



A Feasibility Study on Implementing a New Data Center for  
Thaveerung Co., Ltd.

by

Ms. Suwanna Luangthammuan

A Final Report of the Six-Credit Course  
CE 6998 - CE 6999 Project

Submitted in Partial Fulfillment  
of the Requirements for the Degree of  
Master of Science  
in Computer and Engineering Management  
Assumption University

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The Graduate School of Assumption University has approved this final report of the six-credit course, CE 6998 – CE 6999 PROJECT, submitted in partial fulfillment of the requirements for the degree of Master of Science in Computer and Engineering Management.

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## ABSTRACT

This project examines a feasibility study for implementation of a new data center for Thaveerung Co., Ltd. in order to improve the data center service to help the company's employees.

User Satisfaction Survey was conducted to identify the user satisfaction of the old process and also analyze which service that user needs for more improvement from the new data center. The result shows that 52% of users are not satisfied with the old process about timeliness of service, quality of hardware and software.

After all of the company's current problems have been consolidated, feasibility study is conducted to gather information, Three principal ways are applied operationally, technically and economically. The result from feasibility shows that Thaveerung Co., should implement a new data center at the same building of headquarters office at Phatumwan place because it still has empty space so it can save cost and it has sufficient complete facilities. Moreover, the new data center can generate more revenue of 11,929,900 per year because productivity has increased so sales volume is increased also. Return On Investment is 61% and Break Even Point is 2.5 years. It means that Thaveerung Co. can get the benefit back very fast in 2.5 years and can make more benefits in another 2.5 years because hardware useful life is 5 years before an upgraded option is needed.

So recommendations to Thaveerung Co., are that it should implement a new data center and use this plan to motivate employees, After that the committee should coordinate to monitor this project closely.

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## **I. INTRODUCTION**

### **1.1 Profile of the company**

Thaveerung Co., Ltd. is a headquarter company for Bayer Plant (Thailand) that is a leader in super paint color creations and protection. Thaveerung has a wide variety of paint products for various requirements, such as paint products for medium-to-large scale architecture structures and buildings, spray creating for automobile and motorcycle industries, car paint repair, furniture and computer industries as well as other related industries. Thaveerung has full technological supports from its own research and development team.

The company's vision and mission are constantly striving for excellence in all its endeavors. And the company's philosophy is 'beautiful life everywhere'.

For the company's products technology, fundamental research, development through years of technological knowhow, is the key to its success in producing high value-added paint products and it is also the source of our initiative to expand from paint technology into other disciplines. The prototype, which we have developed for seed technologies, is an example of our effort to respond to the market by creating new & useful products for the future.

### **1.2 Company's Challenge**

And now the challenge for management team is how organization can achieve the company mission within a short term period. Not only increasing in marketing investment but using the information system as a competitive weapon is also important. It can be used to increase revenues, open new markets, provide better customer service and reduce expenses. But the issues that organization faces now is decentralized information system environment , and its components are more numerous.

Nowadays, for most organizations, the computerized information system has become the most important because one of the reasons is the dramatic increase in the cost/performance ratio, this decrease in cost has made computer processing economical. Computers now control entire manufacturing operations such as product design phase by using computer-aided design (CAD), manufacturing phase by using manufacturing planning and control system (MPCS), including functions such as ordering, paying and controlling for raw materials, accepting and filling orders, billing the customers. In addition, the decision-making and communications areas have been heavily influenced by computers such as using electronic mail instead of telephone or fax and management team can use decision support system (DSS) to help them for decision making, executives can quickly obtain and analyze information using the information system, then they can easily communicate decisions by using word processing or excel spreadsheet.

### **1.3 Project Objective**

The objective of this project is providing the feasibility study for implementing a new data center for Thaveerung Co., Ltd. in order to solve the company's current problems of using information system.

### **1.4 Scope of Project**

The scope for this project is focusing on data center implementation at the Thaveerung Co., headquarter Bangkok site by using a feasibility study. User Satisfaction Survey had been taken at random from 6 departments, they are accounting, sales & marketing, operation & administration, financing, IT and Production. The feasibility study will be emphasized on technical feasibility and economic feasibility.

## II. LITERATURE REVIEW

Organizations have long recognized the importance of managing key resources such as labor and raw materials. Information has now moved to its rightful place as a key resource. Decision makers now understand that information is not just a byproduct of conducting business; rather, it fuels business and can be the critical factor in determining the success or failure of a business.

### **Feasibility Study**

During the feasibility study, it is necessary to examine the various approaches to solving the problem. This involves knowing about the technical, economic and operational environments. It is very important that feasibility issues are resolved before extensive analysis and design work is invested on the problem. The feasibility study gives us the basis for deciding to develop a new system. The time and effort spent here will reap returns later in the project.

#### **2.1 Technical Feasibility**

It is concerned with whether the proposed system can be created using current technology, hardware, and software. Under certain circumstances, it may be determined that being an innovator in a new area may be worth the costs and risks. This usually occurs when management discerns that a competitive advantage could be gained from the new system.

##### **(a) Physical environment :**

The physical environment of an information system can be important to the successful operation of the system. The geographical location is one factor. The data center must be close to other company facilities, be in an attractive place to live, and be in an area having a low probability of natural disasters.



The building and associated site should be designed so that the computer center can operate efficiently while adequately protecting the facilities. Some of the major considerations include the physical security of the computer center, wiring the building, air conditioning and heating, fire prevention and control, and electrical power supply.

The comprehensive disaster recovery plan should be designed to allow computer operations to continue despite major failures of the computer system. This plan must consider the loss of data, hardware, personnel and software.

(b) Hardware/Software Acquisition : (Mensingh, 1991)

The acquisition of any computer technology, be it hardware or software, could have a significant impact on other components of the system. For this reason, it is important that all acquisition decisions must be made considering the impact on both the present system configuration and the limitations the decision will place on future decision. The first step in the acquisition of hardware is to determine the mandatory such as hardware/software compatibility, purchase price, speed, delivery date, guarantees/warranty, installation time, operating cost, type of source code, available backup and recovery etc. and desirable attributes of needed equipment such as field upgradability , maintenance contract, free trial period, retention of market value, available financing, etc. An evaluation team will be comparing each of the vendors by using evaluation process which is benchmarking. Physical benchmarking involves testing the equipment in an environment similar to that on the actual production system.

For software acquisition method, it may be purchased as a turnkey system or purchase system and may have a consultant tailor or a purchase system and have internal staff tailor or consultant develops the system themselves or internal staff develop the system themselves.

Before hardware acquisition, hardware design and sizing will be needed in order to serve the function according to user's requirement, Below is some servers definition and its usage. (Groth, 2002)

#### (1) Firewall Server

We use firewall server to protect a local system or network of systems from network based security threats while at the same time affording access to the outside world via wide area networks and the internet. Its goal are all traffic from inside to outside, and vice versa, must pass through the firewall, only authorized traffic, as defined by the local security policy, will be allowed to pass and the firewall itself is immune to penetration.

#### (2) Database Server

Database server will be used for database management system. Its functions are

- (a) Data Integration : It allows multiple users to access data in various ways with a minimum of data redundancy.
- (b) Establish Data Access Policies : It is to determines who should be allowed to read, write, create on various data items
- (c) Data Security : It protects data from unauthorized access or alteration.
- (d) Physical Media Management : It monitors performance of physical storage devices and reconfigures when needed.
- (e) Database Management : It coordinates the usage of the database management system.

#### (3) Network Management Server (NMS)

Network Management Server is the server that is used to install the network management software. Goal for NMS software is to monitor the all servers, equipment

in the network. It provides a powerful network management solution that includes concise, in-depth views of network devices and their status in an intuitive graphical format. It also helps network management evaluate network performance, pinpoint problem sources, and proactively manage their networks and network availability.

#### (4) Application Server

Application Server will be used for developing the application. Thaveerung Co., used both the application developed by internal staff and the turnkey application from vendor. The examples of application that Thaveerung Co., used are accounting application system, billing application system and etc.

#### (5) Web Server

Web server will be used for developing web page and contains web content using the HTTP for Thaveerung Co. by internal web master, The web page will contain a lot of useful contents and company information. The examples of contents are the updated products and service for the company, placing order via web site, updating the company information such as financial statement , organization structure etc.

#### (6) E-mail Server

E-mail server will be used to implement the e-mail system for the organization. Its goals are for the internal user to use the e-mail to communicate in the organization instead of telephone, fax and etc.

#### (7) Back up Server

Back up Server will be used to back up the information, especially for critical information or the information for reporting in the future. Its advantage is if unexpected situation happens such as disasters, human mistakes, and program errors. The information that has already been backed up, can be retrieved back to use or replace the error immediately.

The organization uses the communication control program (CCP) to manage the flow of data across transmission lines. This program formats data so that it can be used on other system by their CCPs. The format used is called a protocol. Data that is sent through a network is packaged in such a way that the receiving system knows that device sends the data and what the destination is supposed to do with it.

