

Maintenance Outsourcing

Term paper for TPK4140 Maintenance management

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Pre-phase

Organizations around the world are looking for new approaches to maintain or/and increase their competitiveness. Maintenance outsourcing as one of the methods to minimize operating cost is sometimes an alternative. For managers facing hiring freezes, cuts in training budgets, aging maintenance workforces, and hard-to-find skilled labour pools, outsourcing may be the single best choice to go through the tough period. The advantages seem obvious, budget flexibility, optimization of manpower and tools, reduction of expense in hiring specialized staff and training, to mention a few, are all results of maintenance outsourcing. At the same time, outsourcing arrangement can be changed easily in according to your maintenance needs. It's sometimes a key reason making company choose outsourcing as the maintenance strategy. Many companies have experienced great success by adapting outsourcing to gain competitiveness.

As a coin has two sides, outsourcing of maintenance may also bring lots of side-effects and disadvantages. The obvious ones are difficult to control the quality of the maintenance work, shortage of skilled people from contractors, inadequate contractor planning of work to be done, poor relationships between client and contractor employees and etc.

Anyway, the decision of the outsourcing or not needs to be made, this paper is an attempt to contribute to make the decision making more rational and scientific.

Summary

In this paper the maintenance outsourcing decision making process and factors need to be considered in the process is discuss.

Core competency based maintenance outsourcing decision making approach is discussed in the first place, the constraint of this approach is considered as well. A more reasonable approach which considers two dimensions of the importance of maintenance to the company is presented. The basic principle of this method is given with a small discussion.

Then the cost and benefit of contracting out of maintenance tasks are briefly discussed, some statistics of the cost saving due to employ of maintenance contractor are presented with some facts. However the lack of considering the whole picture of cost and benefit exists. The importance of considering overall cost and benefit of the organization is addressed.

The tool, technology and skilled personnel relating to maintenance is addressed in the next part. Currently situation of these things with respect to maintenance is

briefly reviewed.

Then the management of relationship between two parties involved in maintenance outsourcing is highlighted. We found both sophisticated contract and mutual trust between client and contractor is necessary to keep the outsourcing relationship in a good way.

At the end a small model of considering risk of maintenance outsourcing is provided with the emphasis on violation of contract.

We did not consider reliability and availability separately in this paper. We believe that a good relationship with mutual trust can ensure high reliability and availability.

Introduction

We are facing the world of shortage of skilled and experienced maintenance engineers. And we strive to achieve minimum operating costs and lean operations in terms of manpower. So we start to consider contract out maintenance. To some companies the decision of maintenance outsourcing is not that difficult, but to some others, it is really not a easy job, especially to those maintenance is their core competency or near core competency.

Then, what is outsourcing in general and what is maintenance outsourcing in particular. According to ventureoutsource's term and definition, Outsourcing is subcontracting a process, such as product design or manufacturing, to a third-party company. And it is easy to understand maintenance outsourcing is subcontracting maintenance task to a third-party company.

Also we mentioned core competency. What is core competency? It is not easy to give a general answer which applies to every company. However according to the same source activities or practices, such as product development, determined by a company as critical to its long-term success and growth. Other authors have different towards this question; we will discuss later in the paper.

In order to make a wise decision with respect to maintenance outsourcing, we are trying to explore the influencing factors. The emphasis of this paper is not to provide a universally applicable method but to find out what really matters when considering contract out maintenance tasks.

Main part

Outsourcing of maintenance is sometimes considered as an effective method to relief the managers from maintenance management and to get more focused on the so

called core competence to their business. All these are the results from simply regard maintenance of all kinds as non-core business activity. However it is not always the case that maintenance is not of primary important to the core competence for the company, for example to pulp and paper mill maintenance is the core business, therefore outsourcing is not the right answer to every maintenance situation. Furthermore the conventional wisdom regarding the outsourcing decision states that you should outsource your non-core business activity is an approach which of the type easy to and hard to carry out. It did not provide the guidance to deciding which activity is non core business. And lots of companies which adopting this approach end up making the judgement highly subjective.

No doubt, to lots of businesses, maintenance outsourcing is a good alternative. The well-known American Duroc management scholars had predicted: "In 10 to 15 years, any business done in the background to support not only the creation of the work of turnover should be outsourced." However it still necessary to think twice before really contracting out the maintenance task. Not only the question if we should let an external supplier to take care of the maintenance, but also the question we should take total outsourcing or partial outsourcing need to be answered.

Maintenance outsourcing decision-making is relating to lots of different factors, which makes it a complex and multi- perspectives problem. In order to make the optimized decision, we think all the following questions should be answered or bear in mind.

- 1) How close maintenance is to the core business or how important maintenance is to the company?
- 2) What are the costs of contracting out maintenance task?
- 3) Do we have sufficient tools, technology and people to carry out the in-house maintenance, and if we can find a capable contractor to turn to?
- 4) How do we manage the outsource relationship in terms of ensuring high quality service?
- 5) What is the risk and benefit of outsourcing?

In the following paragraphs, each of these issues will be addressed separately in attempt to give a broad picture of the decision-making process and considerations for maintenance outsourcing.

Importance of maintenance to the company

In order to answer the first question, the part will emphasis on the what kind of roles does maintenance play in the whole picture of the company, in other words how importance maintenance is to the company level, and how its importance influences the decision of contracting it out.

Usually people will come across the concept of core business and non-core business when considering outsourcing. The fundamental principle here is to outsource these non-core businesses to an external contractor and focus on the core business or core competency. This principle is rather classical and has been adopted by many companies. A core competency philosophy based decision-making scheme of maintenance outsourcing on manufacturing equipments is illustrated by figure 1.

