products and services (checking to make sure that what’s being produced is meeting the required standard) take place during and at the end of the operations process. Juran (1988) defined quality control as the regulatory process through which we measure that actual quality performance, compare it with standards, and act on the difference. It is a more sophisticated management tool aims at preventing goods and services which do not conform to basic requirements from getting to the final consumer.

Quality control refers to activities to ensure that produced items are fulfilling the highest possible quality. Most of tools and techniques to control quality are statistical techniques. Quality control techniques can be classified into basic, intermediate, and advance level, but there is no consensus among researchers in the classification. For example, Xie and Goh (1999) consider DoE as an intermediate level technique whereas Antony et al (1998) classified the technique as advanced.

Nevertheless, the content is more important than the classification. Among the basic techniques are SPC. SPC is a statistical approach for assisting operators, supervisors and managers to manage quality and to eliminate special causes of variability in a process (Oakland, 2003). The initial role of SPC is to prevent rather than identify product or process deterioration, but Xie and Goh (1999) suggest for its new role to actively identifying opportunities for process improvement. The main tools in SPC are control charts. The basic idea of control charts is to test the hypothesis that there are only common causes of variability versus the alternative that there are special causes. By continuously monitoring the process, the manufacturing organisation could prevent defect items to be processed in the next stage and to take immediate corrective action once a process is found to be out of control (Hairulliza et al., 2005).

### 2.4 Overview of Quality Improvement

Improvement can define as the act or quality of improving or state of being improved. FDA’s quality system regulation (QSR) and ISO 9000 encourage device manufacture to incorporate continuous quality improvement process as a part of their quality systems. The intent is always the same while companies have adopted
different methods to control design and manufacturing outcomes: quality improvement.

Hitoshi Kume, a recipient of the 1989 Deming Prize for use of quality principles, defines problems as “undesirable results of a job”. Work best efforts of quality improvement when problems are addressed systematically using a consistent and analytic approach, the methodology should not change just because the problem changes. Keeping the steps to problem-solving simple allows workers to learn the process and how to use the tools effectively.

2.5 Quality Control and Improvement Initiatives

Foley (2010) said performance of an organization need to be improved so that the purpose of their existence can be met, and to satisfy and exceed customers, employees, shareholders, supply chain partners, community and other stakeholder’s expectations. To stay ahead of the market segment, organisational must strive to increase faster than their competitors (Mohammad, 2012). In-depth knowledge in the field of quality control and applied to facilitate the organization to compete and stay ahead.

QCII can be defined as approach, management system, tool and technique that can be used to control and improve quality (Mohammad, 2012; Van der Wiele et. al., 2007). QCII are also known as management tools (Rigby & Bilodeau, 2005), quality management and improvement initiatives (Thawesaengskulthai, 2007), business process improvement methodologies (Bendell, 2005) and performance improvement methods (Harrington & Lomas, 2000). Management gurus, academics and/or practitioners are those that are developing this initiative (Baxter & MacLeod, 2008; Davenport et al., 2003; Greatbatch & Clark, 2005). Table 2.1 summaries the definition and examples of approach, management system, tool and technique.
Table 2.1: The approach, management systems, tools and techniques for improving organisation performance (Mohammad, 2012).

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<td>1</td>
<td>Approach</td>
<td>An approach needs resources (e.g. training, hiring additional and specific personnel), senior management commitment, strategic planning and an “intellectual effort in term of its deployment and adoption” (Van der Wiele et al., 2007, p. 561)</td>
<td>TQM, BPR, Six Sigma, Lean</td>
</tr>
<tr>
<td>2</td>
<td>Management System</td>
<td>“A system comprises written information in the form of instructions and procedures in order to direct and control some form of operation” (Van der Wiele et al., 2007, p. 561).</td>
<td>Quality Management System (ISO9000), Environmental Management System (ISO14000), Occupational Health and Safety Management System</td>
</tr>
<tr>
<td>3</td>
<td>Tool</td>
<td>A tool can be “described as a device which has a clear role and defined application. It is often narrow in its focus and can be and is usually used on its own” (Dale, 1993, as cited in Van der Wiele et al., 2007, p. 562)</td>
<td>Cause and Effect Diagram, Pareto Diagram, Control Chart, Histogram, Relationship diagram, Flowchart</td>
</tr>
<tr>
<td>4</td>
<td>Technique</td>
<td>A technique “has a wider application than a tool”. It requires “more thought, skill,</td>
<td>SPC, Benchmarking,</td>
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Quality control is a topic pioneered by manufacturing sector. Nowadays, the field has developed tremendously and its techniques, tools, concepts, and methodologies can be applied widely in both service and manufacturing sectors. There are wide available techniques to control product or process quality. The following subsections explain several examples of the main quality control and improvement initiatives. These initiatives are 7 Statistical Process Control (SPC) tools, Design of Experiment (DOE), Failure Mode and Effect Analysis (FMEA), Six Sigma, Acceptance Sampling and Quality Function Deployment (QFD).