### (c) Network Design

The devices in a network can be arranged in several different topologies. A topology is basically a map of a network. The physical topology of a network describes the layout of the cables and workstations and the location of all network components. Often, physical topologies are compared to logical topologies, which define how the information or data flows within the network. Each topology has its advantages and drawbacks. Generally speaking, we should balance the following considerations when choosing a physical topology for your network's cost, ease of installation, ease of maintenance and cable fault tolerance. There are five most common topologies :

#### (1) Bus

In a bus topology, all computers are attached to a single continuous cable that is terminated at both ends, which is the simplest way to create a physical network. Originally, computers were attached to the cable with wire taps.

Here are pros and cons to a bus topology. On the pro side, it is simple to install, relatively inexpensive and uses less cable than other topologies. About con side, it is difficult to move and change, little fault tolerance and difficult to troubleshoot.

#### (2) Star

Each computer in a star topology is connected to a central point by a separate cable. The central point is a device known as a hub.

On the pro side for star topology its new stations can be added easily and quickly, a single cable failure won't bring down the entire network and it is relatively easy to troubleshoot. About con side, its total installation cost can be higher because of the larger number of cables, but prices are constantly becoming more and more competitive, and it has a single point of failure, the hub.

### (3) Ring

In the ring topology, each computer is connected directly to two other computers in the network. Data moves down a one way path from one computer to another.

On the pro side, it is relatively easy to troubleshoot. A station will know when a cable fault has occurred because it will stop receiving data from its upstream neighbor. On the con side, it is expensive because multiple cables are needed for each workstation, difficult to reconfigure and not fault tolerant.

### (4) Mesh

In mesh topology, a path exists from each station to every other station in the network. Hybrid mesh topology networks can have multiple connections between some locations, but this is done only for redundancy. Also, it is not a true mesh because there is not a connection between each and every node, just a few for backup purpose.

Today the mesh topology is rarely used, and then only in a WAN environment and only because the mesh topology is fault tolerant. Computer or network devices can switch between these multiple, redundant connections if the need arises. On the con side, the mesh topology is expensive and as you have seen, quickly becomes too complex.

And the organization uses local area network (LAN) to connect with microprocessor-based station that uses both coaxial cable and fiber cable. Local area networks are local only in the geographic sense. They can cross departmental



boundaries providing interdepartmental access to data or hardware or software that was intended for intradepartmental use.

Office Automation (OA) is another technique that Thaveerung Co., will use to develop for the organization. OA is the integration of technology and management practices to increase the productivity and effectiveness of the office professional. This mainly involves enhancing the ability of the organization to develop, process, and analyze both formal and informal information. The proper implementation and management of the office automation resources can reduce operating costs, improve efficiency, and lead to higher-quality decision making. The functions usually included in office automation are word processing , electronic mail, automated document filing and retrieval, desktop publishing and decision support functions. The developing technologies in office automation must also be periodically scanned to determine future directions. (Mensing, 1991)

## **2.2 Economic Feasibility**

It is a clear concept. The term must determine whether the new system will be worth the investment of necessary resources. The determination of costs and benefits is importance here, however, the specific cost estimates for detailed analysis are often not immediately available at this point. Some attempts must be made to derive a realistic estimate of the costs and unnecessary.

### **(a) Hardware and Software Acquisition Methods.**

There are basically two acquisition methods.

(1) Leasing. This term is used when referring to third-party leases. A leasing company purchases the equipment from the vendor and then leases it to the user.

The three types of lease arrangements are :

- (a) The operating lease. This is also referred to as a partial-payout lease, since the lease is relatively short and does not cover the cost and expenses of the lessor for the purchase and other expenses, plus profit of the equipment. The cost of this lease is the most expensive.
- (b) The finance lease. This lease is also referred to as a full-payout lease, since it is generally a long term lease. At the end of each lease period, the user has the option of purchasing the equipment, so that the previously paid leasing amounts purchase and supplementary expenses, plus profit and the residual value for the equipment, where the residual value is the equipment's value at the time of the purchase decision.
- (c) The lease to ownership plan. It is monthly lease payments which are made until some given numbers have been made or until some given amount has been paid, and then title of the computer passes to the lessee.

(2) Purchase. Outright purchase of equipment is financially advantages if the equipment will be retained for a period of time exceeding the trade off point for leasing the same equipment. Purchasing exposes the user to the serious disadvantages of possibly owning unsatisfactory or obsolete equipment.

(b) Analysis of acquisition methods

Three techniques used for financial analyzes are

(1) Return On Investment (ROI) : The average annual cash flow for the life of the investment is divided by the initial investment, producing an annual percentage rate, the higher the rate, the better the investment. In ROI method, time

value of money is also considered, and the classifications of costs had been determined

- (a) The first cost is the initial cost of capitalized property, including transportation, installation, and other related initial expenditures. Fixed cost is the group of costs involved in a going activity whose total will remain relatively constant throughout the range of operational activity.
- (b) Variable cost is the group of costs, which vary in some relationship to the level of operation activity.
- (c) Life-cycle cost (LCC) includes the cost, both nonrecurring and recurring that occurs over the life cycle.
- (d) Interest is a rental amount charged by financial institutions for the use of money
- (e) Interest rate or the rate of capital growth is the rate of gain received from an investment.
- (f) Compound Interest - the interest for an interest period is calculated on the principal sum plus the total amount of interest accumulated in previous periods.

Moreover, economic evaluation needs to be calculated. (Leland and Anthony, 2002)

- (a) Single-Payment Compound-Amount Factor

$$\text{Formula} \quad F = P^{(F/P, i, n)}$$

- (b) Single-Payment Present-Worth Factor

$$\text{Formula} \quad P = F^{(P/F, i, n)}$$

- (c) Equal-Payment-Series Compound-Amount Factor

$$\text{Formula} \quad F = A^{(F/A, i, n)}$$

(d) Equal-Payment-Series Present-Worth Factor

$$\text{Formula} \quad P = A(P/A, i, n)$$

And also the data center manager needs to consider how data center can generate the revenue, not only be the expenditure anymore. The method of charge to other department had been determined and also pros and cons for this method.

(2) Break-Even Analysis. Curves are drawn on a graph to relate accumulated costs against time, the points at which the curves cross indicating at what time purchasing becomes more beneficial than renting and leasing.

### 2.3 Operational feasibility

Operational feasibility helps determine whether the proposed system will function properly within the current structure of the organization and information system. The new system may recommend the restructuring of the department within the organization. Additional personnel may need to be hired, or perhaps employees might be displaced from their current positions.

The overall control cycle should be determined for information center implementation, it is a classical control methodology which consists of three types of activities. (Kendall and Kendall, 1998)

(a) Strategic Planning

Firstly, the management team need to set the strategic management which is the process of determining the future direction of an organization and implementing policies that will move the firm in that direction. Information strategic plan is included in the organization's strategic management, and it should serve as a template for future directions of the information system and it must rely on and support the organization's strategic management. The long range plan is to give individuals a broad idea of the

future direction of the organization, while a plan would describe the anticipated areas of growth and contraction and the magnitude of these changes.

The examples for business strategic planning :

- (1) Produce a consistently high-quality product
- (2) Provide a high level of service to the customers
- (3) Have adequate inventories to satisfy customer's demand
- (4) Allow for special orders and modifications to existing products
- (5) Increase corporate productivity
- (6) Project a positive image to the community and potential customers
- (7) Continue to develop new products

Information strategic plans are, as follows:

- (1) Provide quality service to all of the end-users, including user contracts with each department and guaranteed service levels.
- (2) Improve the marketing information system to serve customers better
- (3) Design a computerized quality control system to track all product failures.
- (4) Enforce all data processing standards so that higher productivity can be achieved.
- (5) Increase the number of work stations and storages connected to the company wide network

(b) Resource Planning (Schaeffer, 1981)

Resource planning can be complex. Many resources are involved and many alternatives exist as follow:



- (1) Organization Structure – It is inevitable that organizations are structured in a hierarchical manner. An important question concerning organization structure, one that is basis and must be answered is : Would centralization or decentralization be more effective?
- (2) Personnel – Personnel resource planning is involved. The recruiting process is almost always done in an atmosphere of intuitive judgment. It is just as common for minimum thought to be given to personnel motivation, to using such techniques as job enrichment, where each person when possible is given a wider range of activities.
- (3) Finances – It is impossible to bypass the budgeting requirements of an organization. More and more organizations are considering, the possibilities of zero-base budgeting. Many organizations have considered chargeout or chargeback systems.
- (4) Site – A site is associated with a large array of resources that must be considered when selecting a site for data center. There will be more details in technical feasibility study.
- (5) Hardware – The main concern in the selection of hardware is adequate. Many installations have become one-vendor shops. Some organizations have sophisticated and sound methods for comparing alternatives. It is also necessary to evaluate the financial alternative for acquiring hardware. The entire hardware-acquisition process requires a reasonable, well-defined procedure that includes activities such as verifying hardware-performance promises by using benchmarks and judging vendor service by questioning current users. It will be more detail in technical feasibility study.

(6) Software – It is all too variety of sophisticated for user applications while almost totally disregarding its own needs.

(c) Processing : The actual processing of the data center's workload.

