Doctor of Business Administration

Dissertation

"Outsourcing total plant maintenance

in Singapore petrochemical industry:

A critical perspective"

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Abstract

There are many books suggesting the many benefits of outsourcing. A survey carried out in 2002 on twenty-four companies in the Singapore petrochemical industry showed that only about 10% of the companies outsourced total plant maintenance. Therefore, the research title was "Outsourcing plant maintenance in Singapore petrochemical industry: A critical perspective". There were three research questions that the research was examining. The first research question was the critical factors that were used in deciding the outsourcing of plant maintenance. The second research question was the factors that influenced the outsourcing critical factors. The third research question was how the research could help outsourcers to win outsourcing contracts.

A combination of qualitative (case study) and quantitative (survey) approaches was selected in this research to meet two important objectives. The first objective was to provide a "critical perspective" in the research by obtaining the feedback from different levels of management in the petrochemical companies and outsourcing organizations. The second objective was to improve the validity and rigor in the research by triangulating the data analysis of the qualitative and quantitative research approaches.

In the qualitative approach eight cases were selected to represent newer and older companies and different types of maintenance outsourcing. In the quantitative approach forty respondents from the petrochemical companies and sixteen respondents from the outsourcer companies were selected because of the relatively large size of the petrochemical companies over outsourcing companies. The pattern matching technique (Yin 1994) was the primary data analysis used to match the interviewees' feedback on the seven outsourcing factors identified in the literature review. The hypotheses derived from the modified Zeithaml's gap model were tested on companies that outsource total plant maintenance and partial plant maintenance. The SPSS statistical software programme was used in the computation of the statistical results.

The two critical outsourcing factors in deciding outsourcing total plant maintenance were outsourcing risks and service quality. The outsourcing risks factor was influenced by the company outsourcing culture and the service quality factor was influenced by the contractor worker experience in maintenance. The significance of this finding is the outsourcing risks may be lowered if the petrochemical and outsourcer companies have high commitment towards outsourcing. The service quality may be improved if the outsourcers hire better experienced and skilled workers. An outsourcing selection matrix was also developed to help both the petrochemical companies and outsourcers. The significance of this matrix is the petrochemical companies can use this matrix to decide outsourcing total plant maintenance. The outsourcers can also use this matrix to examine their strengths and weaknesses and give them a better chance of winning outsourcing contracts.

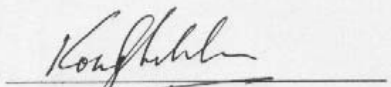
This research also contributed to the existing research knowledge in the areas of service quality, outsourcing benefits and management commitment. One of the knowledge contributions was there is a relationship between service quality expectation and outsourcing benefits. The expectation may be lowered if the outsourcing benefits are high. The research implications for the Singapore government policies on encouraging more companies to outsource plant maintenance were also discussed.

In conclusion, the research had examined and answered the three research questions. In addition, it also contributed to the existing research knowledge and suggested how the government policies could be changed to encourage outsourcing plant maintenance.

Keywords: Outsourcing, industry, maintenance, service, petrochemical, critical

CERTIFICATION OF DISSERTATION

I certify that the ideas, experimental work, results, analyses, software and conclusions reported in this dissertation are entirely my own effort, except where otherwise acknowledged. I also certify that the work is original and has not been previously submitted for any other award, except where otherwise acknowledged.



Kong Chan Nam

June 30, 2005

ENDORSEMENT

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CHAPTER 1
INTRODUCTION

This dissertation is to investigate the critical factors influencing plant maintenance outsourcing decisions in the Singapore petrochemical industry. This chapter serves as an introduction to the dissertation. It comprises eight sections, which cover the background to the research, an overview of the Singapore petrochemical industry, objective of the research and the research questions, justification and significance of the research, a brief description of the methodology, delimitations of this research, and chapter's conclusion.

1.1 Outsourcing background

The concept of outsourcing has become popular in the late 70's (Vercillo 1999). The traditional vertically integrated, self-sufficient organizations of the past (Kotler 1994; Porter 1985) are replaced by interdependent organizations focused on core competencies (Corbett 1999). One of the most common reasons for outsourcing is to add value to the organization and stakeholders by transferring non-core activities to a more competent outside service provider (Corbett 1997; Bendor-Samuel 1999). Adding value from outsourcing means more than reducing operating costs, but also includes freeing up capital and improves quality (Campbell 1995). It is the skilful delegation of specific tasks to outside experts and thus free management and employees to concentrate on being the best at providing their core product or service

(Corbett 1997). However, some companies embark on outsourcing not based on business strategy, but under political pressure or just followed the outsourcing trend (Reilly and Tamkin 1996; Straub 1999). These companies are often driven by headcount restrictions within an organization (Downey 1995).

Many organizations around the world are looking for new approaches to maintain or develop competitive advantage (Campbell 1995). Outsourcing is a strategy that can lead to greater competitiveness (Embleton and Wright 1998). Sometimes it produces higher reliability than in-house maintenance programs (Caspersen 2000). However, there are difficulties in outsourcing maintenance. Firstly, it requires significance commitment between the customers and outsourcers (Swarts 2003). For the customer, this may include selling assets to the outsourcer such as transferring in-house maintenance people. For the outsourcer, this may involve a substantial monetary investment in acquiring assets, absorbing the transferred people, and putting in new facilities, equipment, and systems. Secondly, all levels of managements in both organizations should be committed to outsourcing (Thilander 1992). Lastly, the employees may resist outsourcing because it is synonymous with job loss or change (Useem 2000). The outsourcing background suggests that there are advantages to outsource non-core business activities such as maintenance. The next section is give an overview of the Singapore petrochemical companies and how extensive is plant maintenance outsourced.

1.2 Singapore petrochemical industry overview

There are about sixty-nine petroleum and chemical companies on Jurong Island which forms the Singapore petrochemical cluster (Bo Khin 1999). A cluster is a geographic concentration of interconnected companies, specialised suppliers, service providers, and firms in related industries that complement each other (Porter 1998; Hill and Brennan 2000). In this research, the term ‘petrochemical industry’ is a collective term that represents the petroleum and chemical companies in the petrochemical cluster.

The Singapore business sectors recognize the shortage of maintenance workers since 1998 (Ministry of Trade and Industry 1998). The Singapore Chinese Chamber of Commerce and Industry launched a programme on February 17, 2000 to help organizations to outsource maintenance functions. Similarly, the Singapore Government also encouraged the local enterprises, through the Singapore Economic Development Board, to pool resources to achieve synergy and improve competitiveness (EDB Report 1999). In order to ensure there are sufficient workers to service the industry, the Singapore Economic Development Board has assisted over 1,100 professionals and technical staff and over 2,400 technicians and skilled foreign workers to enter and work in Singapore. To complement the services industry, 900 non-skilled workers and supervisors were also trained under the Regionalization Training Scheme (Woon 1999).

The petrochemical business in Singapore has been transformed from local and regional to global market over the last thirty years. The first company is the Exxon petroleum refinery built in the early 1970. The Hydrocarbon Magazine (1999) has reported that the Singapore petrochemical companies have to compete with global competitors that have the benefits of cheaper resources. A survey conducted by Solomon Consultant in 2002 on petroleum refinery in Asia Pacific has showed the total annual maintenance had increased by 14% from 2001 to 2002. The survey result is consistent with another survey conducted by the Plant Maintenance Resource Center in 2001 indicates that maintenance costs had risen steadily over the last three years. The increase in maintenance expenditures has eroded the industry profit margins.

A survey carried out in USA in 1995 shows that some petrochemical processing plants outsource either all their equipment and facility maintenance, or a particularly specialized or risky aspect of maintenance (Campbell 1995). In the Singapore petrochemical industry, there are four methods of plant maintenance adopted by the petrochemical industry shown in Table 1.1. The first method (Maintenance Type 1) is to use in-house maintenance crew with minimal use of contractors to maintain the plants. This method seems to be common in early 1970 where there were limited supporting industry in Singapore, and the refineries (there were no chemical plant then) had to hire their own workers to maintain all their equipment. The advantage of this method is the management has total control over the maintenance activities and

quality control. However, one disadvantage is the company has to hire many employees as compared to the other three maintenance methods. Another disadvantage is the workers have to be continuously trained in order to take care of the maintenance activities effectively. Old skill sets are constantly become obsolete and the requirement for new skill sets continues to multiply and it becomes harder and harder to find all the needed skills among the permanent staff (Swart 2003). Table 1.1 suggests that this method of plant maintenance is not common in the petrochemical industry today because the equipment installed are much more sophisticated and may require equipment manufacturer supports.

Table 1.1 Petrochemical industry maintenance methods

Maintenance Type	No. of Companies	Companies <10 year-old
1	0	
2	16	10
3	5	4
4	3	3

Maintenance Type:
1) Plant maintenance carried out by only in-house maintenance staff.
2) Most plant maintenance carried out by in-house staff. Only specialised equipment are outsourced. Contractors are hired when workloads are heavy
3) Outsource all plant maintenance activities. Using in-house staff to do maintenance planning and monitoring.
4) Outsource total plant maintenance. No in-house staff to manage maintenance activities.

Source: This table is compiled from the petrochemical companies in Appendix 1.1

The second method (Maintenance Type 2) is just to hire contractors to help the existing maintenance workforce. This method has been used by most of the petrochemical companies in Singapore (Table 1.1) for specialized equipment maintenance and especially during major plant repairs. The advantage of this maintenance method is the petrochemical companies reduce the risk of over-

dependence on the contractors (Downey 1995). The risk of outsourcer failure is lower because the companies have in-house crews to carry on with the maintenance activities. Another advantage of this maintenance method is the petrochemical companies may not need to train the workers to maintain the specialized equipment since the maintenance are outsourced. In fact, some experts say if an organization does not frequently use certain special skills, it is better to contract for these skills (Idhammar 1999). The rationale is even if the in-house crew are trained in specialty skills, they may not able to maintain the equipment because they do not use them frequently enough.

The third method (Maintenance Type 3) is to outsource the maintenance activities to one or more contractors and only keep the maintenance workforce to supervise and manage the plant maintenance programs. This method is commonly used in chemical plants in USA and Europe (Dunn 2001). Some petrochemical companies in Singapore also practice this method (Table 1.1). The advantage of this maintenance method is the petrochemical companies could reduce the number of in-house maintenance staff (Useem et al 2000). However, the disadvantage of this maintenance method is outsourcing can increase a firm's vulnerability to the theft of trade practices and propriety technology (Downey 1995). Furthermore, the older petrochemical plants may face another difficulty with this maintenance method. The managements have to transfer or retrench the in-house maintenance crews since their jobs are no longer required (Useem et al 2000) and these activities can be costly and demoralize the remaining employees.

The fourth method (Maintenance Type 4) is to outsource the whole plant maintenance to a single contractor with no or minimum intervention from the customer on the day-to-day maintenance activities. This method is the *"ultimate"* in outsourcing plant maintenance where the service provider is responsible and accountable for the reliability of the plant equipment. The customer, technically, does not need any maintenance personnel in his payroll. However, there are difficulties to adopt this maintenance method. The customer and outsourcer organizations have to be committed to outsourcing (Useem et al 2000). This commitment requires a paradigm shift among the petrochemical staff and contractor (Useem 1998; Jonsson 1997). The customer has to remove the fear of losing control of the maintenance activities (Jenings 2002; Bebko 1998). This fear may be real as the outsourcers may have

difficulties to hire enough experienced and qualified staff to carry out and manage the maintenance activities (Goolsby 2002; Ericsson and Dahlén 1993). Furthermore, the customer may not enjoy the same level of loyalty among the outsourcer workers because contracted workforce is generally has no loyalty (Finchem 1997). Although the dissatisfaction with total outsourcing is often high, it is difficult for companies to terminate the contracts, as the cost of doing so is prohibitive (Currie 1990).

In summary, the Singapore petrochemical companies mainly outsource some of the plant maintenance. There are only a few companies that outsource total plant maintenance and these companies are lesser than ten year-old. There may be reasons that the petrochemical companies are not keen to outsource total plant maintenance. Could the petrochemical companies use certain critical factors in deciding outsourcing total plant maintenance? This is the research question that is explained in the next section.

1.3 Research issues and hypotheses

It is widely believed that outsourcing of non-core business activities will reduce operating costs and provide competitive advantages (Corbett 1997; Bendor-Samuel 1999). Outsourcing can also yield some great short-term returns, as well as some good long-term opportunities if it is done properly (Finchem 1997). The observation of the Singapore petrochemical companies in Table 1.1 shows that not many companies outsource total plant maintenance. Therefore, the research title is:

"Outsourcing plant maintenance in Singapore petrochemical industry: A critical perspective".

The survey shows that out of a total of thirty-two petrochemical companies on Jurong Islands (Appendix 1.1), most of them outsource partial maintenance activities (Maintenance Type 2). These companies depend on in-house maintenance crews to maintain the majority of the plant equipment. There must be reasons why these

companies have not outsourced total plant maintenance. Are the factors used to consider outsourcing plant maintenance similar to the outsourcing activities in the IT industry suggest by experts like Corbett (1999) and Bendor-Samuel (1999a)? Therefore, the primary research issue is what are the critical factors that decide outsourcing total plant maintenance?

The outsourcing process involves two companies, namely, the petrochemical company and the outsourcer. The satisfaction of the outsourcing activities is influenced by the various management levels in the organizations (Corbett 1999). The rationale of using a critical theory perspective, derived from the critical theory of Habermas (Reed 1999), is to provide a deeper understanding of the decision making process (Avgerou 1995) by the stakeholders at different levels in the customer and outsourcer organizations.

The outsourcing deciding factors may not be mutually exclusive. The factors may be influenced by other not so critical factors. The research is trying to give a holistic approach to the research question by examining what are the other factors, if any, that influence the critical factors in deciding outsourcing plant maintenance. Therefore, the secondary research question 1 is what factors influence the critical factors in deciding outsourcing total plant maintenance?

The research is looking beyond just identifying the critical deciding factors and factors that influence these critical deciding factors. Since the research title is to provide a critical perspective and therefore involve the outsourcers, the research is also to provide a decision tool that helps the outsourcer to win outsourcing contracts. Therefore, the secondary research question 2 is how can the outsourcing contractors use these factors to win outsourcing contracts?

A hypothetical comparison of customer's and outsourcer's perceptions and expectations of the outsourcing factors is given in Tables 1.2. These perceptions-expectations comparisons are based on Zeithaml's Gap Model on service gaps that is explained in the literature review. This gap model is used to identify the service gaps and may help the outsourcers to improve their services. The hypotheses that are derived from the service gaps suggest by Zeithaml (1996) are tabulated in Table 1.2.

Table 1.2

Hypothetical comparisons between perceptions and expectations

	CE	CP	OE	OP
CE	X	H5	H4	H1
CP	H5	X	H3	H6
OE	H4	H3	X	H2
OP	H1	H6	H2	X

Note: H1 to H6 represent the hypotheses to be tested
CE = Customer expectations
CP = Customer perceptions
OE = Outsourcer expectations
OP = Outsourcer perceptions

Source: Compiled for this research

The hypotheses, H1 to H6, in Table 1.2 are based on the modified Zeimathl's gap model. They are based on the gaps that affect the service quality and may be the reasons that prevent the petrochemical companies to outsource total plant maintenance. The six hypotheses below are based on the petrochemical companies that are less likely to outsource total plant maintenance:

H1: The customer expectation is higher than the outsourcer perception
H2: The outsourcer expectation is higher than its perception.
H3: The outsourcer expectation is higher than the customer perception
H4: The customer expectation is higher than the outsourcer expectation.
H5: The customer expectation is higher than its perception.
H6: The outsourcing perception is higher than the customer perception.

To ensure the reliability of the test results of the above six hypotheses (H1 to H6) for companies that are less likely to outsource total plant maintenance, another six hypotheses (H7 to H12) are tested. These hypotheses (H7 to H12) are based on the companies that are more likely to outsource total plant maintenance and are the mirror images of hypotheses H1 to H6.

H7: The outsourcer perception is higher than the customer expectation
H8: The outsourcer perception is higher than its expectation.
H9: The customer perception is higher than the outsourcer expectation
H10: The outsourcer expectation is higher than the customer expectation.
H11: The customer perception is higher than its expectation.
H12: The customer perception is higher than the outsourcer perception.

The research data analysis in Chapter 4 will test the perceptions and expectations relationships of each of the twelve hypotheses. The results of the hypothesis testing are to triangulate the research case study results and also to confirm whether the modified Zeimathl's gap model is suitable for outsourcing total plant maintenance in the Singapore petrochemical industry

In summary, the research title is "Critical factors in outsourcing plant maintenance in Singapore petrochemical industry: A critical perspective". The three research issues are "What are the critical factors that decide outsourcing total plant maintenance?", "What influence the critical factors in deciding outsourcing plant maintenance?" and "How can the outsourcing contractors use these factors to win outsourcing contracts?" The next section is giving an overview on critical perspective as mentioned in the research title.

1.4 Critical perspective overview

In the 1980's strategic management theories aiming to align organizations with their environments to achieve competitive advantage (Porter 1980). In mid 1980, approaches based on total quality management (Deming 1860) gain popularity. Criticisms (by critical theorists) arise that these approaches did not address conflicts among the lower level of management.

The term Critical Theory has its origins in the 20th century by the Frankfurt School and popularized by Jurgen Habermas (Tripp 1992). Early research of this tradition

focused on class oppression and expounded that a more just society could only be achieved through emancipation by empowering the exploited people (Tripp 1992). The critical theorists suggest that positivist research approach, which has its root in the natural science, is instrumental to the obstruction of social changes (Kellner 1989). Critical theory, by contrast, nurtured a critical approach to social analysis that would detect existing social problems and promote social transformation. It emphasizes that research bias (from positive approach) is influenced by the power differential between research respondents and researchers (Clark 2004). The primary characteristic of this school of thought is that social theory, whether reflected to educational research or business, should play a significant role in changing the world, not just recording information. A critical theory would focus on contradiction and conflict as endemic in social relations and raise questions about how and why things might be otherwise.

This research adopts a critical perspective that looks at the different levels of workers in the petrochemical companies and outsourcers (managers, supervisors and technicians) that may influence the outsourcing decisions. The respondents are asked to provide their feedback on their expectations and perceptions on outsourcing. The research methodology is trying to discover the aspect of reality means to the social actors (Putnam 1983). The use of positivist, interpretive and critical approaches in this research will maximize comprehension of information system phenomena (Lee 1991).

1.5 Justification and significance

Outsourcing is an integral part of an ongoing business strategy (Quinn 1994) and there is a growing trend in outsourcing plant maintenance. Many petrochemical plants in US have outsourced all or part of their maintenance to develop competitive advantage and reduce costs (Campbell 1995). In fact, there is an increasing trend to outsourcing total plant maintenance in the petrochemical industry in the US and

Europe since the economic downturn in 1997 (Mullin 2002). This outsourcing also leads to higher plant reliability than in-house maintenance crew (Caspersen 2000).

The Singapore petrochemical industry, like the petrochemical companies in USA and Europe, can also benefit from outsourcing plant maintenance (Campbell 1995). Firstly, the petrochemical companies can enjoy a reduction in the overall plant maintenance costs. Plant maintenance is the contractors' core businesses and they could carry out the work more efficiently (Campbell 1995, Corbett 1997, Caspersen 2000). Secondly, the companies are able to reduce their maintenance crews or transfer some of them to handle the companies' core businesses and hence add to shareholder value (Corbett 1997, Bendor-Samuel 1999).

The observation of twenty-four companies in the Singapore petrochemical industry in Table 1.1 shows that many of these companies only have outsource some of their maintenance activities (for example, specialized equipment) by hiring contract workers to supplement their in-house staffs. In the last few years, there are a few new petrochemical companies outsourced most of their plant maintenance work and hired minimal plant maintenance crews (for example, ExxonMobil Chemicals, Celanese, Lonza and Eastman). The outsourcers are expected to take more responsibilities in the work scheduling, work execution and recording of maintenance history. However, some of these companies hire 'skeleton' maintenance crews to supervise the outsourcers in order to ensure maintenance quality. These crews are responsible for the analysis, work identification and work planning.

Another survey carried out on the petrochemical companies in Appendix 1.1 shows that out of a total of thirty-two companies observed, only three companies outsource total plant maintenance and five companies depend on their employees to supervise the outsourcers. About 21% of the companies have outsourced their maintenance to various contractors. The background study of the Singapore petrochemical industry shows that there is high annual investments and a shortage of skilled workers. Furthermore, the annual employee remuneration in the petrochemical industry is also high compared to other industry in Singapore. Therefore, there is every reason that the petrochemical industry should outsource total plant maintenance to reduce maintenance costs and address the shortage of skilled workers to maintain the plants. Could it be the petrochemical companies are more reluctant to outsource total plant maintenance because the consequence of maintenance failure is great (Jenings 2002,

Bebko 1998). There may be a higher risk associated with the selection of the 'wrong' service providers (Downey 1995) and the difficulties to set precise specifications for the services (Parsuraman, Zeithaml and Berry 1985). Finally, could the reason for not outsourcing total plant maintenance because these companies afraid the risk of leaking of proprietary work practices and technologies (Downey 1995) that may affect their competitive advantages over their competitors. Therefore, there is a good justification to conduct this research to find the critical factors for deciding outsourcing total plant maintenance. The significance of this research is two folds. Firstly, it addresses the shortage of skilled workers to maintain the plant equipment reliability. Poor plant reliability will affect plant production and may affect the decision of future investments by the petrochemical companies. Secondly, outsourcing plant maintenance, which is a non-core business activity, will reduce the overall costs of the plant operations. Plant operating cost is one factor that foreign companies will consider before investing in Singapore.

1.6 Research methodology

This section is to explain the types of research approaches that are used in this research. Qualitative research approach is associated with interpretative approaches from the respondents' point of view. This approach is strong in those areas that have been identified as potential weaknesses within the quantitative approach, e.g. the use of survey interviews to provide a deep, rather than broad, set of knowledge about the outsourcing deciding factors. The argument used is that quantitative methods measure human behaviour "from outside", without accessing the meanings that individuals give to their measurable behaviour. On the other hand, a qualitative research design allows these understandings to be investigated from the respondents' point of view (Easterby-Smith 1991; Remenyi 1998). However, the main argument against qualitative research approach is the concept of validity. It is difficult to determine the truthfulness of the findings. The relatively low sample numbers often

encountered may also arguably lead to claims of findings being unrepresentative of the population (Marsh, et al. 1978). This point is disputed by many researchers such as Yin (1994).

Quantitative research approach is characterized by the assumption that human behaviour can be explained by what may be termed "social facts", which can be investigated by methodologies that utilize "the deductive logic of the natural sciences" (Horna 1994). This approach looks for empirical boundaries and examines the behavioural components of expectations and perceptions of outsourcing plant maintenance. It allows statistical analyses of data collection in order to verify reliability (Guba and Lincoln 1994; Tsoukas 1989). Although the approach is obviously useful in determining the extent of such behaviour or attitudes, the methodology fails to provide any explanation or analysis beyond the descriptive level (Jones 1997). Therefore, the weaknesses of quantitative research lie in their failure to ascertain deeper underlying meanings and explanations of the reasons not to outsource total plant maintenance. The quantitative assumption regarding decisions to outsource plant maintenance is that the outsourcing expectations and perceptions can be reduced to a set of variables. Although quantitative research is strong in measuring such variables, the focus of the research is not examining outsourcing expectations and perceptions.

This research is adopting a combination of qualitative and quantitative research approaches. The crucial aspect in justifying a mixed methodology research approach is that both single methodology approaches (qualitative only and quantitative only) have strengths and weaknesses. The combination of methodologies, on the other hand, can focus on their relevant strengths and highlight the significant contributions of the two research methods (Nau 1995), where "qualitative data can support and explicate the meaning of quantitative research" (Jayaratne 1993). Therefore, the triangulation of the results from both research approaches should ensure that the final research is valid and converge the research evidence towards a common reality (Perry, Riege and Brown 1998).

The research title is *"Outsourcing total plant maintenance in Singapore petrochemical industry: A critical perspective"*. The units of analysis are the Singapore petrochemical companies and outsourcing contractors tabulated in Table

1.3. The units of analysis is "…what constitute a case" (Carson, Gillmore, Gronhaug and Perry 2000, p4). The people or companies chosen for the analysis have to be related to the research question (Yin 1994).

Table 1.3 Units of analysis

	Partial outsourcing plant maintenance	Total outsourcing plant maintenance
Petrochemical companies	X	X
Outsourcers	X	X

Source: Compiled for this research

The petrochemical companies that are chosen in the research are companies that outsource partial plant maintenance (Type 2 or 3) and total plant maintenance (Type 4) and their associated outsourcers. The reason is to provide breath in the research by examining the outsourcing deciding factors from these groups of companies. The analysis is also involving different level of management in each organization. The reason is to provide depth in the research by examining the stakeholders in the outsourcing process. Therefore the unit analysis will also provide a critical perspective of identifying the critical outsourcing factors which is the research question.

The case study research is a multiple-case study approach in order to provide a more compelling and robust research (Herriott and Firestone, 1983). The difficulty is to decide on the number of cases for the research. One suggestion is the decision should be left with the researcher (Romano1989). Another suggestion is to sample to the point of redundancy (Lincoln and Guba 985) which may require too much resources. Eisenhardt (1989) recommends between four and ten cases as a guide in multiple-case study. Since there are no clear guidelines in the literature on the selection criteria, the research decide to choose eight cases to reflect the various combinations of outsourcing activities that would result in theoretical replication (Yin 1994). In order to provide critical perspective in the research, the survey and interviews that are carried out include managers, supervisors and technicians of the petrochemical companies and outsourcers. The Likert scales are used to identify survey data quality.

Therefore, the research analysis (extensively explained in Chapter 4) will be able to triangulate the research data and ensure the findings to be valid and robust (Yin 1994).

1.7 Research limitations

This research has four delimitations of scope that may restrict the generalization of its findings. The research approach seeks to understand the problem being investigated by asking penetrating questions and to capture the organisational behaviour. The conclusion drawn may be specific to the particular organisations (Gable 1994).

Firstly, the critical factors in deciding maintenance outsourcing in the Singapore petrochemical industry may be different from other industries. The petrochemical industry invests heavily in startup costs and pays more attention to plant safety due to their inflammable products than other industries such as electronics and shipbuilding.

Secondly, this study was based on the petrochemical plant in Singapore only. The expectations and perceptions on outsourcing plant maintenance of these companies may be different from the petrochemical plants in other countries. Companies in other countries may have different cost structure and legal requirements. Therefore, the factors that decide plant maintenance outsourcing may be different in similar industry in other countries.

Thirdly, the study is assuming the petrochemical industry and the outsourcing contractors are culture-free. Most of the petrochemical companies in this research are multinational companies with headquarters in USA, Germany and Europe. Furthermore, some of the outsourcers in the research have joint-venture with foreign contractors. The expectations and perceptions of these companies may be different because organizational behaviour does vary with culture (Usunier 1993). For example, the Japanese are generally more ethnocentric than other cultures (Tung

1984). The reason of not including culture in this research is because culture is another major research by itself.

Lastly, the research may not be totally bias-free because the researcher is related to the petrochemical industry. Though effort is made as explained in the interviewing process in Chapter 3 to ensure the research data are as bias-free as possible, it is not possible to prevent the interviewees to provide answers to 'please' the interviewer.

1.8 Conclusion

There is a growing trend in the world to outsource non-core businesses. In the Singapore petrochemical industry, the majority of companies continue to maintain their plant by their in-house crews and outsource some of the maintenance activities. Those companies that outsource most of their plant maintenance are newer plants that are less than ten year-old. This observation is against the environmental backdrop of shortage of skilled workers and high worker annual remuneration compared to other industries in Singapore. Therefore, the primary research question, "Critical factors in outsourcing plant maintenance in Singapore petrochemical industry: A critical perspective" is to identify the critical factors that the petrochemical companies used to decide outsourcing total plant maintenance. The research will also examine the factors that influence the critical outsourcing factors and develop a selection matrix to help outsourcers to win outsourcing contracts. The research methodology is based on a combination of qualitative approach (multiple-case study) and quantitative approach (survey) in order to provide the depth and breath in the research. The involvement of the different levels of management in the petrochemical and outsourcer companies is to provide a critical perspective to the research. The triangulation of evidence from the two research approaches will provide rigor and validity to the research.

The literature review in the next chapter is to examine the Singapore petrochemical industry and identify the factors that may be appropriate in deciding outsourcing plant maintenance in the Singapore petrochemical companies. In addition, hypotheses are

developed based on Zeimathl's gap model that may help the outsourcers to win outsourcing contracts.

CHAPTER 2
LITERATURE REVIEW

This chapter gives an overview of the Singapore petrochemical industry and the potential demand for more maintenance work due to strong investments in the industry. The literature review has identified seven factors that may be applicable in deciding outsourcing plant maintenance in the Singapore petrochemical industry. These factors are service quality, contractor experience, outsourcing contract, risks, outsourcing reasons, training programmes and outsourcing culture. Furthermore, twelve hypotheses that are derived from the Zethaml's gap model may be used to help in the decision making process.

2.1 Introduction

This chapter is to examine the existing research knowledge on outsourcing and the Singapore petrochemical industry. The literature will examine the economic and technical environments in the Singapore chemical industry, the types of maintenance commonly practised and the outsourcing organizations available. Furthermore, this section will also explore the type of outsourcing factors that may be applicable in this research. The primary source of information on outsourcing is from past researches and textbooks on the same subject. The Singapore Government economic reports and annual statistics are primarily used to understand the Singapore petrochemical industry

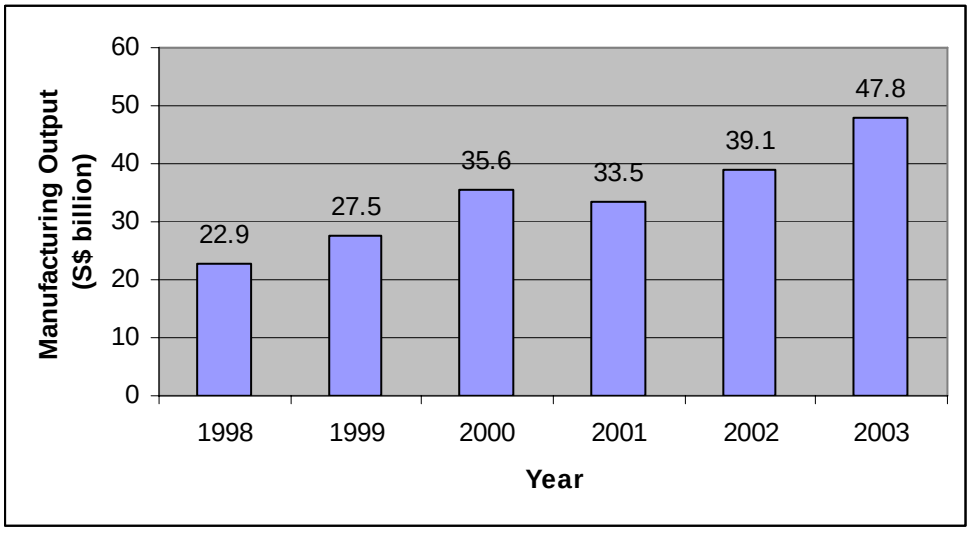
and its economic environment. The literature review will define the boundaries where the research will be carried out.

2.2 Singapore chemical industry

The Singapore petrochemical industry has gone through an economic crisis in early 2000 and the industry is poised to increase their production and profit through 2006 and beyond (Singapore Statistic Yearbook, 2004). There is an expected shortage of skilled labour to handle the growing plant maintenance. However, not many petrochemical companies have outsourced total plant maintenance. Therefore, this chapter is to identify the factors that may decide outsourcing total plant maintenance in the Singapore petrochemical industry. In addition, the chapter also identifies a matrix or model that the outsourcers can be used to win outsourcing contracts.

The manufacturing output in the petrochemical industry has been consistently high except for 2001. The manufacturing output is defined as the total value of all the commodities produced (including by-products) and industrial services rendered. The manufacturing output in 2003 was S$47.8 billion and accounted for about 32% of the Singapore total manufacturing output is shown in Table 2.1. The output from this industry was only second to the electronic sector in 2003. In 2001, the demand for petrochemical products in this region had dropped but the output still managed to achieve S$33.5 billion. The forecast is the petrochemical industry will continue to be a profitable industry and is important to Singapore economy because there is a total committed investment of S$1.6 billion for 2004 (Singapore Ministry of Trade and Industry 2004).

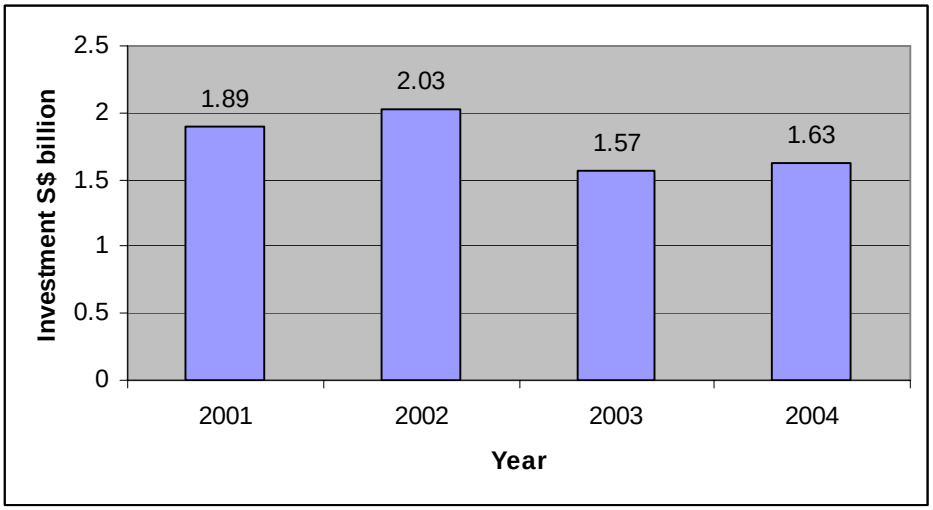
Table 2.1 Singapore petrochemical industry manufacturing output



Source: Singapore Yearbook of Statistics, 2004

In 1998, the Singapore government has identified manufacturing and services sectors as the twin engines of growth for Singapore in the next century (Ministry of Trade and Industry 1998). Since 1998 to 2003, the manufacturing sector (which includes the petrochemical industry) had accounted for 26% of the total Singapore gross domestic product (GDP) (Singapore Ministry of Trade 2004). This sector is only second to the services sector which had accounted for about 62% of the total GDP in the year 2003. Since the manufacturing sector plays a critical role in driving the country economic growth, the government policies are shifting away from the tangible indicators such as employment to supporting the manufacturing sectors, such as the petrochemical industry, and improving the professional skills of the workers. This shift of focus by the government gives the service providers the incentives to expand their investments such as providing more skills training and investing in new equipment to support the petrochemical industry.

Table 2.2 Singapore petrochemical industry investments

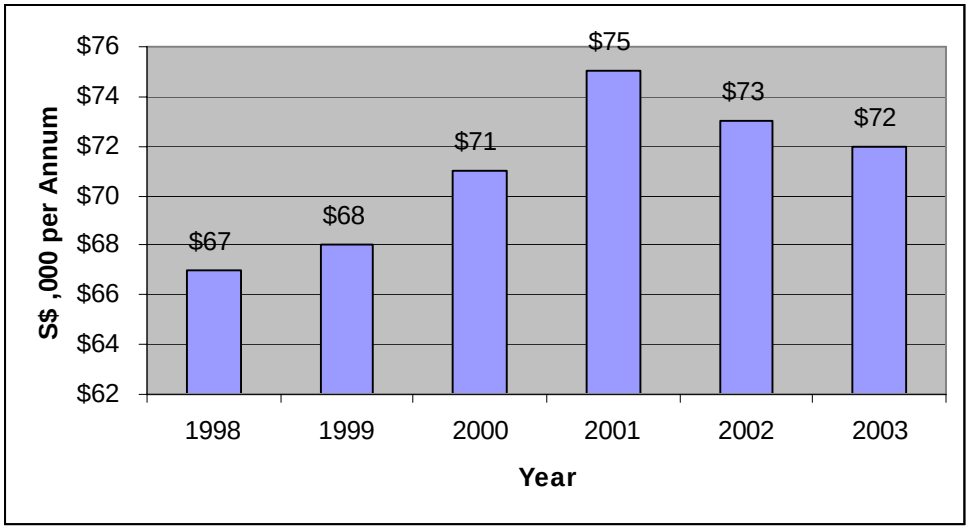


Source: Singapore Ministry of Trade and Industry, 2004

The Singapore government has given more incentives to attract more foreign investments and for the petrochemical companies to use Singapore as the servicing hub for the region. There are synergies among many of these companies because they are integrated in their supply chain. In 1999, there are forty-six petrochemical companies in operation on Jurong Island. In 2000, there are another twenty-three petrochemical companies constructed on Jurong Island (Hydrocarbon Asia 1999). The trend of investments in the petrochemical industry from 2001 to 2004 is shown in Table 2.2. The investments include expanding the existing petrochemical plants to increase production and constructing new plants.

Table 2.2 shows that from 2001 to 2004, the annual investments in the Singapore petrochemical industry were above S$1.5 billion. In 2002, Shell Eastern, a multinational petrochemical company, invested S$2.03 billion to build a chemical plant in the chemical cluster on the Jurong Islands. In 2004, there was a committed investment of S$1.63 billion and will generate an estimated 900 new jobs in the petrochemical industry (Singapore Ministry of Trade and Industry 2004). In 2004, the petrochemical industry has the second largest investments after the electronics industry. The increase number of these new companies means more maintenance work and maintenance workers are required.

Table 2.3 Worker remuneration in the Singapore petrochemical industry



Source: Singapore Yearbook of Statistics 2004

The annual worker remuneration in the Singapore petroleum industry is shown in Table 2.3. The annual remuneration includes salary, bonus, Central Provident Fund contributions and other benefits paid to the workers. The table indicates that the worker annual remuneration rose to a high of S$75,000 in 2001 and dropped slightly in the subsequent years. The average worker remuneration in the petrochemical industry is relatively high as compared to the average worker remuneration of S$37,000 for the manufacturing sector. Although the nature of work in the petrochemical industry is different from the rest of the manufacturing sector, nonetheless, there is a need for the industry to cap the worker remuneration, and perhaps reduce operating costs in order for the Singapore petrochemical industry to stay competitive in the world market. One way to reduce operating costs is to outsource non-core business activities (Corbett 1997). Therefore, the petrochemical companies may need to outsource more non-core business activities such as plant maintenance.

The Singapore business sectors recognize the importance of increasing the pool of maintenance workers in order to support the industries. The Singapore Chinese Chamber of Commerce and Industry launched a programme in 2000 to help small and medium sized enterprises to outsource non-core business functions. The first offering

was in the financial and distribution data processing shared services. This programme enabled small and medium enterprises (SME) to tap expertise in finance and IT (Business Times, February 17, 2000). Similarly, the government is encouraging the local enterprises, through the Singapore Economic Development Board, to pool resources to achieve synergy and improve competitiveness. This policy impacts the outsourcers in the petrochemical industry. The smaller local service providers are encouraged to merge with larger foreign companies to transform into highly effective and efficient outsourcing companies that could service the industry better. Furthermore, to ensure there are sufficient workers to service the industry, the Singapore Economic Development Board assisted over 1,100 professionals and technical staff and over 2,400 technicians and skilled foreign workers to enter and work in Singapore. To complement the services industry, 900 non-skilled workers and supervisors were also trained under the Regionalisation Training Scheme (Gerald Woon, EDB Report, 1999).

The Singapore government recognizes the important role that the foreign skills professional can play in improving the local skills and competitiveness. This is because to attract foreign enterprises, worker good attitudes alone are not enough. Workers' skills must also meet international standards (Kanter 1995). Therefore, in order to attract foreign talents, the government has offered affordable accommodation for the foreign talent through the "Scheme for Housing Foreign Talent" programme. In addition, tax incentives are given to employers who have hired foreign talent in order to subsidize their expenses for the overseas recruitment exercise. Since April 1 1998, the levy for skilled and semi-skilled workers imposed by the Ministry of Manpower (Singapore Ministry of Manpower 1998) has also been reduced from $200 to $100. This policy complements the earlier policy of optimizing the resources. Hence, it may result in increasing the pool of skilled workers for the chemical cluster and the service providers will also benefit from lower employees' wages.

Lastly, the government is planning to attract foreign companies to undertake construction and maintenance activities the manufacturing industry, which includes the petrochemical industry (Singapore Ministry of Trade 1998). The idea is to "force" the local contractors to upgrade their skills or merge with larger foreign companies. Otherwise, they may not be able to compete with the foreign contractors.

Table 2.4 Joint-venture outsourcing companies

Joint Venture Companies	Individual Companies	Country of Origin
PEI	Plant Engineering Company Yokogawa Electric	Singapore Japan
Hiap Seng-Fisher	Hiap Seng Emerson	Singapore USA
Rotary-Honeywell	Rotary Honeywell	Singapore USA
Mun Siong-Stoke	Mun Siong Stoke	Singapore UK

Source: research carried out in the Singapore Chemical Cluster, 2003

Some of the local contracting firms take the Singapore Government advice and started joint-venture outsourcing companies with the more established foreign companies to compete in the plant maintenance outsourcing business. In 2003, four local contractors have merged with foreign companies (Table 2.4). These joint-venture companies are able to increase their resources and expertise very quickly without hiring and training new staff. Furthermore, the companies can project a more reputable corporate image with multinational connections.

The first joint-venture outsourcing company is PEI, which is a joint venture between Yokogawa and Plant Engineering Company. Yokogawa is a well-known Japanese multinational company and is arguably the largest process instrumentation manufacturer in Japan. Its process instrumentation are supplied to many of the petrochemical companies in Singapore. Plant Engineering is a local contracting firm specializing in piping and electrical work in the petrochemical industry. The company mainly handles project work. The merger between Plant Engineering and Yokogawa will provide the necessary skills to maintain plant equipment.

The second joint-venture outsourcing company is Hiap Seng-Fisher. Fisher is a subsidiary of Emerson, a large U.S. conglomerate, and specializes in process instrumentation. Fisher has been selling and supporting their products in Singapore for many years. Hiap Seng is a local contracting firm specializing in piping and

electrical work. Hiap Seng and Plant Engineering are quite similar in size and expertise. They are also competitors in the bidding for piping contracts in the petrochemical industry.

The third joint-venture outsourcing company is Rotary-Honeywell which is a merger between Rotary Electric and Honeywell. Rotary Electric is a public-listed company specializing in mainly construction work in the petrochemical industry. The contractor also participated in construction projects outside Singapore. This company is the largest local company involved in the outsourcing business. Honeywell is a reputable U.S. process instrumentation company similar to Yokogawa. The company's local office has been supporting their products in the Asia Pacific region. Honeywell and Yokogawa are strong competitors in the process instrumentation market worldwide.

The fourth joint-venture outsourcing company is Mun Siong-Stoke which is a joint-venture between Wescon and Stoke. Mun Siong is a local contracting company specializing in construction activities in the petrochemical industry. This company has been successful in some outsourcing activities. Stoke is a UK contracting firm specializing in outsourcing activities. The company is new in Singapore and the merger will allow the company to kick-start their business in this region. The merger between Mun Siong and Stoke seem to be a good combination as both companies can tap on each other expertise and experiences.

In summary, there is a demand for skilled workers to maintain the petrochemical plants as the annual investments in the petrochemical industry are consistently high from the beginning of 2001 to 2004. The Singapore government is aware of the shortage of skilled workers and started training programmes to train the workforce. In addition, she encouraged local contracting firms to merge to form larger firms to handle plant maintenance. Another problem identified in the petrochemical industry is the high annual remuneration compares to other industry. In spite of the difficulties, the survey found that not many petrochemical companies outsource total plant maintenance. Therefore, this research is to find the critical factors that the petrochemical companies decide outsourcing total plant maintenance.

2.3 Outsourcing definitions

The term "outsourcing" has been applied to many different relationships across a variety of business areas. A summary on outsourcing definitions is tabulated in Table 2.5. In essence, outsourcing is when a customer transfers a task which used to be done in-house to a service provider (Bendor-Samuel 1999; Reilly and Tamkin 1996; Best Practices Management 1999; Arthur Anderson 1999; Price Waterhouse 1999; Corbett 1997). However, this definition does not address the strategic reasons for outsourcing. Some authors tried to incorporate the strategic reasons by saying that outsourcing should be the skilful delegation of specific tasks to expert outside resources such as non-core business activities (Best Practice Management 1999; Arthur Anderson 1999; Price Waterhouse 1999; Corbett 1997). The core business is the distinctive capability of the company (including core technologies and core skills) that gives the customer the competitive advantage over its competitors (Kay 1995; Prahalad and Hamel 1990). Those activities that offer long-term competitive advantage must be kept in-house (Prahalad and Hamel 1990; Quinn and Hilmer 1994). Thus it frees management and employees to concentrate on being the best at providing core product or service (Best Practice Management 1999; Aurthur Anderson 1999; Price Waterhouse 1999; Corbett 1997). Therefore, outsourcing is not just the transferring of internal business activities haphazardly to outsourcers and frees the resources to handle core business activities. Outsourcing should be based on the customer's business strategy (Arthur Anderson 1999; Price Waterhouse 1999; Corbett 1997). In addition, outsourcing is also a long-term contracting commitment in order to build relationship and increase shareholder value (Price Waterhouse Coopers 1999; Corbett 1997).

Table 2.5: Summary of outsourcing definitions

	Definition attributes	(1)	(2)	(3)	(4)	(5)	(6)
1	Transfer tasks to third party	X	X	X	X	X	X
2	Skilful delegation of tasks			X	X	X	X
3	To concentrate on core business			X	X	X	X
4	Base on business strategy				X	X	X
5	Long-term contracting					X	X
6	Increase shareholder value					X	X
7	Long-term relationship with all parties						X

Legend: (1) Bendor-Samuel, 1999 (2) Reilly & Tamkin, 1996
(3) Best Practice Management, 1999 (4) Arthur Anderson, 1999
(5) Price Waterhouse, 1999 (6) Corbett, 1997

Source: Summarised for this research

One downside to the above definitions is none of them address the interest of the service providers. Perhaps these definitions are based on traditional (or transactional) marketing mentality (Gronross 1991), which is only relevant for work that is fairly simple. But with the more complex services that are outsourced, relationship marketing is more relevant when the benefits of close relationship with a vendor are substantial (Outsourcing Institute, et al 1999). For example, outsourcing plant maintenance in the petrochemical industry is high risk if the service provider could not perform. Therefore, outsourcing is nothing less than a basic redefinition around core competencies and long-term relationship between the customer and outsourcer (Corbett 1997). These core competencies and relationships will bring the greatest value and productivity to the customer (Corbett 1997). This definition highlights the two key ingredients of outsourcing: core competencies and long-term relationship between the customer and service providers. Therefore, in this research, the definition of outsourcing is the company transfers of non-core business activities to competent outsourcers, and the process should be a long-term relationship between the customer and service provider.