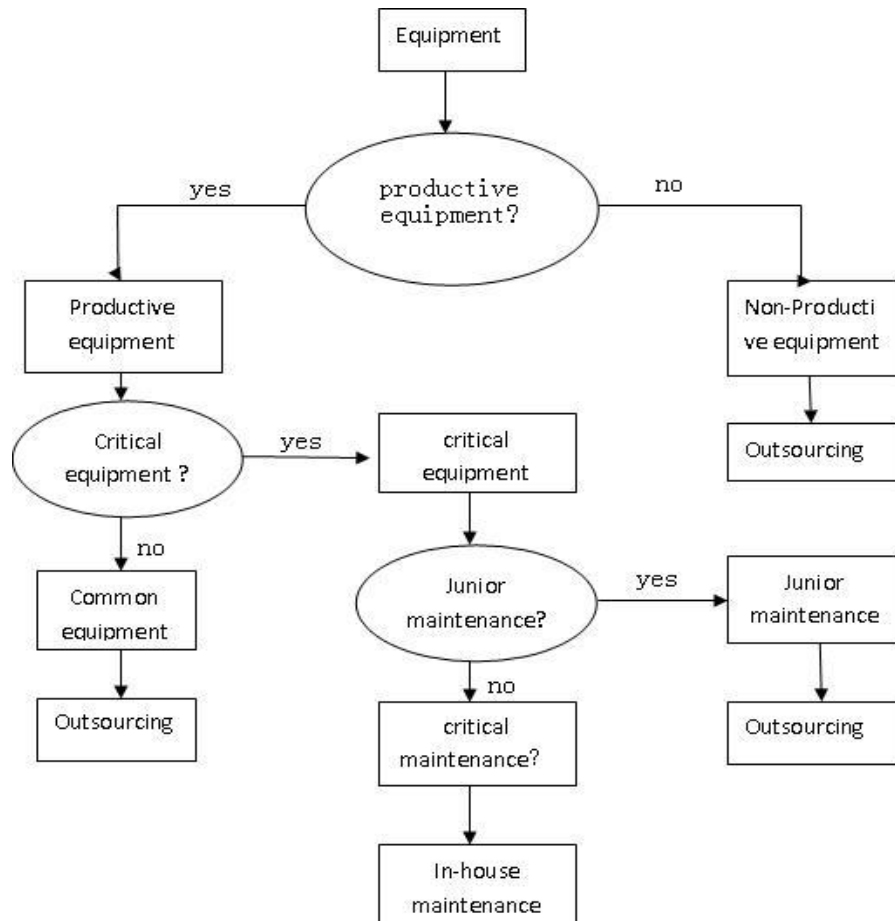


Figure 1

Here, we first have equipment which needs to be maintained. The decision process starts with identifying whether this equipment is directly supplying quality and service for the productions. If the answer is no, we regard this equipment as non-productive equipment, and therefore the maintenance tasks are quite likely to be contracted out as no core business. If the answer is no, it is regarded as productive equipment, therefore we have to further consider if the equipment is critical to the productions. If we get a negative answer, the equipment is just common equipment; consequently, its maintenance will be contracted out. If this equipment is critical to production, then the reliability, availability and regularity of the equipment will be crucial to the company, thus the maintenance outsourcing decision will be rather difficult, very likely we may choose just contract out those junior maintenance like painting, cleaning etc, and keep most of other main maintenance in house due to regarding those maintenance as core competencies to the company. Of course those

main maintenance on critical equipment still has good chances to be outsourced if it feasible, cost-effective and has positive effect on the company’s core competency. However a large proportion of those companies which adopted this approach turned out to be that they don’t have a satisfactory maintenance performance, either those which take maintenance outsourcing or those which do not. Why, why those who follow the classical approach still fail?

On one hand the definition of core competency varies from company to company, from one period to another. Without a clear and correct definition, it’s hardly the case that outsourcing decision based on core competency philosophy will work well. Traditionally, it is defined as the activities an organization does well or the activities that are important to an organization. A third definition which challenged both of above one suggested other practitioners states that core competencies are only activates that an organization must do with internal resources in order to create or maintain a competitive advantage in the marketplace. They further argue that if an activity does not create recognizable value that customers are willing to pay for. Such activity is not a core competency and will not receive the focus necessary for continuous improvement. We believe all these defecion could be correct to certain company at certain time, and they could be all incorrect if the target company changed. Thus every company should define its own meaning in regarding of core competency, and we found it is never a easy task to be accomplished.

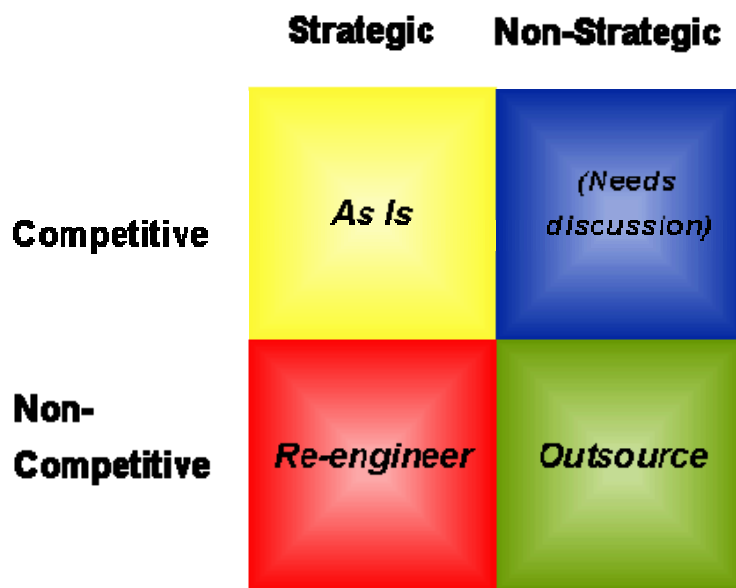


Figure 2(from Sandy Dunn)

On the other hand, even if we had a clear and correct definition, the procedure and practice of picking out the core activities of the noncore ones in regarding of maintenance operation is still a difficult task. We gave a decision scheme for manufacturing maintenance task in figure 1, but it is a rather simple one and sole for the illustration purpose. If we follow this scheme exactly, I am afraid lots of problems will appear sooner or later and quietly likely sooner. Thus more robust decision-making scheme shall be introduced, unfortunately, none such scheme is

available so far and most of these kind of decisions ends up being highly subjective, and in the end, one person's opinion ends up prevailing over another's.

In order to make a better decision, a new approach has been proposed, and this one is typically adopted by Pricewaterhouse Coopers. Instead of just focus on core competency, this approach is to look at the decision in terms of a two by two matrix, as shown in figure 2.

This approach generally considers the outsourcing decision along two dimensions, namely strategic or non-strategic, and competitive or non competitive. The first, strategic or non strategic, consider how important the maintenance proposed for outsourcing is to the company to achieve the long term strategic competitiveness in the market place. This usually varies from organisation to organisation, for example to mining business, to which maintenance and asset ownership costs is usually count for 55-60% of the total costs, thus maintenance acts as strategically important, while maintenance clearly is not strategically important to an university. The second dimensions, competitive or non competitive, relates to how competitive the maintenance being considered for outsourcing is currently being performed compared to external competitive market place. This is highly related to cost- benefit which will be thorough addressed later in this report.

While the two dimensions are decided, the maintenance decision will as illustrated on the picture. The two dimensions together produce 4 different cases.

- 1) Strategically important and currently performed competitively, to this maintenance the current state should be retained.
- 2) Strategically important but currently not performed competitively, to these maintenance we may have two alternative choice, either keep it in house and at the same time to initiate a re-engineer to increase its competitiveness or go for short-term outsourcing and by learning from the contractor or other good practice to gain the competitiveness, eventually come back to in house maintenance again.
- 3) Not strategically important but currently performed competitively, usually we will keep these type of maintenance in the current status, but once it's not that competitive any more, its will be sold out.
- 4) Not strategically important and currently not performed competitively, to these maintenance we will not hesitate to contract it out.