(1) Establishing standards and procedures

The goals and objectives of the information systems area can be operated by adopting a set of standards and procedures. One of the goals of the information system must be to provide quality service to its users. To accomplish this, it is first necessary to understand the user needs. There must be adequate communication between the information system and its users including, user surveys, the results of this survey should give information system personnel a good picture of the system's strengths and weaknesses.

(2) Documentation

It is necessary that operating instructions for application systems are documented. A fire, for example, can create havoc. Even if a contingency plan exists, if it is poorly documented, the staff members may not know what to do as a result.

(3) Computer and data center scheduling and resource allocation

All data center job-processing activities should be scheduled to meet user commitments. More details will be in schedule feasibility study.

(d) Performance Evaluation

It monitors and evaluates computer performance and also examines the overall computer performance evaluation (CPE) process. It includes examination of all data center resources, and it also examines the effects data center activities have on data center costs and user service. For both computer and data center performance evaluation, the performance criteria are segmented into categories of sufficiency, efficiency and effectiveness.

Using Systems Simulation Technology is another way to evaluate the performance. This simulation program will help to generate the improvement result from implementation of information center. (Camm and Evan , 2000)

Because the capabilities of spreadsheets are severely limited to simple situations, dynamic systems are usually simulated using special-purpose simulation software. This software technology automatically takes care of many details of simulation calculations and reporting, such as advancing the simulation clock, collecting statistical information, managing files and producing summary reports, thus allowing the user to concentrate on the modeling process itself. Many even have animation capabilities to allow users to observe the dynamics of a simulation in progress. An example of simulation technology is Arena Business Edition, a general-purpose simulation program designed to facilitate modeling and simulation of business problems.

#### 1) Computer processing

Evaluation is limited to the adequacy of computer resources for the workload, how efficiently these resources are used and how effectively the work is completed. Sufficiency is not limited to only present demands, but also anticipates future demands. Resource utilization considers all computer-related resources, such as real memory , disk storage and tape unit. Furthermore, significant application-processing improvements are possible from packages that analyze program activity so that frequently executed instructions can be isolated and optimized.

#### 2) Data Center Processing

Attending to computer sufficiency, efficiency and effectiveness does not guarantee for data center. Although computer processing may be satisfactory, inadequacies in precomputer or postcomputer processing areas can negate all benefits gained.

### III. CURRENT PROBLEMS

Before any process is started , we need to understand the current situation in Thaveerung Co., Ltd., the feedback from previous information usage in each department concerned ,a useful method of determining the level of user satisfaction to administer user survey. The results of this survey should give information system personnel a good picture of the system's strengths and weaknesses. The survey can be given to all users at one time or specific user groups at various time intervals. A properly designed and administered survey can give a comprehensive picture of the status of the information system. Since the results of the survey may be one of the few formal representations of user attitudes, the survey can be used as justification for budget realignment or information system reorganization.

The result from user satisfaction survey had been generated by SPSS program. From the report, not only the staff who use information center but also high level management and middle management, total user that use information center is 100% and 52% is user dissatisfaction for previous information center's service level and only 8% that users satisfied.

User Satisfaction Survey had been distributed to employees at random from 6 related departments. There are Accounting, Sales and Marketing, Operation and Administration, IT , Financing and Production departments. Total sample size is 50 persons. After consolidating all the survey forms, the professional tool had been used to transform data to useful information by SPSS program.

After generating the report from this program. The summary information is shown in graph format below.

## Overall Service Level Satisfaction

For Thaveerung Co., Ltd.

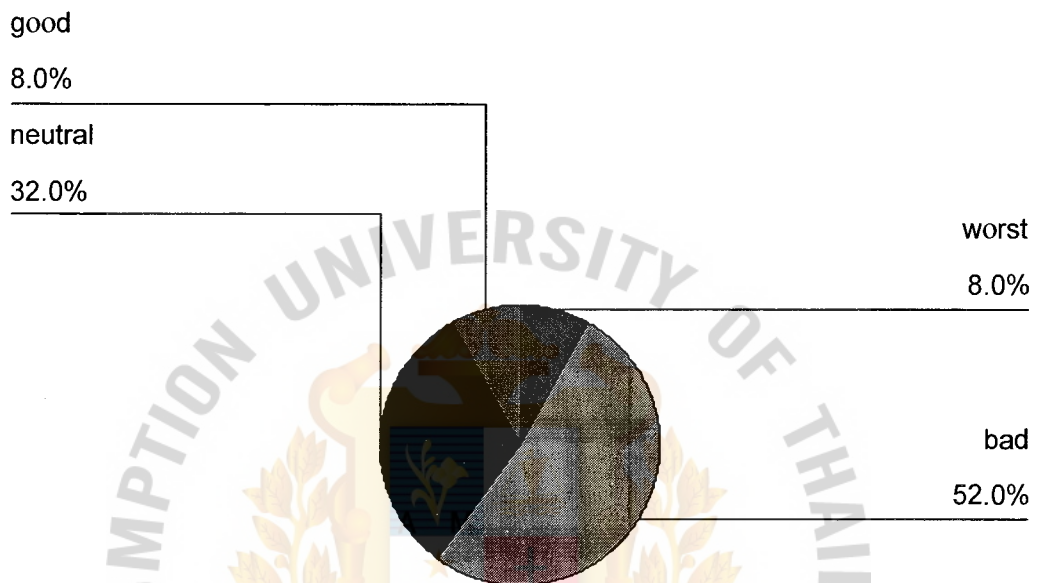


Figure 3.1. Overall Service Level Satisfaction.

The result from user satisfaction survey is generated by SPSS program. From the report, not only the staff but also high level management and middle management use information center. The total number of users that use information center is 100% and 52% are dissatisfied with previous information center's service level and only 8% are satisfied.



Table 3.1. User Satisfaction for Each Type of Service.

Service	Worst	Bad	Neutral	Good	Best
Technical Expertise	3	22	21	3	1
Timeliness of Service	4	26	20	0	0
Quality of Document	4	18	25	3	0
Quality of hardware	7	23	16	4	0
Quality of Software	4	17	22	6	1
Overall level of Service	4	26	16	4	0

The above table shows that employees who are not happy with the old processes of information system i.e. 26 persons out of 50 persons. The service that employees don't like the most is timeliness of service and then quality of hardware and technical expertise respectively. From this information, Thaveerung Company should investigate seriously in development and improvement on new information system or data center.

Thaveerung Company's problems are identified into two types of problems.

### 3.1 Tangible Problems

The tangible problems that Thaveerung is facing now are as follows:

#### (a) Decentralized Computer System :

Now Thaveerung has 8 wholesale branches around the country Each branch consists of many departments such as Financial department, Accounting Department, Sales and Marketing Departments. The problem that the department have is decentralized computer system. Hardware is one of the problems. Each of them has their own database system, own connection to the internet service provider, own

peripheral equipment such as Printer, and scanner. It causes the difficulty of computer management system. Customer Database had been duplicated for each branch in different database which makes duplicated job for database backup and its data will be meaningless for analysis and report.

(b) Special requirement for computer System

Because a computer especially a large system needs special environment, the temperature should be controlled / security room needs to be provided. It means that if Thaveerung Co., has more computer center, they need to invest more on the computer room. Furthermore, more computer rooms need more building space that we need to rent.

From the above problem, there are many intangible problems.

### 3.2 Intangible Problems

(a) Unnecessary Employment

Because the decentralized computer system needs information system manager or at least the administrator to take care of, operate, maintain the system, different computer systems, needs more employees with special knowledge on computer and information technology. It will cost a lot to hire computer specialists.

(b) Human Error

All of the above problems come from decentralized computer system, but if the Thaveerung Co., doesn't provide the computer system for each branch, other problems will also arise such as human errors. Computer System helps accounting department for calculating and report for balance sheet, checking payrolls, and income statements. If the department doesn't have a computer system, human errors always happen and it will take longer time when doing the same task.

(c) Higher cost/Time

When comparing the cost between implementing the computer center at each department and having a decentralized computer system, in the long term, a decentralized computer system or the company work on manually cost higher than implementing the computer center at the headquarters.

(d) Communication Error

Verbal communication always make problems because communication signal may be lost sometimes, there may be misunderstanding of the message which the sender sends. Another problem for verbal communication is that the communication message can't be used for reference in the future.

### **3.3 Case Study for Thaveerung Co., Problems :**

#### **Case Study I: Accounting Department**

The department is still using a manual system, it will take a long time to finish each task. Accounting Department uses a manual system to issue invoice to customers. The result is it takes a long time to generate an invoice, so the collection department can collect the account receivable late. Moreover, there are human errors. Sometimes, an accountant writes the customer's address wrongly, so the company can't collect the payment from that customer. Those situations make the company get the revenue late.

#### **Case Study II : Sales and Marketing Department**

Every week, a sales representative team has to submit the estimated sales volume to the marketing team in order to check the materials. Sometimes, sales representatives have to visit the customer, so they confirmed the estimated sales volume via phone. When the communication signal errors happened, the marketing team heard

the wrong number, so it affects the materials providing process, and materials shortage issue always happen.