The notion of core business is not always clear and sometimes difficult to identify (Johnson and Scholes 1993; Unland and Kleiner 1996; Lankford and Parsa 1999) and it is fraught with many ambiguities (Quinn and Hilmer 1994). The core business can be mistaken because the common misconception of core business is "thing the company does best" (Tsang 2002; Venkatesan 1992). For example, in the 1980's IBM thought their core competency was marketing and thus outsourced operating system to Microsoft and microprocessors to Intel. Today, these two firms are more important to the computer industry than IBM (Carey 1995). Some outsourcing experts try to help the customers by defining core competencies as a bundle of corporate skills across traditional functions (Prahalad and Hamel 1990; Kay 1993). For example, some organizations that have significant inseparable supplementary services may warrant the need for internal sourcing to ensure tighter quality control (Murray and Kotabe 1999). Since there are so much confusion on what to outsource, Willcocks and Fitzgerald (1993; 1994) suggest that outsourcing decisions should be driven by the market opportunities for competitive advantage. Therefore, it may be difficult for the petrochemical companies to decide whether plant maintenance is considered non-core business activities. This research will examine whether the petrochemical companies consider plant maintenance as core business activity and therefore reluctant to outsource this activities.

Outsourcing represents a long-term relationship between the clients and service providers. The clients are relying on the expertise of the service providers for work that were previously done internally (Caspersen 2002; Teas 1993). The advantage is the outsourcers can be a long-term asset, that is, a source of ongoing value to the clients (Bendor-Samuel 1999). It allows companies to maximize the return on their internal resources and develop core competency to protect against competitors (Campbell, 1995). Many researchers suggest that the outsourcing contract period should be at least five years in order to have the expected and sustained results (Idhammar 1999; Bendor-Samuel 1999). The disadvantage is the outsourcers could end up having more bargaining power in renegotiating of the contracts with the clients since the clients may be over-dependent on them (Bendor-Smuel 1999a).

This research will examine whether the duration of the outsourcing strategy affect the deciding factors to outsourcing of plant maintenance activities.

2.4 Outsourcing background

The concept of outsourcing has been in use for over the last twenty to thirty years (Bendor-Samuel 1999). At the beginning, companies that were in financial trouble used outsourcing because the creditors (for example, banks) insisted that the companies hire outside management and financial consultants to sort out the problems. The outsourcing relationship was win-lose, that is, the outsourcers and the banks won and the affected companies lost (Bendor-Samuel 1999).

In recent years, many companies expect outsourcing as an integral part of an ongoing business strategy (Quinn 1994). The outsourcers are expected to add value, and customers and outsourcers should develop a more equal relationship. More companies have outsourced their business processes to outside service providers that are leaders in their fields (Jassen 2001). The rationale is if the companies are not best-in-class in doing something in-house, it is giving up their competitive edge. The company could outsource to the best-in-class providers, up the value and lower the cost (Quinn 1999). Furthermore, outsourcing levels the playing field for those companies who do not have the required expertise and allows companies to compete on the basis of what they know best (Quinn 1994).

There is a growing trend towards the outsourcing of business services, and long-term relationships are gaining increasing importance in the marketing of services (Quinn and Hilmer 1994). In USA and Europe, there is an increasing trend to outsourcing total plant maintenance in the petrochemical industry (Corbett 1999). In Singapore, some petrochemical companies hire multiple contractors to supplement the in-house maintenance crews. There are few petrochemical companies, such as Celanese and Exxon Chemicals, have outsourced total plant maintenance (Appendix 1-1). The remaining companies outsource various levels of plant maintenance. Even for these companies, the extent of the outsourcing activities generally are limited to the outsourcers providing the resources in carrying out the maintenance activities. These companies still employ people to oversee and manage the overall maintenance programmes.

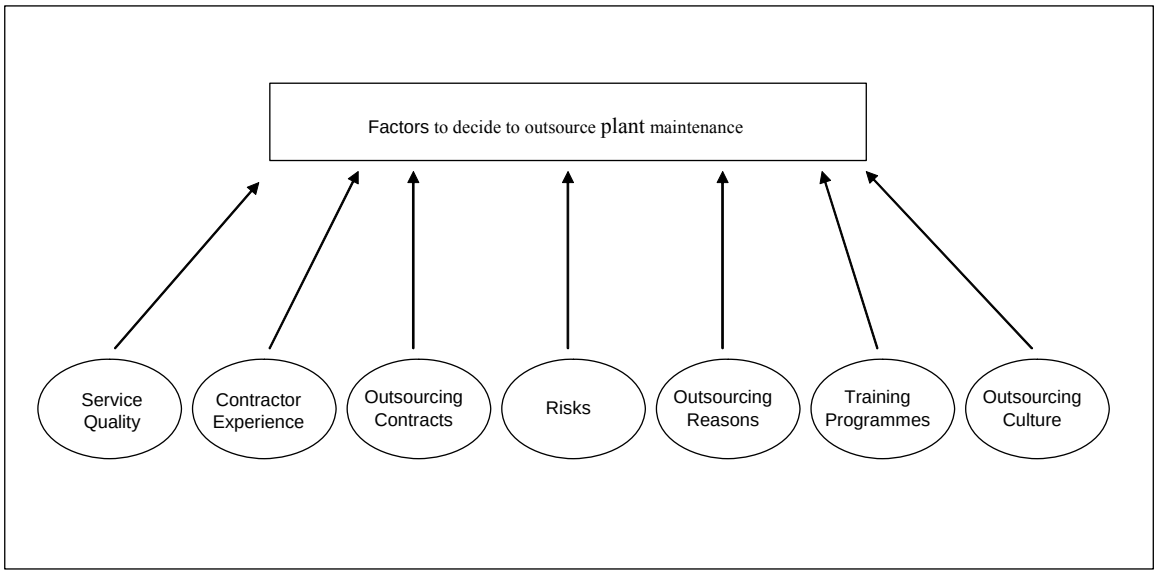
There are many advantages of outsourcing total plant maintenance (Caspersen 2000) but many existing organizations did not embark on it. Perhaps one of the reasons is the risk associated with the selection of the 'wrong' service providers and replacement of existing service providers because services are intangible because it is difficult to set precise specifications for the services (Parsuraman, Zeithaml and Berry 1985). Perhaps the petrochemical companies are more reluctant to outsource total plant maintenance than other industries, such as IT or banking, because the consequence of maintenance failure is great (Jenings 2002, Bebko 1998). Unreliable plant equipment not only leads to production loss, it can also result in unsafe conditions such as fire and losses of lives since the products are inflammable. The petrochemical companies probably face great uncertainties with respect to the quality of services because of there are many factors that affect maintenance service quality (Lovelock and Wright 1999). Besides the risk of poor service quality, the petrochemical companies may also face the risk of leaking of proprietary work practices and technologies that go with outsourcing activities (Downey 1995). The idea of outside contractors could lead to suspicion of employee lay offs, loss of control, and large initial financial investments (Caspersen 2000). In view of the nature of the petrochemical business that emphasizes on safety and fire, and the availability of proprietary work practices and technologies, the factors that influence plant maintenance outsourcing decisions may be different from other industries and businesses.

In Singapore, the first petroleum refinery, Shell Eastern, is built more than 35 years ago. Subsequently more refineries and chemical plants were constructed. There is no record when the petrochemical companies started outsourcing plant maintenance. However, based on the Singapore industrial development history, most probably maintenance outsourcing started after 1975 because this is the period that more workers are technically trained and many equipment repair companies were started. These outsourcing were mainly confined to the motor rewinding and very specialized equipment. The routine plant maintenance was done by the in-house maintenance crews without the help from contractors.

2.5 Outsourcing factors

A survey conducted in early 1990's shows that a considerable number of companies expressed dissatisfaction with outsourcing (Currie 1995; Currie and Willcocks 1997). A similar survey conducted in 1995 also shows that nearly 70% of companies who have outsourced information technology (IT) are unhappy with the service providers and only about half of the outsourcing contracts deliver the promised savings (Lacity et al 1995). In a survey carried out in 1999 on whether the respondents in the IT industry agreed that outsourcing was good value, 44% of the respondents agreed that outsourcing reduced costs as compared to 60% for a similar survey conducted in 1995. Many companies that have outsourced its IT functions are beginning to *"backsource"*. In some cases, customers were pulling those functions back and hire new staff to maintain "in-house" when the outsourcing contracts are expire (Hirschheim 1999). In other cases, contracts are renegotiated or transfer to other service providers (Forst 1999; Kliem 1999). Many customers are increasingly agreeing that the disadvantages of outsourcing outweigh the advantages after outsourcing agreements have been signed (Kliem 1999). What have gone wrong when outsourcing should reduce the companies' operating costs and allow the senior management to concentrate on their core businesses? Are all the benefits of outsourcing only hypes? If outsourcing has been in the IT industry for many years and yet experienced so many failures, can plant maintenance outsourcing be successful in the petrochemical industry? What are the factors that the petrochemical companies have to consider to decide on outsourcing plant maintenance?

Most of the literatures on outsourcing are based on the experiences in the IT industry and many factors related to outsourcing failures are expounded in depth. Many outsourcing experts, such as Bendor-Samuel and Corbett, have suggested factors to consider for outsourcing IT activities. However, there are limited literatures on outsourcing of plant maintenance in the petrochemical industry. Therefore, this research is to identify the major factors that are considered in deciding outsourcing in the IT and other industries, and examine whether they are applicable in the decisions to outsource plant maintenance in the petrochemical industry.



Source: Compiled from literature review

Figure 2.1 Outsourcing deciding factors

The literature review has identified seven factors that are considered in deciding outsourcing activities mainly in the IT industry as shown in Figure 2.1. These factors are service quality, contractor experience, outsourcing contracts, outsourcing risks, outsourcing reasons, training programme and outsourcing culture. There are three assumptions made in Figure 2.1. The first assumption is the seven factors have the same level of importance in influencing the outsourcing decision process. The second assumption is these factors do not have any influence among each others. The third assumption is the outsourcing decision has no influence on the outsourcing factors. The next section explains the seven factors that may affect the decision making process of outsourcing total plant maintenance in the Singapore petrochemical industry.

2.5.1 Service quality

This section explains that the service quality may be one of the factors used in deciding outsourcing total plant maintenance. In today's world of intense competition, the key to sustainable competitive advantage lies in delivering high quality service that will in turn result in satisfied customers (Shemwell *et al*. 1998). A survey conducted in 2002 indicates that service level ranked nearly as high as cost (Avery 2002). Poor perceived service quality would lead to unsatisfaction (Dabholkar 1995). Therefore, Edvardsson (1998) define service quality by the level of service expected by the customer and satisfies his needs and requirements. However, service quality is difficult to evaluate by the customers because it is *"invisible"* (Edvardsson 1998) and *"intangible"* (Levitt 1981; Bebko 2000). Some academics try to simplify the definition of service quality as a subjective blend of what the customer believes *"can be"* and *"should be"* (Zeithaml and Bitner 1996). The difficulty is how to gauge service quality. Different customers could have different service expectations even for the same type of service (Edvardsson 1998). For example, different petrochemical companies may have different expectations on pump repairs. Service quality is even more complex to measure and difficult to measure in an industrial context (Haas 1989). For example, in the petrochemical industry, although the pump performance can be measured by the mean time between failures, the performance indicator is affected by the service quality and how the pumps are operated.

In this research, service quality is gauged by comparing the difference between the service expectations and the perceptions of the service received (Grönroos, 1982; Lewis and Booms, 1983; Parasuraman *et al.*, 1985). The comparison is primarily base on disconfirmation theory, which states that consumer is satisfied with a service experience if the service perception is above his expectation (Bitner, 1990; Bolton and Drew, 1991; Grönroos, 1990). Studies show that environmental cues are used in services to help the customers to form their service expectations (Bebko 2000). In the outsourcing of plant maintenance, the customers' expectations may be based on the perceived service quality of the in-house maintenance crews. The expectations may not be realistic as this chapter has found that some of the contractors may not have the same level of maintenance experience as the in-house crews. Therefore, the research

will examine whether the customers are satisfied with the service level of outsourcing plant maintenance by comparing the customers' expectations and perceptions. It also examine whether service quality is a factor in deciding outsourcing plant maintenance.

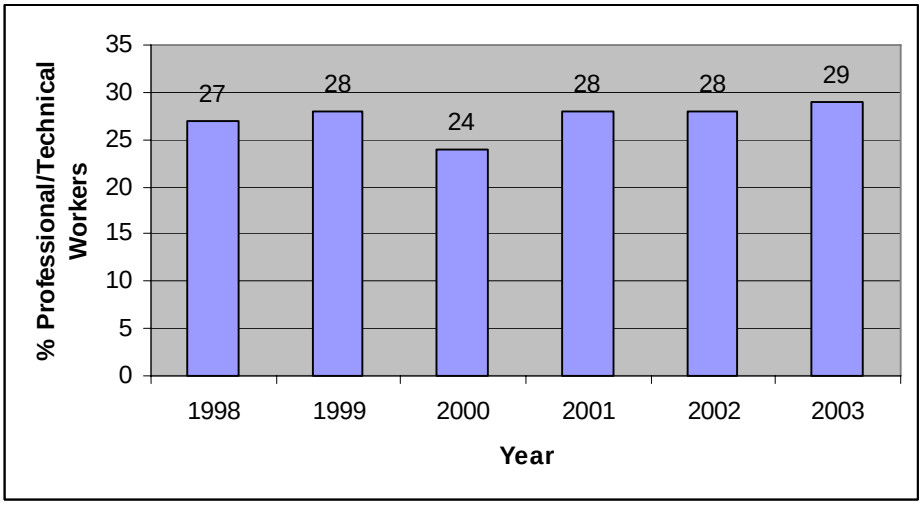
The second method to evaluate service quality is by checking the *"technical quality"* and *"functional quality"* of the outsourcers (Holmlund and Kock 1995). An outsourcer with good technical staff and work system in place gives a positive impression to the customer. Some academics suggest that good corporate image of the outsourcer is perceived to provide high level of service (Gronroos 1991; Lehtinen and Lehtinen 1991). In fact corporate image is believed to be an important factor influencing the perception of quality, customer evaluation of service satisfaction, and customer loyalty (Andreassen 1998). Therefore, one method to raise the perceptions of the outsourcers' abilities to meet the service expectations is to outsource the work to the outsourcers that are the "*best-in-class"* (Bendor-Samuel 1999; Walton 1993). Alternatively, the outsourcers may also be in a leadership position in developing a specific technology or possession of expert knowledge (Blumberg 1998). However, the corporate image is just a perception of good service level because service has to take place before one knows (for sure) whether the service quality is satisfactory (Zeithaml and Bitner 1996).

In this chapter, we mention that in the Singapore petrochemical industry there are a few local outsourcers merged with foreign contractors. If corporate image affects the service quality perception, then these joint-venture outsourcers should stand a better chance than the other local outsourcers in winning outsourcing contracts. Therefore, the research will examine whether the corporate image of outsourcer is considered in deciding to outsource plant maintenance. It also examines whether contractors that had worked with the customers in the past stands a better chance to be selected for the outsourcing contracts.

2.5.2 Contractor experience

This section explains that contractor worker experience may be another factor used in deciding outsourcing total plant maintenance. The growing trend of investments in the petrochemical industry (Table 2.2) will require more experienced and skilled maintenance workers to maintain the new plants. The problems that the local outsourcers are facing are similar to outsourcers in other countries. One of the problems is a shortage of skilled workers (Wireman 1999; Williamson 2000). This problem is compounded as technologies change, the skill sets of some of the existing workers may be obsolete (Robertson 1999). Another problem is how to build up the service capability to handle the outsourcing activities (Blumberg 1998; Widget 1999). This service capability does not confine to maintenance of new equipment and facilities, it also includes managing changing organization structure. Therefore, the skilled workers that the outsourcers need are not just to maintain the equipment but also able to manage the plant maintenance activities. Although these problems may be good to have because they mean more businesses, it is nonetheless an unprecedented set of challenges for the outsourcers (Gummesson 1994; Castor 1993). The literature review will examine whether the Singapore workforce have the service capability to handle the outsourcing activities in the petrochemical industry.

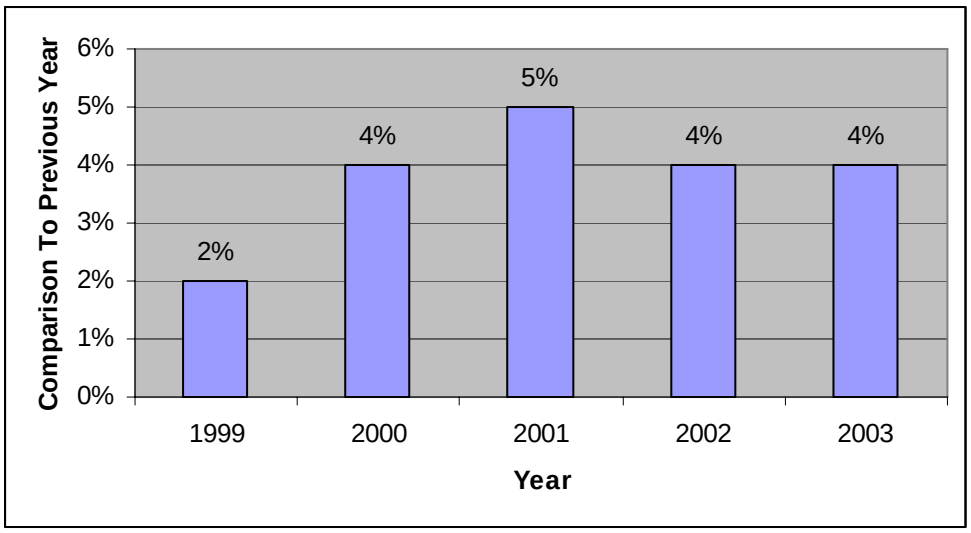
Table 2.6 Professional and technical workers survey



Source: Singapore Year Book of Statistics, 2004

The maintenance of the sophisticated equipment in the petrochemical companies requires skilled workers such as professionals and technicians. The trend of professionals and technicians in the Singapore manufacturing sector is shown in Table 2.6. The pool of skilled workers is hovering about 28% of the total workforce for the last few years. In 2000, the pool of skilled workers was reduced because there was a drop in market demand for the petrochemical products and hence production was reduced. However, with the expansion of the petrochemical over the years with annual investment of more than S$1.5 billion (Singapore Yearbook of Statistics 2004), the pool of skilled workers may not be sufficient. In addition, some of these "skilled" workers may only have the experience in construction or design work but lack the experience in equipment maintenance and managing the plant maintenance activities in the petrochemical industry.

Table 2.7 Singapore petrochemical industry workforce



Source: Singapore Yearbook of Statistics, 2004

Similarly, there is a consistent growth of about 4% year to year in the Singapore petrochemical industry workforce as shown in Table 2.7. The actual growth rate perhaps may be slightly lower if the annual resignation of the professionals and technicians (about 1.4%) in the petrochemical industry is considered (Singapore

Yearbook of Statistics 2004). The slightly higher workforce growth rate in 2001 could be due to a labour shortage after the petrochemical industry started to recover from a period of low production from 1999 to 2000. The workforce growth rate has to support the annual investments of more than S$1.5 billion for the last few years (Table 2.2).

Therefore, it is no surprise that the Singapore Ministry of Labour report indicates that the trend in hiring temporary workers in the labour force has increased. Besides the shortage of skilled workers, another reason for this trend is the regional economic downturn in late 1998 that had led many companies to downsize and hire temporary workers (The Straits Times 1998). These companies may have continued to keep the temporary workers instead of hiring their own employees. In fact, Koh and Lay (2000) observe that the trend of using temporary workers by Singapore companies may become a permanent feature of the modern workplace. This observation is no difference in U.S.A. where approximately one person out of four in the workforce is employed as a temporary worker (Albrecht 1998).

Most of these temporary workers are rewarded with short-term monetary rewards. There is no job security. Since these workers are not obligated to stay with their employers, they tend to change job more often (Koh and Lay 2000). This job-hopping practice may aggravate the already poor skill level among the temporary workers. In order to supplement the workforce, workers from the construction industry are hired to perform maintenance work (Finchem 1997). These construction workers may not improve the skilled labour shortage situation because construction works are not quite similar to maintenance work. This shortage of skilled workers can be a concern to the customers. However, this finding is similar to the outsourcers in U.S.A. whom Blumberg (1998) found them lack the experience, depth and breadth of service capability. A survey carried out in the IT industry also highlights that about 75% of the respondents did not think that the outsourcers could hire and retain better workers than the respondents' organizations (Krapt 1999). Therefore, the selection of the *'right'* outsourcing contractors is a critical factor for successful outsourcing (Hickerson 1999; Corbett 1999).

Therefore, the research will examine whether the outsourcer worker experience is a factor that the customers will consider when deciding to outsource plant maintenance.

2.5.3 Outsourcing contracts

This section explains outsourcing contract may be another factor used to decide total plant maintenance. A well-structured contract shall include two main areas, namely, the scope of the service and the legal consequences of non-compliance (Martin 1997). The first area identifies the customer's expected service level and the second area is to reduce the customers' risks of failure. It is an important instrument to guide the behaviour of both parties. It is a serious commitment by the outsourcer and customer (Bendor-Samuel 1999). A well written contract will lead to a successful and long-term commitment by the outsourcers (Doherty 2002; Bendor-Samuel 1999). The conditions in a well written contract spell out the responsibilities of each party and the expected service level. The contracts should be performance-oriented that will leverage on the contractors' creativity and knowledge to deliver optimal maintenance (Vercillo 1999; Tsang 2002). On the other hand, a poorly developed contract can cause much frustration to both parties and result in poor performance due to failure to understand requirements adequately (Goldsmith 1999). It can also become a basis for disagreement by the customers and outsourcers, and may encourage opportunistic behaviour by outsourcers (Jennings 2002). For example, the outsourcers may want to charge additional costs for work that are not clearly spelt out in the contracts.

Poorly written contracts seem to be the most common cause of outsourcing failures (Bendor-Samuel 1999; White 1999). A survey shows that some companies got into outsourcing problems after the first year of operation because of poorly developed contracts (Everest Consulting 1999). There are two common reasons why outsourcing contracts do not work well for the customers. One reason is the contracts are poorly written because the customers may not have the expertise to draft contracts for outsourcing activities (Tsang 2002; Barthélemy 2001). The lack of knowledge may also happen to the petrochemical industry because most of the contracts are in the area of purchasing of material and isolated maintenance work (Labbs 1998; Barthélemy 2001). For example, the maintenance contract could be just to supply labour and tools to clean a heat exchanger within a certain period. This type of contracts which is called *"work package contracts"* is simple and the contractor is paid when the task is completed (Martin 1997). The customer does all the planning

and the contractor just carries out the task. There is minimal responsibility on the part of the contractor. On the other hand, plant maintenance outsourcing contracts are *"performance contracts"* where the responsibilities of all aspects of plant maintenance are carried out by the contractors. The contracts spell out the responsibilities of the outsourcers in details (White 1999; Bendor-Samuel 1999). For example, they ensure that the workers that are hired meet the minimum expectations of the jobs and meet certain service expectations. The "package contracts" are generally found to be less effective in outsourcing activities because the outsourcers are not given greater accountabilities and responsibilities of their work (Currie 1990). A survey on outsourcing contracts found that many customers do not have the expertise to draft "performance contracts" (Bendor-Samuel 1999).

Some outsourcing experts find that one reason of poorly written contracts is the customers do not know what to expect at the beginning of the outsourcing activities (Gronroos 1998). In fact, many customers were signing contracts with vendors without a complete understanding of just what they were getting into because there wasn't much basis for comparison. The customers may not have sufficient maintenance data to include performance indicators in the contracts, for example, the minimum mean time between failures for pumps. These performance indicators help the customers to track how effective is the outsourced maintenance activities and also gauge the outsourcers' performance (Corbett 1999). This finding is supported by a survey conducted by KPMG and Nolan Norton Institute in 1997 that indicates that over half of the outsourcing customers would like to include performance indicators in their outsourcing contracts to reduce the chance of outsourcing failure.

Another reason that outsourcing contracts do not work well is the customers have unrealistic expectations (Felder and Steiner 1999; Bendor-Samuel 1999). For example, the customer expects a badly corroded equipment to have a service factor of above 90% without replacing the corroded parts. Another observation is some customers do change their expectations during the service period (Gronroos 1998). It is because the service quality expectations tend to increase when the service is more complicated and high in intangibility (Bebko 1998). These new expectations may affect the outsourcer maintenance plans and resources.

The importance of well written contracts is the customers and outsourcers do not have common profit objectives (Lacity and Hirschheim). The customers cannot expect their

service providers to act in the best interest of the customers when there is a conflict of interest situation arises. Survey has found that maintenance saving and other benefits from outsourcing were seldom realized because many contracts tend to be task-oriented rather than performance focused (Tsang 2002). The research will examine whether petrochemical companies' reluctance to outsource total plant maintenance is due to the difficulties in developing outsourcing contracts that safeguard their risks from maintenance failures. The customers have to be very clear on the service quality expectations; otherwise, it would be difficult to decide on the performance indicators to be used (Dean and Kiu 2002). Secondly, is the contract complexity a factor in deciding outsourcing plant maintenance because the customers will be moving away from the "work package" contracts to "performance" contracts?

2.5.4 Outsourcing risks

This section explains outsourcing risk may be a factor used in deciding outsourcing total plant maintenance. While outsourcing maintenance services may have many advantages, they are also subjected to many risks. Some of the more obvious risks are associated with poor service quality, that is, outsourcers are not capable to provide the expected service. Since plant maintenance, like other services, is intangible, the customers find difficulties to predict service level without experiencing it (Parasuraman et al., 1988). One method is to monitor the outsourcer's performance periodically to ensure that the outsourcer is capable of delivering to the required quality standards (Alison and Kiu 2002). But the problem is unless the outsourcers are given the contract, the customers are not able to monitor the outsourcers' performance.

One of the risks of outsourcing is the over-dependence on the outsourcers for critical functions (Downey 1995). The loss of controls of the business activities that are outsourced which many customers fear (Blumberg 1998; Quinn and Hilmer 1994; Campbell 1995). In the petrochemical industry, plant maintenance is considered a

critical function because failure of equipment can result in production loss, unsafe condition or fire. Some researchers say that over-dependence will lead to *"loss of critical skills"* in the organizations because either the in-house skilled workers gradually lose their skills since they are no longer required to carry out the work (Quinn and Hilmer 1994; Campbell 1995) or they may be retrenched because their jobs are outsourced. Hence, the customers may be in dire straits if the outsourcers are not able to maintain the critical work or they terminate the contracts and leave with their expertise (Strout 1999). There are no more in-house skilled workers to rectify the problem. A survey found that there is a shift in the balance of power in favour of the outsourcers during the period of the outsourcing contracts (Tsang 2002). The customers may have to continuously monitor the outsourcers and pay them more, if necessary, in order to keep the equipment running.

There are three methods to mitigate the problem with over-dependence of the outsourcer. One method is to identify alternate outsourcer that can do the job if the customer is having problem with the original outsourcer. The alternate outsourcer can mobilize his workers to maintain the plant where the original outsourcer stopped. The problem with this method is the alternate outsourcer will take sometime to mobilize his workers and the plant reliability may be compromised. Another problem is there is no continuation in the plant maintenance effort. The alternate outsourcer will not know the status and history of the plant maintenance. The second method is to outsource the plant maintenance to two outsourcers which is practised by one of the cases (Case 8) in this research. If one outsourcer fails to perform, the next outsourcer will take over the task. The mobilization time is reduced because the second outsourcer is already at the site. This method gives the outsourcers a sense of competition and it also provides a contingency plan to the customer to mitigate the risk if the contractor is not able to perform (Lacity *et al*. 1995). The third method is to keep a 'skeleton' in-house maintenance workforce (McMillan 1990). The advantage is similar to the second method last explained. However, the disadvantage is the customers may not realize the maximum benefits of outsourcing because this strategy will incur additional operating costs. Therefore, the customers have to balance between the risk of failure and increasing operating costs. The expected cost savings from outsourcing may not be realized when few contractors dominate a specialized market (Greer 1999).

The risk increases if the outsourcing outcome in the future uncertain and the possible negative consequences of a poor decision when companies outsource business activities (Coulter and Coulter 2002). In outsourcing plant maintenance, firstly there may be a risk that it may be a poor decision because the outsourcer is not able to carry out the work better than the in-house maintenance crew and secondly, the further outsourcing contract may not be as favourable. The literature review in this chapter found that not all the contractors have experience in maintenance. The problem is further compounded because there could be a shortage of workers. Since a survey carried out shows that about 50% of maintenance failures were due to human errors (Malmholt 1990), there is a risk that some of the petrochemical companies may not see the benefits in outsourcing.

Business performance has traditionally been measured in financial terms. Therefore, the other risk is the maintenance cost reduction from outsourcing maintenance may be lower than expected. This is common as maintenance saving from outsourcing and other benefits was seldom realized because the contracts tend to be task oriented rather than performance focused (Tsang 2002). Many researchers have found that there is growing evidence that outsourcing may not decrease costs as expected and in some cases, costs increased (Jonsson 1997). Even if the contracts are based on performance measurement, many are based on price and often neglected less tangible issues of performance and quality (Avery, 2000). There is always a conflict of objectives between the maintenance and contracting personnel. The maintenance personnel's objective is to ensure the plant equipment is reliable, whereas, the contracting personnel's objective is to award the lowest-cost contract. Hence, some academics suggest that cost saving should not be the only driver of strategic outsourcing (Bendor-Samuel 2002; Downey 1995).

The next risk is when the contracts are up for renewal in the future, the new contracts may be less favourable than the old contracts. This risk is related to over-dependent on the outsourcers. The outsourcers know that contract termination may not be viable choice because it could affect the plant maintenance in the short-term. The contract termination costs could be high (Currie 1990). Therefore, is the risk of over-dependence on the outsourcers prevent the companies to outsource total plant maintenance? Does the level of outsourcing affects the outsourcing risk of over-dependence of the outsourcer?

2.5.5 Outsourcing reasons

This section explains the reason to outsource may be a factor used in deciding outsourcing total plant maintenance. In the last decade, outsourcing has taken on a different meaning. Traditional vertically integrated, self-sufficient organizations of the past are quickly being replaced by interdependent organizations focused on core competencies (Corbett 1999). However, this reason for outsourcing is not true for all cases. A survey found that most companies overlook the most obvious of elements in that they fail to thoroughly understand what is being outsourced (Bendor-Samuel 1999). Table 2.8 shows some of the reasons for outsourcing.

Table 2.8 Outsourcing reasons

Outsourcing Reasons	Literature References							
	1	2	3	4	5	6	7	8
To add value to the organisation by transferring activities that the organisation are not good at to a more competent outside service provider	X		X	X		X	X	
To enable organisations to control costs by converting the business activities from fixed to variable costs			X		X			
For non-business strategic reasons: political pressure or just follows the outsourcing trend		X						X

Note:
1 - Quinn 1994
2 - Reilly and Tamkin 1996
3 - Bendor-Samuel 1999
4 - Corbett 1999
5 - Mazur 1999
6 - Oxton 1999
7 - Price Waterhouse Cooper 1999
8 - Staub 1999

Source: Compiled for this research

There are all kinds of reasons for outsourcing, but only some are rational (Straub 1999). The most common reason for outsourcing is to add value to the organizations

by transferring the activities that the organizations are not good at to a more competent outside service provider. The outsourcing of these activities level the playing field and allows companies to compete on the basis of what they know best (Quinn 1994). A survey found that many companies overlook the most obvious of elements in that they fail to thoroughly understand what is being outsourced (Bendor-Samuel 1999). Some companies outsource their non-core activities for profit growth rather than to integrate vertically or horizontally with the other business activities (Kotler 1994, Porter 1985). Therefore, one of the strategic issues of outsourcing is whether the maintenance work can be done cheaper and more efficiently by the service provider than in-house staff (Quinn and Hilmer, 1994).

The other reason is to enable the organization to control cost by converting the business activities from fixed to variable costs. The outsourcing process forces these companies to develop separate cost centers that the outsourcers can charge their effort and thus allow the companies to monitor the maintenance costs. However, outsourcing does incur transaction costs. Sometime it involves substantive investments for both parties such as purchase of equipment by the outsourcers and transfer of workers by the customers.

The third reason is non-business strategy, that is, due to political pressure, or just follows the outsourcing trend. For example, some companies just blindly outsource their activities on the back of an environment change such as downsizing, merger, failing product or service (Stanton 1999). These companies believe they are "getting rid of the problems" by outsourcing business activities that they could not manage (Hirschheim 1999; Mariotte 1999).

Therefore, outsourcing must be done carefully, systematically and with explicit goals (Quinn 1999). Although cost efficiency and profitability are the foundations for a strong corporate position in the market place (McKenna 1991), the determination of the service value is a complex and difficult tasks for the customers (Haas 1989). Companies that rush into outsourcing without fully understanding what they hope for often face budget over-run, difficulties with their chosen outsourcer and less than optimal results (Rich 1999). The research will examine what are the strategic reasons, if any, for those petrochemical companies that decide to outsource plant maintenance. Is the lack of a clear strategic reason prevents these companies to outsource total plant maintenance?

2.5.6 Training programmes

This section explains the contractor worker training programme may be a factor used in deciding outsourcing total plant maintenance. A survey carried out in 1990 shows that only about 20% of US companies are using preventive maintenance (Wireman 1990). Preventive maintenance is to carry out maintenance on a piece of equipment base on an agreed interval. Lack of preventive maintenance does not seem to make business sense since the repair costs of breakdown equipment about three times more than the cost of doing preventive maintenance carried out on the same equipment (Mobley 1990). Another survey carried out in 1997 also found that preventive maintenance is not carried out frequently in many companies (Jonsson 1997). Although there is a growing trend the customers are doing condition-based maintenance, preventive maintenance is still required (Tsang 1995). Condition-base maintenance is making use of modern technologies to predict equipment failures. For example, using vibration monitor to check the pump and only take the pump out for repair if the vibration level is higher than the manufacturer recommendation. One possible reason is the outsourcers lack the experience, and depth and breadth of service capability (Blumberg, 1998). This observation is supported by Widget (1999) who comments that there is a shortage of skills and a dearth of good leaders. Similarly, earlier in this chapter, the researcher has shown that Singapore workforce may also have sufficient skilled workers experienced in plant maintenance.

One method to improve the skills of the workforce is to create a *"learning organization"* (Starkey 1996; Redding 1997). That is, the outsourcer organizations have training programmes to continually upgrade the skills of the workers. This "learning organization concept will foster collective learning and unleashes the individual creativity and initiatives (Millett 1998). The collective learning allows the workers to engage in continuous and productive exchange of skills that will achieve results (Nayak, Garvin, Maira and Bragar, 1995).

Table 2.9 Singapore worker training programmes

Programme	Starting Date	Description
Training and Attachment Programme (TAP)	1998	Government sponsored S$50 million. Todate 500 engineers and professionals were trained - 120 trainees attached to Honeywell, Fujitsu and Matsushita Local universities and Polytechnics introduce new courses such as wafer fabrication and IC packaging
Local Industry Upgrading Programme (LIUP)	1995	Developed for semi-skilled workers. Training in welding, rotating equipment, electrical fittings and process instrumentation. The training programme started by Economic Development Board and six major companies in the petrochemical industry.

Source: Singapore Economic Development Board 1999

The Singapore Government realizes that there are insufficient skilled workers. Training programmes are set up to train the workers in the skilled-based industries, such as petrochemical industry, is shown in Table 2.9. The Singapore Economic Development Board recognizes that people is the critical success factor in the country progress. The government manpower master plan emphasizes on human and intellectual capital (Lee Yock Suan, Singapore's Trade and Industry Minister) and set up a $50 million training and attachment programme (TAP) in 1998 to fund the training of 500 engineers and other professionals in new technology areas for the manufacturing and international services sectors. Besides sending more than 120 trainees to the technology leaders (e.g. Honeywell, Fujitsu and Matsushita) for training, EDB also worked with local universities and polytechnics to introduce and sponsor new courses on the latest technology that EDB has identified (wafer fabrication, IC packaging, etc.). Technicians are also trained in process controls to service the petrochemical industry.

Furthermore, the Economic Development Board also supports the growth of promising local enterprises and is committed to nurturing them into world-class

companies. One of the steps taken is the introduction of the Local Industry Upgrading Programme (LIUP) which support the multi-national corporations (mainly in the petrochemical industry) in the plant maintenance activities. This programme is divided into welding, rotating equipment, electrical and instrumentation skills. The trainees have to complete a predetermined number of hours of training. Proficiency tests would be given to the trainees at the end of the training. The successful trainees will be given certificates that are recognized in the local industries. The certificates also enable the trainees to progress to more advance training. The government is subsidizing the contractors up to 75% of the training fees incurred.

The TAP and LIUP training programmes benefit the chemical industry and service providers. It increases the pool of skilled workers and reduces "pinching" of workers between companies. The employers have to play their parts (besides the Singapore Government) and invest in the workers' training needs in order that they can upgrade the workers' skills and compete with foreign competitors. Therefore, training of the workers is the critical success factor to maintain a competitive edge in the chemical industry. But the statistics show that employee training hours had only increased by about 1% from 2000 to 2003 (Singapore Productivity and Standards Board, 2003). Therefore, the research will examine whether the service providers training skill programme is one of the outsourcing deciding factors.

In spite of the Singapore Government effort to increase the pool of skilled workers, Tables 2.6 and 2.7 in this chapter show that there is be a shortage of experienced workers because of the economic recovery in early 2000's in the manufacturing sector. The S$1.63 billion investments in the petrochemical industry in 2004 (Table 2.2) could further aggravate the tight skilled workforce. Furthermore, the employers generally provide only minimum training to their employees (Tsui et al 1997). A survey conducted in Singapore in 2000 indicates that temporary workers are generally under-trained because they are not obligated to stay with their employers (Koh and Lay 2000). The lack of training not only result in unreliable plant operation, the customers may be legally liable if the plants are unsafe due to poorly maintained equipment (Roughton 1995). Therefore, this research will examine whether the outsourcer worker training programmes is considered one of the deciding factors in outsourcing plant maintenance.

2.5.7 Outsourcing culture

This section explains organization culture committed towards outsourcing may be a factor used in deciding outsourcing total plant maintenance. One factor that is often overlooked is finding the right outsourcing mix is corporate culture (Friday 2005). Understanding the impact the corporate culture has on the success or failure of outsourcing can help to avoid the pitfalls associated with a bad arrangement. To find a good fit between the customer and outsourcer, it is essential to understand what corporate culture means. The simplified definition of culture is "The way things get done around this place". Outsourcing culture is different from the traditional culture where relationship is defined as a series of discreet transactions (Corbett 1997a). The traditional skills that made managers successful such as technical skills within their field and operational planning are not the skills needed for success in managing an outsourcing contract. Furthermore, in the traditional work culture, the managers have been in an authoritative position to give order to the contractors and expect things to be carried out. Close supervision and control through bureaucratically applied rules is also inappropriate (Corbett 1999).

On the other hand, in the outsourcing culture, the authoritarian management style that is commonly used is not suitable. The leadership style should be more of a facilitator, leading by example, and encouraging and motivating individuals to learn themselves (Senge, 1996*;* Khatri and Budhwar, 2002). Walton (1985) described this type of leadership as shifting from a "control-based" culture to a "commitment-based" culture. The reason is the outsourcers who are having highly-skilled workers (Quinn 1999) may carry out the work without instructions from the customers. The culture is towards joint risk and reward deals and there is a greater emphasis on looking at value-added sourcing (Currie 1990). A study carried out on Swedish firms that outsource maintenance found that a culture that is lack of responsibility and commitment from foremen and senior managers caused a large part of the breakdowns (Thilander 1992).

A survey found that many Singapore companies are relying on control-based management philosophy (Khatri 1999). These companies have ignored the importance of the importance of commitment-based management and led to recruitment of semi-skilled workers and high worker job-hopping (Khatri 1999). This

problem is recognised by the Singapore Government and it encourages managers to adopt human management techniques to build "worker loyalty" and "team spirit" (Cunningham and Debrah 1995). Research also has found that some managers find it difficult to work in a outsourcing culture of give and take as suggested by this literature review (Levine 1986). The changing of people attitudes and managing people are more difficult than managing technology or capital (Barney 1991; Lado and Wilson 1994). Douglas freeman, Chief Executive Officer of Netbank Inc., said that it was five times more difficult to manage outsourcing than managing own people. The outsourcing managers require skills in communication, negotiation, strategic planning, project management and team leadership which are found in successful general managers (Corbett 1999, Useem 1998). These skills are required to coordinate the relationships strategically for the company (Quinn 1999).

The wrong organization culture can lead to outsourcing failure (Corbett 1999; Useem 1998). Outsourcing culture are mutual respect, desire to align interests as best as possible, commitment and ability to work out the differences. In essence, trust the other party's intentions. The success of outsourcing lies in the hands of the people managing the outsourcing relationship (Quinn 1999). It demands new leadership skills and commitment for overseeing this relationship (Corbett 1999a). In order for outsourcing in an organization to be successful, different levels in the organization hierarchy have to be committed to outsourcing. A survey carried out on organizations that outsourced shows that top management support for outsourcing is widespread. Most of the managers affirmed that their sourcing efforts are surely doomed without it. By contrast, only half viewed their middle-management ranks as supportive, and virtually all hourly employees as opposed (Useem 2000).

Another problem is the larger and more established the institution, the more entrenched and inflexible the culture tends to be (Friday 2005). It may suggest that since most of the petrochemical companies are large and many of them have been established for more than ten years in Singapore, their organization culture may not be "pro-outsourcing". On the other hand, since the outsourcer organizations are relatively small as compared to the petrochemical companies, the outsourcer organization culture may be more committed to outsourcing. Therefore, the research will examine whether the organization cultures of the customer and outsourcer organizations towards outsourcing are a factor considered in the outsourcing decision.

Table 2.10 Outsourcing deciding factors

	Deciding Factors	Reasons	Authors
1	Service quality	• Poor perceived service quality would lead to unsatisfaction • Corporate image influence the perception of quality	Dabholkar 1995 Andreassen 1998
2	Contractor experience	• Workers tend to change job more often • Workers from the construction industry are hired to perform maintenance work.	Koh and Lay 2000 Finchem 1997
3	Outsourcing contracts	• Poorly written contracts seem to be the most common cause of outsourcing failures • Customers and outsourcers do not have common profit objectives	Bendor-Samuel 1999 Lacity and Hirschheim
4	Risks	• Over-dependence on the outsourcers for critical functions • Outsourcing may not decrease costs	Downey 1995 Jonsson 1997
5	Outsourcing reasons	• Fail to thoroughly understand what is being outsourced • Blindly outsource their activities on the back of an environment change	Bendor-Samuel 1999 Stanton 1999
6	Training programme	• Shortage of skills and a dearth of good leaders • Employers generally provide only minimum training to their employees	Widget 1999 Tsui et al 1997
7	Outsourcing culture	• Outsourcing culture is different from the traditional culture • Wrong organization culture can lead to outsourcing failure	Corbett 1997a Corbett 1999; Useem 1998.

Source: Compiled for this research

In summary, Table 2.10 tabulates the seven factors that are expounded by researchers to decide outsourcing. The research case study and survey questionnaires will test which of these factors are critical to deciding outsourcing total plant maintenance in the Singapore petrochemical industry. Furthermore, the research will also identify the

factors that influence these critical deciding factors. Finally, the research is to find how these critical factors help the outsourcers to win outsourcing contracts. Since the research title is taking a critical perspective of the critical factors, the next section is to explain how the research provides a critical perspective.

2.6 Critical perspective

The research title is to provide a critical perspective in identifying the critical deciding factors in deciding outsourcing total plant maintenance. The "critical theory" in the narrow sense designates several generations of German philosophers and social theorists in the Western European Marxist tradition known as the Frankfurt School. A "critical" theory may be distinguished from a "traditional" theory because critical theory it seeks human emancipation, *"to liberate human beings from the circumstances that enslave them"* (Horkheimer 1982). Since this theory aims to transform circumstances that enslave human beings, many other theories have emerged in connection with the social movements in modern societies.

The critical theorists, such as German social theorist Jürgen Habermas, suggest that positivist research approach is instrumental to the obstruction of social changes (Kellner 1989) and influenced by the power imbalance between research respondents and researchers (Clark 2004). This positivist research approach could cause bias because the workers in the organization are not given the opportunities to give their views. Critical studies of organizational culture also show that relationships that sustain organizations are not necessarily consensual (Alvesson 1993, Dertz 1996). Alvesson (1993) also observes that what we see in an organization is not necessarily represented all the core people in the organization. Therefore, critical theory can be seen as an attempt to highlight the characteristics of the ideal situations where such distortions would be avoided and to describe mechanisms for due process to be seen to take place.

It follows from Horkheimer's definition that a critical theory is adequate only if it meets three criteria: it must be explanatory, practical, and normative. That is, it must explain what is wrong with current social reality, identify the actors to change it, and provide both clear norms for criticism. In the outsourcing plant maintenance activities there are different stakeholders within the customer and outsourcer organizations that may affect the outsourcing outcome. The stakeholders are the managers, supervisors and technicians. These stakeholders may have different interests and expectations in relation to the outsourcing activities and therefore, the perceptions of outsourcing may be influenced by them.

Table 2.11 Data comparisons: Critical perspective

	Comparisons	Critical Perspectives
1	Individual customer expectations and outsourcer expectations of each company	Consider the outsourcing expectations of outsourcers and workers that are lower in the organization hierarchy
2	Individual customer perceptions and outsourcer perceptions of each company	Consider the outsourcing perceptions of outsourcers and workers that are lower in the organization hierarchy
3	Average customer expectations and outsourcer expectations for each outsourcing factor	Consider the expectations of outsourcers and workers that are lower in the organization hierarchy on each outsourcing factor
4	Average customer perceptions and outsourcer expectations for each outsourcing factor	Consider the perceptions of outsourcers and workers that are lower in the organization hierarchy on each outsourcing factor

The aspects of critical perspective in this research are taking the views of the different stakeholders in each organization. The method is to examine the relationship of the maintenance outsourcing perceptions and expectations of the stakeholders. In the customer-outsourcer relationship, normally the customer's views may be more overpowering (Alvesson 1993). Furthermore, within an organization, the workers in the lower organization hierarchy are seldom heard. In Table 2.11, Comparisons 1 and 2 are to consider the expectations and perceptions of the outsourcers and workers in lower in the organization hierarchy. Comparisons 3 and 4 are used to analyze the

reasons of the any large gap between the different stakeholders. This comparison method, therefore, will provide a critical perspective to the research.