So based on this approach the factors need to be considered, instead of core competency, will be both strategically importance currently competitiveness.

Maintenance outsourcing cost

To a business cost and benefit are always of primary important, it is not an exception when it comes to the decision-making of maintenance outsourcing. Michael Levery

stated in his paper: as organisations today strive to achieve minimum operating costs and lean operations in terms of manpower, the maintenance activity has become a target for outsourcing. Thus the cost reduction, in other words increasing benefit, is one of the main drives to consider contracting out maintenance. And a maintenance outsourcing survey conducted by Plant Maintenance Resource Centre support it. In this survey 29 responses were received, among which 3 take reduce maintenance costs as the most important reason for using contract maintenance services, 3 take it as second most important reason and another 3 take it as third important reason. The overall ranks reduce maintenance costs second with the same total voters as number one. So contract maintenance to lots of business is a profitable action.

And indeed, in lots of cases, the cost of the company truly reduced by introduction of maintenance outsourcing. The same survey shows among those which using contractors, 3 got significant reduction of cost and some 11 experienced slight reduction, only 1 got significant and 1 got slight cost increase. Similarly, professional services firm McKinsey & Co. estimated that offshore outsourcing can reduce an organization's costs by anywhere from 45 to 55 percent. From this point of view, it is certainly good choice to contract out the maintenance. However the cost stated above is only the direct cost of maintenance, if we add the other costs induce by using maintenance contractor, the picture will be changed, either slightly in some case or significantly in other cases. Then what are exactly the costs saving or additional expenses? How do they influenced by maintenance outsourcing? And whether or not using maintenance contractor will eventually result in overall cost reduction.

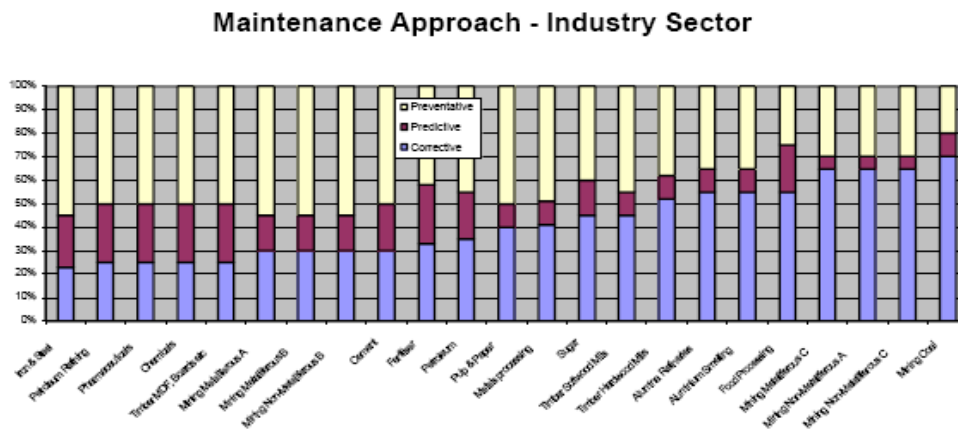


Figure 3(from R Francis)

Firstly, in lots of companies, in-house maintenance makes it too low levels to be efficient and beneficial, and go for external contract may be a remedy to increase the effectiveness. Figure 3 is taken from an extensive national survey conducted in Australia, it indicates a general poor maintenance performance throughout the Industry Sector, and given the organizational inertia, that approximately 60% of maintenance is performed in-house, this must give a ray of hope for the better specialist maintenance contractor, and therefore increase the cost saving. Of course to some organizations which have already done good in-house maintenance,

contracting out maintenance is possible result in lower effectiveness, consequently negative impact over the maintenance.

Secondly, organizations, which adopting in-house maintenance strategy usually requires full time maintenance crew, while the workload varies from day to day, week to week. This will lead to poor utilization of resources and overstaffing. Outsourcing maintenance may enable organizations to use the same or similar workers from external suppliers as temporary employees, which can significantly increase the wage cost.

We also have to take the additional cost of using contractor in to consideration. In order to make sure maintenance is carried out in a good manner, usually we need to prepare a sophisticated contract and make sure the contractor will follow the items in the contract. The establishment of contract may need a costly study of the company and requires lots of expertise, for example analyst and lawyer, which should be paid for. And during the maintenance, the company still need sent staff to supervise the contract and manage the relationship with them. All these will increase the cost.

Of course, there are other cost related considerations need to be addressed, such as the overall effective may be influenced by outsourcing, we will discuss in other parts of this report. The decision influencing factors are mainly maintenance cost saving and overall cost change due to outsourcing.

Tool, technology and skilled personnel

Taking about the maintenance, we cannot avoid discussing maintenance equipment, technology and skilled personnel, without either one of them, the maintenance tasks are not likely to be finished successfully. When the organizations do not have all of these in house or it is not economical to have all of them, they may probably turn to maintenance contractor. Or in other cases, organizations want to outsource its maintenance, but they can hardly find the capable ones. These things of course need to be considered when making the outsourcing decision.

To those maintenance which requires specific tools or technology that we cannot find within the company the first idea we may come up in our mind is to ask these who have for help. Especially, the effective maintenance has changed significantly in recent years. Maintenance today is far more high technology based than it was. And more and more organizations' maintenance strategy turn to preventive maintenance based from former corrective based, which requires more specific tools and high technology. It's always expensive to acquire all these equipment and technology, and lots of organizations don't want to or cannot afford to purchase all these. Consequently, they end up outsourcing. In other cases, the skilled personnel may be difficult to find within the company, then usually the maintenance ends up

outsourcing.

On the contrary, in some cases, the maintenance task may be too specified which required individual based tools and technology. Even the maintenance contractor doesn't have or want afford these equipments due to small market and high risk of losing money. If it is the case, even through outsourcing will bring lots of benefit and it largely outweigh the cost, we cannot contract out maintenance simply because these kind of maintenance contractor is not available. Also the pool of available skilled maintenance technicians is very shallow and the existing maintenance workforce is aging and nearing retirement, thus it's not impossible we cannot find the right person among the contractors. In this case we have to rely on ourselves to train our own technician to perform specific task.

To sum up, we need the right tool, technology and skilled personnel to get our maintenance done. So when considering maintenance outsourcing, we should find where we can have the access them, either within the company or from the contractors, or both. These factors are more or less straightforward but have a dominant influence on the decision.

Management of outsource relationship

Fundamentally, two parties, customer and contractor, involved in the outsource relationship, have different interests, and oftentimes their conflict with each other. How does the customer ensure the contractor will deliver the required reliability and availability? It should be based on a good relationship between the two parties. If the contractor is totally trusted and is doing their possible best they can, the customer should never bother to worry about things like reliability and availability.