#### Case Study III : Customer support and Customer Dissatisfaction

Internet has been used around the world, so ordering products via web page is very popular now, because it takes a shorter time for ordering. Because of internal security law already available. the customers are more confident on payment by credit card. Thaveerung Co., is one of the companies that has customers not only inside the country but also from other countries, especially from the southeast Asian countries. But now Thaveerung Co., doesn't have its own home page, so customers still need to send the purchase order via fax which makes problems of slow and communication unclear statement. It wastes time to call customers back to confirm their order and information on purchase order. Not only the ordering process is slow, customers are dissatisfied.

#### Case Study IV : At IT Department

IT Department faces problems of server shutting down due to electricity outage or human errors. If that server runs for important information needed for other departments such as database server, the data should always be available.

## IV. PROBLEM SOLUTIONS

In order to solve the problems that Thaveerung Co., is facing now, instead of the centralized the computer system at headquarters office, it is necessary to implement the computer data center. And the solution should be designed to cover all of the issues faced by the company ; in addition to improving the working performance.

We have two alternatives for financial feasibility which is Purchase Program and Leasing Program. The management team needs to compare both alternatives for total costs of ownership and time value of money , in order to find out what is the best solution for the company.

### 4.1 Technical Feasibility

#### (a) Physical Environment

Before we plan for hardware acquisition, we need to investigate onsite preparation and we call it physical environment. What the information system operates is an important factor to the successful operation of the system. Many factors need to be considered such as layout of the computer center or the source of electrical power for the system. Failure to deal with potential problems properly could result in a catastrophic failure of the system with an extended period of down time.

The first decision of site selection is the geographical area where to place the new center. We select the second floor of Thaveerung's office at Pratumwan Rd., to be Thaveerung 's data center because of the following reasons:



- (1) It is close to other company's facilities.
- (2) It is an attractive location with adequate parking, convenient access to public transportation, recreational facilities and generally attractive atmosphere.
- (3) It has good transportation facilities.
- (4) There are reliable public utilities especially telephone and electrical power.
- (5) It is far from high probability of natural disaster such as flood, earthquake.
- (6) It is far from hazardous industries in area such as chemical plants, refineries or other facilities which have higher probability of fire or explosion.

When choosing the building site, it is important to find property which has enough space for future expansion. And physical security of the data center is a crucial issue. The data center is a critical component in the operation of any business. The temporary failure of the computer facilities will result in a major disruption of the business. So we plan for other building security as below:

- (1) The building site should be surrounded by a fence or walls which are high enough to discourage intruders.
- (2) The number of entrances should be limited, and guards or at least television cameras should monitor these entrances.
- (3) Proper building design would make access of the center restricted to authorized personnel. Access can also be controlled by using identification badges or cards for each employee and by having doors that can only be opened by authorized personnel.
- (4) To protect the equipment and personnel, a high-quality fire protection system is mandatory. This would include both smoke and ion detectors.

Standard fire extinguishing systems are not acceptable. Both liquid-based and carbon dioxide based system can severely damage the equipment.

After we plan for building and room security, next is computer room design. The computer room should be configured for safe and efficient operations and be large enough to allow for future expansion. These are the characteristics of the computer room that we need to consider:

- (1) The type of flooring should allow for cabling under the floor.
- (2) The temperature of the computer room should be between 65 degrees and 75 degrees Fahrenheit and relative humidity should be held between 45% and 55%.
- (3) The computer room should have its own cooling system, which could be augmented by the main system in case of failure. The air conditioning system must also control dust and other airborne particles.

Next step is preparing computer room layout , It should be on convenience, efficiency, and ease of access. Adequate room for proper ventilation, machine access, and traffic flow should be allowed. Below is the computer room layout for Thaveerung Co.,

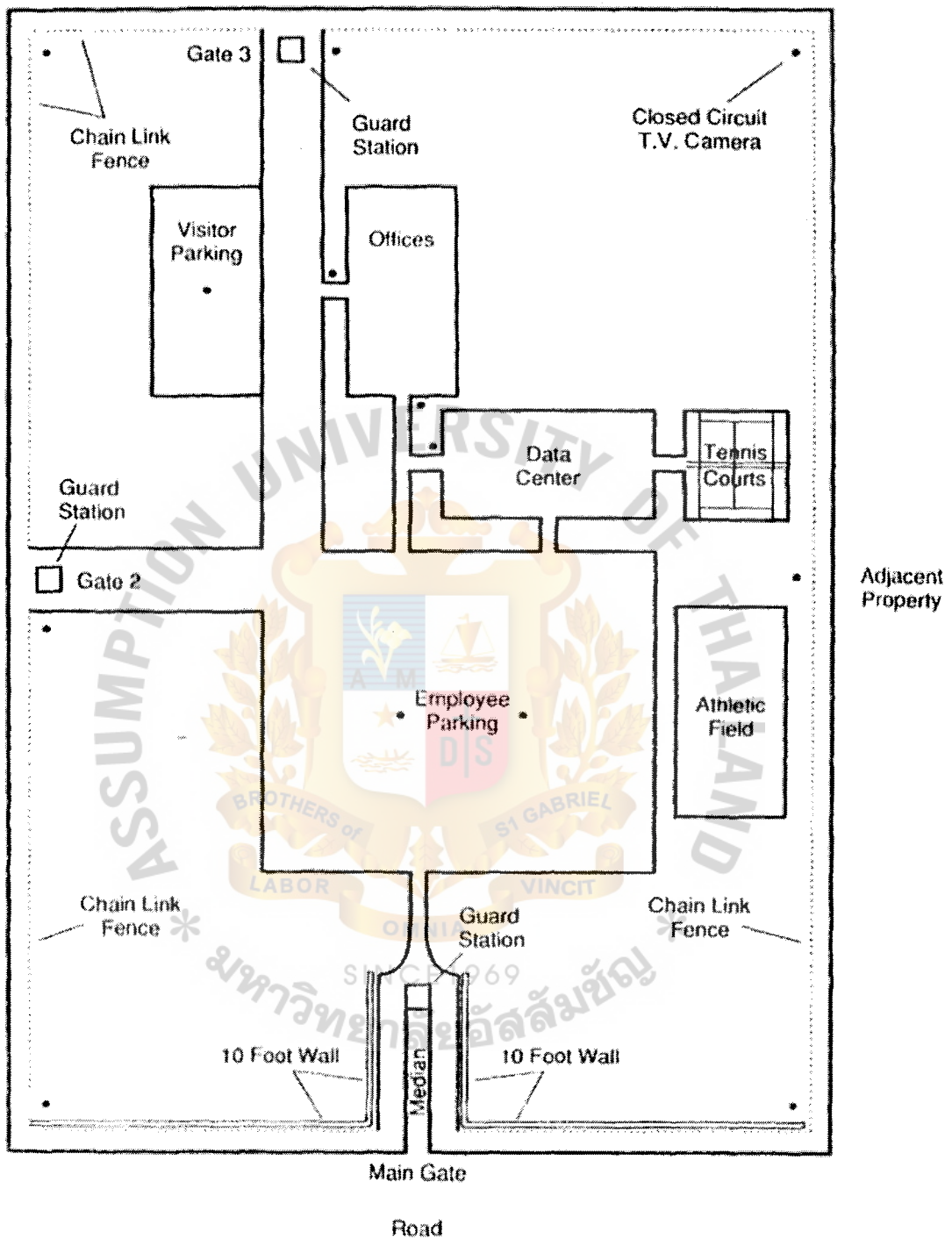


Figure 4.1. Data Center Site.