In summary, there are two things that need to be satisfied in order to provide a critical perspective to this research. Firstly, the research has to involve different levels of management within the organizations. Secondly, it involves the input not only from the petrochemical companies but also from the outsourcer organizations. The triangulation of the input from the various stakeholders in the outsourcing process will provide a critical perspective to the research.

2.7 Outsourcing hypotheses

In maintenance outsourcing, customer perception is the subjective assessment of the actual service experienced by the customer. Customer expectation is the standard or reference point for the service performance against which the service experience is compared. The expectation is normally formulated in terms of what the customer believes should or will happen (Zeithaml et al 1996). In a perfect world, expectations and perceptions would be identical. The outsourcers would provide the service quality as expected by the customers. However, in the real world, outsourcing maintenance come with special challenges, that is, besides the services are intangible (Zeithaml et al 1996), the stakeholders in the outsourcing chains may have different expectations and perceptions of the services. The outsourcing contracts are developed and agreed by the representatives of both organizations but the tasks are carried out by mainly the front-line managers and workers.

The measurement of service quality is functionally identical to satisfaction measures based on the expectancy-disconfirmation model (Rosen and Surprenant 1998). Researchers often distinguish between satisfaction and service quality based on a longitudinal dimension with satisfaction seen as a transaction specific evaluation while quality represents a long-run overall evaluation or attitude. Research on quality focuses heavily on expectations. In fact Zeithaml *et al*. (1996) define quality

as meeting or exceeding customer expectations, the traditional definition of satisfaction within an expectancy disconfirmation paradigm.

The 'Gap' model (Zeithaml *et al*. 1996) is a means of describing customer dissatisfaction in the context of service quality. The model suggests that service quality is affected by lack of communication, lack of performance standards, poor worker skill level and poor leadership. It posits five service gaps that affect the satisfaction of service quality.

Gap 1: The difference between customer expectations and management perceptions of the customer expectations.

Gap 2: The difference between management perceptions of customer expectations and service quality specifications

Gap 3: The difference between service quality specifications and the service actually delivered.

Gap 4: The difference between service delivery and what is communicated about the service to customers.

Gap 5: The discrepancy between customers' expectations of the service and their perceptions of the service performance.

The above five service gaps are to assist the service providers to identify the areas of customer dissatisfaction. The customers may decide whether to continue or expand the outsourcing activities depending on their level of service dissatisfaction. The service gaps are normally based on the observations of the service providers with limited input from the customers (Zeithaml *et al*. 1996). Although researchers have studied the concept of service for several decades, there is no consensus about the conceptualization of service quality (Cronin & Taylor, 1992; Rust & Oliver, 1994). Different researchers focused on different aspects of service quality. There may not have enough research to determine whether the Gap Model is appropriate to determine the service gaps in outsourcing plant maintenance. In this research two hypotheses are tested for each service gap (Table 2.12). One hypothesis is the service gap for outsourcing partial plant maintenance and the other is the service gap for outsourcing total plant maintenance. The two hypotheses are mirror images of each

other. Therefore, a total of twelve hypotheses are identified based on the modified gap model and they will be tested later in the research analysis. Furthermore, to provide a critical perspective to the research, the service gaps are based on the input from different stakeholders (managers, supervisors and technicians) in the customer and outsourcer organizations.

Table 2-12 Hypotheses for outsourcing plant maintenance

Modified Zeithaml's Gap Model	Research Hypotheses: Less likely to outsource total plant maintenance	Research Hypotheses: More likely to outsource total plant maintenance
Gap 1: The difference between customer expectations and Outsourcer perceptions.	H1: The customer expectation is higher than the outsourcer perception	H7: The outsourcer perception is higher than the customer expectation
Gap 2: The difference between service quality specifications and outsourcer perceptions	H2: The outsourcer expectation is higher than its perception.	H8: The outsourcer perception is higher than its expectation.
Gap 3: The difference between service quality specifications and the customer perceived service.	H3: The outsourcer expectation is higher than the customer perception	H9: The customer perception is higher than the outsourcer expectation
Gap 4: The difference between customer expected service and service specifications	H4: The customer expectation is higher than the outsourcer expectation.	H10: The outsourcer expectation is higher than the customer expectation.
Gap 5: The difference between customer expected service and customer perceived service performance.	H5: The customer expectation is higher than its perception.	H11: The customer perception is higher than its expectation.
Gap 6: The difference between customer perceived service and outsourcer perception.	H6: The outsourcer perception is higher than the customer perception.	H12: The customer perception is higher than the outsourcer perception.

Source: Compiled for this research

In summary, the twelve hypotheses are developed based on the modified Zeithaml's gap model. The hypotheses will be tested in Chapter 4 to confirm whether the modified gap model is applicable in the deciding to outsource total plant maintenance. The modified Zeithaml's gap model may then be able to use by the outsourcer to win plant maintenance which is one of the secondary research question.

2.8 Conclusion

The Singapore petrochemical industry output has been growing since the beginning of 2000. For the last four years, the committed investments in the petrochemical industry are above S$1.5 billion per year. These large investments demand a large pool of skilled workers to support the industry. Furthermore, the high worker remuneration as compared to the other industry in the manufacturing sector suggests that the petrochemical companies are keen to cap or reduce the operating costs. The statistics from the Singapore Ministry of Trade suggests that there may be a shortage of skilled workers. The worker training programmes to improve the worker skills seem to be inadequate since the contractors are hiring temporary workers.

In the literature review, seven factors are identified that may affect the decision to outsourcing total plant maintenance in the Singapore petrochemical industry. The factors are service quality, contractor experience, outsourcing contracts, risks, outsourcing reasons, training programmes and outsourcing culture. The research will identify which of the factors are critical to the outsourcing decision and what are the factors that influence these critical factors. In addition, the modified Zeithaml's Gap Model is used to test the twelve hypotheses based on the relationship between service expectations and perceptions. Since the research is to provide a critical perspective, the expectations and perceptions of the various stakeholders (managers, supervisors and technicians) in the outsourcing process will be considered in the research. Lastly, the research will examine whether an outsourcing decision matrix can be developed by using the expectation-perception relationships for the deciding factors in the modified Zeithaml's gap model. This decision matrix may help outsourcers to understand the critical outsourcing deciding factors that the petrochemical companies used and may help them in winning outsourcing contracts.

CHAPTER 3
RESEARCH METHODOLOGY

The chapter explains the process of selecting the research methods, collection of data and reporting. The research methodology section explains the rationales of using research case study and survey questionnaire in carrying out the research. The use of qualitative and quantitative data analysis is to triangulate the research analysis results and result in a more rigor research.

3.1 Introduction

This chapter is to explain the steps taken in this research to ensure the research data are accurate and the research is rigor. This research has selected a combination of qualitative and quantitative research approaches. The reasons are to provide a critical perspective on the research as stated in the research title. The triangulation of the research data from both research approaches will provide more rigor and validity to the research. Furthermore, the research protocol and field procedure are examined to ensure that the samples chosen and the interviewing method used will provide an unbiased and accurate research data.

3.2 Research methods

The first step in the research protocol is to decide on the research methodology. This research is to find the critical factors that decide outsourcing total plant maintenance in the Singapore petrochemical industry. Qualitative research is *"an empirical inquiry"* in research (Yin 1994) such as to identify outsourcing factors in plant maintenance. This approach is appropriate when the phenomena under study are complex, social in nature, and do not lend themselves to quantification (Liebscher 1998). This research topic is certainly complex and social in nature because it involves the perceptions and expectations of outsourcing from the petrochemical companies and outsourcers. The qualitative approach enables the researcher to grapple with relationships and social processes in a way that is denied to the quantitative approach (Denscombe 1998) such as the relationship between the customers and outsourcers. Finally, qualitative research also provides the guidance to enable comparisons and generalizations across social settings (Neuman 1994). For example, qualitative research method may be able to identifying patterns to understand why certain petrochemical companies outsource total plant maintenance. Quantitative research method may not be able to interpret the respondents' experiences and beliefs (Gilmore and Carson 1996).

On the other hand, quantitative research is thought to be objective whereas qualitative research often involves a subjective element (Ross 1999). Many researchers posit that in gaining, analysing and interpreting quantitative data, the researcher can remain detached and objective. This research methodology is appropriate where quantifiable measures of variables of interest are possible, or where hypotheses can be formulated and tested, and inferences drawn from samples of populations (Liebscher 1998). Since this research will be testing the twelve hypotheses on the expectations and perceptions of outsourcing plant maintenance (Chapter 1), the quantitative approach seems to be appropriate. Finally, this "customer-driven quality" approach is able to translate expected quality into output such as design and delivery processes (Evans and Lindsay 2002). This approach may allow the research to examine the modified Zeithaml's

gap model and develop an outsourcing selection matrix to help the outsourcers to win outsourcing contracts.

The examination of the qualitative and quantitative research approaches in the earlier paragraphs shows that neither one research method is able to adequately answer the three research questions on outsourcing total plant maintenance. The qualitative research method can be used to identify the critical outsourcing deciding factors but it may be extremely time consuming to interview so many people in different levels of management in order to provide a critical perspective. Similar, quantitative research method is able to quantify the importance of the various outsourcing factors but it is not able to understand the relationship between them. Therefore, some researchers have found that quantitative research is now being used in conjunction with qualitative research methods in studies that cannot adequately describe or fully interpret such situation (Fierro 2003). The choice of a mixed-mode approach is to compensate for the complexity of the subject matter (Metzler and Davis 2003). The quantitative analysis can augment the qualitative observations and it is good for case study (Yin 1994).

Hence, in this research a combination of both the qualitative (case study) and quantitative (survey) methods are selected. In the case study, the researcher is able to identify the factors that the respondents used to decide outsourcing plant maintenance. It also enables the research to compare the relationship between the deciding factors and respondents' experiences. On the other hand, the data from the research survey help to objectively analyze the expectation-perception relationship with the hypotheses. It also provides a critical perspective by soliciting feedback on outsourcing from different levels of management in the customer and outsourcer organizations. Furthermore, the research is able to triangulate the results from the two research methods and adds depth in understanding the interplay between the outsourcing factors and service gaps. Triangulation is an alternative method to validate the data which increases scope, depth and consistency of the data analyses (Flick 1998). It is the application and combination of several research methodologies in the study of the same phenomenon. There are researchers posit that though triangulation may not necessarily reduce bias or increase validity, the advantage of combining competing theories will generally add range and depth to the analysis (Fielding et al 2001). Nonetheless, it can achieve complementary results by using the

strengths of one method to enhance the other and gain a more complete understanding of the research question can achieve complementary results by using the strengths of one method to enhance the other. (Sale et al 2002).

3.3 Case Selection

In Section 3.2, the researcher has explained that this research is using a combination of research case study and research survey. The first part of this section is to explain the selection criteria for the companies that are selected for the case study interviews.

Some researchers feel that multiple-case studies have a drawback because they reduce the attention of the researchers and may result in weakening the case studies (Wolcott 1995). Another view is the strength of the 'generalization' may be increased with a number of cases (Yin 1994). There is no agreed guideline on the ideal number of cases required in order to provide internal and external validity for multiple-case study (Robson 1993; Romano 1989; Merriam 1988). In this research case study, eight companies from the petrochemical companies are selected shown in Table 3.1. It is because the result from multiple cases is more compelling and leads to more robust research (Remenyi 1998).

In the case study approach, random selection in sampling research was not recommended because it may not represent the 'real world' context in the case study (Eisenhardt 1989; Tellis 1997). Random sampling may also lead to data skewed to a particular subgroup and hence introduces sampling error and is not recommended (Eisenhardt 1989; Patton 1990). Therefore, in this research, the eight companies that are selected are based on companies that practise different type of maintenance (Types 2, 3 and 4). There is no evidence that maintenance Type 1 is practised in the petrochemical industry since it is not cost effective for any company to maintain all the equipment by their in-house maintenance crew. Companies are also selected to represent a wide age group from less than 10 year-old to over 30 year-old. Case studies are not meant to represent the entire population nor do they claim to be (Yin

1998). These research case selection criteria will provide reliable and valid data based on the various combinations of the outsourcing activities (Winegardner 2000; Bennett 1997).

Table 3.1 Research case study samples

Case	Age	Maintenance Type	Senior Manager	Middle Manager
C1	9	3	1	1
C2	10	2	1	1
C3	15	2	1	1
C4	37	2	1	1
C5	5	4	1	1
C6	35	2	1	1
C7	4	3	1	1
C8	30	3	1	1
			8	8

Note:
Maintenance Type 1: Maintenance is done by in-house staff
2: Maintenance is partially outsourced
3: Maintenance are mostly outsourced but managed/supervised by in-house staff
4: Maintenance is totally outsourced. No in-house staff to manage maintenance.

Within each of the case, the senior and middle management are interviewed for their thoughts on outsourcing plant maintenance and whether the seven outsourcing deciding factors that are identified in the literature review are applicable to their companies. There are three reasons that this case selection is able to provide rigor in the research. Firstly, the research data analysis could predict similar results for predictable reasons and replication (Yin 1994; Stake 1994; Perry 1998). Secondly, by looking at a range of similar and contrasting cases, the data strengthen the precision and validity of the findings (Miles and Huberman 1994). Thirdly, the cases allow cross-case analysis to enhance theory building (Yin 1994) and strengthen or broaden analytic generalizations (Winegardner 2000).

Table 3.2: Research survey samples

Case	Position	Years in Operation	Nationality	Manager	Supervisors	Technicians
C1	Customer	9	Germany	1	2	2
C2	Customer	10	USA	1	2	2
C3	Customer	15	USA	1	2	2
C4	Customer	37	USA	1	2	3
C5	Customer	5	French	1	2	
C6	Customer	35	USA	1	3	2
C7	Customer	4	USA	1	2	2
C8	Customer	30	Singapore	1	2	2
O1	Outsourcer	5	Singapore	1	1	
O2	Outsourcer	4	Singapore	1	1	
O3	Outsourcer	5	Singapore	1	1	
O4	Outsourcer	10	Singapore	1	1	
O5	Outsourcer	5	Singapore	1	1	
O6	Outsourcer	10	Singapore	1	1	
O7	Outsourcer	3	Singapore	1	1	
O8	Outsourcer	10	Singapore	1	1	

Note: Contractor technicians were not interviewed because they were generally uninformed. This is to prevent distortion of the research data.

Source: Developed for this research

The next step is to select the companies and respondents for the research survey. Since the objective of the research survey is to validate the research data from the case study, the research survey also select the same eight companies that are involved in the research case study. This is to provide consistency in comparing the research results from the two research methods for the same companies. Since the research title is to use a critical perspective to identify the critical outsourcing factors, employees from different management levels in the petrochemical and outsourcing organizations are involved in the survey. Table 3.2 gives a summary of the respondents involved in the research survey interviews. There are a total of 56 respondents involved in the research survey. Since the petrochemical companies are much larger than the outsourcer organizations, more respondents are selected from the petrochemical companies. In order to provide a critical perspective in this research, the outsourcer senior and middle management are also given the opportunities to give their input on the seven outsourcing deciding factors.

In Tables 3.1 and 3.2, the customers are mainly multi-national companies and have many levels in the organization hierarchy. The Maintenance managers generally

manage the overall plant reliability and maintenance budgets. The detailed maintenance activities are managed by the skills managers together with the supervisors and technicians. The outsourcer workers report to the supervisors. The outsourcers are local companies and are much smaller than the customers. These companies have few management levels in their organization hierarchies. The company organization have a General Manager that manage the company overall activities and site managers that work with the customers. The workers are deployed to the work sites by the site managers. The outsourcer technicians' views are not considered in this survey because many of them are poor in the English Language. Some of them are also quite new to the companies. Their views may not be accurate and may distort the overall outsourcers' expectations and perceptions.

In summary, the eight companies chosen represent the different types of maintenance that are practised in the Singapore petrochemical industry, that is, companies that partially outsource plant maintenance (Types 2 and 3) and company that outsource total plant maintenance (Type 4). The structured interviews are able to understand the expectations and perceptions of these companies towards outsourcing plant maintenance. They help the researcher to understand people and the social and cultural contexts within which they live (Myers 1997). The survey interviews are able to provide a critical perspective of the outsourcing expectations and perceptions. The survey data are able to provide a quantifiable baseline on the relationships between different outsourcing deciding factors.

The next section in this chapter will provide a background of each of the petrochemical companies and outsourcers that are involved in the research case study and survey.

3.4 Case background

The objective of this section is to provide a brief description of the eight companies that are involved in the case study and survey interviews. In order to satisfy the ethical issues and to keep the confidentiality of the respondents and their companies, the petrochemical companies are named C1 to C8, and the outsourcers are named O1 to O8. The respondents did not want to divulge the maintenance budgets and the size of the workforce size. There seems to be common practices that this business information is strategic to the companies.

Customer 1 (C1)

This is a multi-national company with headquarter in Germany. It has been in operation for about nine years and produces specialty chemicals mainly for export. The parent company in Germany has been outsourcing plant maintenance.

The company in Singapore decides to outsource total plant maintenance during the plant construction stage. It embarked on the third method of maintenance as explained in the literature review. That is, the company does not hire plant maintenance workers. However, maintenance manager and two supervisors are hired to manage the plant maintenance activities. The reason could be outsourcing is a serious business decision that should be supervised by managers (Apricella 2002). This decision helped the company to save costs and time in not recruiting the maintenance workers. Furthermore, the company does not need to train the new workers because it has considered the difficulties in hiring skilled workers to maintain the plant effectively.

The early decision by the company to outsource plant maintenance has helped the outsourcer in hiring the workers. The outsourcer knows the difficulties to hire skilled workers and try to mitigate the problem by hiring many of the workers that are involved in the construction phase of the plant. These skilled workers know the plant well and may be in a better position to maintain the plant. The company, by contrast,

found that some of the skilled construction workers do not have the experience to maintain the plant. The observation seems to be similar to some experts who posits that there is a world of difference between installing new equipment and maintaining existing equipment and systems (Finchem 1997).

Customer 2 (C2)

This is an American multi-national company that produces chemicals for export. The company is in operation for about ten years. It started operation by hiring its own maintenance crew to maintain the plant equipment. Some of the specialized equipment is outsourced to the equipment vendors.

In the last three years, the company was under pressure to reduce maintenance costs due to the weakening of the profit margin. The management finds it more difficult to hire good and experienced maintenance workers. It thinks that it is more cost effective to outsource some of the maintenance activities. Therefore, the management decides to outsource more of their plant maintenance to local contractors. Pump repairs and piping work are outsourced to local contractors.

Most of the supervisors and technicians have been working in the company for many years and they are not happy with the outsourcing. They have raised their concerns on the lack of skills among the outsourcer workers. They feel that in-house maintenance crew is much better than contractors. However, the management has no intention to stop the outsourcing effort. Instead, the outsourcing activities may be expanded in the future.

Customer 3 (C3)

This case is an American multinational company that manufactures specialty chemicals. It has been in operation in Singapore for about fifteen years. In the beginning, its in-house crew maintained most of the plant equipment. In the last few

years the management has gradually outsourced some of the plant maintenance activities. The management feels that since the trend of outsourcing is to reduce cost, it is the right thing to do. It feels that the risk of outsourcing failure is not high because the company can fall back to the in-house maintenance crew if the outsourcer fails to perform. The company's long-term plan is to reduce the maintenance in-house crew and by then, the outsourcer should be experienced enough to handle the maintenance effectively. About six months ago, the company has started to reduce the maintenance workforce. Some of the retrenched workers had been with the companies for about ten years. This retrenchment has affected the morale of the remaining workforce.

Customer 4 (C4)

This case is an American multinational petroleum refinery that has been in operation for thirty-seven years. The company has hired in-house crew to maintain the plant equipment because outsourcing was not popular in Singapore three decades ago. It started to outsource maintenance of specialized equipment (such as process computers) about fifteen years ago. As the installation of the specialized equipment increased over time, there are more maintenance activities outsourced. In the last five years, lower skilled maintenance activities such as piping work are also outsourced. The middle management and supervisors feel that the outsourcer workers are not experienced enough to maintain the plant equipment effectively. They also feel that there could be higher risk to the refinery (maybe fire and loss of lives) if more maintenance activities are outsourced.

The management was under pressure from the parent company in USA to continue to reduce maintenance costs due to lower profit margins and increasing competition in the world market. Although the refined product profit margin has improved by many times recently, the annual operating costs are still expected to reduce. In fact, the maintenance budget is expected to reduce by 5% year-to-year. The senior management is sensitive to the higher possibility of plant maintenance failure by the outsourcer. The management is mitigating the risk of maintenance failure by

outsourcing the work to contractors that have been working with the company in the past.

Customer 5 (C5)

This is a European multi-national chemical company that has been in operation for about five years in Singapore. The parent company has outsourced total plant maintenance in Europe. The company in Singapore has followed the parent company's maintenance practice and outsourced total plant maintenance. The whole maintenance activities are given to one local outsourcer. This is the only petrochemical company that outsourced total plant maintenance. In the research, Company 5 is the only company that took the risk and outsourced total plant maintenance.

This company experiences the benefits by not hiring any maintenance staff. It does not have to change the mindset of the in-house workers towards the contractor workers. A study finds that customer managers do have problem to manage outside relationships (Corbett 1998). Secondly, the management does not need to worry about maintenance worker retrenchment and compensation if the organization outsourced plant maintenance in the future.

The outsourcer is providing the workers and management team to manage the whole plant maintenance activities and reports directly to the plant manager. The outsourcer management is responsible for the reliability of the plant equipment. The risk of outsourcing total plant maintenance can be high since the customer may over-dependent on the outsourcer. The cost of changing outsourcer in the future (if the service quality is below expectation) can be prohibitive (Currie 1990).

Customer 6 (C6)

This is another American petroleum refinery that is in operation for about thirty-five years in Singapore. Similar to Company 4, this company started its operation by maintaining all the equipment by their in-house crew. The company places great importance on plant safety and reliability. The middle management and supervisors have clear responsibility to maintain good safety record and high equipment service factors.

This company does not have experience in total maintenance outsourcing. Its affiliates in other parts of the world only outsource their maintenance partially. In view of the high service expectations and lack of total maintenance outsourcing, it has only outsourced some maintenance activities like pump repair, welding work and specialized equipment. The in-house crew which has an average experience of fifteen years feels that the outsourcer workers are not up to their expectations. Owing to the poor profit margin in early 2000, the company is under pressure to reduce operating expenses and one of the strategies is to outsource more maintenance activities in the near future. This could be because outsourcing is one of these strategies that can lead to greater competitiveness (Embleton and Wright, 1998).

Customer 7 (C7)

This is an American chemical company that manufactures many different types of chemicals. It is a world-class chemical plant in Singapore and has been in operation for about four years. Since the company is constructed in a period where the chemical profit margin was weak, the management is "forced" to outsource most of the maintenance activities in order to reduce operating cost and employee head count. Most of the routine maintenance activities are carried out by a single outsourcer. Manufacturer service engineers help in maintaining the specialized equipment. In order to mitigate the risk of failure, the company has a 'skeleton' maintenance crew to oversee the plant maintenance.

The general feelings from the middle management and supervisors are the outsourcer workers do not live up to their expectations. The employees felt that the contractor workers' experience level is below expectations. The problem is compounded because the outsourcer worker turnover is relatively high. The training programmes provided by the outsourcer are less than adequate. Perhaps these temporary workers are generally under-trained because they are not obligated to stay with their employers (Koh and Lay 2000). Therefore, some of the in-house crews are upset because they feel that they are taking on the contractor's maintenance responsibilities.

Plant maintenance reliability is of paramount importance to ensure the company is able to meet the expected production targets. Although risk of failure by the outsourcer is a concern, the company is not over-dependent on the outsourcer. Firstly, the in-house crew is able to help in the maintenance effort. Secondly, the company is able to source the help from the other affiliates outside Singapore to help in an emergency.

Customer 8 (C8)

This petroleum refinery is a joint venture between a local and three multi-national companies. It started operation about thirty years when the petrochemical business was having high growth. The company has started its operation with their own in-house maintenance crew. Over the last five years, the company has outsourced the plant maintenance activities to two outsourcers and reduced the in-house maintenance crew gradually through retirement and retrenchment. The reason to hire two outsourcers is to reduce the risk of failure. If one outsourcer could not perform well, then the other outsourcer could help out. Although there are the common complaints of the contractor workers' experience below expectations, the outsourcing strategy seemed to be working quite well in this company.

This is the only company in the research that changed its maintenance from Type 2 to Type 3 and the only company that is above ten year-old and practise Type 3 maintenance. Currently, the company has low maintenance manpower and is expected to reduce further as the older workers retired or resigned. The company did

not experience any union problem when it started retrenching the maintenance workers five years ago.

Outsourcer 1 (O1)

This is a joint ventured outsourcing company between a local contractor and a European outsourcing company. The company is formed in early 2000 to capture a slice of the maintenance outsourcing business in Singapore. The local company has been doing electrical, instrument and piping installation work for the petrochemical industry for nearly three decades. The foreign company has been successful in the outsourcing market in Europe. It has the experience in providing total plant maintenance.

The outsourcing contract with customer C1 is the major contract that Outsourcer O1 manages to secure in Singapore. The contract scope requires the outsourcer to provide Type 3 maintenance (explained in Chapter 1), that is, the outsourcer is responsible to provide all the maintenance activities to the plant. The customer is responsible to manage the overall maintenance effort. The outsourcer has the skilled workers to handle the routine maintenance activities such as electrical work, piping work and pump repair. For the specialized equipment, it will sub-contract them to local manufacturer representatives. Some of the workers that are hired were involved in the same plant construction. These workers have the advantages of knowing the plant well. The outsourcer organization seems to have the people and expertise to manage the whole maintenance process because its foreign partner has been providing total plant maintenance for some companies in Europe.

Outsourcer 2 (O2)

This company, like many local contractors, provides pump repair service on a call-off basis to many companies in the petrochemical industry. The company only repair the pumps as and when required by its customers. It does not maintain the pumps, that is, monitoring the pump performance and providing failure analysis.

About three years ago, Customer C2 has outsourced the pump repair to this contractor. The reason perhaps is the customer feels that Outsourcer O2 may be able to carry out the pump maintenance better than the in-house maintenance crew. Therefore, the outsourcer workers are replacing the in-house maintenance crew in maintaining the pumps. The outsourcing organization has not changed much in view of winning the service contract. It only increases the number of workers and supervision in the customer premise. There is no training programme organized so far by the outsourcer to upgrade the workers' and supervisors' skills. There is also no immediate plan to expand its expertise and management capability to provide total plant maintenance. Currently, the plant maintenance activities are controlled by the customer own staff.

Outsourcer 3 (O3)

This is a local company whose primary expertise is in the installation of electrical and instrumentation equipment in the petrochemical industry. It has been doing electrical and instrumentation installation work for Customer C3 in the past few years. However, they are not involved in the maintenance of the electrical equipment at the Customer C3 premise.

Outsourcer O3 hires many workers from Malaysia and they tend to change jobs as and when they find other employers that could pay higher remuneration. Employee job hopping seems to be a problem with many small local contractors as they are not able to retain the skill level within the organizations. Therefore, retaining skilled employees is one of the challenges of the company.

Process instrumentation technology continues to change over time. The workers have to continue to acquire new skills in order to be proficiency in maintaining this equipment. The company does not seem to have a structured training programme for the employees. The employees only attended very short training sessions conduct by equipment manufacturers. The management is aware the importance of training for its workers. On the other hand, it feels that the employees may job hop when they are well trained and that is no good for the organization. So the management is trying to decide how much training the workers should have.

Outsourcer 4 (O4)

This is a local contractor that has been mainly involved in project construction work in the petrochemical industry for almost thirty years. It has equipment and workers to do pipe welding and fixed equipment (for example, heat exchangers and furnaces) installation. Over the years, the company management team has grown to be more professional by hiring better qualified managers. The company is now one of the larger local contractors in the petrochemical industry.

The company is one of the many contractors that have been assisting Customer C4 in repairing heat exchangers and changing furnace tubes during the plant major repair. Hence, the customer is aware of the outsourcer capabilities and outsourced the piping maintenance work to the company. The outsourcing activities are Type 2 maintenance where the outsourcer works under the instruction of the customer staff.

Outsourcer 5 (O5)

This company is joint venture between a local contractor and a US-based construction company. The local contractor is arguably the largest local contractor in the petrochemical industry. It has completed many turnkey projects in the petrochemical

industry. The partner is a large US-based contractor who primary involves in construction activities in various industries. Over the years, this company also expands its activities to cover maintenance work.

In early 2000, Customer C5 had given the plant maintenance work to a local contractor. This contractor was not able to perform well due to its internal management problem. Subsequently, Outsourcer O5 is awarded the plant maintenance outsourcing contract. The contractor requires the outsourcer to provide Type 4 maintenance, that is, the outsourcer has to provide the maintenance management team to manage the plant maintenance activities. The outsourcer managers report to the Operations Manager. The outsourcer managers manage the daily maintenance activities and are responsible for the reliability of the plant maintenance.

Outsourcer 6 (O6)

This is a local contractor that has been mainly involved in project construction work in the petrochemical industry for almost thirty years. It has equipment and workers to do pipe welding and fixed equipment (for example, heat exchangers and furnaces) installation. It is a strong competitor of Outsourcer O4. Over the years, this outsourcer has helped Customer 06 in repairing heat exchangers and pipe welding during their many plant shutdown works. The company is awarded the outsourcing contract to repair the piping and fixed equipment in the customer site.

The outsourcer organization is controlled by the founder family members. However, over the last few years, more qualified workers are hired in the management team to raise the organization professionalism. The company has a training programme to qualify its workers to be proficient in their skills. There are plans to improve the overall skill level of the workers. The objective of the company is to be able to handle total plant maintenance in the near future.

Outsourcer 7 (O7)

This company is a joint venture between a local and Japanese company. The local company is a relatively large contracting firm that are successful in providing piping construction in the petroleum industry in Singapore and Malaysia. The Japanese company is large process instrumentation manufacturer that has been operating in Singapore for many years. The joint venture company which started in early 2000 is to combine their skills together to provide total plant maintenance for the petrochemical industry. The company seems to be quite successful in winning a few outsourcing contracts from different companies to maintain certain activities in their plants.

This company has a five year maintenance service contract with the customer (C7). The contract includes a broad spectrum of maintenance such as electrical, instrumentation, piping and machinery. It has hired many of the workers that were involved in the construction of the plant. However, after one year into the maintenance contract, some of the better workers left because they paid better by the new employers. The outsourcer seems to have problem to retain these skilled workers. It has a training programme to improve the basic skills of the workers.

Outsourcer 8 (O8)

This is a local contractor starts involving in the petrochemical companies since 1980. The workers initially involved in project work such as installation of piping and heat exchangers. Over the years, the company expands and then team up with another electrical contractor to expand the scope of the company.

The company is able to win the outsourcing contract from Customer C8 about five years ago. The extent of the maintenance work that was outsourced to this company growing gradually as the in-house maintenance crew reduces due to resignation and restructuring. The company expects the outsourcing activities continue to increase over the years.

The company does have good workers that maintain the plant equipment. However, not all the workers are full-time employees. The company hires some temporary workers to supplement the employees. The worker training programme provided by this company are not does not well structured to ensure that the temporary workers are proper trained as expected by the customer. In spite of the shortcoming, the customer seems to be satisfied with the outsourcer performance.

3.5 Pilot study

The next step in the research protocol is to conduct pilot study. The pilot study is to test out the interviewing questionnaires and identifies whatever shortcomings in the interviewing process (Zikmund 1997). The experience from the pilot study would be used to "fine tune" the research design and field procedures (Kanso, n.d.). Although many authors have emphasised the usefulness of pilot studies (Yin 1994; Eisenhartdt 1989), it is not a 'pre-test' but more like a 'dress rehearsal' (Yin 1994) and not to refine the problem definition (Zikmund 1997).

In this research, a pilot study was carried out on Case 1 for the structured interview and survey questionnaires. The pilot study was first carried out on the interviewing the respondents in Case 1. The interviewing questions in Appendix 3.1 were asked and observed whether they are ambiguous. The questions did not seem to be an issue as the interviewer is able to explain the questions and redirect the questions when the interviewer think the questions are not clear to the interviewees. One issue that was observed in the pilot study was the interviewee was reluctant to answer when the question was seemed to be 'loaded'. For example, it was observed that the interviewee (only outsourcers) was hesitant to answer the question "What were the problems you experienced with maintaining the plant equipment?" The respondent was more willing to answer when the question was rephrased to "What do you think how the plant could be maintained better?"

Secondly, the pilot study is to help the researcher to 'fine-tune' the interviewing time. The interviewing process was initially allotted only between one and one and a half hour. It was discovered that the researcher took about fifteen minutes to slowly start off the interviewing process by engaging in small talk and slowly explaining the objective of the research. Another problem was the interviews are disrupted by telephone calls from time to time. The time allocate for the actual interviews is therefore extended from one and a half-hour to two hours in order to cover all the questions.

The observation from the pilot study shows that the whole interviewing process was not very structure in term of the sequence of the questions asked. More time may be required than necessary in the interviewing process. Therefore, an interviewing sequence is developed shown in Table 3.3 to provide a more structured and effective interviewing process.

Table 3.3 Interviewing sequence

Duration (Minutes)	Interviewing Sequence
15	Social and general questions on the organization
15	Non-controversial questions about the plant maintenance and how to improve plant reliability
30	Questions on maintenance strategies and outsourcing (based on the interviewing questions)
30	Continue with more indepth questions on outsourcing (based on the interviewing questions). Summarise and clarify the interviewing data

Source: Developed from research pilot study

The interviewing sequence in Table 3.3 shows that the interview initially starts slowly to "warm up" the interviewee and make him comfortable. The initial questions give the interviewer the opportunity to scan the business environment in that organization. The interviewee is gradually introduced more difficult questions about outsourcing and maintenance.

Thirdly, the pilot study found that the recording of the interview data was confusing. The data are supposed to be grouped in order to help in the data analysis. It was

found that the grouping chosen shown in Table 3.4 are not consistent with the deciding factors. The data were grouped in four broad groupings that may be difficulty to analyze during the research case study data analysis. The case study data will be grouped according to the seven deciding factors.

Table 3.4 Case study data groupings

Outsourcing deciding factors	Case study data groupings
Service quality	Service quality
Contractor worker experience	Outsourcing strategy
Outsourcing contracts	Outsourcing risks
Outsourcing risks	Management
Outsourcing reason	
Contractor worker training programme	
Outsourcing culture	

Source: Compiled from Appendix 3.1

The pilot study conducted on the survey questionnaires found that some of the questions are repetitive. Question 9 was asking about the "Company organizational culture on outsourcing". This question was similar to Question 1: "Company Senior management commitment to outsourcing activities" and Question 2: "Company Middle management commitment to outsourcing activities". The decision is to delete Question 9 from the survey questionnaires. Question 8: "Level of understanding of outsourcing workscope", which was also found to be confusing and is quite similar to Question 5. Question 8 is also deleted from the survey questionnaires. The questionnaires are re-arranged so that they are grouped according to the outsourcing deciding factors that are identified in the literature review.

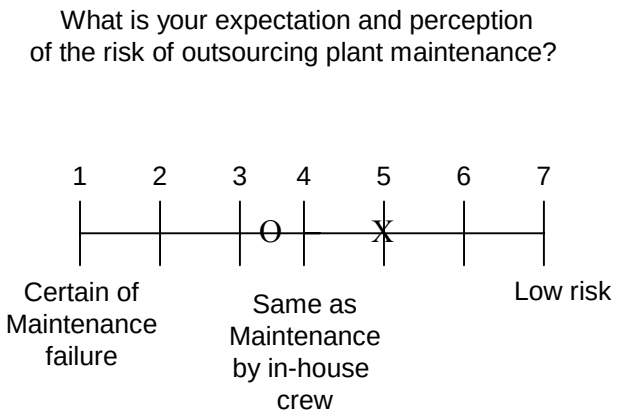


Figure 3.1 Expectation/perception on same Likert scale

There is another important finding in the pilot study that is able to save time for the interviewees and researcher. The survey questionnaires require each interviewee to provide his feedback on his expectations and perceptions on the list of survey questionnaires. The interviewee was requested to give his expectations on set of questionnaires and his perceptions on another similar set of questionnaires. This method would result in 112 survey forms since there are a total of 56 respondents. From the pilot study, the researcher found that the interviewees would save an estimated 280 minutes (Table 3.5) if each interviewee fills one set of questionnaires by marking "O" for perceptions and "X" for expectations on the same Likert scales shown in Figure 3.1. The new method will reduce the interviewee time to fill the survey forms as they can provide the expectations and perceptions to each questionnaire at the same time. Furthermore, the result may be more accurate as the interviewees have a better perspective as they fill the expectation follows by perception. The researcher will also benefit from the new method because he only needs to collect and record the research data of 56 instead of 112 survey forms. The researcher estimated a saving of 112 minutes due to handling lesser survey forms.

Table 3.5 Estimated time saving from pilot study

Activities	Computation	Time Saving (Minutes)
Survey interviews	5 min X 56 forms	280
Survey data collection/recording	2 min X 56 forms	112

In summary, the pilot study carried out on Case 1 is able to "fine tune" the interviewing questions so that they do not seem to be 'loaded' and the respondents are more willing to give the correct answers. The case study interviewing time is found to be underestimated because of interviewees need some time to warm up to the interviews and the unavoidable interruption from telephone calls. The extension of the interviewing time will avoid frustration if the interviewees have to wait for the interviewer if the earlier interviewing session was delayed. The grouping of the research data that do not follow relate to the outsourcing deciding factors can result in difficulties to compare the various research patterns. The regrouping of the research data will result in a more efficient means to analyze compare the case study and survey data. Finally, the making of the expectation and perception on the same Likert scale not only reduce the feedback time but may also result in a more accurate comparison between expectation and perception. Therefore, the pilot study carried out on Case 1 has benefitted the research data collection and analysis. The next section is to explain how the research data are collected.

3.6 Interview protocol

Earlier in the chapter, the Research Methodology section has explained that this research is using a combination of research case study and survey. It is to provide validity and rigor to the research through the triangulation of research data from both research methods. The interview protocol is divided into two sections, namely,

interviewing process and interviewing questions. The interviewing process is a plan to "collect" unbiased interviewing data within the allotted time. The interviewing question section is to explain the research questions that are developed to answer the research questions.

3.6.1 Interviewing Process

The interviewing process is the methodology to collect the interviewing data. The first part of the interviewing process is targeted to the research case study interviews. Case study interview is more than normal conversation between two people. The interview includes non-verbal cues from the interviewee and careful listening. The interviewing sequence follows Table 3.6. In the beginning of the interview, the research issues are not told to the interviewees. Otherwise, the respondents may provide the answers that they think the interviewer wants and the research data will be biased. The interviewer began by explaining to the interviewees the purpose of the research. The rationale of the explanation is to clear the doubt in the interviewee's mind and seeks the interviewee's cooperation. The next step is to explain to the interviewee how the interviewing data are collected. The interviewer is planned to use pen and paper and tape recording to capture the respondent's feedback. Tape recording is able to give accurate quotations to justify the conclusions about "differences between cases in the cross-case analysis" (Carson, Gilmore, Gronhaug, Perry, 2000). The permission to use the tape recorder is requested at the beginning of the interviewing session. The interviewees are told that at anytime if they felt uncomfortable, the tape recorder would be switched off. The interviewer's is most of the interviewees felt uncomfortable when the tape recorder was used. Hence, the interviewer depended heavily on pen and paper to jolt down the main points during the interviews.

The third stage of the interviewing process is to ask the interviewee for their opinion on outsourcing. The rationale is to have a starting question in the unstructured

interview that is content-free in order to capture the interviewees' perception (Perry 1998; Dick 1990). The interviewees are asked the questions based on the case study questionnaires in Appendix 3.3. However, the interviewer tries not to ask leading questions that may influence the interviewees' perceptions (Edwards 1998). The interviewer also frequently seeks clarification during the interviews. This interviewing method will, therefore, enhance the research data reliability and providing the added rigor to the research. The interviewer then thanks the interviewees for their co-operation and also informs them that their companies will be kept confidential in the report. The companies will be given a case identification, C1 to C8, and the interviewing data are coded according to the data coding system explains later in this chapter. The interviewees' co-operations are also requested if further clarification of their comments is required during the data analysis stage.

Table 3.6: Interviewing process

Step	Action	Reasons
1	Explain the interview recording method: pen and paper and tape recording. Remind interviewee to request the tape recorder to be switched off if he feels intimidated.	To allay fear and stress on confidentiality.
2	Explain objective of the research (not the research issues)	To clarify any confusion and seek cooperation
3	Explain the meaning of outsourcing and request interviewee to ask for clarification if any of the terms used are not clear.	To ensure consistency in understanding the questions among all the interviewees
4	Asks non-leading questions. Asks probing questions to clarify comments.	To avoid biased comments. To avoid interviewee giving answers that he thinks interviewer wants to hear.
5	Inform interviewee that they may be called upon again to clarify their comments during the data analysis.	To ensure data accuracy.
6	Thanks interviewee for their time and cooperation	

Source: Developed for this research

3.6.2 Interviewing questionnaires

The research case study interviewing questionnaires in Appendix 3.3 are structured to meet two criteria. Firstly, the questionnaires cover the seven outsourcing factors that are identify in the literature review chapter. Secondly, the questionnaires have to be unambiguous, open-ended and non-leading in order to reduce any bias to the respondents' answers. Care is taken to paraphrase the questions with the words used by the interviewees in order not to reveal the answers that the interviewer prefers (Carson, Gilmore, Gronhaug and Perry 2000). The interviewing questions are divided into seven groups shown in Table 3.7 in order to simplify the coding process of the answers and help in the subsequent data analysis.

Table 3.7 Grouping of case study interviewing questions

	Group	Case study questions
1	Service quality	What is the perception of service quality? Is outsourcer corporate image relates to outsourcing service quality?
2	Contractor worker experience	How extensive construction and temporary workers hired for plant maintenance outsourcing?
3	Outsourcing contract	How important is a comprehensive outsourcing contract for plant maintenance?
4	Outsourcing risk	Are outsourcing plant maintenance result in over-dependence on outsourcers? How are outsourcing risks mitigated?
5	Outsourcing reason	Are the petrochemical companies outsourcing total plant maintenance for different reasons?
6	Training programme	How important is contractor training programme in view of a shortage of skilled workers in Singapore?
7	Outsourcing culture	Does the organization culture committed to outsourcing important to outsource total plant maintenance?

Source: Compiled from case study questions in Appendix 3.3

The first group of questions is on outsourcing service quality. The question is to find out the perception of the service quality and whether the service quality expectations are known to the outsourcer. In the literature review, it is found that corporate image of the outsourcer may relate to the service quality perception. The question in this

group is to find out whether corporate image is important in the outsourcing maintenance in the Singapore petrochemical companies.

The second group of questions is on the contractor worker experience level. Since the literature review found that there is a shortage of skilled workers in Singapore, there is a trend that contractors are using more construction workers and temporary workers in the maintenance of the plant equipment. The interview is to find how extensive is construction workers and temporary workers hired by the outsourcers in the petrochemical industry. Furthermore the interviewees are asked whether the outsourcer worker experience level meet their expectations and affect the decision to outsource total plant maintenance.

The third group of questions is on the outsourcing contracts. The literature review suggests that outsourcing contracts are important to the success of outsourcing. The contracts spelt out the customer expectations and they may help to reduce the risk of outsourcing failure. The interview is to find out whether similar contracts are commonly used in the outsourcing of plant maintenance in the petrochemical industry. What are the clauses in the contract that help in mitigating outsourcing failure?

The fourth group of questions is on the outsourcing risks. There are risks associate to outsourcing such as over-dependent of the outsourcers and the failure of the outsourcers to meet service expectations. Outsourcing risks are low in some companies because the activities are not considered mission critical and do not affect the production of the companies. The interview is to find out whether outsourcing risk is high and how do the petrochemical companies mitigate such risks. Are the outsourcing risks prevented many petrochemical companies to outsource total plant maintenance?

The fifth group of questions is on the reasons for outsourcing. The literature review suggests that many company do not outsource because these companies do not know what to outsource and afraid to outsource the wrong business activities. Since not many Singapore petrochemical companies outsourcing total plant maintenance, the interview is to find out whether this is a deciding factor.

The sixth group of questions is on the contractor worker training programme. The literature review suggests that service quality of the outsourcers may be important in

deciding outsourcing. Since there is a shortage of skilled workers in the Singapore workforce, the contractor training programme may be important to improve the worker skills. The interview is to find out whether the contractor training programme is used to decide outsourcing plant maintenance.

The last group of questions is on the organization culture towards outsourcing. The literature review (Corbett 1999) suggests that outsourcing may not be successful if there is no commitment towards outsourcing among the various level of management in the organization. Most of the petrochemical companies started operations with their own in-house maintenance crews. Some of the management staff may not be committed to the outsourcing activities. Therefore, the interview is to find out whether the organization commitment towards outsourcing is a factor to consider before outsourcing total plant maintenance.

3.6.3 Survey questionnaires

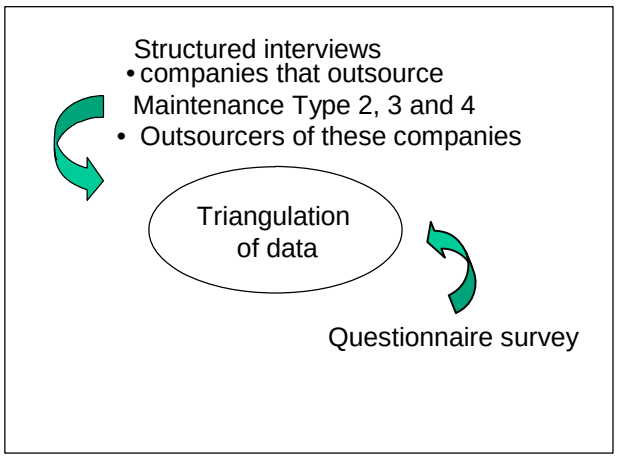
The objective of the survey research is to measure the expectations and perceptions of outsourcing plant maintenance. The Likert scale is used in the questionnaires because it is the most popular method to measure attitudes and easy to administer (Zikmund 1997). It gives the researcher a clearer understanding of the interviewee's feedback on the key issues in the interview. In this research the 7-point Likert scale is chosen to for two reasons. Firstly, it can provide more accurate comparisons between different respondents as compare to the 5-point scale that is commonly used. Secondly, the odd scale is to allow the respondents to choose the neutral answer (point 3) if they are not sure of the answers. Since different levels of management within the petrochemical and outsourcer organizations are involved in the survey, there is a possibility that some of the respondents may be not sure of the answers to some of the questions.