2.5.1 **Statistical Process Control (SPC)**

Among the basic techniques are SPC. SPC is a statistical approach for assisting operators, supervisors and managers to manage quality and to eliminate special causes of variability in a process (Oakland, 2003). The initial role of SPC is to prevent product or process deterioration rather than identify product or process deterioration, but Xie and Goh (1999) suggest for its new role to actively identifying opportunities for process improvement.

SPC involves using statistical techniques to measure and analyze the variation in processes. Most often used for manufacturing processes, the intent of SPC is to monitor product quality and maintain processes to fixed targets. Statistical quality control refers to using statistical techniques for measuring and improving the quality of processes and includes SPC in addition to other techniques, such as sampling plans, experimental design, variation reduction, process capability analysis, and process improvement plans (Montgomery, 2005).

The most comprehensive and detail studies of identifying SPC critical success factors for SPC implementation was done by Antony et. al. (2001), Antony
et. al. (2000), Rungasamy et. al. (2001) and Antony and Taner (2003). Antony identified and discussed the key ingredients for the successful implementation of SPC in both manufacturing and service organizations. They identified 10 key ingredients which are as follows: management commitment and support, process prioritisation and definition, selection of appropriate characteristics, define system devices, selection of control charts, training and education, team world cultural change and use of computer and software packages. In their continuing study on the deployment of SPC, Antony and Taner (2003) reviewed and compared four existing SPC implementation frameworks and proposed their conceptual framework for the successful introduction and application of SPC program in organization.

2.5.2 Design of Experiment (DOE)

DoE and Taguchi methods are powerful tools for product and process development. Taguchi methods, for instance, aim at making product or process that robust to undesirable disturbances such as environmental and manufacturing variations. However, the application of these two methods by industries is limited (Antony and Kaye, 1995). Antony et al (1998) explore the difficulties in the application including improper understanding and fear of statistical concepts in the methods, thus propose a methodology for the implementation. Process capability study is an efficient method to examine the capability of a process to produce items that meet specifications. The method gains rapid growing interest due to increased use of quality system QS9000, where use of process capability studies is requested (Delery et al, 1999). The findings from capability study might require adjustment of process using other statistical technique such as SPC or DoE. Capability studies conducted by Motorcu and Gullu (2004) and Srikaeo et al (2005) show that the machine tool and process capability and production stability was evaluated and necessary steps to reduce poor quality production was carried out using other statistical techniques.

There are various DOE techniques known as 'factorial' (complete or fractionated), 'Taguchi', Plackett-Burmam, among others, but whenever possible a method allows the experimental search of the influence of N variables and their
interactions. The statistical analysis of the results allows the determination of the significance of the results and to obtain an experimental equation that relates the variables and the results. It is often impractical to perform the experimental runs of fractional factorial in completely random order. Bingham and Sitter (2001) introduced that restrictions on the randomization of the experimental trials are imposed and the design is said to have split-plot structure. Similar to fractional factorials, the goodness of fractional factorial split-plot designs can be judged using the minimum aberration criterion. However, from their studies, the split-plot nature of the design implies that not all factorial effects can be estimated with the same precision. In this paper, they discuss the impact of the randomization restrictions on the design and also show how the split-plot structure affects estimation, precision, and the use of resources. Besides that, how these issues affect design selection in real industrial experiment was demonstrated.

Chantarat and Allen (2000) used simulation and assumptions from George and McCulloch (1993) to evaluate the abilities of fractional factorial designs and several analysis methods as well as popular designs on successfully identifying important factors to achieve model identification-related objectives. Kasperski et al. (1993), as well as analysis of variance followed by multiple t-tests. A new class of fractional factorial design, including an unbalanced design, which directly maximizes the probability of correct model identification, was proposed in this study. The results confirm that the probability of identifying important factors is low for commonly used approaches. New fractional factorial designs, derived from simulation optimization, are proposed that maximize the probability of correct selection.