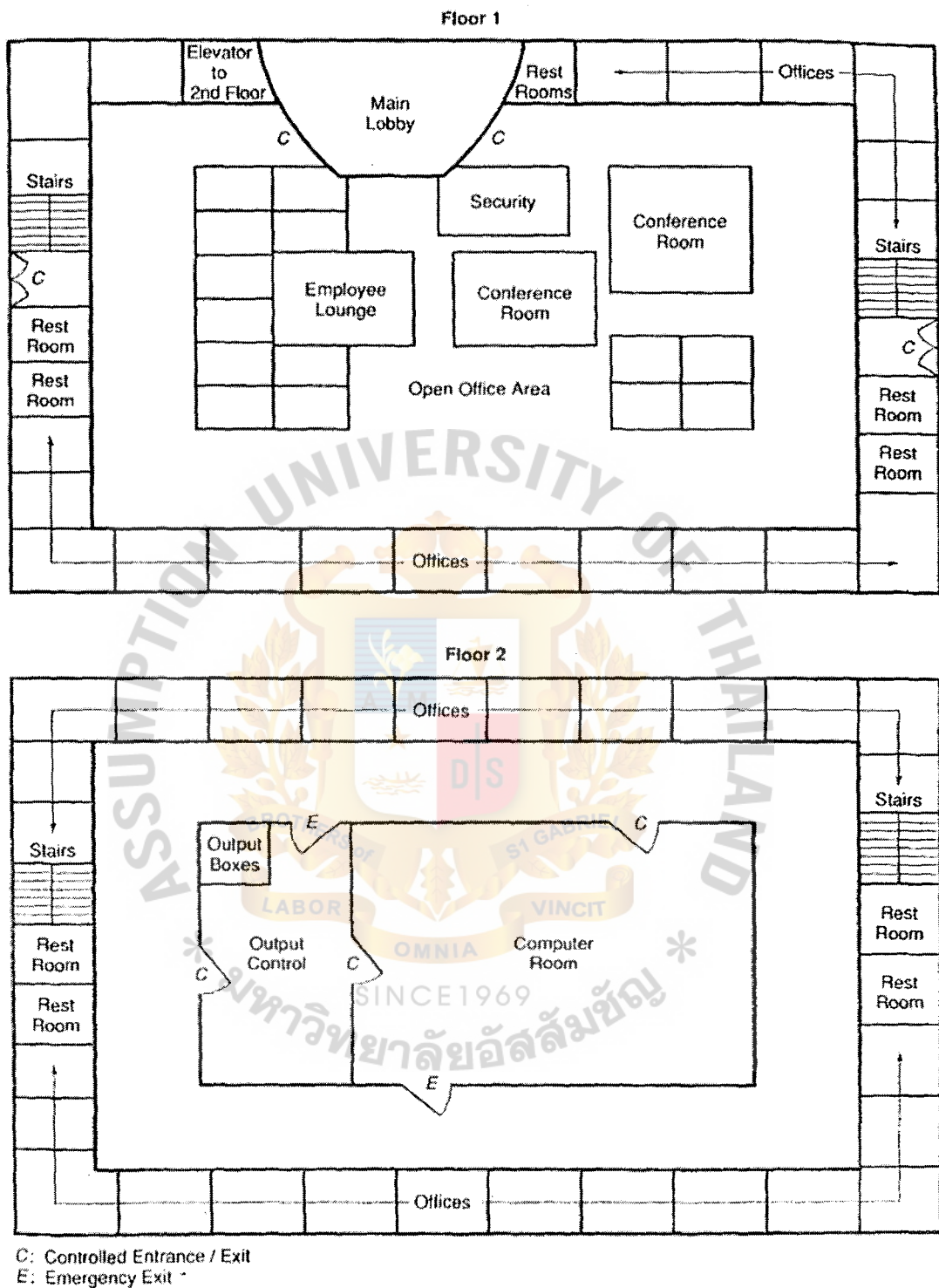


Figure 4.2. Design of the Building.

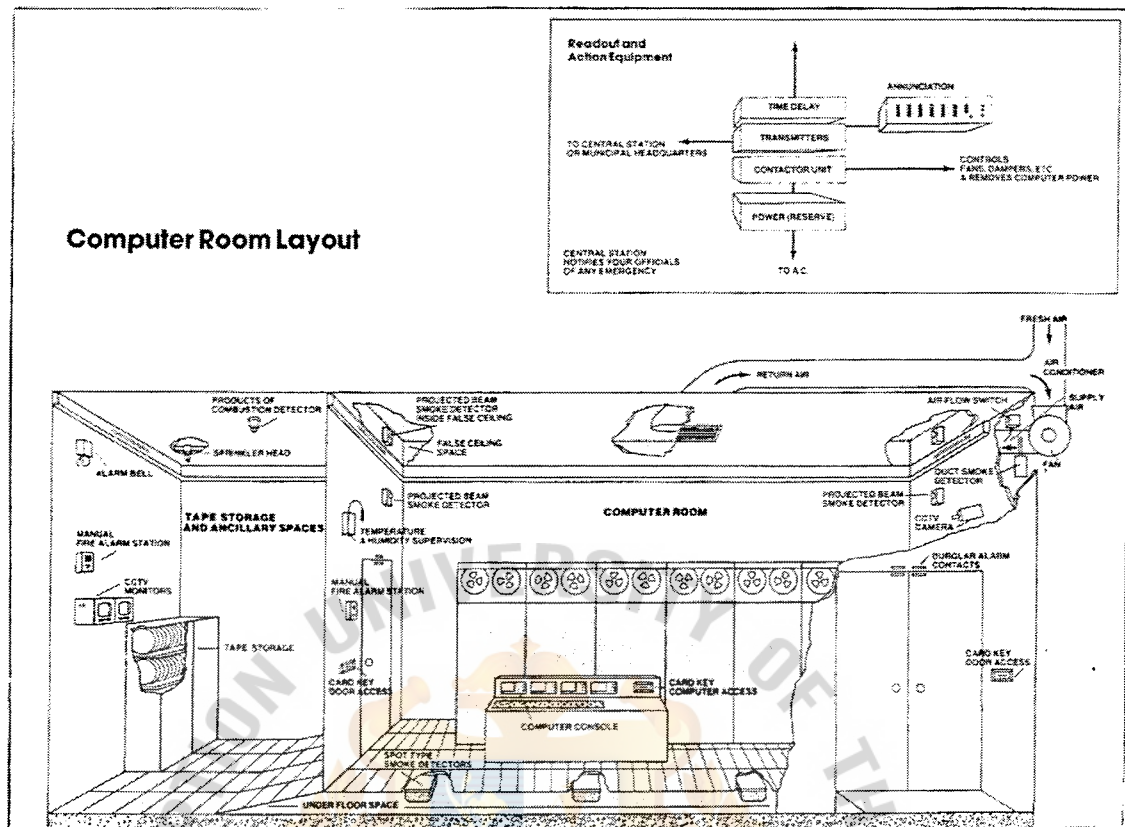


Figure 4.3. Computer Room Layout.

#### (b) Architecture Design and Hardware Sizing

After we have analysed the information from user survey results and study on current and expected issues in the future, we can design the solution diagram in cope with the problem as follows:



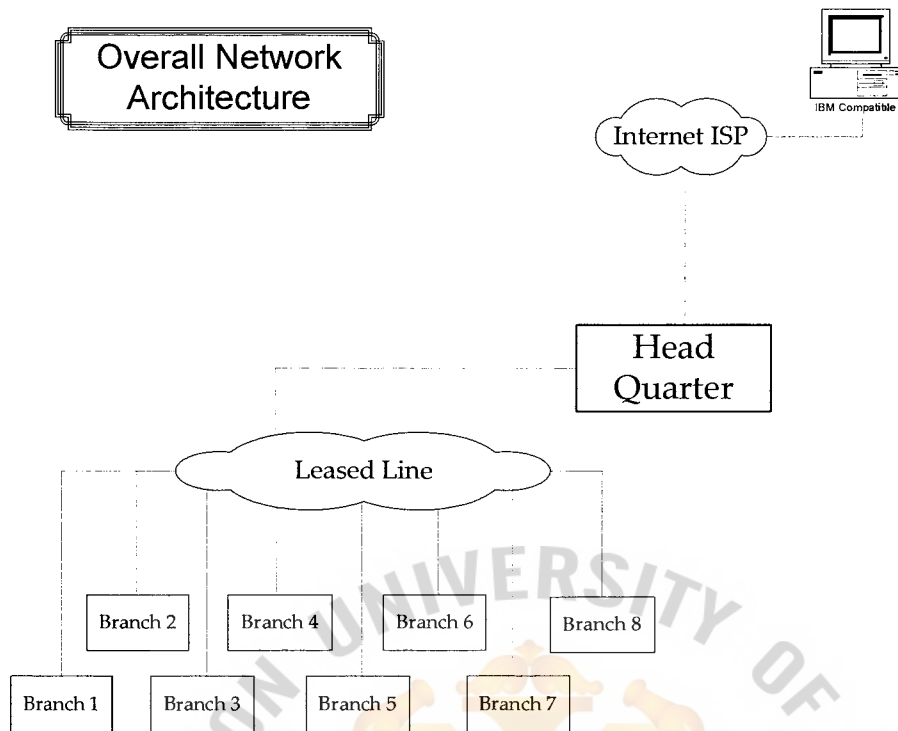


Figure 4.4. Overview Solution Diagram.