The interviewees are given the survey questionnaires as shown in Appendix 3.4. The expectations and perceptions of each of the questions are used to test the twelve

hypotheses explained in Chapter 1 and 2. These hypotheses are derived from Zeithaml's gap model on service quality and tabulated in Table 2-12.

3.7 Data collection

Some researchers posit that in qualitative research data may be collected from sources such as documentation, archival records, interviews, direct observation, participant observation, and physical artifacts (Yin 1994). These sources may not be available in all the cases (Stake 1995, Yin 1994) and may require different skills from the researchers to collect them (Tellis, 1997; Yin 1994). In this research, the case study research is heavily relied on structured interviews as suggest by many researchers (Yin 1994; Sekaran 1992). Although direct observation can provide additional information of the interviewees' behaviours and may be able to triangulate the interviewing data (Tellis 1997), it is not used because all the interviews are carried out in the offices. Similarly though documentation and archival records are very good source of information to complement the body of research data, it is not possible to obtain these sources of information. The interviewees do not want to show these documents and records which they consider confidential. Similarly, the researchers were not able to observe the outsourcers at work because the site policies require the researcher to go through the companies' safety tests. Figure 3.1 summarizes the different types of information that can be used in the research to triangulate the research data.



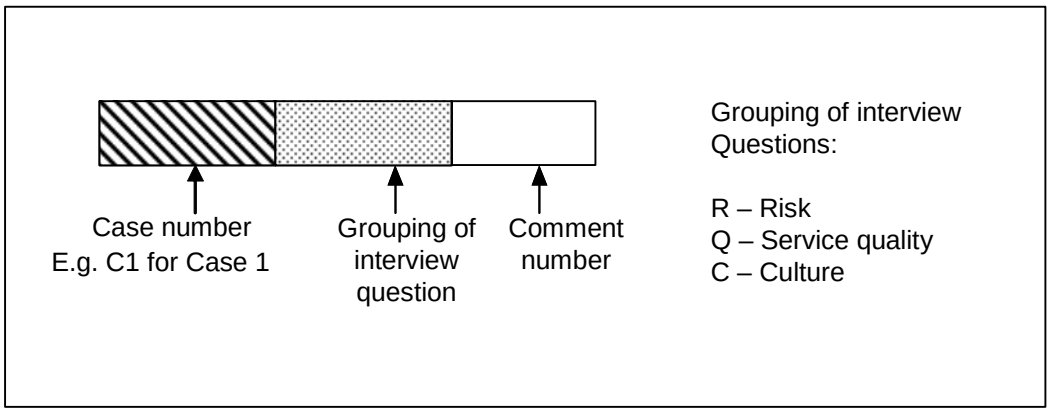
Source: Developed for this research

Figure 3.2 Research data triangulation

3.8 Data coding

Data coding is a process of assigning labels to words and phrases gathered in the interviewing process and to allow the researcher to differentiate and combine the interviewing data during the data analysis stage (Miles and Huberman 1994). The coding helps the interviewer to sort the interviewing data effectively according to a particular question or case (Neuman 1994, Pizam 1994) and enable the cases to be reviewed more easily (Yin 1994).

Data coding can be in the form of matrices or networks, and can be developed to analyze a single case or multiple cases. In this research, the coding method is shown in Figure 3.3. The first two characters indicate the case number. The third character indicates the grouping of the interview questions and the last character indicates the interviewing question number (refer to Appendix 4.1). For example, code C1R2 means the comment is from Case 1 and it is the second comment under the Risk group (refer to Figure 3.3). Data coding is used as a means of organizing and summarizing large amounts of information so the researcher can analyze it.



Source: Developed for this research

Figure 3.3: Research data coding configuration

3.9 Data analysis

An analytical strategy is required to analyze the research data and subsequently leads to the research conclusion (Tellis 1997). Three analytical techniques are considered in the case study data to ensure internal and external validity (Table 3.8), namely pattern matching, explanation-building, and time series analysis (Kanso, n.d., Yin 1994, Miles and Huberman 1984). The pattern-matching technique was used as the primary analysis technique. In this research analysis, the case study data from different interviewees are compared. Those answers to the interviewing questions that have similar patterns are used subsequently to triangulate with the respondents' answers from the survey questionnaires. This technique is one of the "most desirable" for case study analysis (Yin 1994) and would therefore strengthen the internal validity of the research (Trochim 1989).

Table 3.8 : Data analysis techniques

Yin 1994	Miles & Huberman 1984	Kanso n.d.
Pattern matching	Putting information into different arrays	Pattern matching
Explanation building	Making a matrix of categories and placing evidence within such categories	Explanation building
Time-series analysis	Creating data displays	Time-series analysis

Source: Yin, R.K. 1994; MB and Huberman 1994; Kanso n.d.

The time series technique is also used, to a lesser degree, to complement the pattern-matching technique. The research analysis will compare the period that the respondents' companies have been in operation and their maintenance types. This is to whether there is a correlation between types of plant maintenance outsourcing and the number of years the companies have been in operation. Similarly the time series technique also analyzes the correlation between outsourcing expectations and the ages of the companies.

The explanation-building technique is not considered in the data analysis of this research. The reason is this technique is very time consuming when analyzing multiple-case study because the technique is an iterative process of revising the theoretical positions based on the research data examined for every case (Yin 1994). It is more suitable for exploratory research where there is lesser research carried out in that area (Glaser, Strauss 1967, Kanso, n.d.).

The Likert scales give the researcher a clearer understanding of the interviewees' perceptions on the key issues in the interviews (Yin 1994). However, the Likert scales may introduce inaccuracy inadvertently because the scales used are not perfect and there can be error in measurement by the interviewees (Sekaran 1992). Firstly, the scale in the continuum assumed the interval between any two points was uniform. Secondly, interviewees might assume different level of importance on identical perceptions and expectations. Thirdly, the research assumes that the Likert scale of each question has similar weightage. However, using interval scale and statistical computation of means and standard deviations (e.g. ANOVA) of the responses on the variables in this research could reduce these inaccuracies. Statistical analysis

(ANOVA and average) are used to test the correlation of the perceptions and expectations of each company. This statistical analysis will provide theoretical replication of the research design (Carson, Girmore, Gronhaug and Perry 2000).

3.10 Case study reporting

The case study report is primarily intended to serve reportorial and not documentation objectives (Yin 1994). There is no ideal reporting style since the university academic staff, students and managers will read the report (Morris, Fitz-Gibbon and Freeman 1987). However, this report is using the linear-analytic structure of research problem, literature review, industry analysis, research method, data collection, data analysis, conclusion and research implications. Researchers commonly use this reporting style and the writing sequence would ensure completeness (Yin 1994).

Furthermore, the draft report was sent to peer and some respondents for review. This exercise is to confirm whether the evidence and facts are corroborated (Schatzman and Strauss 1973) and therefore, enhanced the accuracy of the report. However, the respondents only reviewed their own case to clarify the data.

3.11 Conclusion

The case protocol is a road map to carry out the whole research to ensure the case study is conducted with rigor and managed smoothly (Yin 1994). Firstly, it provides the research background and reminds the interviewer of the research issues. Secondly, it forces the researcher to examine each stage of the protocol for

weaknesses and identify solutions to mitigate the problems before the actual field work is conducted. Thirdly, it helps the interviewer to focus on the various stages of the research process during the field process in order to ensure the 'completeness' of the research.

The qualitative research method (multiple-case study) is chosen because it provides the methodological guidance to enable comparisons and generalizations across social settings and provide a critical perspective to the research. The quantitative research (questionnaire survey) is also used to triangulate the data collected in the interviews to provide validity and reliability in the research results.

The researcher had paid particular attention on the field interview technique to ensure that the interviewees are cooperative and the survey data were as accurate and unbiased as possible. Note taking instead of tape recording was used in most of the interviews because the interviewees felt uncomfortable when their comments were recorded. The researcher also designed a coding system to categorize all the research data collected so that the data could be easily used in the research analysis.

CHAPTER 4
DATA ANALYSIS

This chapter examines and analyses the research data obtained from the research case study and survey conducted. The analyses are to find the critical deciding factors for outsourcing total plant maintenance in the Singapore petrochemical industry. The triangulation of the data from the case study and survey will provide validity and reliability of the finding. Furthermore, the data analyses also include the perceptions and expectations of the different levels of management of the customers and outsourcers in order to provide a critical perspective of the research finding.

4.1 Introduction

The objective of this chapter is to examine and analyze the data obtained from the research case study and survey conducted. The data analysis in this chapter is divided into two parts. The first part is to analyze the data from the research case study. The analysis is to identify the core patterns of each of the seven deciding factors identified in the literature review. The second section of this chapter is to analyze the data from the research survey on the perceptions and expectations of the customers and outsourcers based on the research methodology expounded by Al-Hakim and Xu (2003). The analysis is to use statistical models from SPSS software programme. There are three objectives to carry out these two data analyses. Firstly, it is to identify the critical factors in deciding outsourcing plant maintenance in the Singapore petrochemical industry. Secondly, the analyses identify the factors that influence

these critical deciding factors. Thirdly, how the deciding factors help the outsourcers to win outsourcing contracts.

4.2 Case study data analysis

Table 4.1 Case study samples

Case	Age	Maintenance Type	Senior Manager	Middle Manager
C1	9	3	1	1
C2	10	2	1	1
C3	15	2	1	1
C4	37	2	1	1
C5	5	4	1	1
C6	35	2	1	1
C7	4	3	1	1
C8	30	3	1	1
			8	8

Note:
Maintenance Type 1: Maintenance is done by in-house staff
2: Maintenance is partially outsourced
3: Maintenance are mostly outsourced but managed/supervised by in-house staff
4: Maintenance is totally outsourced. No in-house staff to manage maintenance.

The case study is to identify the critical factors that the Singapore petrochemical industry uses to decide on outsourcing total plant maintenance. The questions that were asked in the interviews are targeted at the seven outsourcing factors that are identified in the literature review that are applicable to outsourcing decisions. The case study data to be analyzed are based on the interviews conducted on eight cases in the petrochemical industry. The selections of the eight companies are based on different levels of plant maintenance outsourcing from Type 2 to Types 4 as shown in Table 4.1. The senior and middle managements are interviewed in each case in order to provide a critical perspective to the research. The outsourcers are not interviewed

in the case study as the research is primarily examining the decision-making process by the petrochemical companies.

The case study interview data given in Appendix 4.1 are coded by using the data coding system explained in Chapter 3. The coding is used to tabulate the main points in the case study that relate to the seven outsourcing deciding factors. The interviewing main points in Table 4.2 will facilitate the data analysis carried out in this section of the chapter.

Table 4.2 Summary of interviewing data

	Respondents' Comments	Data Coding
1	The main reason to outsource plant maintenance is to reduce operating costs	C1S1, C2S2, C3S1, C4S1, C5S3, C6S1, C7S1, C8S1
2	Local management under pressure to outsource maintenance to reduce operating costs	C3S3, C6S1, C8S1
3	Cost saving from outsourcing may not be very substantial since the organization is still employing own maintenance crew	C3S4, C4S2, C6S2
4	Retrenching in-house crew in favour of outsourcing may not be cost effective alternative	C3S4
5	Outsource plant maintenance gradually as and when the maintenance staff resigned or retired	C4S2
6	The number of employees is used to gauge a company productivity	C3S3
7	The decision to outsource is to follow the parent company's practice in outsourcing plant maintenance and therefore have no problem convincing the parent company to outsource.	C1S1, C5S1, C1S3
8	There is cost saving (in outsourcing) since the company does not need to hire maintenance crew and therefore does not need to spent time in recruiting and training maintenance crew.	C1S2, C5S2
9	Companies (more than 10 year-old) do outsource partial plant maintenance	C2S2, C3S4, C4S2, C6S1, C7S1
10	Company prefer to hire outsourcers that have worked with the company in the past	C2Q8, C3Q9, C4Q12, C5Q8, C6Q8, C8Q7
11	Outsourcers do not have good skill-training programmes for their workers.	C1Q12
12	Wrong maintenance methods can affect plant reliability and equipment repair can be high	C2R10, C3R9, C6R7
13	Temporary workers who are hired by the outsourcers are generally not as committed and motivated as full-time employees.	C2Q10, C3Q12, C4Q17
14	Temporary workers have high turnover and result in skill loss and affect service quality	C3Q12
15	Outsourcers hire workers that are involved in the plant construction because they are more familiar with the plant	C1Q10, C4Q15

	Respondents' Comments	Data Coding
16	Company accept the fact that there is a shortage of qualified maintenance workers	C1Q9, C6Q9, C8Q10
17	Senior management feels that outsourcer service quality meet its expectations. The middle management feels otherwise.	C2Q5, C3Q2, C4Q1, C5Q1
18	Top management's expectations are based on maintenance costs and plant reliability	C3Q6, C5Q5
19	Middle management do not think service quality meet expectations because they have to spend much effort to supervise the outsourcers' work	C3Q3
20	Middle management is comparing the outsourcers with its in-house crew who is very experienced	C4Q2, C6Q5
21	Companies that have outsource total plant maintenance seem to have more commitment among the different management levels	C1C1, C5C2, C7C4
22	Senior management in companies that outsource partial maintenance seem to be more committed than the middle management	C2C4, C3C3, C6C5
23	Reluctance to outsource plant maintenance due to potential high risk of failures	C2R12, C3R11, C4R16, C6R9
24	Plant maintenance failures can result in substantial production loss and fire	C1R12, C2R11, C4R10, C6R7, C7R7, C8R8
25	Outsource plant maintenance to two outsourcers to mitigate risk of failure	C8R9
26	Reduce risk by hiring maintenance personnel to oversee outsourcer's work	C1R14, C5R12

Source: Summarized from Appendix 4.1

Service quality

The first factor to examine is the outsourcing service quality with the main attributes tabulated in Table 4.3. It is to identify the perceived service quality level which reflects the level of satisfaction in the outsourcing decision (Zeithaml et. al. 1990). All the interviewees agreed that service quality is a critical factor in deciding outsourcing total plant maintenance. This finding is consistent with a survey conducted in 2002 that indicates service level ranked nearly as high as cost (Avery 2002). The common reason is plant maintenance failure could result in substantial production loss and fire (Cases C1, C2, C4, C6 and C7). Half the respondents feel that service perceptions are generally lower than expectations. One reason is there is a difference between the service quality expectations between the top and middle managers (Cases C2, C3 and C4). Some top management expectations are based on maintenance costs and plant reliability, whereas, the middle manager expectations are

based on the outsourcer experiences (Cases C3 and C5). There is a tendency that some middle managers compared the outsourcer workers with their in-house maintenance crews that have been working in the same companies for more than ten years. The differences in perceptions could be because service quality is difficult to measure in an industrial context (Haas 1989). Although there is no pattern found in the survey to relate the service perceptions with the ages of the companies, most of the cases that outsource Types 3 and 4 maintenance think that the service perceptions have met their expectations (Cases C1, C5 and C8). Case C5 clarifies by saying that *"The outsourcer does not need to compare with workers working for a few decades in the same organizations like some older plants."* The finding, therefore, suggests that petrochemical companies that realistic with their service expectations may outsource more or total plant maintenance.

Table 4.3 Case study analysis: Service quality

Attributes	C1	C2	C3	C4	C5	C6	C7	C8
Service quality is important for outsourcing total plant maintenance	X	X	X	X	X	X	X	X
Service quality perception is lower than expectation	O	X	O	X	O	X	X	O
Senior and middle management have different service quality perceptions	O	X	X	X	O	O	O	O
Outsourcer's past experience with the customer more important than reputation	X	X	X	O	X	O	O	X

Legend: 'X' = Agree; 'O' = Disagree
Source: Compiled from Research Case Study

In the literature review, some academics suggest that good corporate image of the outsourcer is perceived to provide high level of service (Gronroos 1991; Lehtinen and Lehtinen 1991). In Table 4.3, it is interesting to note that most of the respondents outsource their plant maintenance to outsourcers that have worked with them in the past. This finding suggests these outsourcers may stand a better chance to compete with the international large outsourcers who are new to the Singapore petrochemical companies. Therefore, contractors who are interested in outsourcing work should

consider to do contract work with the petrochemical companies in order to establish their reputations.

Contractor worker experience

Table 4.4 Case study analysis: Contractor worker experience

Attributes	C1	C2	C3	C4	C5	C6	C7	C8
Contractor worker experience is important for outsourcing total plant maintenance	X	X	X	X	X	X	O	O
Construction workers do not meet expectations	O	X	O	O	O	O	O	O
Temporary workers do not meet expectations	X	X	O	X	X	O	X	X
Construction and/or temporary workers are hired	X	O	X	X	X	O	X	X

Legend: 'X' = Agree; 'O' = Disagree
Source: Compiled from Research Case Study

The interviewees' responds on the contractor worker experience is summarized in Table 4.4. The selection of the *'right'* outsourcing contractors is a critical factor for successful outsourcing (Hickerson 1999; Corbett 1999). Most of the respondents agree that the contractor worker experience is an important deciding factor. Some respondents say that there is a shortage of skilled workers among the outsourcers (Cases C2, C5 and C6) which is consistent with the observation by Williamson (2000) in the outsourcing industry. The majority of the respondents agree that the construction workers meet their expectations. In fact, some respondents intentionally outsource the maintenance activities to these construction workers who had involved in their plant construction and familiar with the plants (Cases C1, C4, C6 and C7). These construction workers are supplementing the maintenance workers (Finchem 1997). On the other hand, most of the respondents feel that temporary workers are less committed and do not meet their expectations.

In summary, the finding in this case study suggests that contractor experience is an important factor in deciding outsourcing total plant maintenance. This factor may not be so important if only part of the maintenance activities is outsourced. The

outsourcers may not have sufficient skilled maintenance workers to handle total maintenance activities. Their workforces have to be supplemented by workers who have construction skills and temporary workers. Although some of the temporary workers are good, they are not as committed as the full-time employees.

Outsourcing contracts

Table 4.5 Case study analysis: Outsourcing contracts

Attributes	C1	C2	C3	C4	C5	C6	C7	C8
Outsourcing contract is important to the success of maintenance outsourcing	X	X	X	X	X	O	O	X
Most outsourcing contracts are quite similar to "work package contracts"	X	X	X	X	X	X	X	X
Difficulties in drafting comprehensive outsourcing contracts with performance indicators	X	X	O	O	X	X	O	O
Existing outsourcing contract duration (years)	3	2	1	2	2	1	3	3

Legend: 'X' = Agree; 'O' = Disagree
Source: Compiled from Research Case Study

The third deciding factor that is examined is on the outsourcing contracts in Table 4.5. A well written contract will lead to a successful and long-term commitment by the outsourcers (Doherty 2002; Bendor-Samuel 1999). Most of the respondents agree that comprehensive outsourcing contracts with performance indicators are important to ensure that the outsourcers meet their expectations. It is because maintenance saving and other benefits from outsourcing are realized if the contracts are performance focused (Tsang 2002). However, some do not think the ability to draft comprehensive contracts is critical to the outsourcing decisions (Cases C3, C7 and C8). Some respondents only consider comprehensive outsourcing contracts if they are outsourcing total plant maintenance because the contract price could be higher if more requirements are included in the contracts (Cases C3 and C4). The research data shows that all the outsourcing contracts are similar to the '*work package contracts'*. These contracts have minimum performance indicators to define the

service quality expectations. There are two common reasons that the contracts do not include performance indicators. The first reason is the companies do not have the resources and time to draft these *'performance contracts'* (Cases C3, C5, C6 and C7). Another reason is there is a lack of maintenance records to decide the performance indicators to include in the contracts (Cases C2, C3, C6 and C7). This finding is consistent with Dean and Kiu (2002) who observe that performance indicators are difficult to identify if the service expectations are not clear. Table 4.4 also shows that the contract duration is between one to three years. The reason of this short contract duration is to enable the petrochemical companies to terminate the contracts if the outsourcers are not able to perform (Cases C1, C2, C3, C4 and C7). It also minimizes the risk of over-dependence on the outsourcers. Conversely, the short contract duration may discourage the outsourcers to invest in equipment and resources in the outsourcing activities (Cases C1, C4 and C5).

In summary, most of the companies do not have comprehensive outsourcing contracts. The common reason is they have the difficulties to decide the performance indicators to include in the contracts. Although outsourcing contract is important to mitigate outsourcing failure, it is not a critical factor because most of the contracts are at most only three year duration. Moreover, there is a termination clause in the contracts that allow the petrochemical companies to terminate the contracts on poor performance.

Outsourcing risks

Table 4.6 Case study analysis: Outsourcing risks

Attributes	C1	C2	C3	C4	C5	C6	C7	C8
Outsourcing risk is a critical factor to consider for outsourcing total plant maintenance	X	X	X	X	X	X	X	X
Risk of production loss due to outsourcing failure is important	X	X	O	O	X	X	O	O
Risk of over-dependence on outsourcer is considered	O	X	X	O	O	O	X	X
Keeping 'skeleton crew' to mitigate outsourcing risks	O	X	X	X	O	X	X	O

Legend: 'X' = Agree; 'O' = Disagree

Source: Compiled from Research Case Study

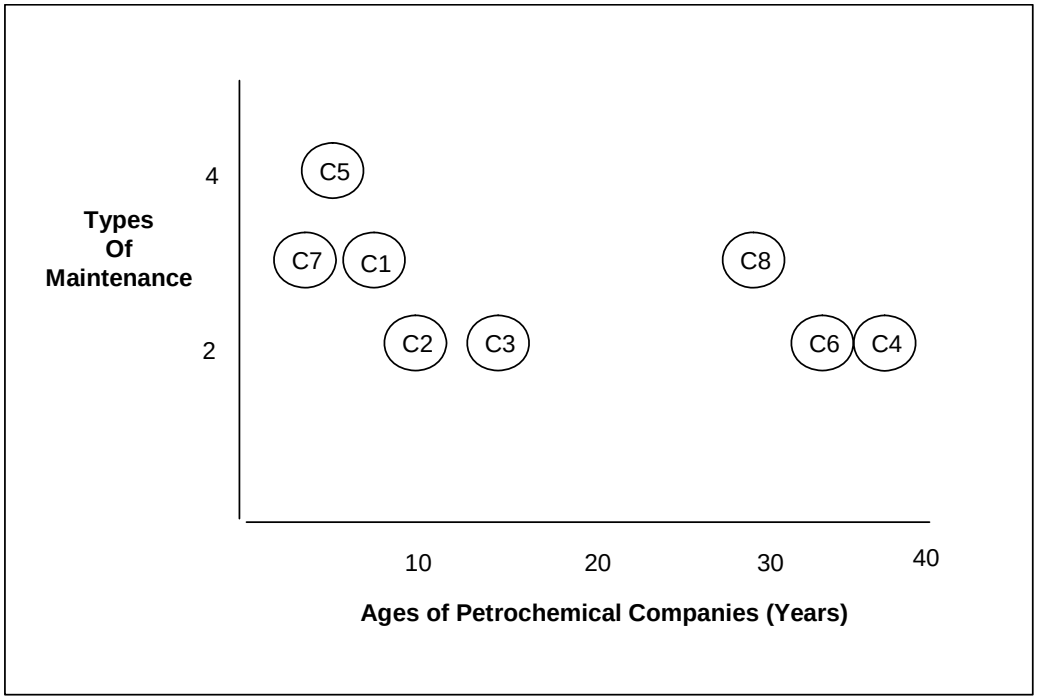
The responses on the outsourcing risk factor are tabulated in Table 4.6. The outsourcing risk factor in deciding outsourcing total plant maintenance is considered critical by all the respondents. Although all the respondents cited production losses as the risk, half of them felt that safety and fire are the higher risks that could result in outsourcing failure. Case C6 said, *"Failure of plant equipment can result in an unsafe situation besides production loss."* The risk of outsourcing is one reason that many companies are slow in outsourcing more maintenance activities (Case C2, C3, C4 and C6). In the literature review, one of the risks of outsourcing is the over-dependence on the outsourcers for critical functions (Downey 1995). However, half the respondents do not consider this as higher risk because either they are having 'skeleton' maintenance crews (McMillan 1990), or mitigating the risk with short-term contracts of not more than 3 years duration. The risks of the loss of critical maintenance skills within the organizations because of outsourcing (Quinn and Hilmer 1994; Campbell 1995) are considered not high because maintenance is considered as non-core business. In summary, the outsourcing risk is a critical deciding factor because it affects production and safety of the plant if the outsourcer cannot perform to expectations.

Outsourcing reasons

The primary reason to outsource plant maintenance is to reduce operating or maintenance costs in all the eight cases. Some of the respondents admitted that they were pressurized to outsource to reduce costs because of strong competition (Case C6) and poor profit margins (Case C3). Other companies (C1 and C5) outsource plant maintenance because of their company-wide policy. The 'promised' cost saving from outsourcing may be easier to realize for companies that have not employed maintenance crews (Case C1, C5, C7 and C8). These companies also save the time and resources to recruit and train the new maintenance crews. On the other hand, those companies that have employed in-house maintenance crews may realize much cost saving, at least initially, if they outsource their plant maintenance. They may have a difficult and expensive task to relocate the in-house maintenance workers (Case C3, C4 and C6). That could be the reason that some respondents are suggesting to gradually outsource more plant maintenance activities (Case C4).

The research analysis would be more convincing if there are maintenance costs from each of the cases to prove the maintenance cost reduction from outsourcing. However, the researcher is not able to obtain these maintenance cost reduction from the respondents. The respondents agree that plant maintenance is not their core businesses. Therefore, it seems that the Singapore petrochemical companies dispel the observation by Bendor-Samuel (1999) that most companies fail to thoroughly understand what is being outsourced.

In this case study, four out of five companies that are more than ten year-old are practising Type 2 maintenance (Figure 4.1). That is, only some of the maintenance activities are outsourced by these companies and the major maintenance activities are handled by their in-house crews. Three of these companies (C3, C4 and C6) gave the reason that the maintenance cost reductions through outsourcing effort were limited because they are still keeping the in-house maintenance crews. Case C6 summed up the sentiment by saying, "*The cost reduction from outsourcing may not be very high because the company has its own maintenance crew*."



Source: Compiled from research interviews

Figure 4.1 Maintenance types versus company ages

It is also interesting to observe that Figure 4.1 shows that most of the companies that are less than ten year-old have adopted Type 3 or Type 4 maintenance. These companies had decided to outsource either all or most of their maintenance activities during the plant construction stage. These companies either hire 'skeleton' in-house maintenance crews (Cases C1 and C7) or did not hire any maintenance staff at all (Case C5). Case C8 is the only exception to the observed outsourcing trend because it had changed its maintenance strategy from Type 2 to Type 3 in early 2000 in response to the poor product profit margins. One of the main differences between Case C8 and the other cases is C8 is a joint-ventured company with partners from different countries. The observation from the case study seems to suggest that joint-ventured companies may be more interested to reduce operating costs at the expense of the employees as compared to multi-national petrochemical companies. However, this research objective is not to prove whether this observation is correct.

The data analysis concludes that the reason to outsource plant maintenance is a deciding factor. All the respondents feel that plant maintenance is not their core

business and the reason to outsource is to reduce maintenance costs. This is in agreement with Quinn and Hilmer (1994) who observe that maintenance work can be done cheaper and more efficiently by the service provider than in-house. However, companies that are greater than ten year-old may not realize the full benefits because they are retaining the in-house maintenance crews. Conversely, companies that are new are more likely to outsource total plant maintenance.

Contractor worker training programmes

Table 4.7 Case study analysis: Contractor worker training programmes

Attributes	C1	C2	C3	C4	C5	C6	C7	C8
Contractor worker training programme is a factor to consider in outsourcing plant maintenance.	O	O	X	X	O	X	O	O
Training programmes are a reflection of the outsourcers' commitments toward outsourcing activities.	X	X	O	X	O	X	X	O

Legend: 'X' = Agree; 'O' = Disagree

Source: Compiled from research case study

The responds to the contractor worker training programmes are tabulated in Table 4.7. Most of the respondents do not think the contractor worker training programmes, though important, is a critical factor to decide outsourcing plant maintenance. Some respondents felt that *"plant equipment is getting more complicated and difficult to maintenance and therefore require more skilled workers"* (Case C2). In the literature review, one of the researchers observes that the lack of training not only result in unreliable plant operation, the customers may be legally liable if the plants are unsafe due to poorly maintained equipment (Roughton 1995). In the petrochemical industry, poor equipment reliability can lead to productivity loss and fire (Case C1, C2, C4, C6 and C7). There is only one respondent (Case C8) mentioned about the legal implication if the workers are unskilled. Some said the training programmes are important because the workers are in the construction sections and not familiar with

maintenance activities (Cases C1 and C5). The repair cost of wrongly maintained equipment can be high (Case C2, C3, C5 and C6). Many respondents said the training programme is an indication on the commitments of the outsourcers toward the outsourcing activities. Therefore, though the contractor worker training programmes are not critical to the decision to outsource total plant maintenance, it may influence the service quality of the outsourcing.

Outsourcing culture

Table 4.8 Case study analysis: Outsourcing culture

Attributes	C1	C2	C3	C4	C5	C6	C7	C8
Outsourcing culture is a critical factor to consider for outsourcing total plant maintenance	O	O	O	O	O	X	O	X
Senior management is committed to outsourcing	X	X	X	X	X	X	X	X
Middle/lower management is committed to outsourcing	X	O	O	X	X	O	X	X
Current outsourcing level is high	X	O	O	O	X	O	X	X

Legend: 'X' = Agree; 'O' = Disagree

Source: Compiled from Research Case Study

The responds to the outsourcing culture factor is tabulated in Table 4.8. Although the wrong organization culture can lead to outsourcing failure (Corbett 1999), the majority of the respondents do not think that this factor is critical in deciding outsourcing. Perhaps one reason is the senior managements in all the companies are committed to outsourcing if the companies are prepared to outsource plant maintenance. On the other hand, there are indications that some middle managers in the older companies are not as committed to outsourcing as the senior management. The reason is these managers do not think that the outsourcer workers are better than the in-house maintenance crews (Cases C2, C3 and C6). One interesting finding is in all the companies that have high level of outsourcing, the middle managements are also committed to outsourcing. Maybe the middle managers have no choices when the in-house maintenance crews are either reduced or relocated.

In summary, the senior managements are committed once they decide to outsource total plant maintenance. The middle managements will tend to be committed to outsourcing when the in-house maintenance crews are relocated and the managers cannot rely on the maintenance crews. Therefore, though outsourcing culture is important in order that outsourcing is successful (Corbett 1999), it is not a critical factor in deciding outsourcing total plant maintenance in the Singapore petrochemical industry because the senior managements are committed to outsourcing.

4.3 Case study conclusion

The research case study analysis identifies two critical deciding factors, namely, service quality and outsourcing risks. Critical deciding factor is defined as the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization (Rockart 1979). All the plant maintenance is outsourced to contractors that have worked with the petrochemical companies in the past. The petrochemical companies do not rely on the corporate image of outsourcers that they had no experience with. Some of the respondents may have unrealistic service quality expectations by comparing the outsourcer worker experience with their in-house maintenance crews that have been working for more then a decade with the companies. The outsourcing risks are mainly from the potential failure of the outsourcers in maintaining the plant which can result in unsafe conditions and fire. Some companies keep 'skeleton' maintenance crews in order to mitigate the situation. That is the main reason that the respondents gradually outsourcing more plant maintenance. Loss of critical maintenance skills is not considered important among the respondents as maintenance is not considered the companies' core businesses.

There is a common reason among all the cases to outsource plant maintenance, that is, to reduce maintenance costs. The study shows that companies that outsource major (Type 3) or total (Type 4) plant maintenance are companies that are less than ten year-

old. These companies either do not have or having 'skeleton' in-house maintenance crews. Conversely, those companies that are more than ten year-old (except Case 8) only outsource partial plant maintenance. These companies do not see a high cost reduction from outsourcing since they are having in-house maintenance crews. It is also costly to relocate the in-house maintenance crews.

Contractor experience is important to the outsourcing service quality. Many companies are using workers that had been involved in the plant construction to maintain the plants because these workers are more familiar with the plants. The temporary workers that are hired by the outsourcers to supplement their workforce are thought to be less committed than employees. The contractor worker training programme is a factor to consider because incorrect equipment maintenance can be costly to repair. It is also an indication on the outsourcer long-term commitment towards the outsourcing contracts.

Outsourcing culture is not an important factor in the petrochemical industry. All the companies that outsource have full senior management commitment. However, in some cases, the middle or lower management are less committed. The interesting finding is the higher the level of outsourcing within the company, the middle management is more committed towards outsourcing.

The case study analysis has identified the two critical factors that decide total plant maintenance outsourcing in the Singapore petrochemical company. The next step is to carry out a quantitative analysis of the survey data. The objective is to validate the same seven deciding factors that are analyzed in the case study analysis earlier in this section.

4.4 Survey data analysis

In this section the twelve hypotheses (explained in Chapter 1) are tested by analyzing the research survey data. The breakdown on the 56 interviewees that participated in the research survey is shown in Table 4.9. In order to provide a critical perspective to

the research, different levels of employees in the petrochemical and outsourcer organizations participated in the survey. However, the technicians in the outsourcers' organizations were not included in the survey because many of them are temporary workers and not very well informed of the companies' activities. The researcher felt that including them could distort the research data.

Table 4.9 Research survey samples

Case	Position	Manager	Supervisors	Technicians
C1	Customer	1	2	2
C2	Customer	1	2	2
C3	Customer	1	2	2
C4	Customer	1	2	3
C5	Customer	1	2	
C6	Customer	1	3	2
C7	Customer	1	2	2
C8	Customer	1	2	2
O1	Outsourcer	1	1	
O2	Outsourcer	1	1	
O3	Outsourcer	1	1	
O4	Outsourcer	1	1	
O5	Outsourcer	1	1	
O6	Outsourcer	1	1	
O7	Outsourcer	1	1	
O8	Outsourcer	1	1	
		16	25	15

Note: Contractor technicians were not interviewed because they were generally uninformed. This is to prevent distortion of the research data.

The results of the questionnaire survey are tabulated in Tables 4.10 and 4.11. These appendices give the mean values of the perceptions and expectations of each of the companies. In this section, statistical models are used to test the seven deciding factors that are imbedded in the twelve hypotheses mentioned in Chapter 1. The hypotheses are based on the modified Zeithaml's gap model.

Table 4.10

Research survey: Customer perceptions and expectations

Survey Questionnaires	Customer Perceptions									Customer Expectations								
	C1	C2	C3	C4	C5	C6	C7	C8	Avg	C1	C2	C3	C4	C5	C6	C7	C8	Avg
Satisfaction level of outsourcing	5	3	5	4.00	6	3.00	4.5	4.5	**4.38**	6	4	6	6.67	5.2	4.83	6	5.5	**5.53**
Importance of outsourcer corporate image	6	4.3	5.5	5.5	6	5	5.5	5	**5.35**	6	5	5	5	5.5	7	7	6	**5.81**
Outsourcer workers experience level	3.2	3	3	4.50	5.5	2.83	5	4.8	**3.98**	5	3.8	5	6.30	5	4.50	6	6	**5.20**
Training program for contractor workers	4.00	3.5	3	4.00	4.5	2.83	5	3	**3.73**	5.2	4	6	5.50	3	5.00	6	5.2	**4.99**
Expectations are clearly defined in the outsourcing contracts	4.00	3.5	4	4	5	3	5	4	**4.06**	6	4	6	6	3	6	7	6	**5.5**
Level of outsourcing risk	4.00	3	3	3.00	6	3.00	5	5	**4.00**	6	3.6	3	4.00	4	4.33	6.5	6	**4.68**
Outsourcing level	6.00	3.4	5	3.50	7	3.00	6	5.6	**4.94**	6.3	3.8	4	5.00	7	4.83	6.5	6.4	**5.48**
Outsourcing reduces maintenance costs	5.00	5.3	5	5.50	6	4.50	5.8	6	**5.39**	6.5	5	5.5	5.00	5	5.00	6	6	**5.50**
Company senior management commitment to outsourcing	6.8	6	5	5.67	7	4.50	6.8	6.5	**6.03**	6.8	6.5	6	6.00	6	6.33	7	6.7	**6.42**
Company middle management commitment to outsourcing	6	5	6	5.33	7	3.30	6.4	5.6	**5.58**	6.2	5.3	6	5.50	5.5	5.33	7	6.2	**5.88**
	5.00	**4.00**	**4.45**	**4.50**	**6.00**	**3.50**	**5.50**	**5.00**	**4.74**	**6.00**	**4.50**	**5.25**	**5.50**	**4.92**	**5.32**	**6.50**	**6.00**	**5.50**

Rating system: 1 = Lowest importance; 7 = Highest importance

Table 4.11

Research survey: Outsourcer perceptions and expectations

Survey Questionnaires	Outsourcer Perceptions									Outsourcer Expectations								
	O1	**O2**	**O3**	**O4**	**O5**	**O6**	**O7**	**O8**	**Avg**	**O1**	**O2**	**O3**	**O4**	**O5**	**O6**	**O7**	**O8**	**Avg**
Satisfaction level of outsourcing	5.5	3.5	5.5	5.00	6	4.00	5.5	6	**5.13**	5	4	3.5	6.00	5.5	3.50	5.5	5.5	**4.81**
Importance of outsourcer corporate image	6	5	6	6	6	6	6	6	**6**	6	5.5	7	6	6	7	6	6	**6.75**
Outsourcer workers experience level	5	3	3	5.00	5	4.50	5.5	5	**4.50**	5	3	5.5	5.50	5	4.50	5	5	**4.81**
Training program for contractor workers	3	3	3	5.00	3	3.70	4	4.5	**3.65**	4	4	5.5	5.00	3	4.50	4	4.5	**4.31**
Expectations are clearly defined in the outsourcing contracts	3	4	3	4	4.4	3	4	4	**3.68**	4	4	5	4.00	4.4	5.00	5	6	**4.68**
Level of outsourcing risk	5	5	3.5	4.50	5	3.50	5.5	5	**4.63**	5.5	4.5	3.5	5.00	5	3.00	6	5.5	**4.75**
Outsourcing level	5	3.5	5	7.00	7	4.50	6	6	**5.50**	6	4.5	4.5	5.00	7	5.50	6	6	**5.56**
Outsourcing reduces maintenance costs	5	5	5	6	6	4.5	6	5.5	**5.38**	6	5	5	4.5	5.5	4	6	5.5	**5.1875**
Company senior management commitment to outsourcing	6.5	7	6	6.50	6	6.00	6.5	6.5	**6.38**	7	6	6.5	7.00	6	6.50	7	7	**6.63**
Company middle management commitment to outsourcing	6	6	6	6.00	6	5.30	6	6.5	**5.98**	6.5	5.5	6.5	7.00	5.5	7.00	6.5	7	**6.44**
	5.00	4.50	4.60	5.50	5.44	4.50	5.50	5.50	**5.08**	5.50	4.60	5.25	5.50	5.29	5.05	5.70	5.80	**5.34**

Rating system: 1 = Lowest importance; 7 = Highest importance

4.4.1 Hypothesis testing: Introduction

In the earlier section of this chapter, the research case study analysis has examined the seven factors that decide plant maintenance outsourcing. The conclusion is though the seven deciding factors are applicable in the outsourcing of plant maintenance, there are two critical factors. This section is to test the twelve hypotheses (expounded in Chapter 1) that may influence the decisions to outsource total plant maintenance in the petrochemical industry. The expectations and perceptions are again based on the same seven deciding factors built into the research survey questionnaires. The research survey is carried out on different level of management within the customer and outsourcer organizations. The objective is to provide a critical perspective in identifying the critical factors in deciding outsourcing total plant maintenance. The use of this quantitative analysis together with the qualitative analysis in Section 4.2 also allows the researcher to triangulate the research data and thus result in a more rigor research finding.

In the literature review, the researcher argues that the probable reasons that many petrochemical companies do not outsource total plant maintenance (Type 4 maintenance) may be related to the service gaps suggest by Zeithaml's Gap Model (Zeithaml et al 1996). The hypothesis testing is carried out in two parts. The first part is to test the seven deciding factors based on survey data from the respondents from the companies that did not outsource total plant maintenance (Table 4.12). The hypotheses (H1 to H6) will be tested based on the expectation and perception relationships shown in Table 4.13. The second part of the hypothesis test (H7 to H12) is to repeat the analysis by using the survey data from the respondents from the company that outsource total plant maintenance (Table 4.21). The objective of the two tests is again to assist the researcher to triangulating the analysis results. Another objective of the hypothesis testing is to examine whether the modified Zeithaml's gap model is applicable to help the outsourcers to win plant maintenance outsourcing contracts by understanding their strengths and weaknesses.

Hypothesis H1 suggests that a company is less likely to outsource total plant maintenance if the customer expectation is higher than the outsourcer perception. Hypothesis H7 validates H1 by suggesting that a company is more likely to outsource

total plant maintenance if outsourcer perception is higher than customer expectation. Hypothesis H2 suggests that a company is less likely to outsource total plant maintenance if the outsourcer expectation is higher than its perception. Hypothesis H8 validates H2 by suggesting that a company is more likely to outsource total plant maintenance if the outsourcer perception is higher than its expectation. Hypothesis H3 suggests that a company is less likely to outsource total plant maintenance if the outsourcer expectation is higher than the customer perception. Hypothesis H9 validates H3 by suggesting that a company is more likely to outsource total plant maintenance if the customer perception is higher than the outsourcer expectation. Hypothesis H4 suggests that a company is less likely to outsource total plant maintenance if the customer expectation is higher than the outsourcer expectation. Hypothesis H10 validates H4 by suggesting that a company is more likely to outsource total plant maintenance if the outsourcer expectation is higher than the customer expectation. Hypothesis H5 suggests that a company is less likely to outsource total plant maintenance if the customer expectation is higher than its perception. Hypothesis H11 validates H5 by suggesting that a company is more likely to outsource total plant maintenance if the customer perception is higher than its expectation. Hypothesis H6 suggests that a company is less likely to outsource total plant maintenance if the outsourcer perception is higher than the customer perception. Hypothesis H12 validates H6 by suggesting that a company is more likely to outsource total plant maintenance if the customer perception is higher than the outsourcer perception.

4.4.2 Hypothesis testing: Partial outsourcing

This section is to test the twelve hypotheses identified in the literature review. The hypotheses are based on the seven factors that are identified to be used in deciding outsourcing plant maintenance. The research survey data tabulated in Table 4.12 are from respondents in companies that did not outsource total plant maintenance. The table gives the mean values of the perceptions and expectations of the outsourcing

factors. The research survey methodology is based on the methodology expound by Al-Hakim and Xu (2003).

Table 4.12 Survey data: Outsource partial plant maintenance

	Customers		Outsourcers	
Companies	**Perceptions**	**Expectations**	**Perceptions**	**Expectations**
1	5	6	5	5.5
2	4	4.5	4.5	4.6
3	4.45	5.25	4.6	5.25
4	4.5	5.5	5.5	5.5
5	6	4.92	5.44	5.29
6	3.5	5.32	4.5	5.05
7	5.5	6.5	5.5	5.7
8	5	6	5.5	5.8

Source: Data are compiled from Tables 4.10 and 4.11

In the literature review, the modified Zeithaml's gap model in Figure 4.2 (at the end of this chapter) is used to develop the twelve hypotheses that will be tested in this section. The hypotheses are related to the expectations and perceptions from the petrochemical and outsourcer organizations shown in Table 4.13. The SPSS statistical software is used to carry out the hypothesis testing.

Table 4.13 Hypothesis-expectation-perception matrix: Partial outsourcing

	CE	CP	OE	OP
CE	X	H5	H4	H1
CP	H5	X	H3	H6
OE	H4	H3	X	H2
OP	H1	H6	H2	X

Note: H1 to H6 represent the hypotheses to be tested
Source: Compiled for this research

Hypothesis 1

The Zeithaml's Gap Model suggests that there is a service gap if the customer service expectation is lower than the service provider perceived service (Gap 1). In this research, the customer may not want to outsource total plant maintenance if the outsourcer perception (OP) of the service quality is lower than the customer expectation (CE). Therefore, this hypothesis is to test whether the petrochemical companies are less likely to outsource total plant maintenance if outsourcers' perceptions are lower than the petrochemical companies' expectations.

Hypothesis $H1_o$: CE = OP (Petrochemical companies more likely to outsource total plant maintenance)

Hypothesis $H1_a$: CE > OP (Petrochemical companies are less likely to outsource total plant maintenance)

Where OP is outsourcer perception and CE is customer expectation.

The test is based on significance value (α) of 0.05.

Table 4.14 Customer expectation and outsourcer perception comparison

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference		t	df	Significance (2-tailed)
				Lower	Upper			
CE - OP	0.5671	0.42688	0.16134	0.1723	0.9619	3.515	6	0.013

The statistical analysis in Table 4.14 shows the observed significance level is 0.006 (based on one-tailed test) and less than α (0.05). Since the test result is highly significant, H1o is rejected and there is no reason not to accept $H1_a$. Therefore the hypothesis test suggests that a company is less likely to outsource total plant maintenance if the customer expectations of the outsourcing factors are higher than the outsourcer perceptions.

Hypothesis 2

The Zeithaml's Gap Model suggests that there is a service gap if there is a difference between management perceptions of customer expectations and service quality specifications (Gap 2). In this research, the service quality specification is the outsourcer expectation of the service specification. If the outsourcer expectation (OE) is lower than the outsourcer perception (OP), then the customer may be satisfied. Therefore, this hypothesis is to test whether the petrochemical companies are less likely to outsource total plant maintenance if the outsourcers' perceptions are lower than their expectations.

Hypothesis $H2_o$: OE = OP (Petrochemical companies more likely to outsource total plant maintenance)

Hypothesis $H2_a$: OE > OP (Petrochemical companies less likely to outsource total plant maintenance)

Where OP is outsourcer perceptions and OE is outsourcer expectations.