When making the decision of maintenance outsourcing, the issue of how to manage the relationship between client and contractor needs to be addressed. All too often, we outsource maintenance in order to "get it off their plate." The desire is to dump maintenance into the lap of the contractor, and this kind of outsourcing is deemed to fail. In order to achieve a successful maintenance outsourcing, two aspects of efforts need to be paid. First a sophisticated contract with clear responsibilities and benefits, plus incentive and punishment need to be established to restrict both parties in the name of justice; secondly long-term co-operative relationships with mutual trust need to be established to achieve the win-win situation.

Since the two parties have different interests, a contract is necessary to clearly confine each party's responsibilities and benefits. With ambiguous contracts, either party could suffer significant loss, very likely the one who assume the suffering will be the client. For example, customer has to deal with particular breakdown of equipment which is not specified on the contract list with contractor. So most organizations would turn to an independent maintenance expert, hire them to write

a specification for their requirements of contractor to tender against. One of the most important items need to be mentioned is incentive and punishment. A contract without these two specific items will never have the chance to be regarded as a good contract. Without incentive the contractor will not work for the good of the customer, since every business takes benefit as their ultimate goal., the contractor need incentive to do extra job and as a result the client get better maintenance than specified on the contract and the maintenance provider get extra money, both parties have happen ending. Punishment is used to protect the benefits of clients from being hurt, with punishment items the client can use legal method to ask for compensation when the provider did something they should not do or should do better, and also deter the contractor from doing things which may damage the clients' benefit for their own good. So a sophisticated contract is necessary to manage the relationship between two parties.

However, only specifications of contract cannot guarantee the success of maintenance outsourcing. Actually, it is far away from enough. In order to achieve the win-win situation, beside contract, long-term co-operative relationships with mutual trust seems much more important. Some people even believe that success will only be achieved through establishing long-term co-operative relationships, not through specifying and tendering. We don't believe only co-operative relationships itself can make things done, but this statement can indicate the importance of co-operation.

Therefore when making the decision for maintenance outsourcing, how much effort and money need to establish the contract and relationship should be considered. Also the difficult of set up a 'perfect' contract and mutual trust should be realized; some time it can be mission impossible. Here the decision influencing factors could be concluded as the contract establishing difficulty and mutual trust building difficulty.

Risk estimate of outsourcing

We have mentioned the two parties related to outsourcing contract have fundamental different with respect to their own interest. Besides to consider the how to management the relationship, we should also take into account the risk of bed relationship, then how likely that the contractor don't comply with the contract? To evaluate this we introduced a mathematical model.

The term "Economic Man" was used for the first time in the late nineteenth century by critics of John Stuart Mill's work on political economy. Mill went on to write that he was proposing "an arbitrary definition of man, as a being who inevitably does that by which he may obtain the greatest amount of necessities, conveniences, and luxuries, with the smallest quantity of labor and physical self-denial with which they can be obtained."

Suppose both customer and contractor pursues the maximal profit as an Economic Man. First we developed the income matrix, table 1 for contractor with the consideration of probability of supervision by customer and the probability that the contractor may violate the contract.

Table 1

Income matrix	Supervision	Non-supervision
Violation of contract	$(1-p)(R_1-C_1)-PL$	R_0-C_1
conformance	R_0-C_0	R_0-C_0

Y_1 and R_1 are the customer's and suppliers' true-life income respectively.
 Y_0 and R_0 are the customer's and the supplier's income in contract respectively.
 C_0 and C_1 are the supplier's service cost f in contract and in reality.
 L is the total loss when supplier doesn't implement by the standard in contract.
 P is probability of detection when supplier doesn't comply with the contract.

Then, the ideal income for the contractor(S) can be calculated as follow.

$$S = \beta\alpha(Y_1 - R_1 - C) + (1 - \alpha)\beta(Y_1 - R_0) + (1 - \beta)\alpha(Y_0 - R_0 - C) + (1 - \alpha)(1 - \beta)(Y_0 - R_0)$$

α is the probability that customer will supervise the maintenance.

β is the probability that contractor will violate the contract.

Take the derivative for this formula with respect to α , and let it equates to zero. The possibility the violation can be obtained.

$$\beta = \frac{C}{R_0 - R_1}$$

From this expression, it's easy to conclude that the possibility of violation increases with the increase of income gap (R_0-R_1) for the contractor. So when making the contract, we should make these gap as low as possible in order to reduce the violation possibility.

Thus when we considering contracting out maintenance we need to estimate the income gap for the contractor in order to evaluate the possible of violation of contract. And to make sure a successful maintenance outsourcing, we believe the estimate of the violation possibility is crucial so the factor, contractor income gap need to be evaluated during the decision-making process.

Conclusion

To sum up, this paper briefly discussed the influencing factors on maintenance outsourcing decision making. Considerations from several perspectives have been

concerned. We found the following factors have influence on the decision making.

1. Importance of maintenance to the company. Traditional core business based decision making approach is not adequate for maintenance outsourcing. Two dimensional approaches may be more appropriate.
2. Maintenance outsourcing cost is a great consideration. From statistics and some industrial facts we found maintenance outsourcing can reduce maintenance cost. However this cost is calculated with respect to maintenance only, we should not lose the big picture, the overall cost of the plant.
3. Tool, technology and skilled personnel. Lacks of these are drives for outsourcing, but sometimes can also be the obstacles for maintenance outsourcing.
4. Management of outsource relationship. The relationship between client and contractor is a great issue for outsourcing, the quality of contractor's service in general and the reliability and availability of contractor provided in particular largely depend on the relationship of the two parties.
5. Risk estimate of outsourcing. Risk induced by maintenance outsourcing should be considered during the decision making phase. A small model to estimate the risk of contractor violating the contract is provided.

References:

- [1] R Francis Consulting Pty Ltd, Lossen the collar, tighten the belt & pull up your socks successful maintenance outsourcing.
- [2] Online material source, <http://www.ventureoutsource.com/node/18/print>.
- [3] Christer Idhammer, Contrat maintenance or not?
- [4] A. B. Maryland. Outsourcing 101-a primer.
- [5] Sandy Dunn. Maintenance outsourcing -critical issues.
- [6] Mark R.Goldstein. Suppose you had to cons.
- [7] ATS, a plan for success.
- [8] Michael Levery. Outsourcing maintenance-a question of strategy.
- [9] Plant maintenance resource center. Maintenance outsourcing survey results-2001.
- [10] ATS, Production Equipment Maintenance-Have you considered outsourcing?

PRE-STUDY REPORT

Aims:

The main purpose of this study is to investigate influencing factors for outsourcing decision of maintenance work as well as their importance. Most of the efforts will be given to achieve the following objectives.

1. Find the primary influencing factors for maintenance outsourcing decision.
2. Revealing the influencing mechanism of factors over maintenance outsourcing decision.
3. Ranking of these factors to indicate their weigh in the decision making.