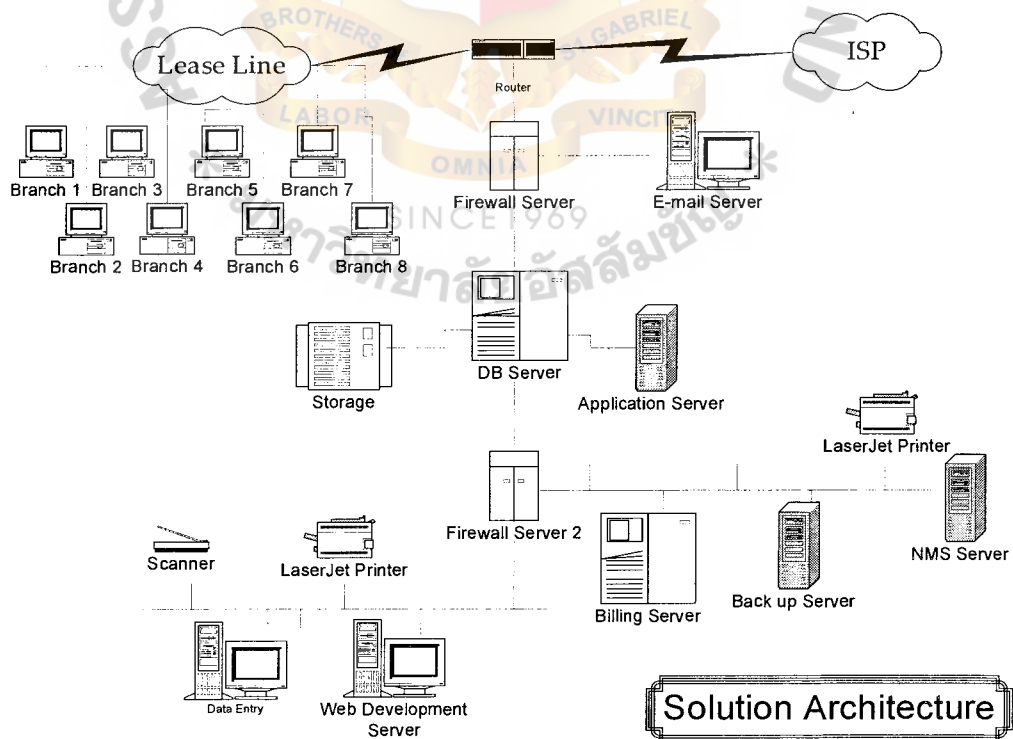


Figure 4.5. Detail Solution Diagram.

Table 4.1. Summary of Hardware Needed.

Item	Description	Quantity Needed
1	UNIX Server for : - Database Server for clustering - Billing Server	3
2	Intel Base Server for : - Firewall Server 1 & 2 - Application Server - Back up Server - Network Management Server	5
3	PC Workstation (Entry Level) for : - Data Entry - Branch PC (all)	9
4	PC Server (High Level) for : - Web Development - E-mail	2
5	Peripheral - Scanner - Printer	3
6	Router	1
7	SAN Switch	1
8	Storage	1

Table 4.2. Summary of Software Needed.

Item	Description	Quantity
	Turnkey software for Billing	1
2	Oracle Database Software	1
3	Check Point Firewall Software	1
4	Network Management Software	1
5	Java Language	1
6	Microsoft 2003 Server	5

Below is Hardware Requirement Spec for each server :

- (1) Database Server : 2 Units for clustering

This server will be used to manage, and control database. Details are as follows:

- (a) Use RISC-based CPU 64 bit which is able to make Symmetric Multi-Processor - There shall be at least 2 built-in CPUs and can be

expanded to the maximum of 4 CPUs. The speed of each CPU should be at least 700 MHz.

- (b) Operating System should be commercial Unix type. It should have a license to support at least 100 users.
  - (c) It should have memory at least 1GB.
  - (d) The capacity of internal hard disk should be at least 36GB.
  - (e) Connect with LAN Switch by using port of 10/100 Base T.
  - (f) Power Supply should be the type of Dual Hot Swap Power Supply.
  - (g) Rack model which includes all accessories needed for clustering solution.
  - (h) Vendors have to provide the Oracle Database License which support at least 10 users.
- (2) Billing System : 1 Unit

It will be used to generate invoice, and customer's payment or Accounting department.

- (a) Use RISC-based CPU 64 bit which is able to make Symmetric Multi-Processor - There should be at least 2 built-in CPUs. The speed of each CPU should be at least 600 MHz.
- (b) Operating System should be commercial Unix type. It should have License to support at least 20 users.
- (c) It should have at least 4GB memory .
- (d) The capacity of internal hard disk should be at least 72GB.
- (e) Connect with LAN Switch by using port of 10/100 Base T.
- (f) Power Supply should be the type of Dual Hot Swap Power Supply

- (g) Bidder should provide the program to run the billing activities and customer's payment compatible with other accounting system.

(3) Firewall Server 1 & 2 : 2 units

This server will be used for controlling Internet usage inside the network.

Qualifications are as follows:

- (a) Use CPU with PIII Xeon, the speed of each CPU at least 2GHz , 2 built-in CPUs
- (b) Operating System should be commercial Microsoft License. It should have Legal License support.
- (c) It should have memory of at least 512 MB.
- (d) The capacity of hard disk should be at least 36GB
- (e) Have Color Monitor of not less than 17 inches, showing details by not less than 1280x1024 points with graphic display card.
- (f) Bidder should propose Commercial Firewall Program which is able to work compatible with whole system.
- (g) Connect with LAN Switch by using port 10/100 Base T.
- (h) Able to protect and prevent data to pass Firewall, in case of not having Proxy for service
- (i) Dual power supply.

(4) Application Server : 1 unit

This server will be used for allocation application to other server and controlling it.

- (a) Use CPU with PIII Xeon, the speed of each CPU at least 2GHz , 2 built-in CPUs.

- (b) Operating System should be commercial Microsoft License. It should have Legal License support
- (c) It should have memory of at least 512 MB.
- (d) The capacity of hard disk should be at least 36GB.
- (e) Have Color Monitor of not less than 17 inches, showing details by not less than 1280x1024 points with graphic display card.
- (f) Connect with LAN Switch by using port 10/100 Base T.
- (g) Dual power supply.

(5) Back Up Server : 1 unit

This server will be used to back up the information and log file in order to avoid data being lost.

- (a) Use CPU with PIII Xeon, the speed of each CPU at least 2GHz , 2 built-in CPUs.
- (b) Operating System should be commercial Microsoft License. It should have Legal License support
- (c) It should have memory of at least 512 MB.
- (d) The capacity of hard disk should be at least 36GB.
- (e) Have Color Monitor of not less than 17 inches, showing details by not less than 1280x1024 points with graphic display card.
- (f) Connect with LAN Switch by using port 10/100 Base T.
- (g) Dual power supply.

(6) Network Management Server : 1 unit

This server will be used to install network management software in order to monitor the server and network performance.



- (a) Use CPU with PIII Xeon, the speed of each CPU at least 2GHz , 2 built-in CPUs.
- (b) Operating System should be commercial Microsoft License. It shall have Legal License support
- (c) Should have memory of at least 512 MB.
- (d) The capacity of hard disk should be at least 36GB.
- (e) Have Color Monitor of not less than 17 inches, showing details by not less than 1280x1024 points with graphic display card.
- (f) Connect with LAN Switch by using port 10/100 Base T.
- (g) Dual Power Supply.
- (h) Vendor have to provide network management software license.
- (i) Contact System manager to program function by Graphic User Interface.
- (j) Able to program control of function, installation and usage of computer system and network for linking.
- (k) Able to monitor traffic and display Utilization and other factors of computer system and network.
- (l) Able to program , control function, installation and usage of Equipment such as Router, Access Server and LAN Switch.
- (m) Able to monitor traffic of each Port of the router and LAN switch.
- (n) Displays network that connects with each port and the whole network, able to handle pictures, and maps.
- (o) Serve Warning in case abnormality occurs in the System related to equipment : LAN, Router, server by displaying in form of changing colors on the screen and print. and checking the causes.

- (7) PC Workstation (Entry Level) : 9 units
- (a) CPU of PIV 2GHz or better
  - (b) Main memory of SDRAM at least 100MHz , totally not less than 128MB, installed in 1 or 2 slots memory module. Memory can be expanded from what is proposed without any additional equipment to the existing system.
  - (c) Capacity of hard disk is at least 20GB.
  - (d) Floppy Disk Capacity is 1.44MB, 3.5 inch.
  - (e) Graphic Card should be at least 16MB
  - (f) At least 2 serial ports and 1 parallel port.
  - (g) Operating System of Microsoft Windows 2003 Thai Language or better.
  - (h) Monitor 15"
- (8) PC Workstation (High Level) : 2 units
- (a) CPU of PIV 2GHz or better
  - (b) Main memory of SDRAM at least 100MHz , totally not less than 256MB, installed in 1 or 2 slots memory module. Memory can be expanded from what is proposed without any additional equipment to the existing.
  - (c) Capacity of hard disk is at least 40GB.
  - (d) Floppy Disk Capacity is 1.44MB, 3.5 inch.
  - (e) Graphic Card shall be at least 16MB
  - (f) At least 2 serial ports and 1 parallel port.
  - (g) Operating System of Microsoft Windows 2003 Thai Language or better.

(h) Monitor 17" Color

(9) Printer : 2 units

Printer to print pictures and information, Details are as follows:

- (a) Able to store pictures put on Memory by at least 8 MB.
- (b) Able to choose fineness for pictures from 800x600 pixel to the maximum of 1152x864 pixel.
- (c) Speed of color printer shall be at least 3.5 pages/minute.
- (d) Can print on A4 paper size.

(10) Scanner : 1 unit

To scan pictures to web page. Details are as follows:

- (a) Scanner can scan both color and black/White pictures.
- (b) Able to scan pictures of A4 size
- (c) The fineness of scan should not less than 600 dot per inch
- (d) Connect with Web Terminal by SCSI or USB.
- (e) Bidder should propose program to control function of equipment as necessary.