The test is based on significance value (α) of 0.05.

Table 4.15 Outsourcer expectation and perception comparison

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference		t	df	Significance (2-tailed)
				Lower	Upper			
OE - OP	0.3286	0.24471	0.9249	0.1023	0.5549	3.553	6	0.012

The statistical analysis in Table 4.15 shows the observed significance level is 0.006 (based on one-tailed test) and less than α (0.05). Since the result is highly significant, H2o is rejected and there is no reason not to accept $H2_a$. Therefore, the hypothesis test suggests that a company is less likely to outsource total plant maintenance if the outsourcer expectations of the outsourcing factors are higher than its perceptions.

Hypothesis 3

The Zeithaml's Gap Model suggests a service gap if there is a difference between the customer service perception and the service quality specification (Gap 3). In this research, outsourcer expectation is based on the service specification (similar to explanation in Hypothesis 2). If the outsourcer expectation of the service is lower than the customer perception of the service may discourage the customer from outsourcing total plant maintenance. Therefore, this hypothesis is to test whether the petrochemical companies are less likely to outsource total plant maintenance if the outsourcers' expectations (OE) are higher than the petrochemical companies' perceptions (CP).

Hypothesis $H3_o$: OE = CP (Petrochemical companies more likely to outsource total plant maintenance)

Hypothesis $H3_a$: OE > CP (Petrochemical companies less likely to outsource total plant maintenance)

Where CP is customer perception and OE is outsourcer expectation.

The test is based on significance value (α) of 0.05.

Table 4.16 Outsourcer expectation and customer perception comparison

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference		t	df	Significance (2-tailed)
				Lower	Upper			
OE - CP	0.7786	0.42608	0.16104	0.3845	1.1726	4.835	6	0.003

The statistical analysis in Table 4.16 shows the observed significance level is 0.0015 and less than α (0.05). Since the result is highly significant, H3o is rejected and there is no reason not to accept $H3_a$. Therefore, the hypothesis test suggests that a company is less likely to outsource total plant maintenance if the outsourcer expectations of the outsourcing factors are higher than the customer perceptions.

Hypothesis 4

The Zeithaml's Gap Model suggests service gap if there is a difference between the service delivery and what is communicated about the service to the customer (Gap 4). In this research, this gap is similar to Gap 3 since the external communications to customer is the outsourcer expectation. However, there may be a service gap between the customer expected service and service standards which is the outsourcer expectation as explained in Hypothesis 3. This is a new service gap that is proposed in this research but not in the Zeithaml's Gap Model. Therefore, in this research the service gap between the customer expectation (CE) and outsourcer expectation (OE) is identified as Gap 4. This hypothesis is to test whether the petrochemical companies are less likely to outsource total plant maintenance if the outsourcers' expectations (OE) are lower than the petrochemical companies' expectations (CE).

Hypothesis $H4_o$: CE = OE (Petrochemical companies more likely to outsource total plant maintenance)

Hypothesis $H4_a$: CE > OE (Petrochemical companies less likely to outsource total plant maintenance)

Where CE is customer expectation and OE is outsourcer expectation.

The test is based on significance value (α) of 0.05.

Table 4.17 Customer and outsourcer expectation comparison

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference		t	df	Significance (2-tailed)
				Lower	Upper			
CE - OE	0.2386	0.32002	0.12096	-0.0574	0.5345	1.972	6	0.096

The statistical analysis in Table 4.17 shows the observed significance level is 0.048 and less than α (0.05). Since the result is significant, H4o is rejected and there is no reason not to accept $H4_a$. Therefore, the hypothesis test suggests that a company is

less likely to outsource total plant maintenance if the customer expectations of the outsourcing factors are higher than the outsourcer expectations.

Hypothesis 5

The Zeithaml's Gap Model suggests a service gap if there is a difference between the customer service expectation and its perception of the service (Gap 5). The customer may not consider outsourcing total plant maintenance if its service expectation (CE) is higher than its service perception (CP). Therefore, this hypothesis is to test whether the petrochemical companies are less likely to outsource total plant maintenance if their expectations (CE) is high than their perceptions (CP).

Hypothesis $H5_o$: CE = CP (Petrochemical companies more likely to outsource total plant maintenance)

Hypothesis $H5_a$: CE > CP (Petrochemical companies less likely to outsource total plant maintenance)

Where CE is customer expectation and CP is customer perception.

The test is based on significance value (α) of 0.05.

Table 4.18 Customer expectation and perception comparison

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference		t	df	Significance (2-tailed)
				Lower	Upper			
CE - OP	1.0171	0.40007	0.15121	0.6471	1.3871	6.727	6	0.001

The statistical analysis in Table 4.18 shows the observed significance level is 0.00 and less than α (0.05). Since the result is significant, H5o is rejected and there is no reason not to accept $H5_a$. Therefore, the hypothesis test suggests that a company is less likely to outsource total plant maintenance if the customer expectations of the outsourcing factors are higher than its perceptions.

Hypothesis 6

The Zeithaml's Gap Model does not include this service gap between customer service perception and the service provider's perception of the service. This research proposes and tests this service gap which is between the customer's perceptions (CP) and outsourcer's perceptions (OP). The hypothesis is to test whether petrochemical companies are less likely to outsource total plant maintenance if the outsourcers' perception is higher than petrochemical companies' perceptions.

Hypothesis $H6_o$: OP = CP (Petrochemical companies more likely to outsource total plant maintenance)

Hypothesis $H6_a$: OP > CP (Petrochemical companies less likely to outsource total plant maintenance)

Where CP is customer perception and OP is outsourcer perception.

The test is based on significance value (α) of 0.05.

Table 4.19 Customer and outsourcer perception comparison

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference		t	df	Significance (2-tailed)
				Lower	Upper			
OP - CP	0.45	0.42915	0.1622	0.0531	0.8469	2.774	6	0.032

The statistical analysis in Table 4.19 shows the observed significance level is 0.016 (based on one-tailed test) and less than α of 0.05. Since the result is significant, H6o is rejected and there is no reason not to accept $H6_a$. Therefore, the hypothesis test suggests that a company is less likely to outsource total plant maintenance if the outsourcer perceptions of the outsourcing factors are higher than the customer perceptions.

In summary, the hypothesis testing shows that there is no reason not to reject all the null hypotheses. In other words, the tests suggest that companies are more likely not

to outsource total plant maintenance based on the relationships between expectations and perceptions tabulated in Table 4.13. The next step is to validate the hypotheses H1 to H6 test results by testing the hypotheses (H7 to H12) for companies that are more likely to outsource total plant maintenance. The objective of hypotheses H7 to H12 is to validate hypotheses H1 to H6, respectively. The survey data is collected from respondents in the company that outsource total plant maintenance shown in Table 4.9.

4.4.3 Hypothesis testing: Total outsourcing

Earlier in this chapter, the hypotheses H1 to H6 is to test the relationships of the customer and outsourcer expectations and perceptions of the decisions not to outsource total plant maintenance in the petrochemical industry. The next stage of the data analysis is to validate the hypothesis test results by comparing the perceptions and expectations of Company 5 that has outsourced total plant maintenance. The hypotheses H7 to H12 are used to test the relationships of the expectations and perceptions that decide to outsource total plant maintenance. Therefore, the hypotheses H7 to H12 are the mirror images of H1 to H6, respectively. The relationships of the expectations and perceptions that the hypotheses (H7 to H12) are to be tested are tabulated in Table 4.20.

Table 4.20 Hypothesis-expectation-perception matrix: Total outsourcing

	CE	CP	OE	OP
CE	X	H11	H10	H7
CP	H11	X	H9	H12
OE	H10	H9	X	H8
OP	H7	H12	H8	X

Note: H7 to H12 represent the hypotheses to be tested
Source: Compiled for this research

In the research survey, only Company 5 has outsourced total plant maintenance. The researcher recognizes that the average score of the expectations and perceptions of Company 5 alone may not provide an accurate analysis and there is no other companies in the research survey had outsourced total plant maintenance. To improve the analysis accuracy, the average scores of each of the ten questions in the research survey are used in this statistical analysis. The average scores of the perceptions and perceptions of the survey questions for Company 5 are tabulated in Table 4.21.

Table 4.21 Company C5: Perceptions and expectations

Survey Questionnaires	Customer		Outsourcer	
	Perceptions	Expectations	Perceptions	Expectations
Satisfaction level of outsourcing	6	5.2	6	5.5
Importance of outsourcer corporate image	6	5.5	6	6
Outsourcer workers experience level	5.5	5	5	5
Training program for contractor workers	4.5	3	3	3
Expectations are clearly defined in the outsourcing contracts	5	3	4.4	4.4
Level of outsourcing risk	6	4	5	5
Outsourcing level	7	7	7	7
Outsourcing reduces maintenance costs	6	5	6	5.5
Company senior management commitment to outsourcing	7	6	6	6
Company middle management commitment to outsourcing	7	5.5	6	5.5
	6.00	**4.92**	**5.44**	**5.29**

Source: Data compiled from Tables 4.10 and 4.11.

Hypothesis 7

In this research, the customer may not want to outsource total plant maintenance if the outsourcer perception (OP) of the service quality is lower than the customer expectation (CE). This service gap is based on Gap 1 of Zeithaml's Gap Model. Therefore, this hypothesis is to test whether Company 5 is more likely to outsource total plant maintenance if outsourcer perceptions are higher than Company 5's expectations. This hypothesis H7 is to validate the Hypothesis 1.

Hypothesis $H7_o$: OP = CE (customers less likely to outsource total plant maintenance)

Hypothesis $H7_a$: OP > CE (customers is more likely to outsource total plant maintenance)

Where OP is outsourcer perception and CE is customer expectation.

The test is based on significance value (α) of 0.05.

Table 4.22 Customer expectation and outsourcer perception comparison

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference		t	df	Significance (2-tailed)
				Lower	Upper			
OP - CE	0.52	0.51597	0.16316	0.1509	0.8891	3.187	9	0.011

The statistical analysis in Table 4.22 shows the observed significance level is 0.005 (based on one-tailed test) and less than α (0.05). Since the result is significant, H7o is rejected and there is no reason not to accept $H7_a$. Therefore the hypothesis test suggests that a company is more likely to outsource total plant maintenance if the outsourcer perceptions of the outsourcing factors are higher than the customer expectations.

Hypothesis 8

In this research, the service quality specification is the outsourcer expectation of the service specification (Gap 2 of Zeithaml's Gap Model). If the outsourcer expectation (OE) is higher than the outsourcer perception (OP), then the customer may be satisfied. Therefore, this hypothesis is to test whether Company 5 is more likely to outsource total plant maintenance if outsourcer perception is higher than its expectation. This hypothesis H8 is to validate hypothesis H2.

Hypothesis $H8_o$: OP = OE (customers less likely to outsource total plant maintenance)

Hypothesis $H8_a$: OP > OE (customers is more likely to outsource total plant maintenance)

Where OP is outsourcer perceptions and OE is outsourcer expectations.

The test is based on significance value (α) of 0.05.

Table 4.23 Outsourcer expectation and perception comparison

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference		t	df	Significance (2-tailed)
				Lower	Upper			
OP - OE	0.15	0.24152	0.07638	-0.0228	0.3228	1.964	9	0.081

The statistical analysis in Table 4.23 shows the observed significance level is 0.04 (based on one-tailed test) and less than α (0.05). Since the result is significant, H8o is rejected and there is no reason not to accept $H8_a$. Therefore the hypothesis test suggests that a company is more likely to outsource total plant maintenance if the outsourcer perceptions of the outsourcing factors are higher than its expectations.

Hypothesis 9

Based on Gap 3 of the Zeithaml's Gap Model, the customer is more satisfied if the service provider's expectation of the service is lower than the customer's perception. Therefore, this hypothesis is to test whether Company 5 is more likely to outsource total plant maintenance if the outsourcer expectations (OE) are higher than Company 5's perceptions (CP). This hypothesis H9 is to validate hypothesis H3.

Hypothesis $H9_o$: CP = OE (customers less likely to outsource total plant maintenance)

Hypothesis $H9_a$: CP > OE (customers is more likely to outsource total plant maintenance)

Where CP is customer perception and OE is outsourcer expectation.

The test is based on significance value (α) of 0.05.

Table 4.24 Outsourcer expectation and customer perception comparison

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference		t	df	Significance (2-tailed)
				Lower	Upper			
CP - OE	0.71	0.53427	0.16895	0.3278	1.0922	4.202	9	0.002

The statistical analysis in Table 4.24 shows the observed significance level is 0.001 and less than α (0.05). Since the result is highly significant, H9o is rejected and there is no reason not to accept $H9_a$. Therefore the hypothesis test suggests that a company is more likely to outsource total plant maintenance if the customer perceptions of the outsourcing factors are higher than the outsourcer expectations.

Hypothesis 10

In this research the service gap between the customer expectation (CE) and outsourcer expectation (OE) is identified as Gap 4. This hypothesis is to test whether Company 5 is more likely to outsource total plant maintenance if the outsourcer expectation (OE) is higher than Company 5's expectation (CE). This hypothesis H10 is to validate hypothesis H4.

Hypothesis $H10_o$: OE = CE (customers less likely to outsource total plant maintenance)

Hypothesis $H10_a$: OE > CE (customers is more likely to outsource total plant maintenance)

Where CE is customer expectation and OE is outsourcer expectation.

The test is based on significance value (α) of 0.05.

Table 4.25 Customer and outsourcer expectation comparison

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference		t	df	Significance (2-tailed)
				Lower	Upper			
OE - CE	0.37	0.49227	0.15567	0.0178	0.7222	2.377	9	0.041

The statistical analysis in Table 4.25 shows the observed significance level is 0.02 and more than α (0.05). Since the result is significant, H10o is rejected and there is no reason not to accept $H10_a$. Therefore the hypothesis test suggests that a company is more likely to outsource total plant maintenance if the outsourcer expectations of the outsourcing factors are higher than the customer expectations.

Hypothesis 11

The Zeithaml's Gap Model suggests a service gap if there is a difference between the customer service expectation and its perception of the service (Gap 5). The customer may consider outsourcing total plant maintenance if its service expectation (CE) is lower than its service perception (CP). Therefore, this hypothesis is to test whether Company 5 is more likely to outsource total plant maintenance if the Company 5's expectations (CE) are lower than its perceptions (CP). This hypothesis H11 is to validate hypothesis H5.

Hypothesis $H11_o$: CP = CE (customers less likely to outsource total plant maintenance)

Hypothesis $H11_a$: CP > CE (customers is more likely to outsource total plant maintenance)

Where CE is customer expectation and CP is customer perception.

The test is based on significance value (α) of 0.05.

Table 4.26 Customer expectation and perception comparison

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference		t	df	Significance (2-tailed)
				Lower	Upper			
CP - CE	1.08	0.66466	0.21019	0.6045	1.5555	5.138	9	0.001

The statistical analysis in Table 4.26 shows the observed significance level is 0.0005 and less than α (0.05). Since the result is significant, H11o is rejected and there is no reason not to accept $H11_a$. Therefore the hypothesis test suggests that a company is more likely to outsource total plant maintenance if the customer perceptions of the outsourcing factors are higher than its expectations.

Hypothesis 12

The Zeithaml's Gap Model does not include the service gap between customer service perception and the service provider's perception of the service. In this research, this service gap is between the customer's perceptions (CP) and outsourcer's perceptions (OP). The hypothesis is to test whether Company 5 is more likely to outsource total plant maintenance if the outsourcer perception is lower than Company 5's perceptions. This hypothesis H12 is to validate hypothesis H6.

Hypothesis $H12_o$: CP = OP (Customers are less likely to outsource total plant maintenance)

Hypothesis $H12_a$: CP > OP (Customers are more likely to outsource total plant maintenance)

Where CP is customer perception and OP is outsourcer perception.

The test is based on significance value (α) of 0.05.

Table 4.27 Customer and outsourcer perception comparison

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference		t	df	Significance (2-tailed)
				Lower	Upper			
CP - OP	0.56	0.55015	0.17397	0.1664	0.9536	3.219	9	0.011

The statistical analysis in Table 4.27 shows the observed significance level is 0.005 (based on one-tailed test) and less than α of 0.05. Since the result is significant, H12o is rejected and there is no reason not to accept $H12_a$. Therefore the hypothesis test suggests that a company is more likely to outsource total plant maintenance if the customer perceptions of the outsourcing factors are higher than the outsourcer perceptions.

The tests conducted on hypotheses H7 to H12 support the alternate hypotheses that the expectation-perception relationships in Table 4.20 more likely support outsourcing total plant maintenance. Similar, the tests conducted on hypotheses H1 to H6 earlier in this section support the alternate hypotheses that the expectation-perception relationships in Table 4.13 less likely support outsourcing total plant maintenance. The relationships of these two tables and the expected outcome are mirror images of each other. Therefore, the second set of hypothesis results validates the first set of hypothesis results.

In summary, the triangulation of the case study analysis (Section 4.2) and the survey data analysis (Section 4.3) results conclude that the seven deciding factors: service quality, contractor experience, contractor worker training programme, outsourcing contract, outsourcing risks, outsourcing reasons and outsourcing culture are applicable in the outsourcing of plant maintenance in the Singapore petrochemical industry. Furthermore, the most important finding is the service quality and outsourcing risk are the two critical deciding factors which is what the research was set up to find. The triangulation of these two different data analysis results adds rigor and validity to the conclusion. The next section is to examine whether the expectation-perception matrix can be used to develop a selection matrix to decide outsourcing plant maintenance. This matrix may answer a research secondary question of helping the outsourcers to win outsourcing contracts.

4.5 Outsourcing decision matrix

In the previous section, twelve hypotheses (Tables 4.13 and 4.20) are used to validate the seven deciding factors. The next step is to examine the tables and find whether an outsourcing decision tool can be identified which will aid the outsourcers in winning outsourcing contracts.

The expectation-perception matrix in Table 4.18 is a mirror image of Table 4.13. The combination of these two matrices can be used to develop a selection matrix to decide outsourcing of total plant maintenance in the petrochemical industry shown in Table 4.28.

Table 4.28 Outsourcing decision matrix: Total plant maintenance

Row \ Column	CE	CP	OE	OP
CE	X	<	<	<
CP	>	X	>	>
OE	>	<	X	<
OP	>	<	>	X

Source: Computed from hypothesis testing

This outsourcing decision matrix shows that the more expectation-perception relationships meet the criteria given in Table 4.28, the more likely the petrochemical company will outsource total plant maintenance. This outsourcing decision matrix is an important finding in this research because the petrochemical companies are now able to decide outsourcing plant maintenance by evaluating the perceptions and expectations of the critical deciding factors. (The critical deciding factors will be explained later in this chapter). Similarly, the outsourcers can also examine their strengths and weaknesses by using the outsourcing decision matrix to win outsourcing contracts. Therefore, this outsourcing decision matrix satisfies the secondary research question.

To use the decision matrix, firstly the petrochemical company has to examine the critical factors that decide outsourcing plant maintenance. Secondly, the company has to identify the average scores for the perceptions and expectations of the critical deciding factors. Thirdly, compare the expectations and perceptions in the rows with those identify in the columns (Table 4.28). For example, the company may consider outsourcing total plant maintenance if the company average expectation of the deciding factors is lower than its average perception.

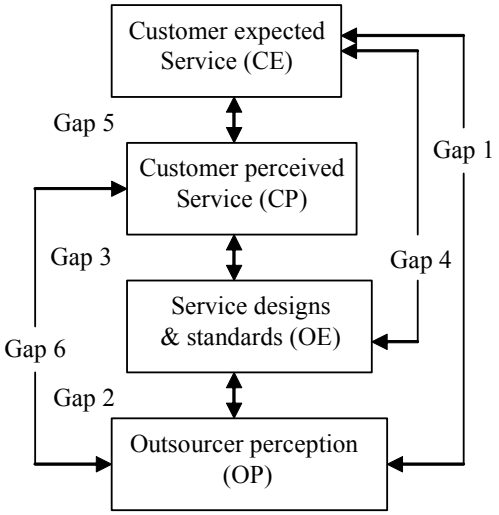


Figure 4.2 Modified Zeithaml's service gap model

The outsourcing selection matrix (Table 4.28) can be used in combination with the modified Zeimthl's gap model to provide a clearer understanding of the expectation-perception relationships shown in Figure 4.2. The modified Zeithaml's gap model has two different gaps, namely, Gaps 4 and 6. Gap 4 is the gap between the customer expected service (CE) and service designs and standards (OE). Gap 6 is the gap between customer perceived service (CP) and outsourcer perception (OP). The expectation-perception relationships in the outsourcing decision matrix (Table 4.28) can be related to the modified gap model to provide a clear understanding the petrochemical or outsourcer organizations' strengths and weaknesses. The petrochemical companies can use this outsourcing decision matrix to decide whether to outsource total plant maintenance. More importantly, the decision matrix helps the

outsourcers to identify their strengths and weaknesses. The improvement on the weaknesses and enhancing the strengths will improve the chance for the outsourcer to win the outsourcing contract over its competitors.

In summary, the triangulation of the results from the two-way hypothesis tests carried out in Section 4.4 proves that the expectation-perception relationships in the outsourcing decision matrix are applicable in the outsourcing of plant maintenance in Singapore petrochemical industry. The combination of the matrix and the gap model will provide a tool for the outsourcers to examine their strengths and weaknesses on the outsourcing factors. Improving the weaknesses and enhancing the strengths will give a outsourcer competitive advantage over its competitors in winning outsourcing contract. Therefore, this outsourcing decision matrix complemented by the modified Zeithaml's gap model answers one of the two research secondary questions: *"How to help the outsourcers win outsourcing contracts"*. The next step is to find the factors that influence the two critical factors: service quality and outsourcing risk.

4.6 Factors influencing critical deciding factors

This section is to identify the factors that influence the critical deciding factors, which is the next secondary research question. The research survey data analyses carried out in the previous sections have concluded that the seven factors that are identified in the literature review in Chapter 2 do influence the decision to outsource total plant maintenance. In the case study analysis, the respondents have unanimously suggested that the two critical factors that decide outsourcing total plant maintenance are service quality and outsourcing risks. The next stage of the analysis is to examine whether the two critical factors are mutually exclusive or there are other factors that are affecting these critical factors.

Table 4.29 Customer expectation correlations

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Q1	-	O	X	O	O	O	O	O	O	O
Q2	O	-	O	O	O	O	O	O	O	O
Q3	X	O	-	O	O	O	O	O	O	O
Q4	O	O	O	-	X	O	O	O	O	O
Q5	O	O	O	X	-	O	O	O	O	O
Q6	O	O	O	O	O	-	X	X	X	X
Q7	O	O	O	O	O	X	-	O	O	O
Q8	O	X	O	O	O	X	O	-	X	X
Q9	O	O	O	O	O	X	O	X	-	O
Q10	O	O	O	O	O	X	O	X	O	-

Notes: Q1: Satisfaction of outsourcing
Q2: Importance of corporate image
Q3: Outsourcer worker experience
Q4: Contractor training programmes
Q5: Contract defined expectations
Q6: Outsourcing risk
Q7: Outsourcing level
Q8: Outsourcing reduce costs
Q9: Senior management commitment
Q10: Middle management commitment

X: Strongly correlated
O: Not strongly correlated

Source: Compiled from Table 4.30.

The statistical correlation test is the method used in this analysis to determine whether there are other factors that are affecting the critical deciding factors. Since the research survey questions are related to the outsourcing deciding factors, the customer expectations of the survey questions in Table 4.10 can be used in the correlation test. The correlation results tabulated in Table 4.29 shows that there are other deciding factors influencing the two critical deciding factors. The first critical deciding factor, outsourcing risk, is correlated to the level of outsourcing, the reduction in maintenance cost and the commitment of the senior and middle management. The second critical deciding factor, satisfactory of the service quality, is related to the experience level of the outsourcer workers.

Table 4.30

Correlations between survey question results

Correlations

		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Q1	Pearson Correlation	1	-.031	.826*	.632	.587	.262	.295	.400	-.066	.492
	Sig. (2-tailed)	.	.942	.011	.093	.126	.531	.479	.326	.876	.216
	N	8	8	8	8	8	8	8	8	8	8
Q2	Pearson Correlation	-.031	1	.140	.245	.486	.684	.449	.355	.621	.463
	Sig. (2-tailed)	.942	.	.742	.558	.222	.061	.265	.389	.100	.248
	N	8	8	8	8	8	8	8	8	8	8
Q3	Pearson Correlation	.826*	.140	1	.504	.539	.482	.501	.337	.114	.551
	Sig. (2-tailed)	.011	.742	.	.203	.168	.227	.206	.414	.788	.157
	N	8	8	8	8	8	8	8	8	8	8
Q4	Pearson Correlation	.632	.245	.504	1	.954**	.297	-.195	.479	.296	.600
	Sig. (2-tailed)	.093	.558	.203	.	.000	.475	.644	.230	.476	.116
	N	8	8	8	8	8	8	8	8	8	8
Q5	Pearson Correlation	.587	.486	.539	.954**	1	.505	-.016	.548	.458	.636
	Sig. (2-tailed)	.126	.222	.168	.000	.	.202	.969	.160	.254	.090
	N	8	8	8	8	8	8	8	8	8	8
Q6	Pearson Correlation	.262	.684	.482	.297	.505	1	.714*	.788*	.872**	.754*
	Sig. (2-tailed)	.531	.061	.227	.475	.202	.	.047	.020	.005	.031
	N	8	8	8	8	8	8	8	8	8	8
Q7	Pearson Correlation	.295	.449	.501	-.195	-.016	.714*	1	.474	.372	.489
	Sig. (2-tailed)	.479	.265	.206	.644	.969	.047	.	.235	.363	.219
	N	8	8	8	8	8	8	8	8	8	8
Q8	Pearson Correlation	.400	.355	.337	.479	.548	.788*	.474	1	.744*	.810*
	Sig. (2-tailed)	.326	.389	.414	.230	.160	.020	.235	.	.034	.015
	N	8	8	8	8	8	8	8	8	8	8
Q9	Pearson Correlation	-.066	.621	.114	.296	.458	.872**	.372	.744*	1	.696
	Sig. (2-tailed)	.876	.100	.788	.476	.254	.005	.363	.034	.	.055
	N	8	8	8	8	8	8	8	8	8	8
Q10	Pearson Correlation	.492	.463	.551	.600	.636	.754*	.489	.810*	.696	1
	Sig. (2-tailed)	.216	.248	.157	.116	.090	.031	.219	.015	.055	.
	N	8	8	8	8	8	8	8	8	8	8

*. Correlation is significant at the 0.05 level (2-tailed).

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

In order to validate the statistical correlation results in Table 4.29, a regression ANOVA tabulated in Table 4.31 is also carried out to test whether the independent variables of outsourcing level (Q7), reduction of maintenance cost (Q8) and commitment of senior and middle management (Q9 and Q10) explain the variation in the outsourcing risk (Q6).

Observed significance value < 0.05 (Independent variables do a good job explaining the variation in the dependent variable)

Observed significance value > 0.05 (Independent variables do not do a good job explaining the variation in the dependent variable)

Table 4.31 Factors influencing outsourcing risks

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.156	4	2.789	12.347	.033[a]
	Residual	.678	3	.226		
	Total	11.833	7			

a. Predictors: (Constant), Q10, Q7, Q9, Q8

b. Dependent Variable: Q6

The regression ANOVA tabulated in Table 4.31 shows the observed significance value of 0.033 and is less than α (0.05). Therefore, the independent variables (Q7, Q8, Q9 and Q10) do a good job in explaining the dependent variable Q6. Therefore, the analysis validates that the level of outsourcing risk (Q6) is influenced by the maintenance cost reduction from outsourcing (Q8), the level of outsourcing (Q7) and the senior and middle management commitment towards outsourcing (Q9 and Q10). Firstly, the finding suggests that the level of outsourcing risk is likely to be lower if the maintenance cost reduction from outsourcing plant maintenance is high. This finding is consistent with the case study analysis that shows that the older petrochemical companies tend to outsource partial plant maintenance gradually because these companies do not see a large maintenance cost reduction (Cases C3, C4 and C6). The reason is these companies do have their own in-house maintenance

crews and it would be costly to relocate them. Conversely, the newer companies do benefit from higher maintenance cost reduction in outsourcing since they do not employ in-house maintenance crews (Cases C1, C5 and C7). Secondly, the finding also suggests that the outsourcing risk is higher if the level of outsourcing is high. This finding is consistent with the literature review that the risk of over-dependence on the outsourcer is higher if the petrochemical companies decide to outsource total plant maintenance (Downey 1995). Finally, the finding suggests that outsourcing risk is lower if management commitment (that is the company culture) towards outsourcing is high. This finding is consistent with Bendor-Samuel (1999a) who says that management commitment is important to the successful of outsourcing.

The statistical analysis in Table 4.31 shows the four factors that influence the critical deciding factors, outsourcing risk. The next step is to identify the factors that significantly influence this critical deciding factor by using the coefficient regression statistical method. The coefficient regression result for identifying the impact of the four independent variables on the critical deciding factor is shown in Table 4.32.

Table 4.32 Factors that influence outsourcing risks

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-12.362	3.014		-4.101	.026
	Q7	.443	.170	.418	2.609	.080
	Q8	.217	.573	.100	.379	.730
	Q9	2.005	.697	.612	2.876	.064
	Q10	9.385E-02	.550	.042	.171	.875

a. Dependent Variable: Q6

Legend:
Q6 – Outsourcing risk
Q7 – Outsourcing level
Q8 – Reducing maintenance cost
Q9 – Senior management commitment
Q10 – Middle management commitment

In Table 4.32, the standardized coefficients are used to measure the independent variables based on a similar measuring unit. These standard coefficients help to rank the importance of the independent variables. The independent variables that have

higher impact have 't' scores above 2.0. The results show that senior management commitment (Q9) and level of outsourcing (Q7) are the two most important independent variables that affect the outsourcing risk.

Finally, to find the factors that influence the second critical factor, outsourcing service quality, the regression ANOVA model in Table 4.33 is used.

Observed significance value < 0.05 (Independent variables do a good job explaining the variation in the dependent variable)

Observed significance value > 0.05 (Independent variables do not do a good job explaining the variation in the dependent variable)

The ANOVA model in Table 4.33 shows that the observed significance level is 0.011 and is lesser than α (0.05). The finding suggests that outsourcer worker experience level influence the service quality service quality. This finding is consistent with the study on the labour scene in Singapore (Koh and Lay 2000) which observe that the trend of using temporary workers by Singapore companies may become a permanent feature of the modern workplace because there is labour shortage.

Table 4.33 Factor that influences service quality

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.348	1	3.348	12.921	.011[a]
	Residual	1.555	6	.259		
	Total	4.903	7			

a. Predictors: (Constant), Q3

b. Dependent Variable: Q1

In summary, the critical deciding factor, outsourcing risk, is closely affected by senior commitment towards outsourcing and level of outsourcing. These two independent variables which are in the research survey questionnaires are related to the outsourcing culture. Therefore, the critical factor, outsourcing risks, is affected by the company outsourcing culture. The more committed the company culture is towards outsourcing, the lower is the outsourcing risks. The other critical factor, service

quality, is affected by the experience of the outsourcer workers which is one of the outsourcing factors. The better experience among the outsourcer workers will lead to higher service quality satisfaction. The petrochemical companies can use the modified Zeithaml's service gap model and outsourcing decision matrix to test the two critical factors to decide outsourcing total plant maintenance. Similarly, the outsourcers can also use the service gap model and outsourcing decision matrix to identify their strengths and weaknesses in order to strategize their chances to win outsourcing contracts.

In the literature review chapter, Figure 2.1 shows the seven factors that may decide total plant maintenance in the Singapore petrochemical industry. The seven factors are intentionally arranged in one row because it is premature then to know whether all the factors are applicable for outsourcing plant maintenance and which are the critical deciding factors. The data analyses carried out in Sections 4.2 and 4.3 have concluded that all the seven factors are applicable in deciding total plant maintenance in the Singapore petrochemical industry. Furthermore, the analyses are able to identify the critical success factors. The summary of the research finding in this chapter can be captured in Figure 4.3.

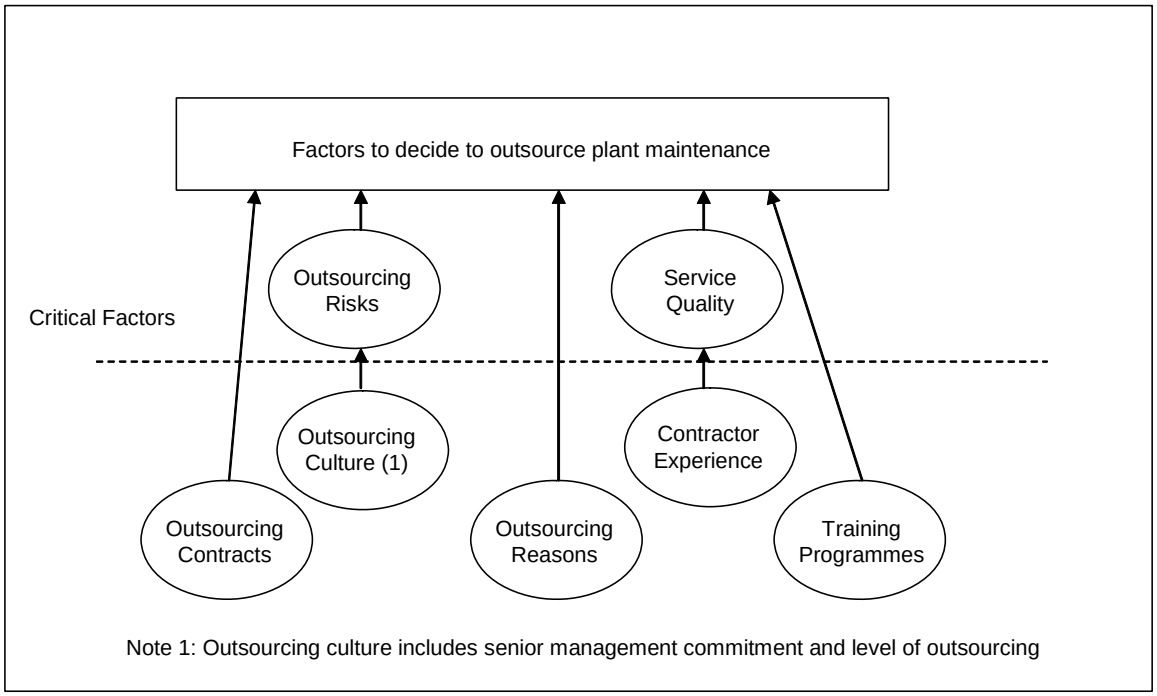


Figure 4.3 Outsourcing factor relationship

Figure 4.3 shows that the outsourcing risk and service quality are the critical factors and locate in the first row. The factors that influence the critical factors are placed in the second row. The remaining outsourcing factors, which are also applicable to the outsourcing decisions, are placed at the third row. The reason is these factors do not influence the critical factors.

4.7 Conclusion

In this chapter, case study and survey data analyses are carried out to test the seven outsourcing deciding factors that are identified in the literature review. Representatives from different level of management in the petrochemical and outsourcer organizations were interviewed. The reason is to give a critical perspective view to the whole research activities. Both research data analyses gave similar conclusion that the seven outsourcing factors: service quality, contractor experience, contractor worker training programme, outsourcing contract, outsourcing risks, outsourcing reasons and outsourcing culture are applicable in the outsourcing of plant maintenance in the Singapore petrochemical industry. More importantly, the case study analysis is able to identify the two critical deciding factors, namely, service quality and outsourcing risk. These two critical factors answer the primary research issue of the research title: *"Outsourcing plant maintenance in Singapore petrochemical industry: A critical perspective"*.

To find the answer to the first secondary research issue *"What influence the critical factors in deciding outsourcing plant maintenance?"* a regression ANOVA is used to test the correlation of all the survey data. The conclusion is the service quality and outsourcing risk is influenced by contractor experience and outsourcing culture, respectively. The better the contractor worker experience in plant maintenance, the service quality will improve. Similar, if the culture of the organization is committed

to outsourcing, the outsourcing risk may reduce. Figure 4.3 shows the relationship of all the outsourcing deciding factors.

The other secondary research issue is *"How can the outsourcing contractors use these factors to win outsourcing contracts?"* In the literature review, the Zeithaml's gap model is identified to test the hypotheses of the new tool that could help the outsourcers to win outsourcing contracts. The hypothesis testing has found an outsourcing decision matrix (Table 4.28) that is derived from the expectation-perceptions of the outsourcing decision factors. The outsourcers can use this decision matrix to identify their strengths and weaknesses in the outsourcing expectations and perceptions. By improving their weaknesses and enhancing their strengths, the outsourcers may be able to win outsourcing contracts.

CHAPTER 5
CONCLUSIONS AND IMPLICATIONS

This chapter summarises the research finding on three research issues. It also mentions the areas that the research is able to contribute to the literature knowledge and the implications of the research for the practices and Government policies related to maintenance outsourcing. Finally, the chapter is suggesting areas that further research can be carried out.

5.1 Introduction

The research title is "Outsourcing plant maintenance in Singapore petrochemical industry: A critical perspective". In this research there are three research issues as follows:

1. What are the critical factors in deciding outsourcing of total plant maintenance in the Singapore petrochemical industry?
2. What are the factors that influence the critical outsourcing factors?
3. How can the research help the outsourcers in winning outsourcing contracts?

The petrochemical is different from IT and other industries. The petrochemical industry has high entry and exit barriers. The failure in plant maintenance is not only result in production loss but also subject the plant to unsafe conditions (Cases C1, C2, C4, C6, C7 and C8). The management, especially for the older plants, is very

cautious in outsourcing the plant maintenance from their in-house maintenance crews to the contractors. Furthermore, the Singapore petrochemical industry is growing (with an annual investment of more than S$1.5 billion from 2001 to 2004) and the growth is putting a demand on the already tight labour pool.

The literature review has found that there is much research in outsourcing in the IT, accounting and services industry but not much on outsourcing plant maintenance in the petrochemical industry. This research has found that the seven factors that affect the outsourcing activities in other industries are to some extent applicable to the Singapore petrochemical industry (Table 5.1). The emphasis on some of these outsourcing factors is different because of the nature of the petrochemical industry. This research is able to contribute to the knowledge of outsourcing.

Table 5.1 Research contributions from outsourcing factors

	Outsourcing Factor	Agreement with literature review
1	Service quality	To some extent
2	Contractor experience	To some extent
3	Outsourcing contract	To some extent
4	Outsourcing risk	Yes
5	Outsourcing reason	To some extent
6	Training programme	To some extent
7	Outsourcing culture	To some extent

Source: Developed from research data analysis

Service quality

The service quality of the outsourcer is a critical factor in deciding outsourcing total plant maintenance. This factor is consistent with the survey conducted in 2002 indicates that service level ranked nearly as high as cost (Avery 2002). The petrochemical companies have difficulties to decide on the service quality expectations because service quality is "invisible" (Edvardsson 1998) and

"intangible" (Levitt 1981; Bebko 2000). The senior management in the older companies (more than ten years) felt that the service quality met their expectations but the middle management did not think so. The middle managers compared the service quality with their in-house maintenance crews which have been working for more than ten years with the companies. The service quality perceptions from the middle managers are less than expectations. On the other hand, the newer petrochemical companies (less than ten-year old) and do not have in-house maintenance crews thought the outsourcer service quality is up to their expectations. The research finding confirms that service quality is critical in deciding outsourcing plant maintenance and in agreement with the literature review.

In the literature review, some academics suggest that good corporate image of the outsourcer is perceived to provide high level of service (Gronroos 1991; Lehtinen and Lehtinen 1991). Corporate image is believed to be an important factor influencing the perception of quality, customer evaluation of service satisfaction, and customer loyalty (Andreassen 1998). In the research, it is found that most of the petrochemical companies outsource plant maintenance to contractors that have past experience working the companies. Many of these successful outsourcers are local companies that are teamed up foreign companies. None of the companies outsource plant maintenance to contractor with good corporate image. This observation suggests that international companies that have good reputation may not be successful in winning plant maintenance outsourcing contracts. The petrochemical companies feel more comfortable to work with contractors that they have experienced with. Therefore, contractor corporate image is not that important for the petrochemical companies in deciding outsourcing plant maintenance.

Contractor experience

The Singapore petrochemical investments were more than S$1.5 billion from 2001 to 2004. However, the skilled workers growth was less than 4% if worker attrition is taken into consideration. Therefore, local outsourcers may not have the capabilities to handle outsourcing activities (Blumberg 1998; Widget 1999). The reason is this is

shortage of skilled worker is a common phenomena in developed countries (Wireman 1999; Williamson 2000) and Singapore (Singapore Statistics 2004). This shortage of skilled workers is a concern among most of the petrochemical companies that employ in-house maintenance crews. The middle managers and supervisors of these companies compared the outsourcer workers with their more experienced maintenance crews. Therefore, they are somewhat reluctant to outsource more maintenance activities. However, those companies that have outsourced most of their maintenance try to mitigate the situation by outsourcing the maintenance to contractors who employ workers who were involved in the plant construction. The reason is these workers are familiar with the plants. Therefore, the research observes that the shortage of skilled worker may affect the outsourcing decision is correct to some extent.

Outsourcing contract

The research found that most of the outsourcing contracts on plan maintenance are not comprehensive and do not include the service expectations such as performance indicators. The common reason is there are insufficient maintenance historical records to decide on the performance indicators. This observation is consistent with Dean and Kiu (2002) who say that unless the service expectations are clear, it would be difficult to decide on the performance indicators to be used. This finding is in agreement with the literature review that many customers may not have the expertise to draft contracts for outsourcing activities (Tsang 2002; Barthélemy 2001). Poorly written contracts seem to be the most common cause of outsourcing failures (Bendor-Samuel 1999; White 1999). However, there is no evidence to suggest that these outsourcing contracts had resulted in outsourcing failure. In fact, the outsourcing contracts for total and partial plant maintenance do not include performance indicators. The inabilities to draft comprehensive contracts do not seem to prevent companies to outsource plant maintenance. Therefore, the research finding suggests that the inability to draft comprehensive outsourcing contracts is not a factor that petrochemical companies would consider in outsourcing.

Outsourcing risk

The literature review suggests that one of the risks of outsourcing is the over-dependence on the outsourcers for critical functions (Downey 1995). The research found that outsourcing risk is a critical factor for the petrochemical companies to decide outsourcing plant maintenance. Many companies are concerned over the risk of outsourcing failure not just because of production loss but also safety that may result in plant fire. Another concern is on the transfer of the in-house maintenance crews because of result of maintenance outsourcing. The lack of in-house maintenance crews means the companies are vulnerable to outsourcing failures. Some companies are keeping 'skeleton' maintenance crews or keeping maintenance supervisors and managers to mitigate outsourcing failures. There is one company (Case C8) outsource plant maintenance to two contractors for the same reason. Therefore, the loss of controls of the business activities that are outsourced which many customers fear (Blumberg 1998; Quinn and Hilmer 1994; Campbell 1995) is observed among the petrochemical companies. Furthermore, the research observes that some companies (that are more than ten year-old) outsource plant maintenance slowly and gradually in order to build their confidence on the outsourcer abilities to maintain the plants (Case C4). The research finding agrees with the literature review to some extent that outsourcing risk is a critical factor in deciding outsourcing total plant maintenance.

Outsourcing reason

The literature review suggests that there are all kinds of reasons for outsourcing, but only some are rational (Straub 1999). Many companies overlook the most obvious of elements in that they fail to thoroughly understand what is being outsourced (Bendor-Samuel 1999). The research did not find any evidence that the petrochemical companies are having problem understanding the reasons and benefits for outsourcing

plant maintenance. In fact, petrochemical companies are clear that plant maintenance is not their companies' core business. All the petrochemical companies outsource to reduce maintenance costs. Many of these companies are 'under pressure' to reduce maintenance costs because of poor profit margin. However, the finding shows that outsourcing is clearly benefited the newer companies that had not employed in-house maintenance crews. The older companies that are having in-house maintenance crews could not realize much cost saving because it can be costly to transfer the in-house maintenance crews. Hence, most of the companies that outsource most of their plant maintenance are companies that are less than ten-year old and did not employ their in-house maintenance crews. The reason to outsource is not a deciding factor for outsourcing plant maintenance. Rather the real cost saving on outsourcing plant maintenance is the deciding factor.

Training programme

The Singapore petrochemical industry had an annual investment of more than S$1.5 billion from 2001 to 2004 (Singapore Statistics 2004). In spite of the Singapore Government effort to increase the pool of skilled workers there is be a shortage of experienced workers because of the economic recovery in early 2000's in the manufacturing sector. The lack of worker training not only result in unreliable plant operation, the customers may be legally liable if the plants are unsafe due to poorly maintained equipment (Roughton 1995). A survey conducted in Singapore in 2000 also indicates that temporary workers are generally under-trained because they are not obligated to stay with their employers (Koh and Lay 2000). The research found that though many petrochemical companies agreed that the contractor worker training programmes are below expectations, they do not think it is an important factor. These companies are giving outsourcing contracts to outsourcers who employ workers that had been involved in the plant maintenance. These construction workers are the next best solution after skilled maintenance workers to maintain the plants. Therefore, this research does not agree to some extent to the literature review that contractor training contract is a factor that decides outsourcing total plant maintenance.

Outsourcing culture

Outsourcing culture is different from the traditional culture where relationship is defined as a series of discreet transactions (Corbett 1997a). The research found that the senior managements of the petrochemical companies are committed to outsourcing plant maintenance. Most of the middle managements in companies that have in-house maintenance crews are not as committed as the senior managements. Perhaps the middle managers who are managing in-house maintenance crews find it difficult to work in an outsourcing culture. This is not surprising as Levine (1986) finds that many managers find it difficulty to work in an outsourcing culture. On the other hand, for those companies that outsource most of their maintenance activities, the middle managements are committed to outsourcing. The finding suggests that the middle managers may able to change their culture when more maintenance activities are gradually outsourced. In addition, there is no question of commitment among the senior management as long as they decide to outsource plant maintenance. Therefore, the outsourcing culture is not an important deciding factor to outsource total plant maintenance. The research finding does to some extent disagree with the literature review

In summary, the examination of the outsourcing factors is able to contribute to the knowledge on outsourcing. The research finding on the seven outsourcing factors can be significant as it shows these factors have different importance in the context of the Singapore petrochemical industry. The next section is to conclude the research issues.