Description of the topic:

Organizations around the world are looking for new approaches to maintain or/and increase their competitiveness. Maintenance outsourcing as one of the methods to minimize operating cost is sometimes an alternative. For managers facing hiring freezes, cuts in training budgets, aging maintenance workforces, and hard-to-find skilled labor pools, outsourcing may be the single best choice to go through the tough period. The advantages seem obvious, budget flexibility, optimization of manpower and tools, reduction of expense in hiring specialized staff and training, to mention a few, are all results of maintenance outsourcing. At the same time, outsourcing arrangement can be changed easily in according to your maintenance needs. It's sometimes a key reason making company choose outsourcing as the maintenance strategy. Many companies have experienced great success by adapting outsourcing to gain competitiveness.

As a coin has two sides, outsourcing of maintenance may also bring lots of side-effects and disadvantages. The obvious ones are difficulty to control the quality of the maintenance work, shortage of skilled trades people from contractors, inadequate contractor planning of work to be done, poor relationships between client and contractor employees and etc.

So the decision of contracting maintenance to external organizations is never easy to make. For those companies, maintenance is or is close to the core of their operations, it is even more difficult to decide whether or not to outsource. However, the question "outsource or not?" must be answered. Conventional wisdom regarding the outsourcing decision states that you should outsource your "non-core" business activities. The difficulty with this approach, however, is that it provides no guidance for deciding which activities are "non-core". Instead of defining "core" and "non-core" business activities, this study is an attempt to find these primary factors, which the importance of maintenance to the company is one of them, that the management shall take into consideration

when making the decision whether outsource the maintenance to an external organization or not as well as to evaluate the importance of these factors in terms of influence over the final choice. The result of this project is supposed to be able to assist the decision making process and be used as a reference in practice.

Methods:

In order to determine the primary factors and its importance to the outsourcing decision making, this project will employ following approaches:

1. Information collection of Internet websites
2. Case investigation of company considering maintenance outsourcing
3. Discussion with experts from industry or academic circle (Example: professors in NTNU)
4. Published academic references investigation

References:

- (1). R Francis Consulting Pty Ltd, Lossen the collar, tighten the belt & pull up your socks successful maintenance outsourcing.
- (2). Christer Idhammer, Contrat maintenance or not?
- (3). A. B. Maryland. Outsourcing 101-a primer.
- (4). Sandy Dunn. Maintenance outsourcing -critical issues.
- (5). Mark R.Goldstein. Suppose you had to cons.
- (6). ATS, a plan for success.
- (7). Michael Levery. Outsourcing maintenance-a question of strategy.
- (8). Plant maintenance resource center. Maintenance outsourcing survey results-2001.

Project plan:

10 th -20 th Sep.	Collecting related information about maintenance outsourcing and browsing and refining these materials
21 th Sep. -10 th Oct.	Analysis of collected data, case study and discuss with the experts. Finding these factors and preliminary rank
11 th -20 th Oct.	Refining the findings, produce the draft report
21 st -31 st Oct.	Revising and discussing to finalize the formal report
1 st Nov.	Handing in the formal report

MAINTENANCE OUTSOURCING

Baiyu, Teng; Bin, Xie; Hui, Jin

What is maintenance outsourcing?

- ▶ Outsourcing is subcontracting a process, such as product design or manufacturing, to a third-party company.
- ▶ Maintenance outsourcing is subcontracting maintenance task to a third-party company.

Why outsource maintenance?

- ▶ Focus on the core competencies.
- ▶ Reduce the operational in terms of maintenance.
- ▶ High utilization of manpower.
- ▶ Lack of skilled technician, tools and/or know-how.
- ▶ Making use of the industry's best practice.
- ▶ Plus many others.

What are the drawbacks?

- ▶ Difficult to control the quality of the maintenance work in terms of Reliability and Availability.
- ▶ Issues of relationship management with contractors.
- ▶ Risk of violation of contract.
- ▶ Contractors may lack of knowledge of client's plant and equipment.
- ▶ Safety issues related to maintenance.
- ▶ Etc.

Outsourcing or not?

- ▶ The decision of maintenance outsourcing needs to be made, even though it will not be an easy decision to those who make it. Maintenance makes an important role in their business.

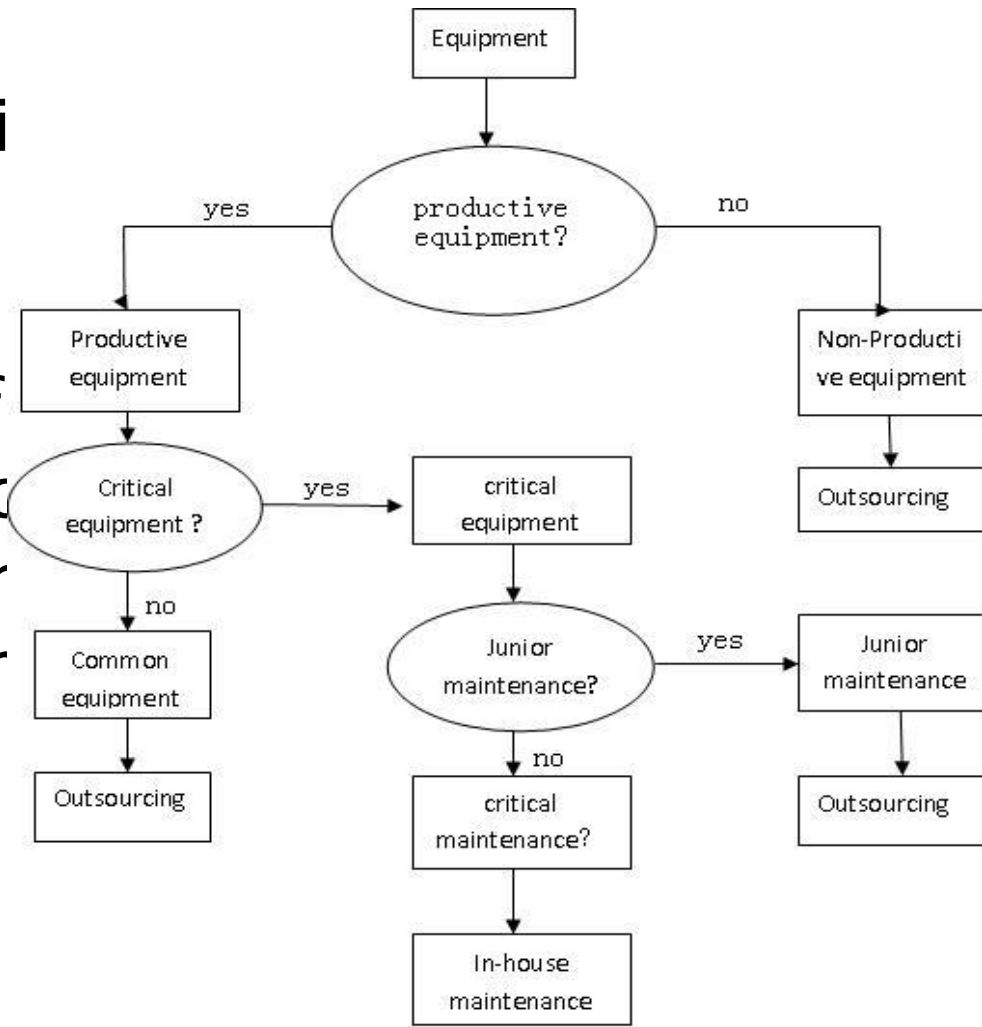
Decision influencing factors?