2.5.3  Failure Mode and Effect Analysis (FMEA)

The FMEA was innovated by NASA in the 1960’s. This is a tool that in a structured way helps to analyse and document complex problems. The FMEA is normally used at an early stage in the product or process design life, but can also be used as a corrective tool. It is widely used in for example the automotive and the aerospace industry. FMEA is used to:
FMEA is a powerful method to detect where exactly problems can occur and to prioritise possible problems in the order of their severity (Dale et al., 2003). The tool is useful to identify problems in product, i.e. design FMEA, as well as to trouble shoot problems in process, i.e. process FMEA (Xie and Goh, 1999).

2.5.4 Six Sigma

Six sigma is also a statistical tool for ensuring defect free products through process continuous improvement. The term six sigma originated at Motorola and many inspired worldwide organizations have set goal towards a six sigma level of performance (Breyfogle and Cupello, 2001). The application of six sigma has been mainly used in manufacturing industry. An example of the use of six sigma in nonmanufacturing industry is in software development (Mahanti and Antony, 2005). Today, the six sigma is used worldwide, across continents, across different sector of industry.

Pojasek (2003) said that:

“The six sigma philosophy maintains that reducing “variation” will help solve process and business problems. By using a set of statistical tools to understand the fluctuation of a process, management can begin to predict the expected outcome of that process. If the outcome is not satisfactory, associated tools can be used to further understand the elements influencing the process. Most six sigma programs focus on process improvement. These efforts seek to eliminate the causes of variation in processes while leaving the basic process intact.”

2.5.5 Acceptance Sampling

Acceptance sampling is another statistical technique to make a decision whether to accept or reject a lot based on the information from sample. The application of
acceptance sampling allows industries to minimise product destruction during inspection and testing, and to increase the inspection quantity and effectiveness. The application of acceptance sampling has been mainly used in manufacturing industry (Hairulliza, 2005). Similarly, its application in nonmanufacturing industry is widely reported such as Thorpe et al. (1994), Gardiner and Mitra (1994) Bathika (2003) and Slattery (2005).

2.5.6 Quality Function Deployment (QFD)

According to Rosenthal and Tatikonda (1992), it is a systematic approach for the design of new products or services based on close awareness of customers desires, coupled with integration of corporate functional groups. QFD is a set of planning and communication techniques that focus and coordinate organizational capabilities in order to develop products that closest meet customers’ needs. King (1989) defines QFD as a system for designing product or service based on customer demands and involving all members of the producer or supplier organization.

According to Hutton (1999) QFD, when implemented correctly, can bring several benefits for both companies and their customers. The advantages of QFD are listed below:

- improved communication and sharing of information within a cross-functional team responsible for developing a new product,
- identification of weaknesses in the current knowledge of the design team,
- the capture and display of a wide variety of important design information in one place in a compact form,
- support for understanding consensus, and decision making, especially when complex relationships and tradeoffs are involved,
- the creation of informational base which is valuable for repeated cycles of product improvement.

As it can be observed, the benefits of implementing QFD methodology go far beyond satisfying customers’ needs and gaining higher profit margins as well as increasing market share. It provides a company with an opportunity to improve a
broad scope of its operations that reach far beyond the development of products, for example it facilitates team work and knowledge sharing within organizations.

### 2.6 Previous Studies Related to Quality Control and Improvement Initiatives

Most of the previous studies only focused on one specific initiative, such as, benchmarking (Adebanjo & Mann, 2008), ISO9000 (Bendell, 2000) and Six Sigma (Antony, 2007). Each of these studies tends to promote the particular initiative and goes into detail about the purpose, strengths, limitations and/or implementation process of the initiative. Unfortunately, very limited studies have been found (such as, Mohammad, 2012, Thawesaengkhultai, 2007 and Kwok & Tummala, 1996) to address how to implement and manage multiple improvement initiatives in the manufacturing companies. Table 2.2 summarise three previous studies related to multiple improvement initiatives.