(11) Switch : 1 unit

To connect Equipment. Details are as follows:

- (a) Able to link all the equipment proposed by using port of 10Base-T and port of 100Base-TX working as Full Duplex.
- (b) There should be ports 10Base-T/100Base-TX that are Auto-sensing, at least 16 ports and able to expand ports by increasing equipment into LAN Switch directly.
- (c) Supports protocol standard SNMP
- (d) Have Console with cable.

- (e) Have cable to connect LAN, the number equal to Port LAN proposed.
- (f) Propose other details for LAN Switch.

(12) Router : 1 Unit

Being Router equipment. Details are as follows:

- (a) Have WAN port by using Internet Phase V. 35 at least 2 ports.
- (b) Have LAN of 10 Base, at least 2 in the same module
- (c) Have console for connection
- (d) Have memory for storing data at least 16MB.
- (e) Have program control function

(13) Storage : 1 unit

This storage will be used for storing database, Details are as follows:

- (a) The capacity for storage is at least 100GB with RAID 5
- (b) Should be connected by Fiber Channel.
- (c) Bidder should provide the related program to manage storage and allocation resources.

After we send the Request For Proposal (RFP) to 2 vendors (SUN, HP) to propose the total solution, the next step is to proceed for evaluation. The first step in evaluation is theoretical benchmarking. This method is divided into two separate evaluations. Each vendor's proposal must be evaluated for compliance with the mandatory attributes. If any of the mandatory attributes are not present, then the proposal is unacceptable and is eliminated from consideration. The remaining proposals that satisfy the mandatory attributes must then be evaluated based on the desirable attributes. To simplify this process a checklist could be used to organize the evaluation.

Table 4.3. Checklist for Rating Mandatory Attributes for SUN Solution.

Attribute	Satisfied? Yes(Y), No(N)	Description of Attribute
<b>Hardware spec:</b> 1. Data Base Server SUN Fire V480  2. Billing System SUN Fire V480  3. Firewall & Application & Backup & Network Server SUN V650  4. PC Workstation (Entry Level) and PC Server (High Level)  5. Printer & Scanner EPSON  7. 3COM Switch  8. Storage SUN StorEdge 3300	Y	SUN Fire V480 with 2 CPUs UltraSPARC 1.05GHz (8MB L2 cache), 4GB RAM, 36GB HDD, LAN card, Redundant Power Supply  SUN V650 PIII Xeon 2.8GHz 2 CPUs, 512KB L2 cache, 512MB RAM, 36GB HDD, LAN card, Monitor, Redundant Power Supply  Dell Dimension 4600 P4 2.6GHz, 512MB RAM, 40GB HDD, 17" Color Monitor  Stylus Photo 925 print speed 8.5 ppm Memory 32 Kbyte  3COM SS 3 Switches 4950 12 auto-negotiating 10/100/1000 ports 6 fixed 1000 Base-SX port, 6 GBC ports  SUN StorEdge 3300 with 36GB HDD 5 units
<b>Speed :</b> CPU speed and I/O Bandwidth	Y	
<b>Maintenance :</b> - 3 Years , 7 days/24 hours	Y	
<b>Delivery :</b> - Within 30 days	Y	
<b>Installation :</b> - Vendor installation within 2 weeks	Y	
<b>Compatible :</b> - With existing hardware and software	Y	

Table 4.4. Rating Desirable Attributes for SUN Database and Billing Server.

Attribute	Description of Attribute	For internal Use Only		
		Weight	Score	Extension
<b>Speed :</b> I/O bandwidth 1.2 GB/s Average seek time < 20 s	SUN Fire V480 with UltraSPARC 1.05GHz (8MB L2 cache), 4GB RAM, 36GB HDD, LAN card, Redundant Power Supply	0.20 0.10	8 8	1.60 0.80
<b>Physical Attribute :</b> Dimensions (HxWxD) Weight	22.2(5U)x44.6x61cm 44 kg.	0.05 0.05	8 9	0.40 0.45
<b>Power Consumed</b>	1440W	0.05	6	0.30
<b>Maintenance</b>	3Y	0.10	8	0.80
<b>Cost</b>	1,000,000 Baht	0.20	8	1.60
<b>Installation</b>	1 weeks	0.05	8	0.40
<b>Field upgrades</b>	Yes	0.10	7	0.70
<b>Financial Alternative</b>	No	0.10	6	0.60
<b>Total Scores</b>				7.65



Table 4.5. Rating Desirable Attributes for SUN Firewall, Application, Backup and Network Server.

Attribute	Description of Attribute	For internal Use Only		
		Weight	Score	Extension
<b>Speed :</b> CPU Xeon 2.8GHz Cache 512KB L2	SUN V650 PIIXeon 2.8GHz 2CPUs, 512 KB L2 cache , 512 MB RAM , 36GB HDD , LAN cad and RPS	0.20	8	1.60
		0.10	7	0.70
<b>Physical Attribute :</b> Dimensions(HxWxD) Weight	8.7(2U)x43x64.8 cm 22.7 kg.	0.05	8	0.40
		0.05	9	0.45
<b>Power Consumed</b>	500 W	0.05	6	0.30
<b>Maintenance</b>	3Y	0.10	8	0.80
<b>Cost</b>	100,000 Baht	0.20	9	1.80
<b>Installation</b>	3 days	0.05	6	0.30
<b>Field upgrades</b>	Yes	0.10	7	0.70
<b>Financial Alternative</b>	No	0.10	6	0.60
<b>Total Scores</b>				7.65

Table 4.6. Rating Desirable Attributes for PC Workstation (Entry Level) and PC Server (High Level).

Attribute	Description of Attribute	For internal Use Only		
		Weight	Score	Extension
<b>Speed :</b> CPU Pentium IV 2.6GHz Max memory 2GB	Dimension 4600 Tower Pentium IV 2.6GHz DDR SDRAM 256MB up to 2GB 40GB Ultra ATA CDRW Internal and 17" CRT	0.20	8	1.60
		0.10	8	0.80
<b>Physical Attribute :</b> Dimensions(HxWxD) Weight	14.5x7.25x16.75 inches 15 kg.	0.05	8	0.40
		0.05	9	0.45
<b>Power Consumed</b>	250 W	0.05	7	0.35
<b>Maintenance</b>	3Y	0.10	8	0.80
<b>Cost</b>	50,000 Baht	0.20	8	1.60
<b>Installation</b>	1 days	0.05	8	0.40
<b>Field upgrades</b>	Yes	0.10	7	0.70
<b>Financial Alternative</b>	No	0.10	6	0.60
<b>Total Scores</b>				7.70

Table 4.7. Rating Desirable Attributes for Printer .

Attribute	Description of Attribute	For internal Use Only		
		Weight	Score	Extension
<b>Color :</b>	Stylus Photo 925 print speed 8.5 ppm Memory 32 Kbyte	<b>0.50</b>	<b>8</b>	<b>4.00</b>
<b>Maintenance</b>	1Y	<b>0.10</b>	<b>7</b>	<b>0.70</b>
<b>Cost</b>	12,000 Baht	<b>0.30</b>	<b>8</b>	<b>2.40</b>
<b>Financial Alternative</b>	Y	<b>0.10</b>	<b>8</b>	<b>0.80</b>
<b>Total Scores</b>				<b>7.90</b>

Table 4.8. Rating Desirable Attributes for Scanner .

Attribute	Description of Attribute	For internal Use Only		
		Weight	Score	Extension
<b>Color : Processor 64 bit</b>	EPSON Scanner	<b>0.50</b>	<b>8</b>	<b>4.00</b>
<b>Maintenance</b>	1Y	<b>0.10</b>	<b>7</b>	<b>0.70</b>
<b>Cost</b>	12,000 Baht	<b>0.30</b>	<b>6</b>	<b>1.80</b>
<b>Financial Alternative</b>	Y	<b>0.10</b>	<b>8</b>	<b>0.80</b>
<b>Total Scores</b>				<b>7.30</b>

Table 4.9. Rating Desirable Attributes for Storage.

Attribute	Description of Attribute	For internal Use Only		
		Weight	Score	Extension
<b>Speed :</b>	SUN StorEdge 3300			
Storage Enclosure : Max	Rackmount 2U Dual	<b>0.20</b>	<b>7</b>	<b>1.40</b>
Drives 12	redundant RAID			
Drives Supported : 36GB-15K rpm, 73GB and 146GB 10K rpm	controllers	<b>0.10</b>	<b>7</b>	<b>0.70</b>
<b>Physical Attribute :</b>				
Dimensions (HxWxD)	8.2(2U)x44.7x53.3 cm	<b>0.05</b>	<b>9</b>	<b>0.45</b>
Weight	22.7 kg.	<b>0.05</b>	<b>9</b>	<b>0.45</b>
<b>Power Consumed</b>	610	<b>0.05</b>	<b>6</b>	<b>0.30</b>
<b>Maintenance</b>	3Y	<b>0.10</b>	<b>8</b>	<b>0.80</b>
<b>Cost</b>	320,000 Baht	<b>0.20</b>	<b>7</b>	<b>1.40</b>
<b>Installation</b>	2 days	<b>0.05</b>	<b>7</b>	<b>0.35</b>
<b>Field upgrades</b>	Yes	<b>0.10</b>	<b>7</b>	<b>0.70</b>
<b>Financial Alternative</b>	No	<b>0.10</b>	<b>6</b>	<b>0.60</b>
<b>Total Scores</b>				<b>7.15</b>

Table 4.10. Checklist for Rating Mandatory Attributes for HP Solution.