- ▶ Importance of maintenance to the company.
- ▶ Cost saving or increasing cost both locally and globally.
- ▶ Tool, technology and skilled personnel
- ▶ Management of outsource relationship.
- ▶ Risk of maintenance outsourcing.
- ▶ Others. such as keep low employee.

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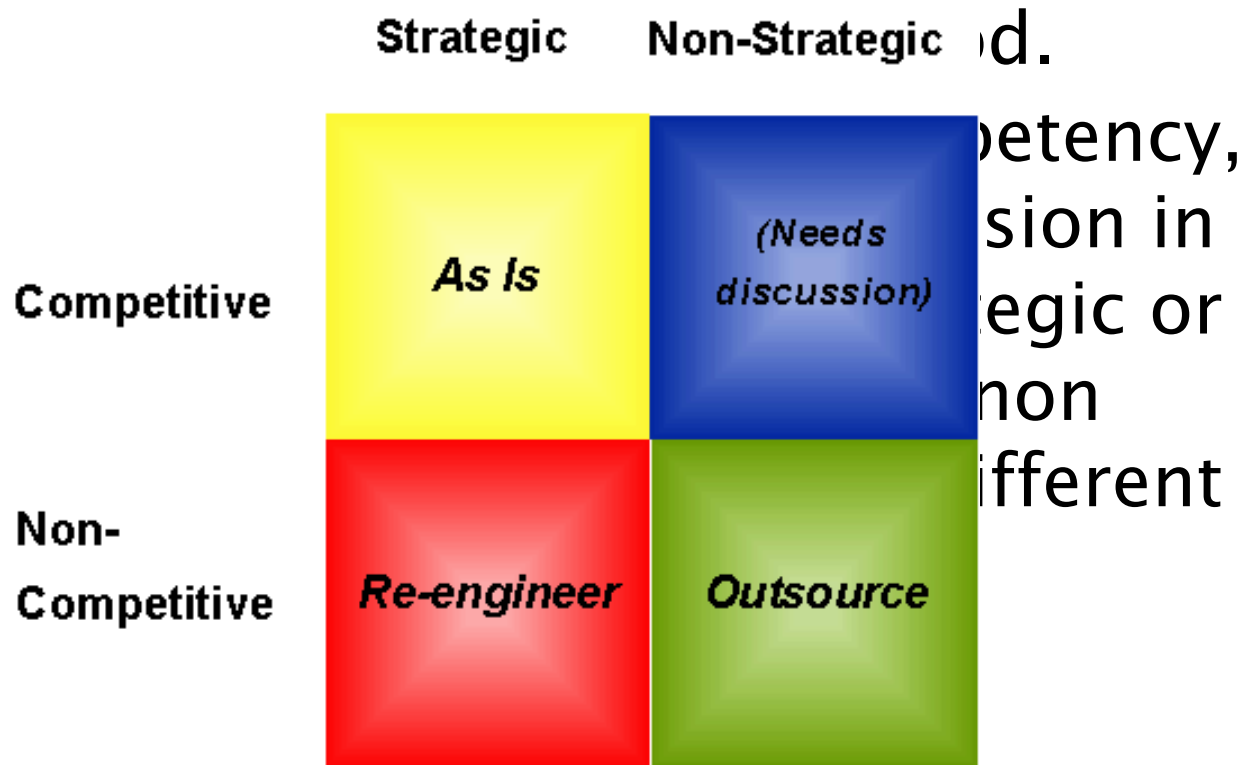


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Manage outsource relationship

- ▶ The importance: the quality of contractor's service in general and the reliability and availability of contractor provided in particular largely depend on the relationship of the two parties.
- ▶ How: sophisticated contract with incentives and punishments PLUS mutual trust between client and contractor is necessary to keep the outsourcing relationships

Risk estimation.

Income matrix	Supervision	Non-supervision
Violation of contract	$(1-p)(R1-C1)-PL$	$R0-C1$
conformance	$R0-C0$	$R0-C0$

The ideal income for the contractor (S) can be calculated.

$$S = \beta\alpha(Y_1 - R_1 - C) + (1-\alpha)\beta(Y_1 - R_0) + (1-\beta)\alpha(Y_0 - R_0 - C) + (1-\alpha)(1-\beta)(Y_0 - R_0)$$

Take the derivative for this formula with respect to α , and let it equate to zero. The possibility the violation can be obtained.

$$\beta = c / (R0 - R1)$$

THANK YOU FOR
YOUR ATTENTION!

Thematical description1

A Royal Australian Navy (RAN) Sea King helicopter from HMAS Kanimbla crashed on the Indonesian island of Nias, at approximately 7:30 pm (Australian Eastern Standard Time) on Saturday 2 April 2005.

When the Navy helicopter, Sea King Shark 2, made its landing approach on the island, for a few seconds, it hovered 20 meters above the ground and then, as locals looked on, it suddenly pitched forward and fell to earth. Within minutes, it was burning and nine people onboard were killed while the other two were seriously injured.

The later report into the crash said the accident was primarily caused because a nut and a split-pin were incorrectly fitted during maintenance.

There are three bell cranks, or elbows, that change the direction of the control system and keep the aircraft flying. And any failure of the bolt or the bell crank to the point where it loses its link leaves us with no control in the cockpit in that direction. Unfortunately, in the report, the investigation team found no split pin had been used to secure the bell crank to the control tubes. Investigators knew the bell crank on 'Shark 2' had been pulled apart and reassembled by the maintenance team on the 'nimbla' one month before the accident. They went looking for the paperwork confirming the part had been correctly installed. To their horror, they found that paperwork was incomplete. In other words, there was no real evidence the bolt had ever been properly put back in place.

Indeed this was not the first and only time of Sea King's maintenance problem. Commander James Tobin, who used to be in charge of Squadron 817 in the year before the crash, said: "During July 2004, the AEO and I noted a disturbing trend in maintenance incidents. In a number of areas, people had developed a culture of authorized shortcuts and workarounds to get the job done." He also said: "in a few cases personnel were using incorrect parts."