Table 2.2: Comparison between previous studies related to the multiple improvement initiatives

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Methodology</th>
<th>Main Outcomes/Findings</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mohammad (2012)</td>
<td>▪ Global exploratory survey</td>
<td>- A guidance model for selecting organizational improvement initiatives was developed using acronym of GUIDE which represents the five key steps to select improvement initiatives: (1) Goal setting; (2) Understand relevant improvement initiatives; (3) Identifying decision criteria; (4) Deciding on the appropriate initiative, and (5) Evaluating</td>
<td>Focuses on the decision making process in selecting appropriate improvement initiatives. Does not cover the adoption and maintenance of initiatives.</td>
</tr>
</tbody>
</table>
- The proposed GUIDE model is one of first to focus on holistic processes to be used in selecting improvement initiatives whereby it contents are explicitly aligned to Business Excellence Models such as Baldrige Criteria for Performance Excellence.
- Part of the GUIDE model consist of a framework that shows the examples of 30 main improvement initiatives that can be adopted towards BE by narrowing down the option according to the areas of implementation and organisational maturity.

| Thawesaengkhultai (2007) | ▪ Literature review
▪ Case studies – conducted in Thailand
| Kwok & Tummala (1996) | ▪ Literature review
▪ Consulting experiences | A quality control and improvement system based on total control methodology to integrate isolated quality control tools. | Only focus on quality control tools used by the companies in Hong Kong. |
Based on a literature review has been made, it can be concluded that there is very limited available case study focuses on the selection and/or execution of quality control and improvement initiatives in Malaysian manufacturing companies. It is likely that the case studies and in-depth knowledge related to this issue in Malaysia is still lagging. Applying appropriate quality control and improvement initiatives is one of crucial steps to improve the production system and product quality in the race of globalization. To prosper and always be on top, the manufacturing companies must constantly improve the quality of their operation and products.

2.7 Conclusion to the Chapter

Based on the literature review that has been made, it is found that there are various types of QCII used in manufacturing industry today. Among these are the SPC, DOE, FMEA, Six Sigma, and Acceptance Sampling. This initiative aims to improve the quality of use of a product produced apart from getting useful feedback from customers.
CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction to the chapter

In this chapter, it explains the research methodologies that were used for supporting the analysis of the study. Some of the elements in methodology include the study plan, flowchart of the research, and data collection methods.

3.2 Research Approach

This research has been conducted using case study approach. Two manufacturing companies involved in this study.

A case study is the problem of narrative about something that can be resolved through appropriate methods. The problems that can be solved through case study might be likely including a special, unique or interesting thing involves organization, process, people, or even things. (Yin & Robert, 2003).

Yin (2003) said that”

“a case study design should be considered when: (a) the focus of the study is to answer “how” and “why” questions; (b) you cannot manipulate the behaviour of those involved in the study; (c) you want to cover contextual conditions
because you believe they are relevant to the phenomenon under study; or (d) the boundaries are not clear between the phenomenon and context.”

The information gained from a case study might provide a much more detailed compared to the other methods. It also allows to presents the data collected from multiple methods in order to strengthen the ideas towards the conclusion. The method could be find through several sources such as project documents, project reports, monitoring visits, mystery client reports, facility assessment reports, interviews, questionnaire/survey results, evaluation reports, and observation (Yin & Robert, 2003).

The steps in doing a case study might be different from one another. But basically there are some main processes involved that must be included to make sure that the result from the case study is reliable. The main processes involved as in Figure 3.1.

![Figure 3.1: Process involved in case study](image)

It is important to have a systematic plan before conducting the case study. Part of the planning processes involved identifying potential case companies, contacting potential case company and finalizing the case companies that willing to participate in this research. Planning process is very important in a case study. This
is because, with the planning process structured and organized, it will facilitate a method to run. How to collect the necessary data will be more easily and quickly. Further ways to analyze the data to be more systematic and effective.

Subsequently, a data collection instrument has been developed. There are three methods used in collecting data. Firstly, through interviews with industry representatives ranging from the quality manager and followed by three employees who perform or carry out three quality control tools. The second method is through observation. This observation is like looking at the state of the industry in terms of quality control and also see how people who are responsible for implementing a quality control of the work. The last method used is through the document reviews. Documents are as magazines, industry web site, Standard Operation Procedure (SOP), newsletters and others. Once all the data has been collected, the final process is to analyze the data.

3.3 Research Procedures/Processes

These research procedures/processes are shown in Figure 3.2. First of all, the case companies are identified. The application to industry visit being preceded to confirm the manufacturing industry for the study. When it gets approval from the case company, the preparation for visits in detail are done. Design data collection instruments (questionnaire) are made to ease the process while in the industry. This is in preparation so that there are no problems will occur during the interview and observation sessions on case studies conducted. So, till the stage of data collection, an observation for the data whether in control limit specification or out of the standard using different of tools. Besides, some of the measurements need to be carried out for getting the data.