5.2 Conclusion about research issues

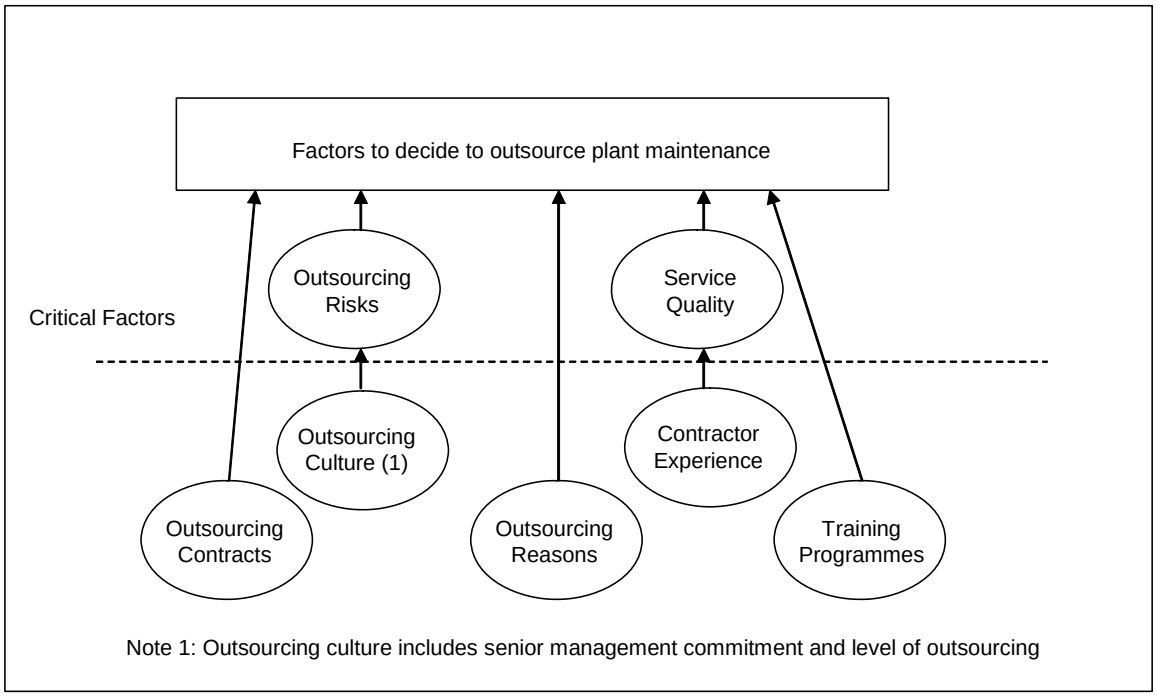


Figure 5.1 Outsourcing factor relationship

There are three research issues that this research is addressing. The primary research issue is to find the critical factors in outsourcing plant maintenance in the Singapore petrochemical industry. Figure 5.1 summarizes the seven factors that affect the decision to outsource total plant maintenance. The figure indicates the level of importance of each outsourcing factor. There are two critical factors, namely outsourcing risks and service quality and the factors that influence these two critical factors are outsourcing culture and contractor experience, respectively. The research found that the remaining three outsourcing factors, outsourcing contract, outsourcing reasons and training programme, are not important to some extent in deciding outsourcing total plant maintenance. The next section is to summarize the research finding on the outsourcing critical factors.

5.2.1 Critical outsourcing factors

The primary research issue is what are the critical factors that decide outsourcing total plant maintenance in the Singapore industry? The quantitative research approach carried out support the seven outsourcing factors identified in the literature review. The outsourcing factors are tested on two cases: companies that did not total plant maintenance (hypotheses H1 to H6) and on company that outsourced total plant maintenance (hypotheses H7 to H12). On both cases, the tests are not able to reject the outsourcing factors. Furthermore, the case study approach found that two outsourcing factors, service quality and outsourcing risks, are critical in deciding the outsourcing of plant maintenance. All the respondents in the case study agreed that service quality and outsourcing risk are critical in deciding outsourcing plant maintenance.

Service quality of plant maintenance is important because the common concerns are outsourcing failure can result in substantial production loss and fire (Cases C1, C2, C4, C6 and C7). The research agrees with the literature review on the difficulties in defining service quality expectations (Edvardsson 1998). There is a difference between the service quality expectations between the senior and middle managers (Cases C2, C3 and C4) in the older plants (more than ten-year old) with in-house maintenance crews. On the other hand, the senior and middle managers seemed to agree that the service perceptions are up to expectations for the newer plants (less than ten-year old) that do not have in-house maintenance crews. The reason is the service quality expectations of the middle managers in the older plants are based on their experienced in-house maintenance crews. Therefore, though service quality is critical, there are no common expectations among the petrochemical companies. Furthermore, the research finding does not agree with the literature review that good corporate image of the outsourcer is perceived to provide high level of service (Gronroos 1991; Lehtinen and Lehtinen 1991). The case study found that most of the petrochemical companies outsourced plant maintenance to contractors that they had past experience with (Cases C2, C3, C4, C6 and C8). This finding may be significant because contractors that have past experience with the petrochemical companies may stand a better chance in winning outsourcing contracts than reputable international contractors.

Outsourcing risks shown in Figure 5.1 is another critical deciding factor in outsourcing plant maintenance. The respondents agreed with the literature review that over-dependence on the outsourcers is a risk (Downey 1995). Outsourcing failure is not only result in production loss but also can lead to unsafe condition in the plant. Most petrochemical companies mitigate the outsourcing risk by either keeping 'skeleton' maintenance crews or employing maintenance managers and supervisors to manage the outsourcing maintenance activities (Cases C2, C3, C4, C6 and C7). Outsourcing risk is one reason that the petrochemical companies are slow in outsourcing more plant maintenance.

In summary, the outsourcer service quality and outsourcing risk are two critical deciding factors to outsource plant maintenance. The outsourcer perceived service quality tends to be higher for companies that do not have in-house maintenance crews. There is another significant finding that reputable contractors that had not worked with the petrochemical companies may have lesser chance to win outsourcing contracts compares to contractors that had worked with the petrochemical companies. The outsourcing risk of maintenance failure is a reason that many petrochemical companies are slow in outsourcing more plant maintenance. Many companies mitigate the outsourcing risk by keep 'skeleton' maintenance crews and mangers to oversee the outsourcers.

This section has summarized that the critical outsourcing factors are service quality and outsourcing risk. The next section is to summarize the secondary research issue, that is, the factors that influence these critical outsourcing factors.

5.2.2 Factors influencing critical outsourcing factors

This section is to summarize the secondary research issue, that is, the factors that influence the critical outsourcing factors. Figure 5.1 shows that contractor experience and outsourcing culture influence the service quality and outsourcing risk, respectively.

The statistical analysis model (ANOVA) carried out in Chapter 4 shows that contractor experience influences the outsourcer service quality (Table 4.30). The Singapore petrochemical industry is growing with an annual investment of more than S$1.5 billion from 2001 to 2004 (Singapore Statistics 2004). The skilled workers population is only growing at less than 4% per year (less attrition). This has led to a shortage of experienced workers in Singapore which is similar to other developed countries like US (Wireman 1999; Williamson 2000). The shortage of experienced workers will affect the service quality of the outsourcers. The case study find that most of the petrochemical companies try to mitigate the situation by intentionally outsource the maintenance activities to these construction workers who had involved in their plant construction and familiar with the plants (Cases C1, C4, C6 and C7). The outsourcers also hire temporary workers to supplement the workforce. This finding is consistent with the literature review that the trend in Singapore in using temporary workers may become a permanent feature of the modern workplace (Koh and Lay 2000).

The data analysis in Chapter 4 also suggests that outsourcing culture influences outsourcing risks (Table 4.29). In this research, outsourcing culture consists of senior and middle management commitment towards outsourcing and level of outsourcing. The case study found that senior and middle managers are committed to outsourcing for those petrochemical companies that outsource most of the plant maintenance (Cases C1 and C5). Conversely, the senior management is more committed than middle management for those companies that outsource partial maintenance (Cases C2, C3 and C6). The research finding agree to some extent with the study carried out on Swedish firms finds that a culture that is lack of responsibility and commitment from foremen and senior managers caused a large part of outsourcing breakdowns (Thilander 1992). The finding that outsourcing culture influences outsourcing risk is also agree to some extent with the literature review that the wrong organization culture can lead to outsourcing failure (Corbett 1999; Useem 1998).

This section summarizes that contractor experience and outsourcing culture are the two factors that influence service quality and outsourcing risk, respectively. The next section is to summarize the next secondary research issue on how the research can help the outsourcers to win outsourcing contracts.

5.2.3 Winning outsourcing contracts

This section is to summarize the research issue on how the research can help the outsourcers to win outsourcing contracts.

The literature review suggests that the Zeithaml's gap model is used in analyzing service quality. This research modifies the Zeithaml's gap model to include the expectations and perceptions of the petrochemical companies and outsourcers. A total of twelve hypotheses developed from the gap model were tested on two cases, namely, companies outsourcing partial plant maintenance and total plant maintenance. The outsourcing decision matrix (Figure 5.2) is developed from the data analysis of the hypotheses in Chapter 4.

The outsourcing decision matrix is based on the expectation-perception relationships between the petrochemical companies and outsourcer. To use the matrix, the petrochemical companies input the expectations and perception of each of the critical outsourcing factors. In each of the critical outsourcing factors, the more expectation-perception relationships satisfy the selection matrix, the more likely the success in outsourcing total plant maintenance.

		Column			
		CE	CP	OE	OP
Row	CE	X	<	<	<
	CP	>	X	>	>
	OE	>	<	X	<
	OP	>	<	>	X

Source: Computed from hypothesis testing

CE = Customer expectation CP = Customer perception
OE = Outsourcer expectation OP = Outsourcer perception

Figure 5.2 Outsourcing decision matrix

Similar, the outsourcers can also use this outsourcing decision matrix to examine their strengths and weaknesses based on the expectation-perception relationship. The analogy of using the decision matrix is in order to win the war one has to know the enemy's strategy. If the outsourcers enhance their strengths and improve their weaknesses base on the expectation-perception relationship, they will stand a better chance of winning the outsourcing contracts.

5.3 Conclusion about research problem

Section 5.1 has summarized the research findings that may contribute to the literature knowledge. These contributions in Table 5.1 are related to the three research issues. This section highlights the research findings that are not considered in the literature review but are contributing to the research knowledge. The contributing knowledge that is tabulated in Table 5.2 is identified while carrying out data analysis on the research problem.

The data analysis found that middle managers have a lower service factor perception for companies that have in-house maintenance crews. The literature review mentions that service quality is difficult to define. The research finds that service quality seems to be influenced by the environment. A case to support this argument is Case C8 who transferred their in-house maintenance crew and outsourced its maintenance activities to two outsourcers. The respondents in this company did not mention that the service quality of the outsourcers were below expectations. Therefore, the significance of this research finding is the service quality perceptions by the middle managers may improve if the in-house maintenance crews are transferred.

Table 5.2 Research contributions from research problem

Research Finding	Knowledge Contribution
Service expectation of the middle manager may be lowered if there is no in-house maintenance crew.	Service expectation is not constant but change with the environment
Service expectation may be lowered if the outsourcing maintenance cost saving is high.	Service quality is a balance between expectation and maintenance cost
Outsourcing reason is weaken if the company has in-house maintenance crew	Overall cost saving of all maintenance activities is important to decide outsourcing maintenance.
Local companies tend to outsource maintenance if parent companies practise outsourcing plant maintenance.	Outsourcers may find it easier to convince to convince companies that have policy to outsource plant maintenance.
Many middle managers are not committed to outsourcing maintenance.	For outsourcing to be successful, organization has to "convince" middle managers to be committed to outsourcing.

Source: Compiled from research data analysis

The next research finding is service quality is a balance of maintenance cost and service quality expectations. The management of most of the companies that outsource most of the plant maintenance seems to think the outsourcers meet their expectations. These companies seem to benefit from higher cost reduction because they do not have in-house maintenance crews. On the other hand, the middle managers are not quite happy for companies not outsource some of the plant maintenance. In the case study, there is no evidence that the outsourcers are different. Therefore, the significance of this finding is service quality expectations may be lowered if there are higher cost benefits from outsource plant maintenance.

The literature review mentions that outsourcing reduces costs and is in agreement with the case study that indicates that the outsourcing reason is mainly to reduce maintenance costs. However, the literature review does not mention about the plight of those companies that employ in-house maintenance crews. The case study finds that these companies generally only outsource some maintenance activities. The reason is these companies think the costs of relocating or transferring the in-house maintenance crews are high. Hence, the reduction in maintenance cost through outsourcing may take a much longer time to realize. On the other hand, local companies with parent companies in other countries outsource plant maintenance do not experience any problem in justifying outsourcing (Cases C1 and C5). The significance of this research finding is outsourcers may find it easier to convince new

companies to outsource plant maintenance than older companies that are having in-house maintenance crews. Furthermore, local companies that have policies to outsource maintenance will not need much convincing by the outsourcers.

Lastly, the senior managements of all companies that outsource plant maintenance either totally or partially are committed to outsourcing. Conversely, not all the middle managers are committed to outsourcing. Since the wrong organization culture can lead to outsourcing failure (Corbett 1999; Useem 1998), it is important for the organization to "change" the attitude of the middle managers. The significance in this research finding is the middle managers may be the "weak link" in the success of outsourcing maintenance.

In summary, the research is able to contribute to the knowledge of outsourcing and gone beyond the literature review. Therefore, this knowledge contribution increases the breath and depth of the knowledge of outsourcing.

5.4 Implications for practice and policy

The finding to the research issues are summarized in Sections 5.2 and 5.3. The critical outsourcing factors are service quality and outsourcing risks. The factors that influence service quality and outsourcing risks are contractor experience and outsourcing culture, respectively. This section is to look at the implications of the research finding on the outsourcing practice and Government policies affecting outsourcing.

5.4.1 Implications for outsourcing practice

This section is to explain the implications of the research on the outsourcing practice. Figure 5.2 in this chapter provides an outsourcing selection matrix that helps the petrochemical companies to decide outsourcing total plant maintenance by comparing the expectation-perception relationship of the critical outsourcing factors. This outsourcing matrix need sometime to compute in order to get a more accurate outsourcing decision. An Outsourcing Preliminary Checklist is a simplified checklist developed as shown in Figure 5.3 to help the petrochemical companies to carry out a quick check before embarking on the outsourcing selection matrix.

Table 5.3 Outsourcing preliminary checklist

	Considerations	**Comments** (Yes/To some extent/No)
1	Outsourcer has skilled workers or workers involved in the plant construction	
2	Outsourcer has past experience working on projects or maintenance for the company	
3	Middle managers are committed to outsourcing	
4	Current level of outsourcing is high	
5	Currently company has "skeleton" maintenance crew	
6	**Lesser Importance:** Contract with performance indicators	
7	Good contractor training programme	
8	Company policy to outsource plant maintenance	

The Outsourcing Preliminary Checklist is developed from the research contributions mentioned earlier in Tables 5.1 and 5.2. Items 1 to 5 in the checklist are derived from the service quality and outsourcing risk which are the two critical outsourcing factors.

Items 6 to 8 are derived from other factors that are of lesser importance. The petrochemical company marks "Yes", "To some extent" or "No" against each of the eight items. If the majority of the items are marked "Yes", then the company proceeds to the Outsourcing Decision Matrix (Figure 5.2). Similarly, the outsourcer can also make use of this Preliminary Outsourcing Checklist to quickly assess their probability of winning the outsourcing contract before proceeding to the outsourcing decision matrix.

5.4.2 Implications for government policy

This section is to suggest how the Singapore Government can help to encourage outsourcing total plant maintenance by changing the existing policies or introduce new policies to encourage more maintenance outsourcing. The research has identified the areas of improving the skills of the outsourcer workers and transferring of the in-house maintenance crews that may have impact on the maintenance outsourcing. Figure 5.4 tabulates the implications for the government policies.

The literature review has identified the two Singapore Government initiatives that help the local contractors. One of the initiatives is the training programme for the contractor workers such as the Training and Attachment Programme (TAP) that was started in 1998 and the Local Industry Upgrading Programme (LIUP) that was started in 1995. However, the training programmes may not be sufficient or targeted to a higher skill level. The respondents in the case study have said that the contractor training programmes are not up to their expectations. These companies are doing the next best thing by giving contracts to outsourcers who are hiring workers that were involved in their plant construction. Perhaps, the Government should review these training programmes. The skill training requirements may have changed since the programmes were started almost ten years ago.

Table 5.4 Implications for policies

	Existing Policies	Proposed Policies
1	Contractor training programmes (TAP, LIUP) need improvement	Contractor training programmes include higher maintenance skill training
2	Policy to merge between local and international contractors not effective - quick transfer of skills to local outsourcers	Review existing policy and perhaps include incentives for local contractors to merge with international contractors
3	No policy to encourage international outsourcers to increase the pool of skilled workers	Government set an example by outsourcing maintenance on selected facilities to international contractors. - encourage petrochemical companies to consider outsourcing maintenance to international outsourcers.
4	No policy to encourage outsourcing maintenance	Incentives to petrochemical companies to retrain and transfer in-house maintenance personnel. Incentives for outsourcers to hire maintenance personnel retrenched by petrochemical companies.

Source: Compiled from this research

The second Government initiative is to encourage the local contractors to joint venture with reputable and experienced international contractors to 'boost' the skills of the local contractors. This initiative is one method to quickly improve the maintenance skills of the local outsourcers. However, the literature review suggests that this initiative is not very successful because not many local contractors have joint venture with international contractors.

The research also concludes that it is difficult for the international contractors to win outsourcing contracts because the petrochemical companies tend to give the outsourcing work to contractors that they had experience with in the past. Perhaps, the Government can alter the policies to give incentives for the local companies to merge with international contractors. Another method is for the Government to hire international contractors to maintain some of the Government facilities to convince the petrochemical companies that the risk of outsourcing to these contractors is not high.

The research found that the main objective to outsource plant maintenance is to reduce maintenance costs. Most of the companies that outsource most of their plant activities are companies less than ten-year old and do not have in-house maintenance crews. Many older companies do not realize maintenance cost saving because they

are keeping the in-house maintenance crews. To transfer the maintenance crews or retrench them may be costly to the companies. To reduce the maintenance crews by natural attrition and resignation may take too long a time before these companies outsource total plant maintenance. Perhaps there are two proposals that the Government can help the petrochemical companies. The first proposal is to provide incentives for the companies to retrain and transfer the maintenance personnel to other positions in the organization. The second proposal is to provide incentives for the outsourcers to hire these maintenance personnel. These two proposals may achieve two important objectives, namely, the petrochemical companies are encouraged to outsource total plant maintenance and increase the pool of skilled workers for the outsourcers.

5.5 Limitations

This research is on the outsourcing of plant maintenance in the Singapore petrochemical industry. The research finding may not be accurate on either outsourcing other than maintenance activities or outsourcing maintenance in other industries. The reasons are petrochemical industry is capital extensive and maintenance failure can result in unsafe conditions besides product loss.

The samples used in the case study and research survey provide a good representation of companies that outsource partial and total plant maintenance. Furthermore, the combination of qualitative and quantitative research approaches had provided rigor and validity to the research results.

5.6 Implication for further research

The literature review suggests that operating costs among companies in the petrochemical industry are continuously subjected to scrutiny because of poor profit margins and stiff competitions from the world market. That means the industry has to constantly look for better equipment reliability but at lower maintenance costs. Therefore, the maintenance strategies in this industry will continue to change in the future. The factors that decide outsourcing plant maintenance may also be different in the future. This report has identified four possible cases to support this suggestion. One possible case is the increase in remote maintenance of sophisticated equipment. In future, there will be more sophisticated equipment that can be monitored remotely and fault diagnosis can be carried out remotely. The local petrochemical companies may have a choice either to outsource the maintenance of these equipment to local outsourcers or foreign outsourcers who will be stationed overseas. The risks of outsourcing failure perhaps could be different because the petrochemical companies may have lesser influence on these overseas outsourcers. In addition, the outsourcers are based overseas, the outsourcer culture may also be a critical outsourcing factor. The second possible case is the outsourcers may want to have a share of the saving from reduction in plant maintenance expenditures. The petrochemical companies are continually trying to reduce maintenance costs by pressurizing the outsourcers to come out with innovative methods to improve plant reliability but with lower maintenance costs. If the petrochemical companies have to share the maintenance saving with the outsourcers, new factors may be required to ensure that the outsourcers are fairly compensated. Perhaps, the outsourcing contracts with well defined service expectations may be a critical outsourcing factor. The third possible case is that with the advancement in information technology, new maintenance practices are more easily available. The outsourcers may be required to constantly keep up with the latest maintenance practices. A new set of outsourcing factors may be required to select this type of outsourcers. The last possible case is more foreign outsourcers may compete with the local outsourcers in the plant maintenance

outsourcing market. This globalization leads to keen competition and raise the maintenance skill level of the outsourcers. The local outsourcers may have to change their human resource policies to hire better skilled workers to compete with the foreign outsourcers. Worker training programmes may be taken more seriously by the outsourcers. This situation may also result in a different set of outsourcing factors. Hence, future research has to be conducted to find a new set of critical outsourcing factors because of the possible changes in the outsourcing environment.

Next, there are many theories on service quality and pricing. Some theories say that customers use high price to relate to perceived good service quality. On the other hand, the customers may want to consider the risk if the price difference is large. Therefore, further research is also required to find out how much cost difference between in-house maintenance and outsourcing before the plant maintenance outsourcing industry becomes price sensitive.

Bibliography

Albrecht, D.G. 1998, *"New heights: Today's contract workers are highly promotable",* Workforce, April, pp.42–8.

Al-Hakim, Latif & Xu, Hongliang 2003, "*On work alignment: Do IT professionals think differently?"* In Issues of Human Computer Integration, Sacramento, A. (Ed.), IRM Press, Hershey, USA.

Alison, M. Dean, Christopher Kiu 2002, *"Performance monitoring and quality outcomes in contracted services",* International Journal of Quality & Reliability Management, Vol. 19, No.4, pp.396-413.

Alvesson, M. 1993, Cultural perspectives on organizations, Cambridge University Press, Cambridge.

Alvesson, M., Deetz, S. 1996, "*Critical theory and postmodernism approaches to organization studies"*, in handbook of Organization Studies (Clegg, S., Hardy, C., Nord, W.), Sage Publications, London.

Anderson Consulting 1999, *"Managing the Knowledge Worker",* Best Practice Management, Issue 35, May.

Andreassen, Tor Wallin 1998, *"Customer loyalty and complex services: The impact of corporate image on quality, customer satisfaction and loyalty for customers with varying degrees of service expertise"*, International Journal of Service Industry Management, Vol.9, No.1, pp.7-23.

Apricella, Mario 2002, *"Outsourcing storage is often worth the risk",* Info World, Vol.24, Issue 8, p36.

Avery, Susan 2002, *"Supplier performance is more important than ever",* Informex, February 2002.

Avgerou, Chrisanthi 1995, *"The challenge of BPR to the information systems profession",* New Technology, Work and Employment, Vol.10, No.2, pp.132-141.

Barney, J., 1991, "*Firm resources and sustained competitive advantage*", Journal of Management, Vol.17, No.1, pp.99-120.

Bebko, Charlene Pleger 1998, *"Employee perceptions of 'profiled' customers' expectations"*, Journal of Hospital Marketing, Vol. 12, Issue 2.

Bebko, Charlene Pleger 2000, "*Service intangibility and its impact on consumers expectations of service quality"*, Journal of Services Marketing, Vol. 14, No.1.

Bendor-Samuel, Peter, 1999 *"The Admixture We Know as Outsourcing*", Outsourcing Journal, June, http://www.outsourcing-journal.com/issues/jun1999/index.html.

Bendor-Samuel, Peter 1999a, *"Redefining outsourcing: the value model",* Everest Consulting.

Bendor-Samuel 1999b, *"Avoid a multi-million dollar mistake"* Outsourcing Journal.

Bendor-Samuel, Peter 2002, *"Outsourcing Relationships: Why are they so difficult to manage"*, Outsourcing Journal, January.

Bennett, Andrew, George, A.L. 1997, *"Developing and using typological theories in case study research"*, Paper presented at the International Studies Association Conference, Toronto, March.

Bitner, M. J. 1990, *"Evaluating service encounters: the effects of physical surroundings and employee responses,"* Journal of Marketing, Vol.54, April, pp.69-82.

Blumberg, Donald F 1998, *"Strategic assessment of outsourcing and downsizing in the service industry",* Managing Service Quality, Vol.8, No.1, pp.5-18.

Bo, Khin 1999*, "Rationalisation in refining," Hydrocarbon Asia*, October.

Boing, H 1994, *"The role of a salesperson within a long term buyer-supplier relationship in the industrial market",* Relationship marketing, theory, methods and applications, Research Conference Proceedings, Atlanta.

Bolton, R.N., Drew, J. H. 1991, *"A longitudinal analysis of the impact of service changes on consumer attitudes*", Journal of Marketing, Vol.55, No.1, pp.1-10.

Buttle, Francis 1996, Relationship Marketing: Theory and Practice*,* Paul Chapman, London.

Campbell, John 1995, *"Outsourcing in maintenance management: A valid alternative to self-provision"* International Center of Excellence for Maintenance Management, Toronto, Canada

Carey, R. 1995, *"Consider the outsource"*, Incentive: Performance Supplement, No. 4:4.

Carson, D, Gilmore, A., Gronhaug, K., Perry, C. 2000, Qualitative Research in Marketing*,* Sage, London.

Caspersen, Bruce 2000*, "Outsourcing Mantenance: How it can improve the bottomline",* Plant Engineering*,* Vol. 54, Issue 12.

Clark, Lynn Schofield 2004, *"Critical theory and constructivism",* http://www.colorado.edu/journalism/mcm/qmr-crit-theory.htm.

Corbett, Michael 1998, *"Best Practices in Managing the Outsourcing relationship",* Outsourcing Center*,* http://www.corbettassociates.com/

Corbett, Michael 1999, *"How America's Executives Source their Operations and Why",* The 1999 Strategic Outsourcing Study, Michael Corbett & Associates, Ltd. http://www.corbettassociates.com/resources/researchlibrary/preview/sos1999.asp

Corbett, Michael F. 1997, *"The U.S. Business Revolution*", Outsourcing Journal, Spring.

Corbett, Michael 1997a, "Outsourcing: The New Partnership", Journal of Business Strategy, Issue July/August

Cunningham, J.B., Debrah, Y.A. 1995, "Skills for managing human resources in a complex environment: the perceptions of human resource managers in Singapore", The International Journal of Human Resource Management, Vol.6 No.1, pp.79-101.

Currie, Wendy 1990, New Strategies in It Outsourcing "Outsourcing Gains a Foothold but There is Still Much to Learn,"

Currie, W. 1995, Managing Strategy for IT, Pitman Publishing, London.

Currie, W. and Willcocks, L.P. 1997, "*New Strategies in IT Outsourcing: Major Trends and Global Best Practice",* Report, Business Intelligence Ltd, London, December.

Dabholkar, P.A. 1995, *"Contingency framework for predicting causality between customer satisfaction and service quality,"* in Sujan, M. and Kardes, F. (Eds), Advances in Consumer Research, Vol.22, pp.101-8.

Debrah, Y.A. 1994, *"Management of operative staff in a labour-scarce economy: the views of human resource managers in the hotel industry in Singapore"*, Asia Pacific Journal of Human Resources, Vol.32, No.1, pp.41-60.

Deming, W. 1986, "Out of the crisis", MIT Centre for Advanced Engineering Study, Cambridge, Massachusetts.

Denscombe, M. 1998, The good research guide for small-scale social research projects, Philadelphia: Open University Press.

Dick, B. 1990, *Convergent interviewing, Interchange,* Brisbane, Australia.

Doherty, Sean 2002, *"Let's make a deal,"* Network Computing, Vol.13, Issue 8, pp.52-57.

Downey, Jane Marie 1995, "*Risks of outsourcing – applying risk management techniques to staffing methods*", Facilities Vol.13, No.9/10, August, pp.38–44.

Dunn, Sandy *"Maintenance outsourcing: Critical issues",* http://www.plant-maintenance.com/outsourcing_crit_issues.shtml#section1

Easterby-Smith, M., Thorpe, R., Lowe, A. 1991, Management Research: An Introduction, Sage, London.

Edvardsson, Bo 1998, *"Research and Concepts: Service Quality Improvement*", The Managing Service Quality, Vol.8, No.2, pp.142-149

Edwards, David, J.A. 1998, *"Types of case study work: a conceptual framework",* Journal of Humanistic Psychology, Vol.38, Issue 3, pp.36-71.

Eisenhardt, K.M. 1989, "Building theories from case study research", *Academy of Management Review*, Vol. 14, No. 4, pp. 532-50.

Embleton, P.R., Wright, P.C., 1998, "*A practical guide to successful outsourcing*", Empowerment in Organizations, Vol.6, No.3, pp.94-106.

Ericsson, J. and Dahlén, P. 1993, *"Disruption reduction – an important tool in order to reach just in time",* Internal report, Department of Production and Materials Engineering, Lund University.

Evans, J. & W. Lindsay. 2002. The Management and Control of Quality, 5th ed. Cincinnati, OH: South-Western.

Fierro, Julie 2003**, "**Quantitative Research", http://www2.gsu.edu/~mstswh/courses /it7000/ papers/quantita.htm

Finchem, Kirk J 1997, *"Contract maintenance benefits hinge on management's focus",* Pulp & Paper, July Vol.71, Issue 7, pp.71-75.

Flick, U. 1998, An Introduction to Qualitative Research, London: Sage Publications Ltd.

Friday, Stormy 2005, *"Avoiding culture clash: Forming successful outsourcing relationships"*, FacilitiesNet, http://www.facilitiesnet.com/bom/article.asp?id=2569

Forst, L.I. 1999, *"Outsourcing: you get what you ask for"*, Journal of Business Strategy, Vol.20, No.1, May/June, pp.11-14.

Gable, G. 1994, *"Integrating Case Study and Survey Research Methods: An Example in Information Systems",* European Journal of Information Systems, Vol. 3, No.2, pp.112-126.

Gerald Woon 1999, Singapore Economic Development Board Report

Gilmore, A., Carson, D. 1996, "*Integrative qualitative researching a services context",* Marketing Intelligence and Planning, Vol.14, No.6, pp.21-26.

Glaser, B. G., Strauss, A.L. 1967, The Discovery of Grounded Theory, Aldine, Chicago, IL.

Godfrey, P.C., Hill, C.W.L. 1995, *"The problem of unobservables in strategic management research",* Strategic Management Journal, Vol.16, pp.519-533.

Goolsby, Kathleen 2002, *"Accenture and BP partnership in accounting"*, Outsourcing Journal, February.

Gronroos, C. 1982, *"Strategic Management and Marketing in the Service Sector"*, Swedish School of Economics and Business Administration, Helsingfors.

Greer, C.R., Youngblood, S.A., Gray, D.A., 1999, "*Human resource management outsourcing: the make or buy decision*", The Academy of Management Executive, Vol.13, No.3, pp.85-92.

Gronroos, C 1990, *"Relationship Approach to Marketing in Service Contexts"*, Journal of Business Research, Issue 20.

Gronross, C 1990, *"Marketing Redefined*", Management Decision, Vol.28, No.8, pp.5-9.

Gronroos, C. 1991, *"The marketing strategy continuum: Toward a marketing concept for the 1990s"*, Management Decision, Vol. 29, pp.7-13.

Gronroos, C. 1998, *"Marketing services: the case of a missing product*", The Journal of Business & Industrial Marketing, Vol. 13, Issue. 4/5, pp.322-338.

Guba, E.G., Lincoln, Y.S. 1994, The Landscape of Qualitative Research: Theories and Issues, Thousand Oaks, CA, Sage.

Gummesson, E. 1994, *"Is relationship marketing operational?"*, A paper presented at the 23rd conference of the European Marketing Academy Marketing its Dynamics and Challenges, May 17-20.

Gummesson, E. 1994, *"Service management: an evaluation and the future"*, International Journal of Service Industry Management, Vol.5, No.1, pp.77-96.

Haas, R.W. 1989, Industrial Marketing Management, PWS-Kent Publishing, Boston, MA.

Herriott, R.E., Firestone, W.A. 1983, *"Multi-site qualitative policy research: Optimizing description and generalizability"*, Educational Research, Vol.12, pp.14-19.

Hill, Edward W., Brennan, John F. 2000, *"A methodology for indentifying the drivers of industrial clusters: The foundation of regional competitive advantage,"* Economic Development Quarterly, Vol.14, No.1.

Hirschheim, Rudy 1999, Myths, Metaphors and Realities: Beyond the Information Systems Outsourcing Bandwagon, J. Wiley & Sons.

Holmlund, M., Kock, S. 1995, *"Buyer perceived service quality in industrial networks"*, Industrial Marketing Management, Vol.24, pp.109-21.

Horkheimer, M. 1982. *Critical Theory*. New York: Seabury Press.

Horna, J. 1994, *The study of leisure*. Oxford: Oxford University Press.

Idhammar, Christer 1999, *"To contract maintenance or not?*", Pulp & Paper, October, Vol.73 Issue 10, pp.33.

Jayaratne, T. 1993, Quantitative methodology and feminist research. In M. Hammersley (Ed.), *Social research: Philosophy, politics and practice* (pp. 109-123). London: Sage.

Jennings, David 2002, *"Strategic sourcing: benefits, problems and a contextual model",* Management Decision, Vol.40, No.1.

Johnson, Gerry, Scholes, Kevan 1993, Exploring Corporate Strategy – Text and Cases, Prentice Hall, 3rd ed. 1993.

Jones, Ian 1997, *"Mixing qualitative and quantitative methods in sports fan research*", The Qualitative Report, Vol. 3, No. 4.

Jonsson, Patrik 1997, *"The status of maintenance management in Swedish manufacturing firms",* Journal of Quality in Maintenance Engineering, Vol.3, No.4, pp.233-258.

Kay, John 1993, *"The structure of strategy",* Business Strategy Review. Vol.4, pp.17-37.

Kay, John 1995, Foundations of Corporate Success – How Business Strategies Add Value, Oxford University Press

Kellner, Douglas 1989, Critical Theory, Marxism, and Modernity, Cambridge and Baltimore: Polity Press and John Hopkins University Press.

Kellner, Douglas 2004, *"Critical theory today: Revisiting the classics",* http://homepage newschool edu/~quigleyt/vcs/kellner.html

Khatri, Naresh 1999, *"Emerging issues in strategic HRM in Singapore*", International Journal of Manpower, Vol.20, No.8, pp.516-529.

Khatri, N. 1998, *"Strategic HR practices in Singapore"*, HR Review, Vol.7, pp.14-15.

Khatri, N., Budhwar, P.S. 2002, "*A study of strategic HR issues in an Asian context",* Personnel Review Vol.31, No.2, pp.166-188.

Klein, P. 1999, *"Outsourcing's third wave"*, Information Week, Issue 761, November, pp. 126-7.

Koh, William L., Lay Keow Yer 2000, *"The impact of the employee–organization relationship on temporary employees' performance and attitude: testing a Singaporean sample*", International Journal of Human Resource Management, Vol.11-2, pp.366-387

Kotler, Philip 1994, Marketing Management: Analysis, Planning, Implementation and Control, 8th ed., Prentice-Hall, Englewood Cliffs, USA.

Laabs, Jennifer 1998, *"The dark side of outsourcing",* Workforce, September, Vol.77, Issue 9.

Lacity, M.C., Willcocks, L.P., Feeny, D.F. 1995, "*IT outsourcing: maximize flexibility and control*", Harvard Business Review, Vol.73, No.3, pp.84-93.

Lado, A.A., Wilson, M.C. 1994, *"Human resource systems and sustained competitive advantage: a competency-based perspective"*, Academy of Management Review, Vol.19 No.4, pp.699-727.

Lankford, W.M., Parsa, F. 1999, "*Outsourcing: a primer*", Management Decision, Vol.37, No.4, pp.310-16.

Lee, A. S. 1991, *"Integrating Positivist and Interpretive Approaches to Organizational Research"*, Organization Science, Vol.2, No.4, pp.342-365.

Lehtinen, U.,Lehtinen, J.R. 1991, *"Two approaches to service quality dimensions"*, The Service Industry Journal, Vol.11, No.3, pp.287-303.

Levitt, T. 1981, ``*Marketing intangible products and product intangibles''*, Harvard Business Review, Vol.59, pp.94-102.

Lewis, R.C., Booms, B.H. 1983, *"The marketing aspects of service quality,"* in Berry, L., Shostack, G., Upah, G. (Eds), "*Emerging Perspectives on Services Marketing"*, American Marketing Association, Chicago, IL, pp.99-107.

Liebscher, P. 1998, "Quantity with Quality? Teaching Quantitative and Qualitative Methods in an LIS Master's Program." Library Trends.

Lincoln, Y.S., Guba, E.G. 1985, Naturalistic Inquiry, Sage, London.

Lovelock, Christopher and Wright, Lauren 1999, *Principles of Service Marketing and Management,* Englewood, Cloffs, NJ, Prentice Hall.

Madhavan, R., Shah, R.H., Grover, R. 1994, *"Relationship Marketing: An Organizational Process Perspective"*, in: Sheth, J:N., Parvatiyar, A., Relationship Marketing: Theory, Methods and Applications, Emory University.

Malmholt, O. 1990, *"Produktionsstörningar, människan och tekniken",* UTC-meddelande nr 4, UTC, Stockholm.

Marsh, P., Rosser, E., Harre, R. 1978, *The rules of disorder,* London: Routledge and Kegan Paul.

Mazur, Laura 1999, *"Why marketing is too important for outsourcing marketing",* Haymarket, July, pp.16.

McKenna, R. 1991, Relationship Marketing – Successful Strategies for the Age of the Customer, Addison-Wesley, Reading, MA.

McLaughlin, C. H.1996, *"Implications of Global Change: Technology Education's Role."* Technology Teacher, Vol.55, No.5, February, pp.14-18.

McMillan, J. 1990, "*Managing suppliers: incentive systems in Japanese and US industry"*, California Management Review, Vol.32, No.4, pp.38-55.

Merriam, S.B. 1988, Case Study Research in Education: A Qualitative Approach, San Francisco, CA: Jossey-Bass Publishers.

Miles, M.B., Huberman, A. M. 1994, Qualitative Data Analysis: An Expanded Sourcebook, 2nd ed., Thousand Oaks, CA: Sage.

Millett, B. 1998, "*Managing the Processes of Organisational Change and Development: Study Book",* University of Southern Queensland.

Ministry of the Environment, Singapore 1998, *Annual Report*, http://www.env.gov.sg/info/ar98/index.html

Morris, L.L., Fitz-Gibbon, C.T., Freeman, M.E. 1987, How to communicate evaluation findings, Newbury Park, CA: Sage.

Mullin, Rick 2002, *"Few follow DuPont in outsourcing",* Chemical Week, February 6 Issue

Murray, Janet Y., Kotabe, Masaaki 1999, *"Sourcing Strategies of U.S. Service Companies: A Modified Transaction-Cost Analysis,"* Strategic Management Journal, Vol. 20, pp.791-809

Myers, Michael 1997, *"Qualitative Research in Information Systems",* MISQ Discovery, June 1997

Nau, D. 1995, "*Mixing Methodologies: Can Bimodal Research be a Viable Post-Positivist Tool?*" The Qualitative Report Vol. *2* No.3.

Nayak, P.R, Garvin, D.A., Maira, A.N., Bragar, J.L. 1995, *"Creating a Learning Organisation",* in Prism, The Learning Organisation: Making it Happen, Making it Work, Third Quarter, Arthur D. Little, Cambridge, USA

Nowlan, Bob 2001, University of Wisconsin-EauClaire, http://www.uwec.edu/ ranowlan/ intr_whystudy_crit_thy.htm

Nueman, W.L. 1994, Social Science Research Methods Qualitative and Quantitative Approaches, Allyn and Bacon, Boston.

Oliver, R.L. 1981, *"What is customer satisfaction?"*, The Wharton Magazine, Spring, pp.36-41.

Parasuraman,A., Zeithaml, V.A., Berry, L.I. 1985, A Conceptual Model of Service Marketing.

Parasuraman, A., Zeithaml, V., Berry, L. 1988, *"SERVQUAL: A multiple Item scale for measuring consumer perceptions of service quality"*, Journal of Retailing, Vol.64, Spring, pp.12-40.

Patton, M.Q. 1990, Qualitative Evaluation and Research Methods, Sage, Newbury Park, California.

Payne, Adrian, Martin Christopher, Moira Clark 1995, Relationship Marketing for Competitive Advantage: Winning & Keeping Customers, Butterworth Heinemann, UK.

Peppers, Don, Martha Rogers 1999, *"Is Your Company Ready for One-to-One Marketing?"* Harvard Business, Jan/Feb, Vol.77 Issue 1, p151.

Perry, C. 1998, *"Processes of a case study methodology for postgraduate research in marketing",* European Journal of Marketing, Vol.32, No.9/10, pp.785-802.

Perry, C., Riege, A., Brown, L. 1999, "*Realism's role among scientific paradigms in marketing research",* Irish Marketing Review.

Pizam, A. 1994, *"Planning a tourism research investigation",* in Travel, Tourism and Hospitality Research, eds J.R.B. Ritchie and C.R. Goeldner, John Wiley and Sons, New York, pp.91-104.

Porter, M.E. 1980, Competitive Strategy: Techniques for Analyzing Industries and Competitors, Macmillan, New York, NY.

Porter, Michael 1985, Competitive Advantage: Creating and Sustaining Superior Performance, The Free Press, New York.

Porter, Michael 1998, "Location, competition, and economic development: local clusters in a global economy," et al.

Prahalad, C.K., Hamel, Gary 1990, *"The core competence of the corporation",* Harvard Business Review, May-June Issue.

Price Waterhouse Cooper 1999, *"What is business process outsourcing?"* Quality and its Implications for Future Research, Journal of Marketing, Vol.49, pp.41-50.

Putnam, Linda L. 1983, *"The interpretive perspective: An alternative to functionalism",* in Communication and Organizations: An Interpretive Approach, Ed. Linda L. Putnam and Michael Pacanowsky. Beverly Hills, CA: Sage, pp. 31-54.

Pyman, G., 1998, *"Outsourcing, relationship, integration, empowerment: a case study of maintenance contracting at South East Water Ltd",* Proceeding of the 3rd International Conference of Maintenance Societies, Adelaide, Australia, pp1-6.

Quinn, J.B., Hilmer, F.G. 1994, *"Strategic Outsourcing,"* Sloan Management Review, pp.42-55.

Quinn, J.B. 1999, *"Strategic outsourcing: leveraging knowledge capabilities"*, Sloan Management Review, Vol.40, No.4, Summer, pp.9-22.

Redding, J. 1997, *"Hardwiring the Learning Organisation",* Training and Development, Vol.51, No.8, pp.61-67.

Reed, D. 1999, *"Stakeholder management theory: A critical theory perspective",* Business Ethics Quarterly, Vol.9, No.3, pp.453-483.

Reilly, Peter, Tamkin, Penny 1996, IES Report, Issue 320, UK.

Remenyi, D., Williams, B., Money, A., Swartz, E. 1998, Doing Research in Business and Management, Sage Publications.

Rich, Hebert 1999, *"Call center outsourcing is changing the way that financial institutions communicate with their customers and better customer loyalty,"* TeleServices News, August, p.16.

Robertson, J., 1999, *"Precision maintenance requires diagnostic skills and hands-on skills",* Strategic Work Systems, www.swspitcrew.com/html/march_99.html.

Robson, C. 1993, Real World Research: A Resource for Social Scientists and Practitioner-Researchers, London: Blackwell.

Romano, C.A. 1989, *"Research strategies for small business: a case study approach"* International Small Business Journal, Vol.4, pp.35-43.

Rosen, Deborah and Surprenant, Carol 1998, *"Evaluating relationships: Are satisfaction and quality enough?"* International Journal of Service industry Management, Vol.9, No.2, pp.103-125.

Ross, John 1999, "*Ways of approaching research: Quantitative Designs*", http://www.fortunecity.com/greenfield/grizzly/432/rra2.htm

Roughton, J.E. 1995, *"Contractor safety"*, Professional Safety, January Issue

Schatzman, L. and Strauss, A. 1973, Field Research, Englewood Cliffs. NJ: Prentice Hall.

Sekaran, U. 1992, The Hallmarks of Scientific Research: Research Methods of Business, John Wiley, USA.

Senge, P. 1996, *"Leading Learning Organisations"*, Executive Excellence, Vol.13, No. 4, pp.10-11.

Shemwell, D.J., Yavas, U., Bilgin, Z., 1998, "*Customer-service provider relationships: an empirical test of a model of service quality, satisfaction and relationship oriented outcome*", International Journal of Service Industry Management, Vol.9, pp.155-68.

Singapore Economic Development Board, January 2000

Singapore Ministry of Trade and Industry 1998, Committee on Singapore's Competitiveness, Singapore National Publishing.

Singapore Statistics 2004, Singapore Departments of Statistics.

Stake, R.E. 1994, *"Case studies"*, in Handbook of Qualitative Research, Denzin, N.K. and Lincoln, Y.S, Sage, Thousand Oaks, CA.

Stanton, Alex 1999, *"Can only consultants be 'strategic'?"* Brandweek, Vol.40, Issue 27, p19, New York, USA.

Starkey. K. 1996, How Organisations Learn, International Thomson Business Press,

London.

Straub, Detmar 1999, *"Considering all the costs"*, Georgia State University http://www.outsourcing-academics.com/html/acad12.html,

Strout , Erin 1999, *"Expert for hire"*, Sales and Marketing Management, Vol.151, Issue 8, p74, New York.

Swarts, Katherine 2003, "Manufacturing the Future", Outsourcing Center Journal, January 2003 issue.

Teas, R.K. 1993, "Expectations, performance evaluations and consumers' expectation of quality," *Journal of Marketing*, Vol. 57, October, pp 18-34.

Tellis, Winston 1997, *"Application of a case study methodology"*, The Qualitative Report, Vol.3, No.3, September.

Thilander, M. 1992, *"Some observations of operation and maintenance in two Swedish firms"*, Integrated Manufacturing Systems, Vol.3, No.2, pp.24-31.

Tilley, Kate 1999, *"Outsourcing brings benefits, risks"*, Business Insurance Chicago, Vol.33, Issue 50, p32.

Tomlingson, P.D. 1993, "*Effective Maintenance – The Key to Profitability"*, Van Nostrand Reinhold Company, New York, NY.