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Thematical description 2

Life cycle cost (LCC) stands for the estimate of the total cost of purchasing, installing and running an item of equipment for a designated period of time. It provides a method to allow us to compare the overall profitability of different solutions as well as helps us to choose the solution that will do the least harm to the environment.



Life cycle cost consisting of acquisition costs and ownership costs

To lots of companies, the introduction of LCC management system brings them not just profits but also good environment performance in terms of energy saving and pollution reduction. These companies are from manufacturing, railroad, energy industry and aviation industry and Etc. Here, we give two companies as examples of successful application LCC.

The first one is ComEd, an Exelon company, which is one of the biggest electric utilities with more than \$15 billion in annual revenues. Early in 1995, the company deployed the life cycle management strategy, and the same year ComEd joined EPRI's life cycle cost management system. After adopt this management system, ComEd estimates the increased net revenues of \$635,000 per year as a result of switching to in-house management of the repair, disposal, and salvage of small overhead transformers; a saving of \$186,000per year from using a dehumidification process instead of chemical treatment to control befoiling in the condenser tubes at a generating facility, reducing chemical usage by 250,000 gallons per year. And in the document provided by the company indicates a more \$8 million benefits that ComEd identified company-wide during its first year of actively applying the LCC management system. Lou Del George, Vice President ComEd, said:“ Life-cycle management is an essential, yet visionary, strategy that every ComEd business unit can embrace in the flight to aggressively reduce costs and enhance revenues.”

Another example is GRUNDFOS, one of the world's largest pump manufacturers with an annual production of approximately 16 million, as well as a forerunner in the field of life cycle cost analysis of the pump system. Using the LCC calculating method, which is the result of collaborating researches including Hydraulic Institute, Euro-pumps and the Office of Industrial Technologies (OIT), in comparing different pump systems indicated 30-50% consumption of energy could be saved by, for example, changing the pump systems to speed-controlled solutions as the electronics of the speed-controlled pumps ensure optimum adaptation to flow and thus optimal energy utilization. And the energy saved through optimising pump systems can be transformed into cost savings, or it can be utilized to ensure the lines of energy supply. The Hydraulic Institute, Euro-pumps and the Office of Industrial Technologies (OIT) at the US department of energy co-stated that, " The Life Cycle Cost(LCC) analysis is a management tool that can help companies minimize waste and maximize energy efficiency for many types of systems, including pump systems."

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Thematical description 3

1. Ocean Empire International Ltd sales the traditional Cantonese congee favorites and becomes the first congee chain shops in Hong Kong. This customer-oriented corporate has applied the up-to-date management skill to the conventional congee business



Each year, with the purpose to extend this "5S Management" to all these locations, the company would sponsor all offices, workshop section heads and branch supervisors to receive training from the Principal Franchised Assessor of "5S Management"

The factory and branches are closely monitored by the "5S Management Assessment Election". What is more, the best performed shop will be elected.

Ocean Empire has spent a lot ^[1], and employed professional consultants for managing staff .The management system controls the products and service .Every product should have definite production procedures for achieving the equal effect of quality and quantity.

2. The NDE laboratory implements main steps in 5S management system ^[2]:

- 1).getting the theme convinced of the need
- 2). organizing a task team and plan a one hour program to explain the technique
- 3).developing a plan for each of the `S`
- 4).publicly announcing the program



5).Evaluating the results of the program after the implementation check for acceptance of the program by the core concerned in the laboratory.

5S contribute to reducing waste and maintain a high degree of cleanliness and orderliness to provide a personalized customer service in NDE laboratory.

3. Changzhou Bayi Cable Co., Ltd (CBC) established 5S management group and the office .Plans and the time arrangement have been detailed by the warehouse 5S implementation work formulation



There are lots of mottos in the company, such as ^[3] “5S is all improvement activity foundation”, “5S” is the reorganization and the reorganization sweeps clear, cleanly, the accomplishment”, people working here will be in positive action.

The implementation of 5s management system helps to reduce waste, organize the place in a customer friendly manner. Focus of improvement on health and safety of the concerned ensure better data management. The experience tells us that 5s management system is the safe, clean, and orderly arrangement of the workplace that provides a specific location for everything and eliminates anything that is not required.

Reference:

[1] http://www.oceanempire.com.hk/eng/p1_3.asp

[2]<http://www.ultrasonic.de/article/nde-india2006/files/tp-45-pap.pdf>

[3]<http://en.81cable.com/newEbiz1/EbizPortalFG/portal/html/index.html>

Thematical description 3

Shell Canada Ltd takes preventative measures to reduce maintenance costs. This company planned to build a large-scale upgrade plant and prepare this new source of crude oil for processing at their Scotford Refinery due to recent development of the world's largest oil sand deposit in Canada. And the Shell global solutions were requested to provide assistance to design a robust maintenance strategy. They introduced Shell Global Solution's risk and reliability program as a tool to create a preventative maintenance strategy that was geared to ensure optimum reliability and plant availability from the startup of the new plant. The Shell reliability centered maintenance program (Shell-RCM) was conducted. And the startups of this upgrade plant succeeded. The aims of the Shell-RCM methodology are multi-ply, such as assessing the probability of failure and the associated to business, comparing the consequences of 'taking on action' to cost-benefit consequences of a 'proactive maintenance plan' and creating an optimized maintenance strategy. Shell global solutions believe that simply learning 'how to improve' is not an adequate solution. It is the 'correct implementation' that is crucial for success. And they aim to help their client personnel take ownership of routine maintenance on a daily basis and thus sustain an optimal regime.

Maintenance management has collided with local people life in some field recently with the development of maintenance. Network Rail has a dilemma to deal with the conflict between maintenance and local people life. Network Rail owning and operating Britain's rail infrastructure tries hard to keep noise & disruption to a minimum. In order to improve the safety & reliability of the railway, Network Rail has done much maintenance work such as looking after tracks, signals & power supply, track replacement. The railway is a 24-hour a day, 365 days a year operation which implies maintenance work is huge. Engineering projects and complicated planning work is arranged as early as possible. They give advance notice of local resident simultaneously.

Maintenance outsourcing is a kind of trend in Japan Airlines (JAL). Enigma is the support chain company, supplying private exchanges or channel solutions that provide integrated customer support and e-commerce capabilities. Critical repair and service information to the company's 5,000 engineers and mechanics 24-hours a day is powered by Enigma's maintenance solution. Maintenance outsourcing can make JAL's 150 large jets receive the specific maintenance they require and reduce the JAL's maintenance cost. Maintenance outsourcing is not only to provide support for the initial

deployment of 150 aircraft but also to scale with JAL's anticipated growth--a sign that the company's forward-looking approach is paying off.