A visit to the case companies have done twice to do interviews and observations to obtain information related to the study. At the first visit, is the first interview conducted on the manager, people who selected the QCII. Observations were also made at various levels in the application of quality control set. Second visit are made to interviews the persons who are implementing the QCII. The second visit carried over to improvements to the data collected and the study. This step shows the
quantity of the data measurements has been carried out whether is enough for the research.

Figure 3.2: Procedures for conducting research

At the stage of data analysis, it will concern to analysis some of the data that has been measured achieved the numbers of acceptance or not. If the data analyzed
do not meet the objectives set, then it will be performed again to get the correct and accurate data. Result and discussion was made on the data obtained.

3.4 Data Collection Methods

Data of the study are collected through interviews, observations and document review.

3.4.1 Interviews

An interview is a series of questions a researcher addresses personally to respondents. An interview may be structured (where ask clearly defined questions) or unstructured, where allow some of questioning to be led by the responses of the interviewee. Semi-structured interviews were used in this study. It was one of the sources in the data collection of a case study. Semi-structured interview was also known as qualitative interviews (Saunders, 2009).

Interviews are a useful method to investigate issues in an in depth way. It discovers how individuals think and feel about a topic and why they hold certain opinions. Besides that, interviews can investigate the use, effectiveness and usefulness of particular library collections and services. It also informs decision making, strategic planning and resource allocation. A sensitive topic which people may feel uncomfortable discussing in a focus group is also a useful method of interviews. Interviews also add a human dimension to impersonal data and deepen understanding and explain statistical data.

In this interview, researchers may give a set of written questions about the research, record the interview session using audiotape, or transcribe the interview. There are several types of interviews such as face-to-face, focus group, online focus group, and telephone interviews (Saunders, 2009). Face-to-face interview was used for this research. The interviews were conducted in two phases:
• 1st Phase Interview

Respondents for 1st phase interview are people who involved in the selection of QCII in the case company such as Quality Manager and General Manager.

The interview questions are attached in Appendix A. As shown in Appendix A, the questions asked during the 1st phase interview are: company profile, work background, the list of quality control and improvement initiatives currently being implemented, three main initiatives being implemented, key process involved in the selection of the initiatives, person in charge for three main initiatives, purposes, strengths and limitations of the three main initiatives, main challenges faced and how to overcome the challenges.

For the first interview, a formal approach is for people who were interviewed were from the upper classes. It is much to get information about the QCII selection itself. An appointment has been made with the Quality Manager of each company for an interview. The meeting enables to get as much information about quality control selecting and implementation in the company. A list of questions has been prepared prior to the company visit as a guidance to get the information. The interviews with the Quality Manager and factory visit take about two to three hours for each company.

• 2nd phase interview

Interviewees for 2nd phase interview include executives, engineers and/or technicians who are involved in the implementation of three main QCII. The interview questions are attached in Appendix B. As shown in Appendix B, the questions asked during the 2nd phase interview are: key processes involved in implementing the initiatives; purposes, strengths and limitations of the three main initiatives; main challenges faced; how to overcome the challenges.

An appointment has been made with the people who are in charge with the quality control tool of each company for an interview. The interviewing enables to get as much information about quality control implementation in the company. A list of questions has been prepared prior to the company visit as a guidance to
get the information. The interviews with the engineer and technician and also another factory visit take about two to three hours for each company.

3.4.2 Observations

Observation is an action or process of observing something or someone carefully or in order to gain information. In this case study, the observation is to see how the person in charge does the work to achieve the established quality control and improvement initiatives. Through observation, the data obtained is through observing the workers in industries undergoing their daily lives at work wrought. It was obtained during visits to industrial environments after interviews held. During this session, the questions and the problems that arise will be recorded and planned to find an answer in order to facilitate the process of report writing.

Often, during the interviews, a lot of things that cannot be remembered by the people interviewed. Therefore, this very important observation is done so that all the remaining data can be recorded. In the other word, in an interview situation or in response to a questionnaire item, a person may not always provide accurate or complete information, or they might answer in ways that correspond to what is socially desirable. There is a recognised source of bias in self-report techniques referred to as a 'social desirability set', which means that in many spheres of social life there are socially desirable ways of behaving and, consciously or unconsciously, individuals will tend to respond in that way, although in the 'real world' they might behave differently.

3.4.3 Document Review

Document review is a way of collecting data by reviewing existing documents. Documents are as magazines, industry web site, Standard Operation Procedure (SOP), newsletters and others. Through the study of these documents, many
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