Trade Development Board, Singapore 1999, *"The next frontier for Singapore's logistics industry".*

Tripp, David 1992, "*Critical theory and educational research*", Educational Research, Vol.2, No.1, pp.13-23.

Trochim, W. 1989, *"Outcome pattern matching and program theory",* Evaluation and Program Planning, Vol.12, pp.355-366.

Tsang, Albert, 1995, "*Condition-based maintenance: tools and decision making*", Journal of Quality in Maintenance Engineering, Vol.1, No.3, pp.3-17.

Tsang, Albert 2002, *"Strategic dimensions of maintenance management",* Journal of Quality in Maintenance Engineering, Vol.8, No.1, pp.7-39.

Tsoukas, H.1989, *"The validity of idiographic research explanations",* Academy of Management Review, Vol.24, No.4, pp.551-61.

Tsui, A.S., Pearce, J.L., Porter, L.W., Tripoli, A.M. 1997, *"Alternative Approaches to the Employee–Organization Relationship: Does Investment in Employees Pay Off?",* Academy of Management Journal, Vol.40, No.5.

Tung, Rosalie L. 1984, Business Negotiations with the Japanese, Lexington Books, Lexington, MA.

Unland, Mark and Brian Kleiner, 1996, *"New development in organising around core competences"*, Work Study, Vol. 45, No.2.

Usunier, Jean-claude 1993, International Marketing: A Cultural Approach, Prentice Hall, UK.

Useem, Michael 1998, *"Lateral leadership for organizations that are outsourcing",* May Edition, Executive Search

Useem, Michael 2000, "*Leading Laterally in Company Outsourcing*", Sloan Management Review , Vol.41, Issue 2, p25

Venkatesan, R., 1992, "*Strategic outsourcing: to make or not to make*", Harvard Business Review, Vol.70, No.6, pp.98-107.

Vercillo, Tony 1999, "Maintenance outsourcing for the new millennium", Food Distributor Magazine, May/June.

Walton, Dorothy 1993, "*Getting outsourcing business*", Journal of Property Management, Sept/Oct.

Walton. R.E. 1985, *"From control to commitment in the workplace"*, Harvard Business Review, March-April, pp.77-84.

Watson, P., 1998, *"Performance specified maintenance contracts - why it is better for a client to specify desired results rather than how to achieve them",* Proceeding of the 3rd International Conference of Maintenance Societies, Adelaide, Australia, pp.1-9.

White, Robert 1999, "*IT outsourcing: The next generation*", Lucidus Management Technologies, http://www.lucidus.co.uk/

Widget, Finn, 1999, "*Your head in someone else's hands*", Director, Vol.53, Issue 1, pp65-66.

Willcocks L., Fitzgerald, G. 1993, *"The outsourcing of information technology and services: Case evidence from the UK"*, paper for the Outsourcing Information Systems Services Conference, Dreinerburght, University of Twente, The Netherlands.

Willcocks L. and Fitzgerald, G. 1994, *"A business guide to outsourcing information technology"*, A Study of European Best Practice in the Selection, Management and Use of External IT Services, Business Intelligence Ltd, Wimbledon, London, pp.372.

Williamson, R.M., 2000, "Maintenance training 2000: time is running out! Are you ready?" http://www.swspitcrew.com/html/jan_00.html.

Winegardner, K.E. 2000, "*The case study method of scholarly research*", Graduate School of America, http://www.tgsa.edu/online/cybrary/case1.html.

Wireman, T. 1990, "*World Class Maintenance Management",* Industrial Press Inc., New York.

Wolcott, H.F. 1995, The Art of Fieldwork, Walnut Creek, CA: Altamira.

Yin, R.K. 1994, "*Case Study Research: Design and Methods",* Applied Social Research Methods Series Vol.5, 2nd ed., Sage, Newbury Park. CA.

Yin, R.K. 1998, *"The abridged version of case study research: design and method",* Handbook of Applied Social Research Methods, Thousand Oaks, CA: Sage.

Zeithaml, V.A., Bitner, M.J. 1996, Services Marketing, McGraw-Hill, Malaysia.

Zeithaml, V.A., Parasuraman, A., Berry, L.L. 1990, Delivering Quality Service: Balancing Customer Perceptions and Expectations, Free Press, New York, NY.

Zikmund, W. G. 1997**,** Business Research Methods, The Dryden Press, New York.

Appendix 1.1

Petrochemical companies on Jurong Islands

1	ExxonMobil
2	Singapore Refining
3	Asahekasei Tenac Singapore Pte Ltd
4	Celanese Singapore Pte Ltd
5	Chemical Industries (Far East) Pte Ltd
6	Chevron Chemical (Far East) Pte Ltd
7	Croda Singapore Pte Ltd.
8	Denka Singapore Pte. Ltd.
9	Du Pont Singapore Pte Ltd.
10	Eastman Singapore Pte Ltd.
11	Lonza Singapore Ptel Ltd.
12	Mitsui Bisphenol Singapore Pte Ltd
13	Poval Singapore Pte Ltd
14	Seraya Chemicals Singapore Pte Ltd
15	Singapore Syngas Pte Ltd
16	Teijin Polycarbonate Singapore Pte Ltd
17	Petroleum Corporation of Singapore
18	Ethoxylates Manufacturing Pte Ltd
19	Ethylene Glycols Singapore Pte Ltd
20	Kureha Chemical Singapore Pte Ltd
21	Philips Petroleum Singapore Pte Ltd
22	Tetra Chemicals Singapore Pte Ltd
23	The Polyolefin Company Singapore Pte
24	Denka Singapore Pte. Ltd.(Carbon Black)
25	Sumitomo Chemical Singapore Pte Ltd
26	Singapore Acrylic Pte Ltd
27	Singapore Acrylic Ester Pte Ltd
28	Singapore MMA Monomer Pte Ltd
29	Sumika Glacial Acrylic Pte Ltd
30	ExxonMobil Chemicals
31	Singapore Aromatics Company Pte Ltd
32	Infenium Singapore Pte Ltd

Appendix 1.2

Outsourcing Companies Servicing Petrochemical Industry

	Outsourcing Companies	Contracting Company Nationality	Type of outsourcing contract
1	Honeywell Rotary	Joint venture between local & US companies	2, 3
2	PEI	Joint venture between local & Japanese companies	2, 3
3	Mun Siong-Stork	Joint venture between local & US companies	2, 3
4	Hiap Seng-Fisher Rosemount	Joint venture between local & US companies	2, 3
5	Hai Leck	Joint venture between local & European companies	2
6	ABB Brown Bovare	Multinational company from Sweden	2
7	Siemens	Multinational company from Germany	2

Note:
These companies are vying for total plant maintenance contracts in the petroleum and chemical industries.

Outsourcing Types:
1 Plant maintenance carried out by in-house maintenance staff.
2. Most of the plant maintenance carried out by in-house maintenance staff. Only specialised equipment are outsourced and contract workers are hired when workloads are heavy.
3. Outsource all plant maintenance activities but using in-house maintenance staff to do maintenance planning and monitoring.
4. Outsource total plant maintenance. No in-house staff to manage maintenance activities.

Appendix 3.1

Pilot Study: Interviewing Questions

CASE 1

A) Outsourcing Strategy

1. What are the main reasons that petrochemical companies outsource plant maintenance? What are the significant differences in outsourcing reasons between different groups of companies?

C1S1 The primary objective is to reduce operating costs. Outsourcing is practised by the parent company in Germany.

C1S2 Outsourcing not only reduces maintenance costs but also reduce cost in hiring maintenance crew. The company had saved effort and money by not interviewing and hiring the maintenance crew. Furthermore, without the in-house maintenance crew, the Human Resource Department has lesser employees to take care.

C1S3 There was not much effort to convince the parent company that the Singapore company is outsourcing plant maintenance. Conversely, the local management would have a difficult time to convince the parent company if the Singapore company wanted to employ its own maintenance crew.

2. What is the expected outsourcing duration?

C1S4 Since the plant does not have a maintenance crew, the plant has depended on the outsourcer to provide plant maintenance. The plan is to continue to use the existing outsourcer as long as they can do a good job in maintaining the plant.

C1S5 This outsourcing contract is only for two years but there is a provision to extend by the customer. The reason is the customer does not have sufficient experience with the outsourcer on plant maintenance.

C1S6 The two-year outsourcing duration will ensure that the contractor is "on their toes" and put in the extra effort to meet the customer's service quality expectations.

C1Q1 The benefits of using the same outsourcer for a long time is not to lose the field experience that the contractor has acquired over time. Secondly, the contractor would be more willing and motivated to invest in hiring more and

Appendix 3.1 (Continued)

Pilot Study: Interviewing Questions

better workers and tools if there is an understanding that they will continue to maintain the plant if their service meet the customer expectations.

B) Service Quality

3. What is the perception of the contractor service quality?

C1Q2 The contractor does not meet the customer service quality expectations. The contractor just responded to complaints by the Operations Department on plant equipment problems. However, there is no formal written expectations on the service quality expectations. The main reason is we (the customer) are not sure what are the performance indicators to use.

4. What are the significant differences in service expectations for different groups of petrochemical companies (size, type of petrochemical business, nationality, etc.)?

C1Q3 There are different service quality expectations between different companies. The larger the companies, the higher the service quality expectations because these companies have the "muscles" to demand the service level.

C1Q4 The more established companies would have the plant maintenance history and experience to decide on the excepted equipment performance level. Since this company is new, it is difficult to set the performance level. It could be too stringent and not achievable.

5. What are the differences between the management perceived service quality versus actual quality?

C1Q5 The contractor worker training program is not up to the expectation. Most of the workers are not well trained. The contractor did not have an acceptable training program. Poorly trained and low paid workers would lead to poor service quality.

Appendix 3.1 (Continued)

Pilot Study: Interviewing Questions

C1Q6 Most of the contractor workers are more experienced with construction than maintenance work. The reason is the contractor is not able to hire enough workers with maintenance experience.

6. How is the contractor's corporate image affects the outsourcing decision?

   How the petrochemical companies gauge the service providers' corporate images?

C1Q7 Contractor reputation certainly played an important part in selection of the outsourcer. However, reputation alone does not guarantee outsourcing success. Therefore, the customer has given the outsourcing contract to the contractor that helped to construct the plant. The customer felt that since the contractor workers installed the equipment, they should be in a better position to maintain them.

C1Q8 The customer gauged the outsourcer's corporate image by references from other that had used their services. In addition, resume of past experience was also considered.

7. How important is the petrochemical companies consider the contractor skill-training program in gauging the worker quality?

C1Q9 The customer definitely felt that the contractor worker training was important to improve the service quality. Therefore, training was one of the factors in deciding the outsourcer.

8. How extensively the outsourcer makes use of construction workers and temporary workers in plant maintenance? Do these workers meet the petrochemical companies' expectations?

C1Q10 The outsourcer is making use of construction workers extensively. This is not ideal but there is a lack of experience maintenance workers in the market. Furthermore, the customer consciously hired the construction workers to maintain the plant because they know the plant better.

Appendix 3.1 (Continued)

Pilot Study: Interviewing Questions

C) Management

9. What is the level of outsourcing?

C1M1 The whole plant maintenance has outsourced plant maintenance. The company did not hire maintenance workers. However, manager and supervisors are hired to oversee the outsourcer.

10. What is the extent of the organization multi-level commitment towards outsourcing of plant maintenance? (Literature review suggests that multi level relationship is important to the success of outsourcing).

C1M3 Yes. There is high level of commitment by the top and middle management. The outsourcer management also shows total commitment to the success of the plant maintenance.

C1M4 Outsourcing is definitely long-term. The reason is there is no in-house maintenance crew.

D) Risk

5. How important is the risk of plant maintenance failure in the outsourcing decision process?

C1R1 Unreliable plant can result in productivity loss. The local company has to report to the Headquarter in Germany if the plant production loss is high. Therefore, risk of outsourcing failure is very important.

C1R2 Another risk of maintenance failure is it is difficult to get additional help in straightening the plant condition because there is no in-house maintenance crew.

Appendix 3.1 (Continued)

Pilot Study: Interviewing Questions

6. How do the petrochemical companies mitigate their risk of plant maintenance outsourcing failures?

   What are the significant differences in risk of over-dependence of contractors, hidden costs of outsourcing between different groups of companies?

C1R3 The management recognizes the risk of outsourcing failure. Firstly, the company mitigates the risk by hiring a few maintenance supervisors to monitor the outsourcer work quality. Secondly, the contractor that had constructed the plant is hired to maintain the plant.

C1R4 The company could have prevent a potential higher maintenance cost over time by having a longer contract period.

C1R5 Those companies that are having a in-house maintenance crew would be in a better position to mitigate outsourcing failure.

7. How are the outsourcing contracts written to mitigate the risk of failure?

   What are the significant differences in contracts that have performance indicators among the different companies?

   What extent the difficulty in drafting outsourcing contracts prevented some companies to outsource plant maintenance?

C1R6 Generally, the outsourcing contract is quite similar to the conventional service contracts. However, the contract does not include quantifiable service quality. Therefore, there is potential problem when the contractor challenges the perceived service quality. The two-year contract period is one way to mitigate outsourcing failure.

C1R7 The difficulty of drafting contract should not hold up the process of outsourcing if it is important enough to the organization.

8. How important is the service contract to your company?

   Are those companies that outsource plant maintenance had proper contracts with structured performance measurements that hold the outsourcer accountable?

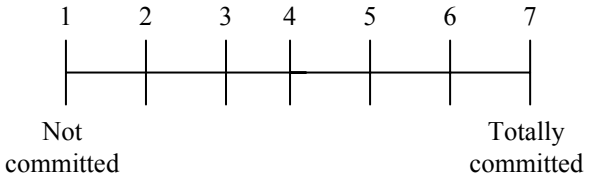
C1R8 A good service contract with the necessary performance indicators would help in ensuring no misunderstanding with the contractor. However, a good contract cannot guarantee contractor performance.

C1R9 Not many companies have outsourcing contracts that include performance measurements. The most common reason was they are not sure what performance indicators to include in the contracts.

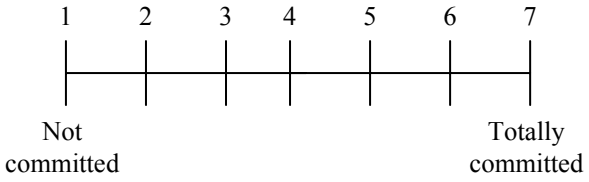
Appendix 3.2

Pilot Study: Research Survey Questionnaires

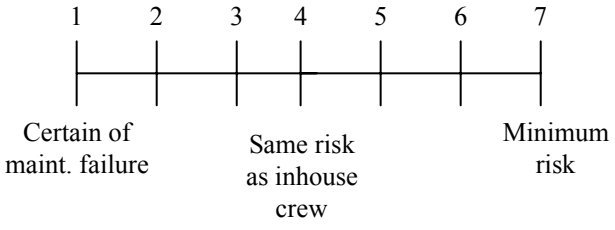
(1) Is the company Senior management commitment to outsourcing activities?



(2) Is the company middle management commitment to outsourcing activities?



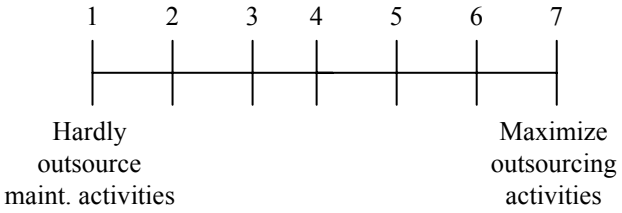
(3) What do you think is the risk in outsourcing plant maintenance?



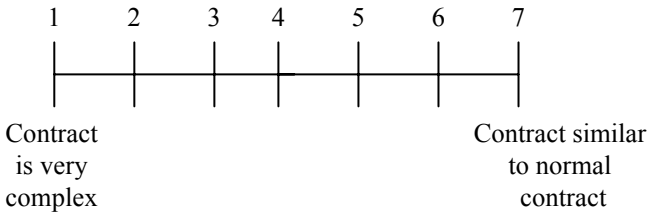
Appendix 3.2 (Continued)

Pilot Study: Research Survey Questionnaires

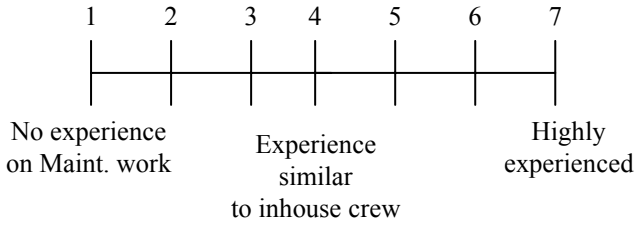
(4) What do you think is the current level of outsourcing maintenance activities?



(5) What is the complexity of the outsourcing contract?



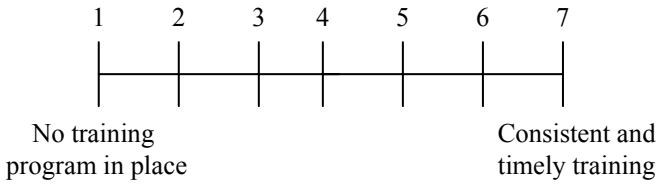
(6) What do you think is the contractor workers' experience level?



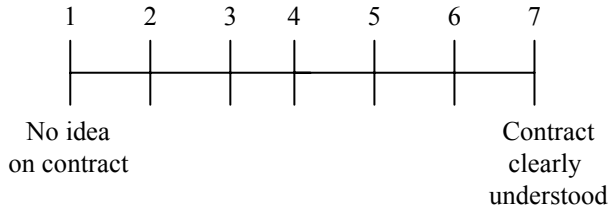
Appendix 3.2 (Continued)

Pilot Study: Research Survey Questionnaires

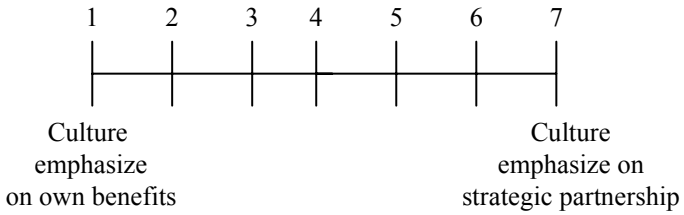
(7) What do you think of the training program for contractor workers?



(8) Do the workers understand the workscope in the outsourcing contract?



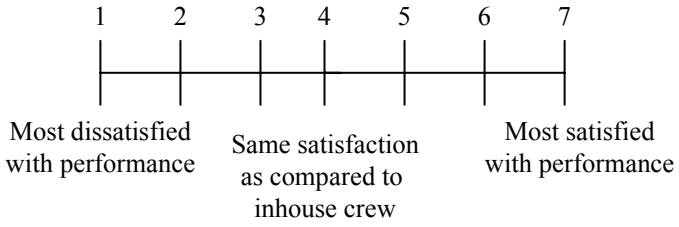
(9) Is the company's organization culture committed to outsourcing?



Appendix 3.2 (Continued)

Pilot Study: Research Survey Questionnaires

(10) How is the satisfaction level of maintenance outsourcing in the company?



Appendix 3.3

Research Case Study Interviewing Questions

(A) Service Quality

1. What is the perception of the contractor service quality?

10. What are the significant differences in service expectations for different groups of petrochemical companies (size, type of petrochemical business, nationality, etc.)?

3. How does the contractor's corporate image affect the outsourcing decision?

   How do the petrochemical companies gauge the service providers' corporate images?

(B) Contractor Worker Experience

4. How extensively the outsourcer makes use of construction workers and temporary workers in plant maintenance? Do these workers meet the petrochemical companies' expectations?

(C) Outsourcing Contracts

9. How are the outsourcing contracts written to mitigate the risk of failure?

   What are the significant differences in contracts that have performance indicators among the different companies?

   What extent the difficulty in drafting outsourcing contracts prevented some companies to outsource plant maintenance?

Appendix 3.3 (Continued)

Research Case Study Interviewing Questions

10. How important is the service contract to your company?

    Are those companies that outsource plant maintenance had proper contracts with structured performance measurements that hold the outsourcer accountable?

7. What is the expected outsourcing duration?

(D) Outsourcing Risk

8 How important is the risk of plant maintenance failure in the outsourcing decision process?

9. How do the petrochemical companies mitigate their risk of plant maintenance outsourcing failures?

   What are the significant differences in risk of over-dependence of contractors, hidden costs of outsourcing between different groups of companies?

(E) Outsourcing Reasons

10. What are the main reasons that petrochemical companies outsource plant maintenance? What are the significant differences in outsourcing reasons between different groups of companies?

Appendix 3.3 (Continued)

Research Case Study Interviewing Questions

(F) Training Programme

11. What is your view on the contractor training programmes?

12. How important is the petrochemical companies consider the contractor skill-training program in gauging the worker quality?

(G) Outsourcing Culture

13. What is the level of outsourcing?

14. What is the extent of the organization multi-level commitment towards outsourcing of plant maintenance? (Literature review suggests that multi level relationship is important to the success of outsourcing).

Appendix 3.4

Research Survey Questionnaires

August 20, 2004

Dear Sir/Madam,

I am conducting a research on outsourcing plant maintenance activities in the petroleum and chemical industry in Singapore. This research has identified some of the factors affecting the decision making process on outsourcing plant maintenance. I would appreciate if you could help me by completing the attached survey form.

Outsourcing of business activities has been around for a long time. There are many research papers suggested the benefits of outsourcing non-core business activities. In the petroleum and chemical industry, almost all companies have outsourced some of their maintenance activities. However, there are few companies embarked on outsourcing total plant maintenance.

The survey form is divided into two parts. The first part explains the questionnaires and the meaning of the scales. The second part is for the interviewees' feedback on their expectations and perceptions of each of the factors. Furthermore, the interviewees are encouraged to comment on their answers especially for those questionnaires that have large discrepancies between expectations and perceptions. In order to obtain a balanced view, we would like to extend the survey to the Senior Management, Middle Management and Supervisors of the companies and their outsourcing contractors.

Please send the survey form to email: philkon@pacific.net.sg
If you need clarification, please contact me at 96309233.

Thank you for your cooperation.

Yours truly,

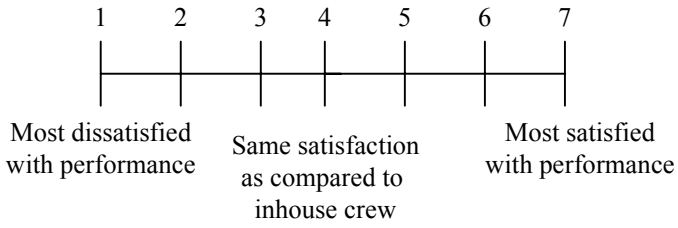
Kong Chan Nam

Appendix 3.4 (Continued)

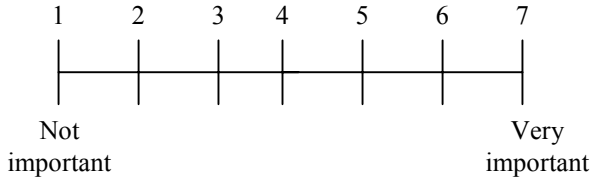
Research survey: Outsourcing plant maintenance in the Singapore petrochemical industry.

Please mark your perception and expectation against each question.
Perception = 0; Expectation = X

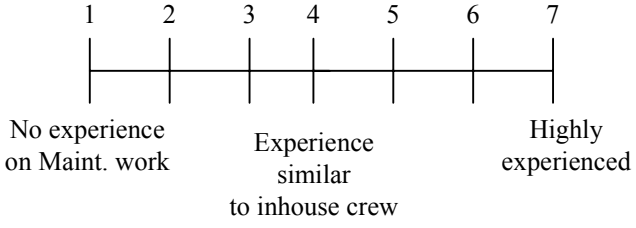
(1) Are you satisfied with the service level of the outsourcer?



(2) How important is the outsourcer corporate image in deciding outsourcing plant maintenance?



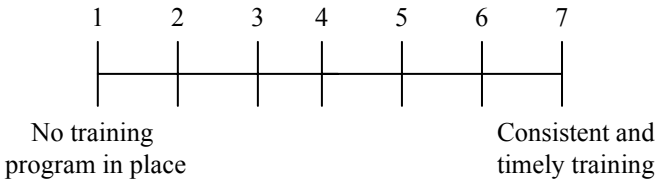
(3) What is the experience level of the outsourcer workers?



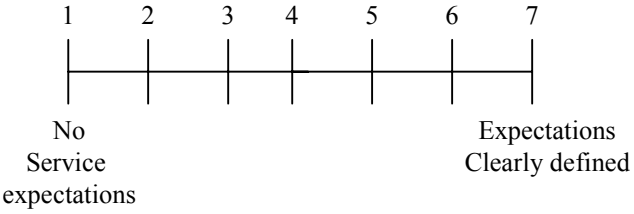
Appendix 3.4 (Continued)

Research Survey Questionnaires

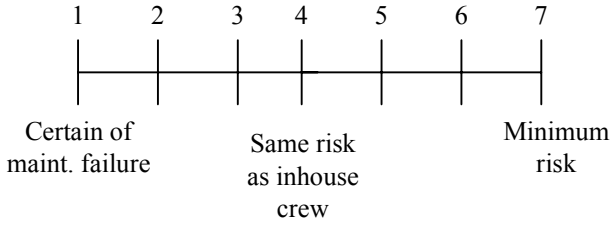
(4) How do you gauge the outsourcer training programmes?



(5) Does the outsourcing contract clearly define the service level?



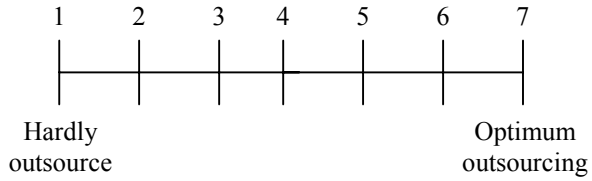
(6) What is the risk of outsourcing plant maintenance?



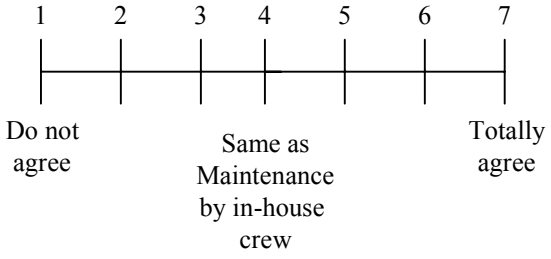
Appendix 3.4 (Continued)

Research Survey Questionnaires

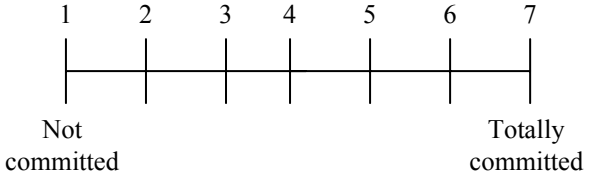
(7) Are you satisfied with the current level of outsourcing plant maintenance?



(8) Do you agree that outsourcing plant maintenance will reduce maintenance cost?



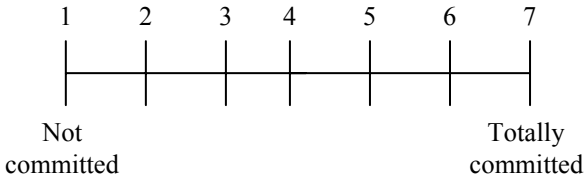
(9) Is the company senior management committed to outsourcing activities?



Appendix 3.4 (Continued)

Research Survey Questionnaires

(10) Is the company middle management committed to outsourcing activities?



Appendix 4.1

Transcripts of case study interviews

Case study questions. The following are a list of questions that were asked during the interviews. The interviewer was probing these questions in the discussions.

CASE 1

(A) Service Quality

11. What is the perception of the contractor service quality?

C1Q1 Although the contractor is doing a reasonable job in maintaining the plant, there is room for improvement. The contractor just responded to complaints by the Operations Department on plant equipment problems. The management expects the contractor workers to have more initiatives.

C1Q2 We did not do a good job in defining our service quality expectations. We did not know what are the performance indicators expected from the contractor.

C1Q3 We felt that the performance indicators from our parent company might not be suitable for Singapore. We want to monitor the equipment performance and then work with the contractor. This could be the reason why the expectations are not met.

12. What are the significant differences in service expectations for different groups of petrochemical companies (size, type of petrochemical business, nationality, etc.)?

C1Q4 There are different service quality expectations between different companies. Larger companies may have higher service quality expectations because these companies have the "muscles" to demand the expectations from the contractors.

Transcripts of case study interviews

C1Q5 The more established companies would have plant maintenance history and experience to decide on the expected equipment performance level. Since this company is new, it is difficult to set the performance level. If our expectations are too stringent, the contractor will have difficulties to achieve them.

3. How does the contractor's corporate image affect the outsourcing decision?

How do the petrochemical companies gauge the service providers' corporate images?

C1Q6 Contractor reputation certainly played an important part in selection of the outsourcer. However, reputation alone does not guarantee outsourcing success. The contractor has been given the outsourcing contract because it had involved in the plant construction. We feel that since the contractor workers installed the equipment, they should be in a better position to maintain them.

C1Q7 If there were contractors with reputation of handling plant maintenance, we would certainly consider outsource the maintenance to them.

C1Q8 We gauge the outsourcer's corporate image by their references from other petrochemical companies that had used their services. The experience need not be confined to Singapore only.

(B) Contractor Worker Experience

5. How extensively the outsourcer makes use of construction workers and temporary workers in plant maintenance? Do these workers meet the petrochemical companies' expectations?

C1Q9 Contractor worker experience is an important factor to consider when outsourcing plant maintenance. The contractor is making use of construction workers extensively. This is not ideal but there is a lack of experienced maintenance workers in the market.

Appendix 4.1 (Continued)

Transcripts of case study interviews

C1Q10 We consciously hired the contractor to maintain the plant because the construction workers know the plant better. The construction workers generally meet expectations.

C1Q11 Another problem that we are conscious of is temporary workers are hired extensively by contractors. The temporary workers will not stay long with anyone contractor and there will be a loss of skills. Some of the temporary workers are good.

(C) Outsourcing Contracts

11. How are the outsourcing contracts written to mitigate the risk of failure?

What are the significant differences in contracts that have performance indicators among the different companies?

What extent the difficulty in drafting outsourcing contracts prevented some companies to outsource plant maintenance?

C1R1 Generally, the outsourcing contract is quite similar to the conventional service contracts. However, the contract does not include quantifiable service quality because we were not sure the performance indicators to include in the contract.

C1R2 The difficulty of drafting contract should not hold up the process of outsourcing if it is important enough to the organization.

C1R3 The contract can be easily terminated if we find that the contract is not able to perform to our expectations.

12. How important is the service contract to your company?

Are those companies that outsource plant maintenance had proper contracts with structured performance measurements that hold the outsourcer accountable?

Appendix 4.1 (Continued)

Transcripts of case study interviews

C1R4 A good service contract with the necessary performance indicators will certainly help in ensuring no misunderstanding with the contractor. However, a good contract cannot guarantee contractor performance.

C1R5 Like many companies, we do not have outsourcing contracts that include performance measurements. The reason is we are not sure what performance indicators to include in the contracts.

C1R6 We felt that the outsourcing contracts that are used in Germany might not be applicable in Singapore.

8. What is the expected outsourcing duration?

C1R7 Outsourcing is definitely a long-term activity. This is especially so for us because we do not have in-house maintenance crew. The benefit of using the same outsourcer for a long time is not to lose the field experience that the contractor has acquired over time. Secondly, the contractor would be more willing and motivated to invest in hiring more and better workers and tools if there is an understanding that they will continue to maintain the plant if their service meet the customer expectations.

C1R8 Since the plant does not have a maintenance crew, the plant has depended on the outsourcer to provide plant maintenance. The plan is to continue to use the existing outsourcer as long as they can do a good job in maintaining the plant.

C1R9 This outsourcing contract is only for three years but there is a provision to extend. The reason is we do not have sufficient experience with the outsourcer on plant maintenance.

C1R10 The three-year outsourcing duration will ensure that the contractor is "on their toes" and put in the extra effort to meet the customer's service quality expectations.

C1R11 There is potential problem when the contractor challenges the service expectations and may request for higher contract price. The three-year contract period is one way to prevent this potential problem.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(D) Outsourcing Risk

8 How important is the risk of plant maintenance failure in the outsourcing decision process?

C1R12 Unreliable plant can result in productivity loss. The local company has to report to the Headquarter in Germany if the plant production loss is high. Therefore, risk of outsourcing failure is very important factor in deciding outsourcing.

C1R13 Another risk of maintenance failure is it is difficult to get additional help in straightening the plant condition because there is no in-house maintenance crew.

10. How do the petrochemical companies mitigate their risk of plant maintenance outsourcing failures?

What are the significant differences in risk of over-dependence of contractors, hidden costs of outsourcing between different groups of companies?

C1R14 The management recognizes the risk of outsourcing failure. Firstly, the company mitigates the risk by hiring a few maintenance supervisors to monitor the outsourcer work quality. Secondly, the contractor that had constructed the plant is hired to maintain the plant.

C1R15 Those companies that are having in-house maintenance crews will be in a better position to mitigate outsourcing failure.

C1R16 The company prevents a potential higher maintenance cost over time by having a 3-year contract period. This will lock the contractor to the contracted price for the three years.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(E) Outsourcing Reasons

14. What are the main reasons that petrochemical companies outsource plant maintenance? What are the significant differences in outsourcing reasons between different groups of companies?

C1S1 The primary objective to outsource maintenance is to reduce operating costs. It is easy to decide on outsourcing maintenance because the parent company (in Germany) has outsourced plant maintenance. In fact, we might have a difficult time to convince the parent company if we decided not to outsource plant maintenance.

C1S2 We don't think we are just following others in outsourcing maintenance. The parent company has experience cost saving in outsourcing maintenance.

C1S3 Outsourcing not only reduces maintenance costs but also reduces cost in hiring maintenance crew. The company had saved effort and money by not interviewing and hiring maintenance crew. Furthermore, without the in-house maintenance crew, the Human Resource Department has lesser employees to take care.

C1S4 We had decided to outsource long before the plant was constructed. Besides cost saving as mentioned earlier, we felt that we might have difficulties to hire good and skilled workers.

C1S5 I am not sure why other petrochemical companies outsourced. I think these companies may have a difficult time in convincing their parent companies to outsource plant maintenance since they have been maintaining the plant with their own maintenance crews.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(F) Training Programme

15. What is your view on the contractor training programmes?

C1Q12 The contractor worker training program is not up to expectation. The contractor does not have an acceptable training programme. We are concern that poorly trained and low paid workers would lead to poor service quality.

C1Q13 Another reason that the contractor workers need to be trained is most of the workers are more experienced with construction than maintenance work. The contractor is not able to hire enough workers with maintenance experience.

16. How important is the petrochemical companies consider the contractor skill-training program in gauging the worker quality?

C1Q14 The contractor worker training was important to improve the service quality. Therefore, training was one of the factors in deciding the outsourcer.

C1Q15 The quality of the training programmes shows the commitment of the contractor towards outsourcing.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(G) Outsourcing Culture

17. What is the level of outsourcing?

C1C1 We have outsourced total plant maintenance. The company does not hire in-house maintenance workers to repair the plant equipment. However, manager and supervisors are hired to oversee the outsourcer. We want to make sure the maintenance activities are well managed.

C1C2 Perhaps, in the future we may even transfer the management of the plant maintenance to the contractor as well. This decision will depend on the contractor performance.

14. What is the extent of the organization multi-level commitment towards outsourcing of plant maintenance? (Literature review suggests that multi level relationship is important to the success of outsourcing).

C1C3 There is a high level of commitment by the top and middle management. The outsourcer management also shows total commitment to the success of the plant maintenance.

C1C4 I believe that it is easier for this organization to develop an outsourcing culture than the older organizations. Since this is a young organization, there is no "old baggage" to dispose. The different levels of management are practicing outsourcing culture. The contractor is our strategic partner and we depend on them.

Appendix 4.1 (Continued)

Transcripts of case study interviews

Case 2

(A) Service Quality

1. What is the perception of the contractor service quality?

C2Q1 The experience level of the contractor workers is lower than expectations. The contractor performance is compared with the in-house maintenance crew.

C2Q2 The general perception of the contractor service quality is not encouraging because one reason to outsource is to improve equipment reliability. Of course the other reason is to reduce overall maintenance costs.

2. What are the significant differences in service expectations for different groups of petrochemical companies (size, type of petrochemical business, nationality, etc.)?

C2Q3 We may not require quick response from the contractor since the company has in-house maintenance crew to handle emergency. However, those companies that do not have in-house maintenance crew will require their outsourcers to respond quickly in emergency.

C2Q4 Our operations are similar to those chemical companies that have batch operations. We may have a lesser stringent service quality level because there are more opportunities for the plant to stop production and repair the faulty plant equipment. On the other hand, petroleum refinery may not have that many opportunities to stop the equipment for maintenance as the plant is normally running continuously for a longer period of time.

3. What are the differences between the management perceived service quality versus actual quality?

Appendix 4.1 (Continued)

Transcripts of case study interviews

C2Q5 The senior management perception of the service quality by the contractor seems to be higher than what the lower management level felt. One reason is the senior management generally is not personally involved in the day-to-day equipment repair activities. Another reason is the field supervisors are reluctant to complain about the contractor's service quality because it is their responsibility to ensure equipment reliability.

C2Q6 If we are going to outsource more maintenance activities, the contractor service quality is certainly important to decide whether to outsource plant maintenance. As we gradually outsource more maintenance activities, directionally our in-house maintenance crew will be reduced and we will be at a higher risk of outsourcing failure.

4. How does the contractor's corporate image affect the outsourcing decision?

How the petrochemical companies gauge the service providers' corporate images?

C2Q7 Corporate image or reputation can initially help in deciding outsourcing because the customer does not know what else to compare. We do not consider corporate image much since we have operated here for many years and know the capabilities of many of the contractors in the petrochemical industry.

C2Q8 The contractor reputation is based on past experience with the company. Therefore, most of the outsourcing contractors have worked with the organization in the past.

C2Q9 The may also consider the outsourcer track record if the contractors are new to the organization. However, this method to determine contractor reputation is not very accurate because the environment that the outsourcer worked in the past may be very different to what it is in Singapore.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(B) Contractor Worker Experience

5. How extensively the outsourcer makes use of construction workers and temporary workers in plant maintenance? Do these workers meet the petrochemical companies' expectations?

C2Q10 Our contractors do not use construction workers for the plant maintenance because the amount of outsourcing activities is not much. I am not surprise that if we expand the outsourcing activities, the contractor will have problem to hire enough skilled maintenance workers and we will have temporary workers working in the plant. The temporary workers are not very committed in their work as compared to own maintenance crew.

C2Q11 In fact, the current contractor workers are not as skilled and experienced as our in-house maintenance crew. Our own maintenance workers have about ten years of working experience.

C2Q12 The contractor worker experience will be one of the deciding factors when we expand our outsourcing activities in the future.

(C) Outsourcing Contracts

6. How are the outsourcing contracts written to mitigate the risk of failure?

C2R1 The outsourcing contract is quite similar to the normal service contracts. The contract does not include quantifiable service expectations. One reason is the company is building the experience in outsourcing.

C2R2 The two-year contract duration will mitigate outsourcing failure. In addition, there is a clause in the contract that allows the company to terminate the contract if the outsourcer is not able to perform.

Appendix 4.1 (Continued)

Transcripts of case study interviews

C2R3 I don't think the current service contract is comprehensive enough to mitigate outsourcing failure. There are opportunities for the contractor to challenge us if we have to terminate the service contract on poor service quality.

7 How important is the service contract to your company?

Are those companies that outsource plant maintenance had proper contracts with structured performance measurements that hold the outsourcer accountable?

C2R4 It is important to have a comprehensive outsourcing contract as it will prevent misunderstanding and confusion. The outsourcing contract should be amiable to both parties so that the outsourcer is motivated to carry out the contractual obligations.

C2R5 A good outsourcing contract can result in a win-win situation, that is, the contractor will put in extra effort to improve plant reliability. The contractor will also be rewarded for the good result.

C2R6 The contract does not include quantifiable service level. The reason is the company does not have historical trend on mean time between failures of each type of equipment.

8. What is the expected outsourcing duration?

C2R7 Contractors should view outsourcing as a long-term activity. However, the experience is contractor did not view it as long-term: no plan to train their workers.

C2R8 Contractors may be reluctant to invest more if there is no guarantee that they will recover their investments.

C2R9 I am not sure what is the ideal contract duration? The current outsourcing contract is two years with the option to extend. This contract duration will limit the risks of outsourcing failure. I believe that the two-year contract is long enough to give incentive for the contractor to invest in more workers and tools to service us.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(D) Outsourcing Risks

9. How important is the risk of plant maintenance failure in the outsourcing decision process?

C2R10 Equipment reliability is very important in a chemical plant. Poor equipment maintenance could result in a fire.

C2R11 The company has estimated to lose more than US$100,000 per day if the plant stop product due to equipment unreliability. Chemical product profit margin is much higher than refining products.

10. How do the petrochemical companies mitigate their risk of plant maintenance outsourcing failures?

Are there significant differences in risk of over-dependence of contractors, hidden costs of outsourcing between different groups of companies?

C2R12 The ideal method to mitigate over-dependence on contractors is to continue to have in-house maintenance crew. It is easier to manage in-house staff. Past experience has shown that when there is only one contractor, the cost is extremely high. When there were three contractors, the cost was much lower because of competition.

C2R13 Outsource total plant maintenance is risky. The company will be over-depending on the outsourcer. Perhaps the best compromise is to outsource 30% of the plant maintenance activities. The in-house crew will handle the remaining 70% of the maintenance activities.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(E) Outsourcing Reasons

11. What are the main reasons that petrochemical companies outsource plant maintenance? What are the significant differences in outsourcing reasons between different groups of companies?

C2S1 Although plant maintenance is considered a non-core business, it is regarded an important activity and required quick repair when equipment failed.

C2S2 Maintenance cost reduction is the primary factor for outsourcing. Currently about 30% of maintenance is outsourced, e.g. , turnaround and metal work. Electrical and rotating equipment are generally maintenance by in-house crew. Ideal ratio should be 50/50.

C2S3 We are quite clear on the reasons to outsource plant maintenance. It is recognized that the trend is towards outsourcing plant maintenance to reduce maintenance costs. However, the company is doing it very gradually because of lack of good and experienced contractor workers.

C2S4 Generally, almost all the chemical companies outsource in order to reduce operating costs. Some companies may consider outsourcing total plant maintenance because these companies do not have experienced in-house maintenance crews.

C2S5 Companies like ours will find it difficult to decide to outsource total plant maintenance. We have established a certain maintenance expectations that the outsourcers may have difficulties to duplicate. On the other hand, the new companies do not have this expectations.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(F) Training Programmes

12. How important is the petrochemical companies consider the contractor skill-training program in gauging the worker quality?

C2Q13 Skill training is always considered important. The plant equipment is getting more complicated and difficult to maintain and therefore require more skilled workers. Furthermore, the customers will not want the outsourcers to damage the equipment due to lack of maintenance skills.

C2Q14 Contractor worker training program is an indication on the outsourcer's commitment on service quality. It also shows the contractor has considered outsourcing as a long-term commitment.

C2Q15 I will consider the experience level of the outsourcer in maintaining plant equipment. Although training programmes are important, I will consider them secondary because they are long-term.

(G) Outsourcing Culture

13. What is the level of outsourcing in your organization?

C2C1 The level of outsourcing is not very high. The in-house crew is still doing the bulk of the maintenance work. However, the long-term plan is to outsource more plant maintenance. But this will depend on the skill level of the outsourcer.

C2C2 The higher the level of outsourcing, the easier is the decision to go for total plant maintenance outsourcing. The reason is higher outsourcing level means there will be lesser in-house maintenance staff and there will be higher pressure to outsource the remaining maintenance activities. Therefore, level of outsourcing is a factor to decide total outsourcing. The effect of this factor is more critical if more activities are already outsourced.

Appendix 4.1 (Continued)

Transcripts of case study interviews

14. What is the extent of the organization multi-level commitment towards outsourcing of plant maintenance? (Literature review suggests that multi level relationship is important to the success of outsourcing).

C2C3 Although there is much effort in trying to communicate the importance of outsourcing plant maintenance, many employees are still suspicious. Therefore, it is not surprising that the top and middle management are not perceived to be totally committed. Perhaps, it could be due to poor communication within the organization.

C2C4 Our senior management is more committed to ensure the outsourcing activities are successful. Failure of outsourcing will affect the plant reliability and they have to report to Headquarter.

C2C5 The contractor management is also committed to the outsourcing activities. The success of these outsourcing activities will give the contractor the credentials that it needs to stand a better chance to win other outsourcing contracts.

C2C6 The middle management may have perceived to be less committed to outsourcing because they tend to complain about the outsourcer. The reason is they feel that the contractor skill level does not meet their expectations. Secondly, they feel that they are 'pressurized' to adopt the outsourcing activities.

C2C7 Contractor normally is more accommodating when the management requests certain things to be done. It may have given a good perception to the senior management that the contractor is providing good service.

Appendix 4.1 (Continued)

Transcripts of case study interviews

CASE 3

(A) Service Quality

1. What is the perception of the contractor service quality?

C3Q1 The management and supervisors felt that the contractor service quality is up to their expectations. However, the supervisors seemed to have a lower expectation than the senior management. The supervisors have the mindset that the contractors are generally not as good as their in-house crew.

C3Q2 The management felt that the service quality is good because the management does not hear any complaint.

C3Q3 The supervisors did not think the contractor service quality meet expectations because they have to supervise closely on the contractor's work.

2. What are the significant differences in service expectations for different groups of petrochemical companies (size, type of petrochemical business, nationality, etc.)?

C3Q4 Some companies gauge their outsourcers based on the agreed quantifiable service quality such as the cost of repair and mean time between repairs. This type of service expectation is good but the measurements are difficult to develop due to lack of equipment repair historical data.

C3Q5 For other companies, service quality is based on the contractor workers turning up to work on time and obediently taking instructions. The contractors that work for us basically just carry out the instructions.

Appendix 4.1 (Continued)

Transcripts of case study interviews

3. What are the differences between the management perceived service quality versus actual service quality?

C3Q6 There is a difference between the management perceived service quality and the actual service quality. The management does not spend much time in the field to know the work carried out by the contractor workers. Sometime the management gets the feedback from the middle management. I do not think the difference between the management's perception and the actual situation is a cause for concern.

C3Q7 The perceived service quality is certainly a critical factor in deciding outsourcing plant maintenance. The service quality relates to the outsourcing risks and the quality of the outsourcer workers. Although maintenance cost reduction is important, service quality cannot be compromised.