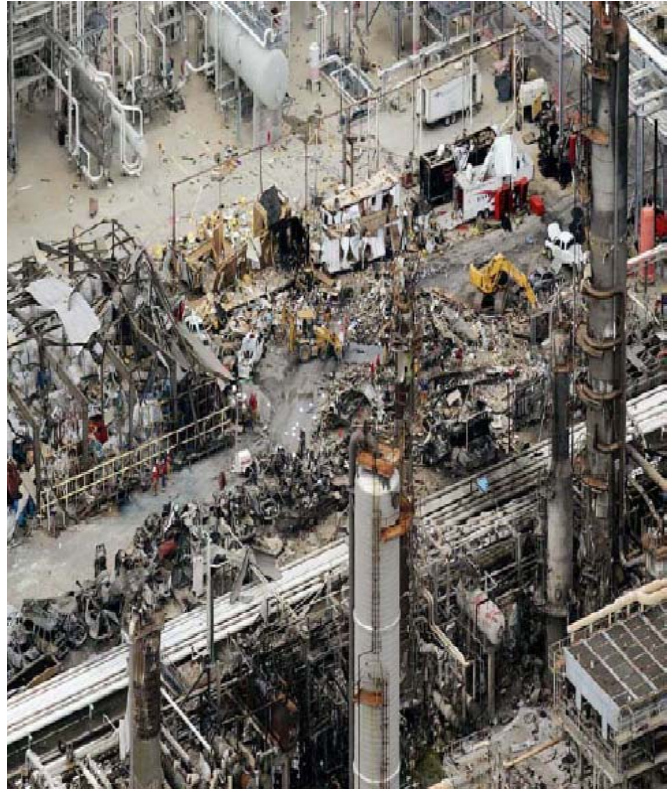
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Thematical description 5

On March 23, 2005, tragedy struck BP's Texas City, Texas, refinery when a cloud of hydrocarbon vapor exploded, killing 15 workers and injuring more than 180 others. It has been noted as one of the most serious industrial incidents in the past two decades.

The direct explosion process in most news reports is described horrifically below. Slapdash actions led to the raffinate splitter with liquid, overheating of the liquid and the subsequent over pressurization and pressure relief. Hydrocarbon flow to the blow down drum and stack overwhelmed it, resulting in liquids carrying over out of the top of the stack, flowing down the stack, accumulating on the ground, causing a vapor cloud, which was ignited by an abandoned white pickup truck with the ignition on.



Many people believe the tragedy --like so many other workplace accidents--was entirely avoidable. How can we avoid the accident?

1) BP Group Board should have provided effective oversight of the company's safety culture and major prevention programs.

- * Hazards of high tower level were not identified Maintenance

2) An effective mechanical integrity program should have been planned to maintain instruments and process equipment.

- * Relief valve and header study which was 13 years overdue was not completed

- * Mis-calibrated level transmitter gave operators false readings that the tower level was declining

- * Dirty level sight glass on the tower was unreadable

- * The redundant high level alarm failed to sound

3) BP should have an effective vehicle traffic policy to control vehicle traffic into hazardous process areas or to establish safe distances from process unit boundaries.

- * Hydrocarbon was ignited by an abandoned white pickup truck with the ignition on

4) BP should have ineffectively implemented their PSSR policy; nonessential personnel were not removed from areas in and around process units during the hazardous unit startup.

- * The accident killed 15 workers and injuring more than 180 others.

5) BP should have incorporated good practice design in the operation of the ISOM unit.

- * No flare to safely combust flammables entering the blow down system
- * Lack of automated controls in the splitter tower triggered by high-level, which would have prevented the unsafe level
- * Inadequate instrumentation to warn of overfilling in the splitter tower

6) BP should have make operators supervised and supported by experienced, technically trained personnel during unit startup.

- * Level control valve was placed in manual and closed

7) BP should have provide adequate resources to prevent major accidents; budget cuts impaired process safety performance at the Texas City refinery.

- * Communication Understaffed and not supervised (likely fatigued)
- * Identified Maintenance program was deficient
- * Training was ineffective

All of measures mentioned above are important and necessary. What if only one measure was carried out? I think the catastrophe would be prevented . Maintenance management take an exclusive role in the analysis . Let's pray for dead and I believe such tragedies will be reduced in the future with the development of maintenance management in the all kinds of companies.

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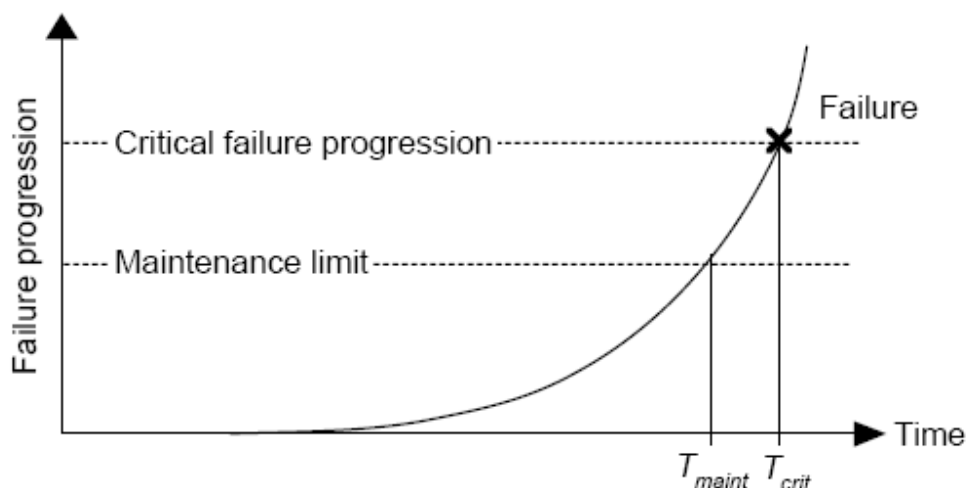
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Thematical description 6

Engineers use a mathematical model to analyze a system to be controlled or optimized [1], in analysis, they can build a descriptive model of the system as a hypothesis of how the system could work, or try to estimate how an unforeseeable event could affect the system. Similarly, in control of a system, engineers can try out different control approaches in simulations.

Mathematical models can take many forms, including but not limited to dynamical systems, statistical models, differential equations, or game theoretic models.

Some basic failure models can be used for preventive maintenance. For example, the observable gradual failure progression:



When there are many different states, we can use the Markov analysis to model systems. Markov analysis is well suited for deciding reliability characteristics of a system. Especially the method is well suited for small systems with complicated maintenance.

What is more, Life times can be treated as stochastic variables. Life times are restricted to non negative values, and are thus a narrower class than stochastic variables.

Also, there are many probability distributions which can be used for maintenance, the normal distribution, the Weibull distribution, the exponential distribution, the gamma distribution, the inverted Gamma distribution etc

[1] http://en.wikipedia.org/wiki/Mathematical_model