4. How does the contractor's corporate image affect the outsourcing decision?

How the petrochemical companies gauge the service providers' corporate images?

C3Q8 Corporate image does help if the customer is not familiar with the contractor.

C3Q9 Normally track records are used to infer the corporate service quality and reputation. However, the outsourcer is chosen based on its past experience with the company.

C3Q10 Contractor's corporate image may not be very important in deciding outsourcing plant maintenance as compare to references from other petrochemical companies.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(B) Contractor Worker Experience

5. How extensively the outsourcer makes use of construction workers and temporary workers in plant maintenance? Do these workers meet the petrochemical companies' expectations?

C3Q11 Some of the outsourcer workers had also worked in the construction sector. However the number is small. Most of the outsourcer workers have maintenance experience.

C3Q12 It is a local practice for the contractors to hire temporary workers instead of full-time employees. The reason is due to the uncertain workloads. Therefore, some of the outsourcer workers are temporary workers. Temporary workers tend to switch jobs very frequently and cause disruption and inefficiency in the maintenance activities.

C3Q13 The contractor worker experience is an important factor to decide outsourcing plant maintenance. The risk of failure may be higher if there is no in-house maintenance crew to mitigate any maintenance shortcoming. Although it is not practical for the outsourcers to hire all full-time employees, too many temporary workers will discourage companies to expand their outsourcing activities.

(C) Outsourcing Contracts

6. How are the outsourcing contracts written to mitigate the risk of failure?

C3R1 The outsourcing contract is similar to the conventional service contracts. The contract does not include performance clauses. In fact, the supervisors felt that the workscope is not very clear in the outsourcing contract. Everyone feels that the service quality expectations should be included in the outsourcing contract.

Appendix 4.1 (Continued)

Transcripts of case study interviews

7. How important is the service contract to your company?

C3R2 Although the service contract is important, it should be the last line of defence against maintenance failure. It is a commitment from both parties. We have difficulties to draft the contract because we do not have quantifiable service quality that are reasonable in the industry.

C3R3 Not many companies have outsourcing contracts that include performance measurements because it required resources and time to develop the contracts. Without these indicators, it may be difficult for the customers to force the outsourcers to meet the obligation.

C3R4 The performance indicators should be quite similar since the equipment installed in the petrochemical industry are standard. Therefore, if the petrochemical companies exchange note, it should not be difficult to decide on the performance indicators.

C3R5 The ability to draft a comprehensive contract should not be a critical factor in deciding outsourcing plant maintenance. There is a cost behind each performance indicator includes in the contract. If the performance indicators are too stringent, the outsourcing cost will be higher. Therefore, it is important to be clear on the service expectations.

8. What is the expected outsourcing duration?

C3R6 The hidden cost of outsourcing may be high if the outsourcing duration is short. However, the outsourcing contract is yearly renewable because the company is testing the effectiveness of the outsourcer. In addition, there is no hurry to outsource since the company is having its in-house maintenance crew.

C3R7 The outsourcers do not seem to be very excited about the outsourcing contracts because it is short-term. There is no guarantee that they would continue with the contract the following year. This could explain the outsourcers' reluctant to invest in more equipment and better workers.

C3R8 I think the optimum outsourcing contract period should be about three years. The period is long enough for the outsourcer to prove to the customer whether it has the capability to perform. Furthermore, the period is also long enough for the outsourcer to recover its investment in hiring and training better workers.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(D) Outsourcing Risks

9. How important is the risk of plant maintenance failure in the outsourcing decision process?

C3R9 The emphasis is on a reliable and safe plant. In the petrochemical industry, unreliable equipment could result in fire and accident. Therefore, risk of failure is very important.

C3R10 For some companies that are having in-house maintenance crew, outsourcing failure is less risky as compare to those companies that rely solely on the outsourcers. The in-house crew is able to take over the work that is handled by the outsourcers.

10. How do the petrochemical companies mitigate their risk of plant maintenance outsourcing failures?

Are there significant differences in risk of over-dependence of contractors, hidden costs of outsourcing between different groups of companies?

C3R11 Outsourcing risk is a critical factor to decide outsourcing plant maintenance. The company feels that it is able to mitigate the risk by only outsource about 10% of the maintenance activities. The in-house crew is able to help the outsourcer if it is not able to perform. In this way, the company does not over-depend on the outsourcer.

C3R12 Some companies outsource the work to more than one outsourcer in order to mitigate outsourcing failure. This method also introduces competition among the contractors so that the contract costs could be reduced.

C3R13 The contractor workers are also hand-picked by the supervisors based on the workers' experience. This is to help to maintain service quality and mitigate maintenance failure.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(E) Outsourcing Reasons

11. What are the main reasons that petrochemical companies outsource plant maintenance? Are there significant differences in outsourcing reasons between different groups of companies?

C3S1 The primary objective is to outsource some of the non-core business units such as plant maintenance. It is believed that outsourcing will be able to reduce maintenance costs in the long-term.

C3S2 The strategy is to outsource the higher skilled work (e.g. distributed control instrumentation system) and the lower skilled work (laying electrical conduits and wiring). The in-house maintenance crew takes care of the remaining maintenance activities.

C3S3 There is pressure by management to outsource more work and reduce existing in-house maintenance crew in the future. This will help the local management in the "head count" game. This is an indication used by the organization world wide to gauge efficiency and productivity of each of the affiliates.

C3S4 Since this company has its own in-house maintenance crew, it will take a longer period to realize any saving from outsourcing plant maintenance. The main reason is it is costly to retrench the workers and retrenchment will also result in de-motivating the remaining employees.

C3S5 The reason to outsource plant maintenance may not be a critical deciding factor. I do see there is any difference in the reason to outsourcing plant maintenance between different companies. I believe the main reason is to reduce maintenance costs. In fact, the petrochemical companies are more careful and therefore slow to outsource any activities. The tradition method is to try to do more in-house so that the organizations can have better control over the activities.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(F) Training Programmes

12. How important is the petrochemical companies consider the contractor skill-training program in gauging the worker quality?

C3Q14 Skill training for the contractor workers is very important because some of the plant equipment is difficult to maintain. Wrong maintenance practices could result in damaging the equipment beyond economic repair.

C3Q15 Poorly trained workers can also lead to production loss due to equipment failure. Restarting the plant could take a few days.

C3Q16 We do consider the contractor training programmes for their workers when evaluating the outsourcers because the worker service quality depends on their skill level.

(G) Outsourcing Culture

13. What is the level of outsourcing in your organization?

C3C1 About 10% of the maintenance activities are outsourced. The in-house maintenance crew handles the remaining work.

C3C2 The plan is to outsource more maintenance gradually when the outsourcer has proven their expertise.

Appendix 4.1 (Continued)

Transcripts of case study interviews

14. What is the extent of the organization multi-level commitment towards outsourcing of plant maintenance? (Literature review suggests that multi level relationship is important to the success of outsourcing).

C3C3 The top management is totally committed in plant maintenance outsourcing. The middle management initially had some reservation. However, over time they gradually supported the outsourcing activities.

The contractor management (top and bottom) is totally committed to the outsourcing activities. They felt that they are more appreciated and 'respected' by the customer organization.

C3C4 The technicians are not very committed in maintenance outsourcing. They feel that the outsourcer do not have the experience to maintain the plant equipment. The technicians also feel that they have to harder to rectify some of the mistakes made by the contractor workers.

C3C5 Although the organization culture is important, it is not a critical factor to decide outsourcing plant maintenance. The organization culture need time to develop especially outsourcing does not play a large part in the organization.

Appendix 4.1 (Continued)

Transcripts of case study interviews

Case 4

(A) Service Quality

1. What is the perception of the contractor service quality?

C4Q1 The senior management perceived that the contractor service quality is good. Middle management and supervisors thought that contractor service quality is not as good as they would have expected.

C4Q2 The perceived service quality is generally lower than expectations. The reason is the contractor workers are compared with the in-house maintenance workers. These workers have been working in the same organization for three decades. Maybe the service quality expectations of the outsourcer are not realistic.

C4Q3 The senior management perceived that the outsourcer workers are able to do the maintenance work effectively. The management has not experienced plant equipment problems that could not be solved. We have to give the outsourcer time to gain the experience.

C4Q4 The service quality is a critical factor in deciding to expand the outsourcing activities. Service quality gives an indication on the skills and commitments of the outsourcing organization. Outsourcing total plant maintenance is a very critical decision for the refinery. One the decision is made there is no turning back.

2. What are the significant differences in service expectations for different groups of petrochemical companies (size, type of petrochemical business, nationality, etc.)?

C4Q5 There is no major difference in service expectations between companies in the same industry. The main problem is the difficulties in quantifying the service expectations. Furthermore, each company has its own method to gauge service quality.

Appendix 4.1 (Continued)

Transcripts of case study interviews

C4Q6 The challenge for the company is we expect the mean time between repairs (MTBR) and mean time between failures (MTBF) to increase every year. These indices will result in lower maintenance cost.

C4Q7 The expectation of some companies is for the outsourcers to respond quickly to equipment breakdown. I don't think there are explicit expectations for the outsourcers to develop plans to improve equipment reliability.

3. What are the differences between the management perceived service quality versus actual service quality?

C4Q8 It is difficult for the management to experience the actual service quality since they are not involved in the day to day plant maintenance. Their perceived service quality is based on the number of complaints and equipment failures. However, most of these complaints do not reach the senior management unless they are very serious.

C4Q9 The middle management and supervisors is in better positions to gauge the actual service quality. Most of them prefer in-house crew because they are more committed than outsourcer workers. Many of the outsourcer workers are hired on a temporary basis and they are not very motivated.

C4Q10 One positive attribute of the outsourcer workers is that they are more accommodating and more willing to take instructions than the in-house crew.

4. How does the contractor's corporate image affect the outsourcing decision?

How the petrochemical companies gauge the service providers' corporate images?

C4Q11 Contractor reputation is one of the deciding factors if the contractor is new to the organization. There is no other good method to check the capability of the contractor.

C4Q12 Generally, the outsourcer selection criteria is based on the outsourcer past experience with the company. Outsourcers with experience with plant maintenance in other companies would be considered.

Appendix 4.1 (Continued)

Transcripts of case study interviews

C4Q13 Outsourcers with international reputation stand a better chance to be selected. Firstly, other affiliates may able to comment on the contractors' experience. Secondly, it is easily for the senior management of the local company to explain to its Headquarter if the reputable outsourcer fails in the maintenance activities.

C4Q14 Another advantage to use international reputable contractors is these companies tend to able to attract better skilled workers. They are also seemed to be more willing to invest in equipment and personnel.

(B) Contractor Worker Experience

5. How extensively the outsourcer makes use of construction workers and temporary workers in plant maintenance? Do these workers meet the petrochemical companies' expectations?

C4Q15 The outsourcer was involved in the maintenance of the plant equipment for the company in the past. Some of the contractor workers had also involved in the construction activities for the contractor.

C4Q16 There are not many temporary workers hired by the outsourcers because the maintenance activities that are outsourced are not very large. Conversely, I believe that all contractors hire temporary workers to help them out during the heavy workload period.

C4Q17 Outsourcer worker experience is important to the success of the outsourcing activities. This will be a factor to consider when more maintenance activities are outsourced in the future. We are concern on the temporary workers hired by the outsourcers. These workers are generally less committed to the work. Furthermore, the contractors would not send these temporary workers for further skill training.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(C) Outsourcing Contracts

5. What is the expected outsourcing duration?

C4R1 The existing outsourcing contract is two year period and there is a clause for extension.

C4R2 The contractor is quite reluctant to invest in too many equipment and people because of the short contract period.

C4R3 The short contract period is also a safe guard for the company in case the outsourcer is not able to perform.

6. How are the outsourcing contracts written to mitigate the risk of failure?

C4R4 The outsourcing contract is similar to the conventional service contracts. The contract does not include performance clauses. The reason is most of the maintenance is still handled by the in-house crew.

C4R5 The outsourcing contracts should included clauses on service quality expectations. These clauses are important to ensure the contractor performance is up to the company's expectations.

C4R6 It depends on the risk that the management wants to take. However, I think company would like to safeguard against outsourcing failure by included as many requirements as possible in the contracts. The disadvantage is the outsourcing contract prices will be higher.

7. How important is the service contract to your company?

C4R7 Service contract is important. Unfortunately there was no time to draft a contract with the expected service level. Furthermore, the contract group is more familiar with the normal contracts than outsourcing contracts.

C4R8 Being a large multi-national company, it does not want to settle any matter in court. Therefore, a comprehensive outsourcing contract is important.

Appendix 4.1 (Continued)

Transcripts of case study interviews

C4R9 I think a comprehensive contract will be more important when we outsource more maintenance activities. At this time, it may be alright not to include the performance indicators in the contract as the time spent and resources to identify the indicators may not be justified.

(D) Outsourcing Risks

8. How important is the risk of plant maintenance failure in the outsourcing decision process?

C4R10 Failure of plant equipment can result in an unsafe situation besides production loss.

C4R11 Fortunately, the risk may be lower than those companies that depend solely on the outsourcers for their maintenance activities.

C4R12 With the low profit margin trend in the refining products, unreliable equipment may put the refinery in the red.

C4R13 The outsourcing risk is a critical factor to consider even if limited maintenance activities are outsourced. Production loss due to poor maintenance may not justify the saving from outsourcing maintenance activities.

9. How do the petrochemical companies mitigate their risk of plant maintenance outsourcing failures?

Are there significant differences in risk of over-dependence of contractors, hidden costs of outsourcing between different groups of companies?

C4R14 Some companies may not want to take the risk of hiring contractors to maintain their plant equipment.

C4R15 Certainly, reducing the contract duration is one way to limit the exposure of the risk of failure. The better option is to include measurable service quality in the contract. This will minimize misunderstanding and easier for both parties to manage the maintenance activities.

Appendix 4.1 (Continued)

Transcripts of case study interviews

C4R16 This company still have its own maintenance crew and therefore, it does not totally depend on the outsourcer. Failure of the contractor will not seriously affect the plant reliability.

C4R17 The risk varies depending on the quality of the outsourcers. If the outsourcer is good, risk of over-dependence of the contractor may not be a high.

(E) Outsourcing Reasons

10. What are the main reasons that petrochemical companies outsource plant maintenance? Are there significant differences in outsourcing reasons between different groups of companies?

C4S1 The primary objective for the company to outsource is to reduce operating costs. However, the company places equipment reliability more important than maintenance costs. That is, the company will not outsource the work if it feels that the outsourcer is not capable to do.

C4S2 The company also feel that the initial cost saving from outsourcing plant maintenance may not be high because of the in-house maintenance crew. On the other hand, new employees may not be required if the workers leave the company as the outsourcer can do the work.

C4S3 Outsourcing is a trend and most companies will continue to outsource their maintenance activities. However, the skills and competency of the outsourcers will determine the extent of the outsourcing activities.

C4S4 The reason for outsourcing is quite clear. I think the justification of the cost saving compare to the risk and effort required to outsource the maintenance activities is more difficult to identify.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(F) Training Programmes

7. How important is the petrochemical companies consider the contractor skill-training program in gauging the worker quality?

C4Q18 Worker training is important to reduce the risk of outsourcing failure. The company will be doubtful whether the workers can do the work if they are not properly trained.

C4Q19 Contractors that have good skills training programs for their workers indicate to their customers that they are committed to the outsourcing activities.

C4Q20 Contractor workers will be more motivated if they are trained. Furthermore, the workers have to continue to learn as plant equipment are getting more sophisticated and expensive. The contractor training programme is certainly a factor to decide to outsource total plant maintenance.

(G) Outsourcing Culture

10. What is the level of outsourcing in your organization?

C4C1 The level of outsourcing is not very high. The company is going slow in outsourcing because of the risk of failure. In fact, the outsourcer does not expect the company going to outsource the whole plant maintenance in the near future.

C4C2 I do not see the company drastically increase the level of outsourcing. There is a cost to consider relocating the existing in-house maintenance crew. Perhaps the decision to outsource is easier for new companies who have not hired in-house maintenance crew.

Appendix 4.1 (Continued)

Transcripts of case study interviews

11. What is the extent of the organization multi-level commitment towards outsourcing of plant maintenance? (Literature review suggests that multi level relationship is important to the success of outsourcing).

C4C3 There is strong commitment from the top and middle management. However, the technicians do not have high expectation that the management is totally committed. Perhaps what is lacking is good communication.

C4C4 The outsourcer management also totally committed to the contract. In fact, the perception is the outsourcer management is more committed than the customer management.

C4C5 It is important to work strategically with the outsourcer in order to reap the maximum benefits of outsourcing. Therefore, the organization culture towards outsourcing is important for the success of outsourcing. However, I do not think this is a critical factor in deciding outsourcing.

Appendix 4.1 (Continued)

Transcripts of case study interviews

Case 5

(A) Service Quality

1. What is the perception of the contractor service quality?

C5Q1 The senior management is satisfied with the service quality provided by the outsourcer.

C5Q2 The middle management is also felt that the service quality meets their expectations. One reason, perhaps, is the middle management and supervisors do not have in-house maintenance crew that the outsourcer workers can compare with.

C5Q3 Service quality is an important factor that was considered before deciding to outsource total plant maintenance to the current outsourcer. Although this is a new plant, the outsourcer has to meet the minimum maintenance service quality expected in the petrochemical industry. Therefore, the outsourcer has to convince the management that they have the expertise to meet these expectations.

2. What are the significant differences in service expectations for different groups of petrochemical companies (size, type of petrochemical business, nationality, etc.)?

C5Q4 The company expects the outsourcer to manage the whole maintenance activities. The outsourcer has to provide the maintenance crew to carry out the equipment repair and identify areas for improvement. Hence, the outsourcer has to provide a management team at the customer's site on a daily basis. On the other hand, other companies that do not outsource total plant maintenance may not expect the outsourcers to manage the whole maintenance effort.

Appendix 4.1 (Continued)

Transcripts of case study interviews

C5Q5 Since this is a new company, it does not have a past expectation that the outsourcer has to meet. The outsourcer does not need to compare with workers working for a few decades in the same organizations like some older plants.

3. What are the differences between the management perceived service quality versus actual service quality?

C5Q6 The management has perceived that the service quality meets its expectation because the outsourcer manager is constantly working closely with the customer. The management also perceived that the outsourcer is willing to learn and try their best to meet the expectations.

C5Q7 The outsourcer does have problems to manage the whole plant maintenance activities because the outsourcer manager is not experienced in plant maintenance. The outsourcer's background is basically doing construction work.

4. How does the contractor's corporate image affect the outsourcing decision?

C5Q8 The company has selected the contractor because of its experience in constructing the plant.

C5Q9 Another reason is the outsourcer management has built a relationship with the company management. The outsourcer has built up a trust with the company management.

C5Q10 Although the reputation and experience of other contractors were considered, relationship seems to be more important. Therefore, corporate image is not an important factor to consider in this case.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(B) Contractor Worker Experience

5. How extensively the outsourcer makes use of construction workers and temporary workers in plant maintenance? Do these workers meet the petrochemical companies' expectations?

C5Q11 The outsourcer is basically in the construction area. Therefore, most of its workers do not have much experience in maintenance work. The workers seemed to be doing quite well in meeting the company's expectations. However, the service expectations will be higher as the workers gain more experience in the maintenance activities. Temporary workers generally do not stay long in an organization. They can be disruptive in the maintenance activities. Therefore, temporary workers generally do not meet expectations.

C5Q12 We are aware of the shortage of the skilled workers in the petrochemical industry. We had considered this factor when deciding the type of maintenance strategy. We worked more closely with the outsourcer management in the first two years to ensure that minimum service quality is maintained. So far we do not experience major problems.

(C) Outsourcing Contracts

6. What is the expected outsourcing duration?

C5R1 The outsourcing contract is renewable every two years. However, the company will most likely continue to outsource plant maintenance to the same contractor. The company is not too eager to change outsourcers every two years as long as the outsourcer is able to perform up to the company's expectations.

C5R2 The contractor is quite reluctant to invest in too many specialized equipment and skilled people since the contract period is not very long.

Appendix 4.1 (Continued)

Transcripts of case study interviews

7. How are the outsourcing contracts written to mitigate the risk of failure?

C5R3 The contract does not include much quantifiable service expectations. The local management is new and no experience in drafting the outsourcing contract. Another reason is the local outsourcer is not familiar with plant maintenance and tends to put a premium on the quantifiable service quality. The contract cost will be much higher than what the management is prepared to pay.

C5R4 There will be more and realistic quantifiable service expectations in the future contract since the company and outsourcer gain more experience.

8. How important is the service contract to your company?

C5R5 Service contract is an important piece of document if the contractor is not able to perform and the company wants to take legal redress.

C5R6 The contract clearly documents the cost for the service expectations so that the contractor has no excuse to ask for more cost.

C5R7 Although a comprehensive service contract will protect both parties, our experience shows that it does not seem to be critical in deciding outsourcing. However, in order to prevent any misunderstanding and dispute, we will consider to include the performance indicators when the existing contract is up for renewal.

(D) Outsourcing Risks

9. How important is the risk of plant maintenance failure in the outsourcing decision process?

Appendix 4.1 (Continued)

Transcripts of case study interviews

C5R8 The risk of plant maintenance failure is more important for this company because the contract workers are basically from the construction industry and there is no in-house crew to mitigate any maintenance failure. Therefore, it is a critical factor in deciding to outsource maintenance.

C5R9 There is no question about the decision to outsource total plant maintenance since it is a practice by the parent company. Therefore, the local management may not need to explain about the decision to outsource if the outsourcer is not able to perform and affect the plant production.

10. How do the petrochemical companies mitigate their risk of plant maintenance outsourcing failures?

Are there significant differences in risk of over-dependence of contractors, hidden costs of outsourcing between different groups of companies?

C5R10 There is always a risk of over-dependent of the outsourcer. However, the experience from the parent company is that the risk is low.

C5R11 Some other companies may not depend on the outsourcer as this company because they do not outsource total plant maintenance. Time will tell whether over-dependent on the outsourcer is an issue.

C5R12 Additional supervision by the management is required to spot any potential problem before it becomes an issue. Close supervision will help in mitigating the risk of failure.

(E) Outsourcing Reasons

11. What are the main reasons that petrochemical companies outsource plant maintenance? Are there significant differences in outsourcing reasons between different groups of companies?

Appendix 4.1 (Continued)

Transcripts of case study interviews

C5S1 Outsourcing total plant maintenance is practised by the parent company outside Singapore. The local company is just following the practice of the parent company.

C5S2 Outsourcing resulted in saving effort and costs in recruiting maintenance crew and training them. Moreover, the management has lesser employees to manage.

C5S3 The total plant maintenance outsourcing practice in this company is a quantum change as compared to many of the other chemical companies. Most of the other companies keep at least a skeleton maintenance crew to supplement the outsourcing activities.

C5S4 The bottom line of outsourcing is to reduce operating costs by reducing the number of employees. Since the company world-wide has been outsourcing plant maintenance, this factor to decide outsourcing is not important.

(F) Training Programmes

12. How important is the petrochemical companies consider the contractor skill-training program in gauging the worker quality?

C5Q13 Periodic training is an important part of maintenance in order to enable the workers to maintain the equipment as per the manufacturers' recommendations.

C5Q14 Since most of the workers are more familiar with the construction activities, it is more important that the contractor has a skill training program for its workers.

C5Q15 The company has more difficulties to mitigate the risk of plant unreliability since it does not have in-house maintenance crew. Worker skill training program is therefore help to mitigate equipment unreliability.

Appendix 4.1 (Continued)
Transcripts of case study interviews

C5Q16 Although contractor training programme is important for the long-term improvement of the maintenance service quality, it is not considered critical in deciding outsourcing or choosing the outsourcer. We are aware that if we put high weightage to this factor, most probable none of the contractors would be considered. We need to prioritize the factors that would give us the most benefits.

(G) Outsourcing Culture

13. What is the level of outsourcing in your organisation?

C5C1 The level of outsourcing is 100% since the company is outsourcing total plant maintenance.

14. What is the extent of the organization multi-level commitment towards outsourcing of plant maintenance? (Literature review suggests that multi level relationship is important to the success of outsourcing).

C5C2 There is a total commitment in the company and outsourcer organizations towards outsourcing. The employees were told to treat the outsourcer staff as their strategic partners. In fact, the outsourcer workers are involved in many of the company's organized activities.

C5C3 Another reason that made this outsourcing decision successful is most of the company staff and outsourcer staff started working in the organization about the same time. The workers seem to work better together. There is lesser "cultural gaps" between the two groups of workers as compared to other older companies.

Appendix 4.1 (Continued)

Transcripts of case study interviews

Case 6

(A) Service Quality

1. What is the perception of the contractor service quality?

C6Q1 The company management thinks that the contractor service quality is not up to their expectations. They are not totally satisfied with the service when compared with the in-house maintenance crew.

C6Q2 One of the conditions of increasing the outsourcing level is the outsourcer must be able to improve the equipment reliability. The company views service quality as a critical factor in deciding outsourcing.

2. What are the significant differences in service expectations for different groups of petrochemical companies (size, type of petrochemical business, nationality, etc.)?

C6Q3 Some companies expect the outsourcer just to carry out the equipment repair. However, the company expects the outsourcer to have the ability to suggest methods to improve the performance of the plant equipment. The long-term plan is to improve the equipment reliability. It does not require the outsourcer to manage the maintenance activities.

C6Q4 Many companies that outsource total plant maintenance will expect the outsourcers to manage the complete maintenance activities. We expect the outsourcer to come up with suggestions to reduce the annual maintenance costs.

3. What are the differences between the management perceived service quality versus actual service quality?

C6Q5 There is no significant difference between the perceived and actual service quality. The company middle management does not expect the outsourcers to perform better than their own in-house maintenance who have been working for more than three decades.

Appendix 4.1 (Continued)

Transcripts of case study interviews

C6Q6 The outsourcer employing lower paid and poorly trained workers could have resulted in the lower service quality.

4. How has the contractor's corporate image affected the outsourcing decision?

C6Q7 Contractor reputation is one of the deciding factors. Contractor's corporate image and together with industry intelligence were used to gauge the contractor capabilities.

C6Q8 The current outsourcers are chosen based on their past experience working for the company. Reputable international outsourcers were also considered but these outsourcers were only interested in total plant maintenance.

(B) Contractor Worker Experience

5. How extensively the outsourcer makes use of construction workers and temporary workers in plant maintenance? Do these workers meet the petrochemical companies' expectations?

C6Q9 The outsourcers have hired some temporary workers to work together with their employees. The outsourcers also hire workers that have construction experience. However, the company would like the outsourcers to have workers with plant maintenance expectation. The company also knows that there is a shortage of such skills in Singapore.

C6Q10 It is difficult to gauge the outsourcers' capabilities to carry out plant maintenance because many local contractors do not have past experience in handling outsourcing plant maintenance in the petrochemical industry.

C6Q11 Since we only outsource some maintenance activities, contractor worker experience level is not critical in deciding outsourcing. If we decide to outsource total plant maintenance in the future, worker experience will be a critical factor.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(C) Outsourcing Contracts

6. What is the expected outsourcing duration?

C6R1 The outsourcing contract is yearly renewable. The company may not expand the outsourcing of total plant maintenance in the near future depending on the experience with the current outsourcers.

C6R2 The contractor is quite reluctant to invest in too many equipment and people since the contract period is short. Therefore, two or three years contract period is ideal as it provides enough time for the outsourcers to recover their investments. The longer contract period is also required in order for the customers to evaluate the outsourcers' performance. One year, perhaps, is too short to evaluate the outsourcers.

7. How are the outsourcing contracts written to mitigate the risk of failure?

C6R3 The outsourcing contract is quite similar to the conventional service contracts. The contract includes some performance clauses to mitigate maintenance failure. It was felt that the outsourcers may increase the contract prices if performance indicators are included in the contracts.

C6R4 The performance indicators can be different among the companies because equipment quality expectations can be different. There is always a cost against the level of service quality required.

8. How important is the service contract to your company?

C6R5 The service contract is a means to ensure the outsourcer live up to their side of the bargain. It is design to mitigate the risk of failure and avoid misunderstanding. However, the reason that the service contract does not include quantifiable service expectations is the company does not want to spend the resources to identify the performance indicators based on historical repair data. Furthermore, the inclusion of the performance indicators may increase the contract price.

Appendix 4.1 (Continued)

Transcripts of case study interviews

C6R6 The inclusion of the performance indicators is necessary for outsourcing total plant maintenance because there may not be any in-house maintenance crew to mitigate the maintenance problems. The effort requires to develop these performance indicators are therefore justified.

(D) Outsourcing Risks

9. How important is the risk of plant maintenance failure in the outsourcing decision process?

C6R7 Failure of plant equipment can result in an unsafe situation besides production loss. Outsourcing risk is considered critical in deciding outsourcing total plant maintenance. There is no turning-back once the organization embark on total plant maintenance.

C6R8 Some companies may not want to take the risk of hiring contractors to maintain their plant equipment.

10. How do the petrochemical companies mitigate their risk of plant maintenance outsourcing failures?

Are there significant differences in risk of over-dependence of contractors, hidden costs of outsourcing between different groups of companies?

C6R9 The company mitigates the risk by only outsourcing some maintenance activities. It is keeping the in-house maintenance crew as the main maintenance force.

Appendix 4.1 (Continued)

Transcripts of case study interviews

C6R10 The outsourcing contract is renewable yearly in order to allow the company to change to another outsourcer easily. This short contract period hopefully will warn the outsourcer to perform or it would not have the contract extended the following year.

C6R11 As a large multinational company, it also has the ability to get help from other affiliates if the plant gets into reliability problems.

C6R12 The smaller petrochemical companies may have limited options to mitigate the risk of failure. These companies' problems may be compounded if they have outsourced total plant maintenance to a single outsourcer.

C6R13 The inclusion of service quality expectations in the contracts will help to ensure there is no misunderstanding and allow the petrochemical companies to take legal actions against the outsourcers if they could not perform.

C6R14 The risk varies depending on the quality of the outsourcers. If the outsourcer is good, risk of over-dependence of the contractor may not be a high.

(E) Outsourcing Reasons

11. What are the main reasons that petrochemical companies outsource plant maintenance? Are there significant differences in outsourcing reasons between different groups of companies?

C6S1 The reason to outsource is not a critical deciding factor. The management is clear that the primary objective to outsource is to reduce operating costs. In fact, the company is under pressure to reduce maintenance cost due to stiff competition and low profit margin.

C6S2 The cost reduction from outsourcing may not be very high because the company has its own maintenance crew. The decision is how much maintenance to outsource in order to balance the cost saving and outsourcing risks.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(F) Training Programmes

12 How important is the petrochemical companies consider the contractor skill-training program in gauging the worker quality?

C6Q12 Workers' training is important in the petrochemical industry as the equipment are getting more sophisticated and difficult to maintain. Poorly trained workers may have difficulties to maintain these equipment and could result in plant unreliability and fire.

C6Q13 The training program will train the workers on safety practices in their skill areas. An unskilled worker not only hurts himself but also others working in the vicinity. An unsafe worker can set the plant on fire or kill other workers.

C6Q14 The training programme is a factor to consider as it is related to the service quality and experience level of the workers. Moreover, the training programme is also a long-term commitment by the outsourcer on supporting the customer.

(G) Outsourcing Culture

13. What is the level of outsourcing in your organization?

C6C1 The company has only outsourced some plant maintenance activities. The in-house crew handles the remaining maintenance activities. The company plan to gradually expand the outsourcing activity base on its existing outsourcing experience.

C6C2 Many outsourcers have felt that the company should outsource more work. Other outsourcers thought that it is a big step forward for the company to outsource some of the maintenance activities if based on their past practices.

Appendix 4.1 (Continued)

Transcripts of case study interviews

C6C3 There is a gap between the expectations of the top management and the supervisors. The top management felt that it was a bold step by outsourcing some of the plant maintenance since the company used to do almost all their maintenance. The management is reluctant to increase the level to outsourcing so soon because of the high risk of failure.

C6C4 The outsourcing level does play a part in the outsourcing decision. Since this company has only outsource some maintenance activities, the decision to outsource total plant maintenance is a more difficult decision to make as compare to companies that have outsourced major parts of their maintenance activities.

14. What is the extent of the organization multi-level commitment towards outsourcing of plant maintenance? (Literature review suggests that multi level relationship is important to the success of outsourcing).

C6C5 The management is committed to outsourcing. The supervisors thought otherwise because of the level of outsourcing. Perhaps there is a breakdown in communication.

C6C6 The organization needs a mindset change since the workers have been maintaining the plant with minimum outsourcing. There is a noticeable change in attitude of the middle management and contractor towards the contractors.

C6C7 The outsourcer management is seemed to be more committed to outsourcing. The top and middle management are very supportive. Maybe the weak link is the workers in the factory floor who are less committed than the management. Generally, besides cost reduction, the middle management will prefer to use in-house maintenance crew as it is easier to manage the work quality than contractors.

C6C8 The organization culture towards outsourcing is definitely a factor to consider when the company decide to outsource total plant maintenance.

Appendix 4.1 (Continued)

Transcripts of case study interviews

Case 7

(A) Service Quality

1. What is the perception of the contractor service quality?

C7Q1 The general perception is the contractor is not as good as expected. There is no significant difference in the perception and expectation of the service quality. The supervisors felt that the outsourcer could improve their service quality.

C7Q2 The main contributor for poor service quality is the attrition rate among the contractor workers was high after working for one year. Furthermore, the contractor did not provide sufficient training to their workers as expected.

C7Q3 Service quality is a critical factor when the company decided to outsource almost all the maintenance activities to the outsourcer. The reason of hiring a 'skeleton crew' to oversee the outsourcer is a good testimony on the importance of maintenance service quality.

2. What are the significant differences in service expectations for different groups of petrochemical companies (size, type of petrochemical business, nationality, etc.)?

C7Q4 It is difficult to quantify the service expectations. However, if the chemical companies outsource total plant maintenance, the expectations would be for the outsourcers to manage the entire maintenance activities. On the other hand, if the chemical companies outsource partial plant maintenance, then generally the chemical companies will manage the plant maintenance activities.

Appendix 4.1 (Continued)

Transcripts of case study interviews

C7Q5 In this company, the maintenance supervisors and manager are expected to manage the maintenance activities. Hence, the outsourcer is expected to maintain the plant equipment and ensure that it is operating reliably. The outsourcer workers are suppose to know what to do without being told and recommend ways to improve the equipment performance.

3. What are the differences between the management perceived service quality versus actual service quality?

C7Q6 The actual service is quite similar to the perceived service. The management is realistic on the skills of the outsourcer. The frequent communication between the management and the technicians and supervisors help to the management to know what are happening in the field.

4. How has the contractor's corporate image affected the outsourcing decision?

C7Q7 Contractor reputation is one of the deciding factors. However, if the outsourcer reputation cost too much, then the companies will have second thought of hiring the outsourcer.

C7Q8 The company selected the outsourcer based on its reputation and experience working in the petrochemical industry. Although the company could hire international outsourcer who has extensive experience, the company decided on the local contractor base on costs and familiarity.

(B) Contractor Worker Experience

5. How extensively the outsourcer makes use of construction workers and temporary workers in plant maintenance? Do these workers meet the petrochemical companies' expectations?

Appendix 4.1 (Continued)

Transcripts of case study interviews

C7Q9 The outsourcer provides a combination of workers from the construction industry and workers with past maintenance experience. Those workers who have maintenance experience have been working for equipment manufacturers before joining the outsourcing company.

C7Q10 The company has accepted that there will be temporary workers in any organization. However, it is important that the outsourcer hire temporary workers that have relevant working experience that can contribute to the plant maintenance effort. It is a fact that the temporary workers may not be as committed as full-time employees but nothing that the company could do.

(C) Outsourcing Contracts

6. What is the expected outsourcing duration?

C7R1 The outsourcing contract is 3 years but there is option to extend depending on the performance of the outsourcer.

C7R2 The contract duration is meant to give the outsourcer the incentive to perform but short enough for the organization not to over-dependent on the outsourcer.

7. How are the outsourcing contracts written to mitigate the risk of failure?

C7R3 The outsourcing contract is quite similar to the conventional service contracts and consists of some non-quantifiable service expectations. The problem is the plant was new when the outsourcing contract was developed. The contract does not include performance clauses.

C7R4 The next contract may include performance indicators to clarify the expectations.

Appendix 4.1 (Continued)

Transcripts of case study interviews

8. How important is the service contract to your company?

C7R5 Many petrochemical plants have contracts that include all the performance expectations. Even comprehensive contract cannot prevent contractor poor performance. The only advantage is the customer could have legal recourse if the contractor failed.

C7R6 A comprehensive is certainly a factor to consider in outsourcing total plant maintenance. However, it should not be a 'show stopper' in the outsourcing decision.

(D) Outsourcing Risks

9. How important is the risk of plant maintenance failure in the outsourcing decision process?

C7R7 Failure of plant equipment can result in an unsafe situation besides production loss. Safety is of paramount importance in this company because any safety incident is reported to the company head quarter. Secondly, production loss for each day can result in a loss of US$300,000.

C7R8 Outsourcing risk is a critical factor in deciding outsourcing total plant maintenance. It is because outsourcing total plant maintenance is a big change from the traditional way to maintain the plant. Failure of outsourcing may result in serious repercussion to the local management.

10. How do the petrochemical companies mitigate their risk of plant maintenance outsourcing failures?

Are there significant differences in risk of over-dependence of contractors, hidden costs of outsourcing between different groups of companies?

C7R9 The best way to mitigate the risk of outsourcing failure is to ensure the contractor workers are trained and experienced. The workers should not change too often to provide continuity in the work.

Appendix 4.1 (Continued)

Transcripts of case study interviews

C7R10 This company is able to seek assistance from other affiliated plants in other parts of the world if the contractor failed. However, this is a costly decision which the management will rather try to avoid.

C7R11 The company does not over-dependence on the outsourcer by having a "skeleton" maintenance crew of supervisors and a few technicians. This crew is able to handle any emergency if the outsourcer could not perform. This situation will change if the company advances to the next stage of outsourcing total plant maintenance.

(E) Outsourcing Reasons

11. What are the main reasons that petrochemical companies outsource plant maintenance? Are there significant differences in outsourcing reasons between different groups of companies?

C7S1 Most of the maintenance activities are outsourced to one contractor. The primary objective is to reduce operating costs.

C7S2 The company only employs maintenance supervisors and a limited crew of technicians to guide the outsourcer and management the overall maintenance activities.

C7S3 The company has decided to outsource plant maintenance during the plant construction stage.

(F) Training Programmes

12. How important is the petrochemical companies consider the contractor skill-training program in gauging the worker quality?

Appendix 4.1 (Continued)

Transcripts of case study interviews

C7Q11 Worker training is important to improve the workers' skills and reduce the risk of equipment failure. The workers' training program is also a reflection on the outsourcer commitment on outsourcing and improving the service quality.

C7Q12 The contractor training programme is not considered an important factor to decide total plant maintenance outsourcing. However, this factor will relate to the contractor worker experience level and service quality which are more important.

(G) Outsourcing Culture

13. What is the level of outsourcing in your organization?

C7C1 The company has outsourced almost 90% of the plant maintenance. A handful of supervisors and managers are hired to ensure the equipment are maintained properly.

C7C2 Company's management decision is to outsource plant maintenance. Therefore, outsourcing plant maintenance is a long-term activity. However, there is no plan to reduce the in-house crew over time because the company wants to control the management of the maintenance activities.

C7C3 The outsourcing culture is secondary in deciding outsourcing. The culture can be changed over time as long as the senior management is totally committed.

14. What is the extent of the organization multi-level commitment towards outsourcing of plant maintenance? (Literature review suggests that multi level relationship is important to the success of outsourcing).

Appendix 4.1 (Continued)

Transcripts of case study interviews

C7C4 It was unanimous that the whole organization is committed to outsourcing. The whole organization is aware that the outsourcer is a strategic partner to the organization.

C7C5 The outsourcer management is also committed to outsourcing.

Appendix 4.1 (Continued)

Transcripts of case study interviews

Case 8

(A) Service Quality

1. What is the perception of the contractor service quality?

C8Q1 The satisfaction level of the service quality is generally high. The technicians have slightly lower satisfaction level than the management.

C8Q2 The service quality is a critical factor in the decision to outsource plant maintenance.

2. What are the significant differences in service expectations for different groups of petrochemical companies (size, type of petrochemical business, nationality, etc.)?

C8Q3 The training of the contractor workers is lower than expected. This can be a potential problem to the reliability of the plant equipment as the equipment are getting more sophisticated.

C8Q4 Some of the contractor workers are good. Poor service quality was mainly due to the contractor employed poorly trained and low paid workers.

C8Q5 The company's expectations are the outsourcers should be capable to manage the maintenance activities. These expectations could be different for other companies who have their own maintenance crews.

3. What are the differences between the management perceived service quality versus actual service quality?

C8Q6 The outsourcing is performing reasonably well and it is quite similar to our perceived service quality. However, some of the day-to-day problems may not be surfaced to the management as they are handled within the supervisory level.

Appendix 4.1 (Continued)

Transcripts of case study interviews

4. How has the contractor's corporate image affected the outsourcing decision?

C8Q7 The contractor was given the contract based on their past experience working with the organization. The contractor workers had been assisting the in-house maintenance crew.

C8Q8 The contractor reputation is based on contractors' past experiences working for other petrochemical plants.

C8Q9 Many petrochemical companies hire the outsourcers based on their past working experience in the petrochemical industry.

(B) Contractor Worker Experience

5. How extensively the outsourcer makes use of construction workers and temporary workers in plant maintenance? Do these workers meet the petrochemical companies' expectations?

C8Q10 The expectation is the outsourcer should have relevant maintenance experience. However, there is a short supply of skilled workers. Therefore, not all the outsourcer workers working in the company have the relevant maintenance background. Some of the workers are formerly in the construction industry.

C8Q11 The outsourcer hires some temporary workers to supplement their workforce. It may not be realistic if we insist that no temporary workers to be hired. Although some of the temporary workers are equally good, many of them are not as committed as full-time employees. The temporary workers tend to change jobs much more often than full-time employees.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(C) Outsourcing Contracts

6. What is the expected outsourcing duration?

C8R1 The outsourcing contract is 3 years but extendable. The company wants to have the flexibility to terminate the contract if the outsourcer could not perform. It may be too disruptive to if the outsourcing contract is less than 3 years.

7. How are the outsourcing contracts written to mitigate the risk of failure?

C8R3 The outsourcing contract included performance clauses to protect the company against poor workmanship. However, the contract does not include comprehensive performance indicators to indicate the service expectations.

C8R4 Not many companies have outsourcing contracts that include performance measurements. The performance indicators may be different depending on the manufacturers and the age of the equipment.

C8R5 It is difficult to identify the performance indicators. Perhaps the next contract may include more comprehensive performance indicators as we gather more experience with outsourcing.

8. How important is the service contract to your company?

C8R6 The service contract is important in order to protect the company from poor service level. It will help to manage the maintenance costs and prevent the outsourcers from overcharging.

C8R7 The service contract certainly is not considered a critical deciding factor. Otherwise, the company will not outsource plant maintenance. However, service contract will be more important if we depend more on the outsourcer.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(D) Outsourcing Risks

9. How important is the risk of plant maintenance failure in the outsourcing decision process?

C8R8 Outsourcing risk is considered a critical factor in deciding outsourcing platn maintenance. Failure of plant maintenance has high consequences. Equipment failure may take a few days to restart the plant. The production loss could result in a few hundred thousand dollars per day. Furthermore, plant unreliability could result in fire and loss of lives.

10. How do the petrochemical companies mitigate their risk of plant maintenance outsourcing failures?

Are there significant differences in risk of over-dependence of contractors, hidden costs of outsourcing between different groups of companies?

C8R9 The company mitigates the outsourcing risk by outsourcing the plant maintenance to two main contractors. One outsourcer will back up the other outsourcer if anyone of them is not able to perform. This mitigation method may have disadvantage as the company may not able to take advantage of the economies of scale. On the other hand, the outsourcers know that the company is not over-dependent on anyone of them.

C8R10 Some petrochemical companies may keep a small maintenance workforce to mitigate outsourcing risks.

(E) Outsourcing Reasons

11. What are the main reasons that petrochemical companies outsource plant maintenance? Are there significant differences in outsourcing reasons between different groups of companies?

Appendix 4.1 (Continued)

Transcripts of case study interviews

C8S1 The company started off by hiring in-house maintenance crew to maintain the plant equipment. The management decided to outsource plant maintenance in 2000 which was a period where the company profitability was not very good. The management was under pressure to reduce operating costs. The outsourcing of plant maintenance was one of the many measures that the management had taken to reduce operating costs.

C8S2 The outsourcing plant maintenance resulted in the retrenchment of some of the existing in-house maintenance. The remaining in-house maintenance crew will not be replaced when they retire or leave the organization.

C8S3 Outsourcing has been around for sometime and the benefits of outsourcing are known. It was clear that maintenance is not the core business in the petrochemical industry. Therefore, outsourcing reason is not an important factor in deciding outsourcing plant maintenance.

(F) Training Programmes

12. How important is the petrochemical companies consider the contractor skill-training program in gauging the worker quality?

C8Q12 Skill training is important in maintenance activities. There are constantly new methods in maintenance and it brings benefits to the outsourcer as well.

C8Q13 Another reason is the worker turnover rate is rather high and therefore, the training program will help the new contractor workers to "get up to speed".

C8Q14 The company may get into a legal problem if it outsource the plant maintenance to an outsourcer that are not competent.

Appendix 4.1 (Continued)

Transcripts of case study interviews

(G) Outsourcing Culture

13. What is the level of outsourcing in the organization?

C8C1 The company has outsourced most of the plant maintenance to two main outsourcers. The reason is to reduce the risk in case one outsourcer not able to perform.

14. Is there any evidence that there is multi-level commitment in the organization that outsource plant maintenance? (Literature review suggests that multi level relationship is important to the success of outsourcing).

C8C2 Both the company and outsourcer management are totally committed to the outsourcing activities. The company management accepts the outsourcer as a strategic partner.

C8C3 There is a plan not to rehire any in-house maintenance when they leave the company either due to retirement or resignation. The outsourcers will take over the duties of these employees.

C8C4 The company had taken a bold decision to outsource most of the maintenance activities. The decision may not be difficult when pressure is to reduce overheads. This may be a "showcase" for the other companies to follow in the future.

C8C5 The company culture does play a part in deciding outsourcing plant maintenance. Since this is a joint-ventured company, the partners are happy as long as the overheads are reduced. In this case, the culture to outsource is an important factor.