Attribute	Satisfied? Yes(Y), No(N)	Description of Attribute
<b>Hardware spec:</b> 1. Data Base Server HP rp5470  2. Billing System HP rp5405  3. Firewall & Application and Backup Server HP Proliant DL380G3  4. Network Server HP Proliant DL580G2  5. Pc Workstation (Entry Level) HP Pavilion a250n Desktop PC  6. PC Server (High Level)  7. Printer & Scanner HP Deskjet 9300 and HP Scanjet 4570c  8. 3COM Switches  9. Storage Modular SAN Array 1000	Y	HP rp5470 with 875MHz 2 CPUs with 4GB RAM, 36GB HDD, LAN Card, Redundant Power Supply  HP rp5405 with 2 PA-8700 RISC , 4GB RAM, 36GB HDD, LAN card, Redundant Power Supply  HP DL380G3 PIIXeon 2.8GHz, 2 CPUs, 512MB RAM, 36GB HDD, 17" Color Monitor, LAN Card and RPS  HP DL580 Xeon Processor MP 2.8GHz 2 CPUs , 1024MB RAM 36GB HDD , 17" Color Monitor , LAN Card and RPS  HP Pavilion a250n Intel Pentium IV 2.66GHz cache L2 512KB , 256MB RAM , 40GB HDD , M703 Curved Screen Monitor 17"  HP XW4100 P4 3.2GHz, Intel 875 chipset, ECC memory, 1GB RAM, 40GB HDD, 17" Monitor  HP Deskjet 9300 Black 600 dpi and Color 4800 dpi HP Scanjet 4570c Colour Processing 48-bit  3COM SS 3 Switches 4950 12 auto-negotiating 10/100/1000 ports 6 fixed 1000 Base-SX port , 6GBC ports  HP MSA1000 Storageworks with 36GB HDD 5 units, 1GB cache
<b>Speed :</b> Transfer rate > 1.5 mb/s Average seek time < 20 s	Y	
<b>Maintenance :</b> - 3 Years , 7 days/24 hours	Y	
<b>Delivery :</b> - Within 30 days	Y	
<b>Installation :</b> - Vendor installation within 2 weeks	Y	
<b>Compatible :</b> - With existing hardware and software	Y	

Table 4.11. Rating Desirable Attributes for HP Database Server.

Attribute	Description of Attribute	For internal Use Only		
		Weight	Score	Extension
<b>Speed :</b> I/O bandwidth 3.2 GB/s  Average seek time < 20 s	HP rp5470 with 875MHz 2 CPUs with 4GB RAM, 36GB HDD, LAN Card, Redundant Power Supply	0.20	8	1.60
		0.10	8	0.80
<b>Physical Attribute :</b> Dimensions (HxWxD) Weight	35.6(8U)x48.2x77.4 cm 68Kg	0.05	6	0.30
		0.05	7	0.35
<b>Power Consumed</b>	1283 W	0.05	9	0.45
<b>Maintenance</b>	3Y	0.10	8	0.80
<b>Cost</b>	1,200,000 Baht	0.20	7	1.40
<b>Installation</b>	1 week	0.05	8	0.40
<b>Field upgrades</b>	Y	0.10	7	0.70
<b>Financial Alternative</b>	Y	0.10	8	0.80
<b>Total Scores</b>				7.60

Table 4.12. Rating Desirable Attributes for HP Billing Server.

Attribute	Description of Attribute	For internal Use Only		
		Weight	Score	Extension
<b>Speed :</b> I/O bandwidth 3.2 GB/s  Average seek time < 20 s	HP rp5405 with 650MHz 2 CPUs with 4GB RAM, 36GB HDD, LAN Card, Redundant Power Supply	0.20	8	1.60
		0.10	8	0.80
<b>Physical Attribute :</b> Dimensions (HxWxD) Weight	35.6(8U)x48.3x77.4 cm 68Kg	0.05	6	0.30
		0.05	7	0.35
<b>Power Consumed</b>	1360 W	0.05	8	0.40
<b>Maintenance</b>	3Y	0.10	8	0.80
<b>Cost</b>	660,000 Baht	0.20	8	1.60
<b>Installation</b>	1 week	0.05	8	0.40
<b>Field upgrades</b>	Y	0.10	7	0.70
<b>Financial Alternative</b>	Y	0.10	8	0.80
<b>Total Scores</b>				7.75

Table 4.15. Rating Desirable Attributes for PC Workstation (Entry Level) .

Attribute	Description of Attribute	For internal Use Only		
		Weight	Score	Extension
<b>Speed :</b> CPU Pentium IV 2.66GHz  Max memory 2GB	HP Pavilion a250n Intel Pentium IV 2.66GHz cache L2 512KB , 256MB RAM , 40GB HDD , M703 Curved Screen Monitor 17"	0.20	8	1.60
		0.10	8	0.80
<b>Physical Attribute :</b> Dimensions (HxWxD) Weight	14.5x7.25x16.75 inches 15 kg.	0.05	8	0.40
		0.05	9	0.45
<b>Power Consumed</b>	250 W	0.05	7	0.35
<b>Maintenance</b>	3Y	0.10	8	0.80
<b>Cost</b>	40,000 Baht	0.20	8	1.60
<b>Installation</b>	1 day	0.05	8	0.40
<b>Field upgrades</b>	Y	0.10	7	0.70
<b>Financial Alternative</b>	Y	0.10	8	0.80
<b>Total Scores</b>				7.90

Table 4.16. Rating Desirable Attributes for PC Server (High Level) .

Attribute	Description of Attribute	For internal Use Only		
		Weight	Score	Extension
<b>Speed :</b> CPU Pentium IV 3.2GHz  Max memory 2GB	HP XW4100 P4 3.2GHz, Intel 875 chipset, ECC memory, 1GB RAM, 40GB HDD, 17" Monitor	0.20	9	1.80
		0.10	8	0.80
<b>Physical Attribute :</b> Dimensions (HxWxD)  Weight	14.5x7.25x16.75 inches 15 kg.	0.05	8	0.40
		0.05	9	0.45
<b>Power Consumed</b>	250 W	0.05	7	0.35
<b>Maintenance</b>	3Y	0.10	8	0.80
<b>Cost</b>	90,000 Baht	0.20	8	1.60
<b>Installation</b>	1 day	0.05	8	0.40
<b>Field upgrades</b>	Y	0.10	7	0.70
<b>Financial Alternative</b>	Y	0.10	8	0.80
<b>Total Scores</b>				8.10



Table 4.17. Rating Desirable Attributes for Printer .

Attribute	Description of Attribute	For internal Use Only		
		Weight	Score	Extension
<b>Color :</b> <b>Black 600 dpi and Color 4800 dpi</b>	HP Deskjet 9300	<b>0.50</b>	<b>9</b>	<b>4.50</b>
<b>Maintenance</b>	<b>1Y</b>	<b>0.10</b>	<b>7</b>	<b>0.70</b>
<b>Cost</b>	<b>12,000 Baht</b>	<b>0.30</b>	<b>8</b>	<b>2.40</b>
<b>Financial Alternative</b>	<b>Y</b>	<b>0.10</b>	<b>8</b>	<b>0.80</b>
<b>Total Scores</b>				<b>8.40</b>

Table 4.18. Rating Desirable Attributes for Scanner .

Attribute	Description of Attribute	For internal Use Only		
		Weight	Score	Extension
<b>Color :</b> <b>Processing 48-bit</b>	HP Scanjet 4570c Colour	<b>0.50</b>	<b>8</b>	<b>4.00</b>
<b>Maintenance</b>	<b>1Y</b>	<b>0.10</b>	<b>7</b>	<b>0.70</b>
<b>Cost</b>	<b>12,000 Baht</b>	<b>0.30</b>	<b>6</b>	<b>1.80</b>
<b>Financial Alternative</b>	<b>Y</b>	<b>0.10</b>	<b>8</b>	<b>0.80</b>
<b>Total Scores</b>				<b>7.30</b>

Table 4.19. Rating Desirable Attributes for HP Storage.

Attribute	Description of Attribute	For internal Use Only		
		Weight	Score	Extension
<b>Speed :</b> Storage Enclosure : Max Drives 14	HP MSA1000 Storageworks with 36GB HDD 5 units, 1GB cache	<b>0.20</b>	<b>9</b>	<b>1.80</b>
Drives Supported : 18.2GB,36GB-15K rpm, 73GB and 146GB 10K rpm		<b>0.10</b>	<b>8</b>	<b>0.80</b>
<b>Physical Attribute :</b> Dimensions (HxWxD)	17.5x48.3x52.1	<b>0.05</b>	<b>8</b>	<b>0.40</b>
Weight	38.56 kg.	<b>0.05</b>	<b>8</b>	<b>0.40</b>
<b>Power Consumed</b>	549	<b>0.05</b>	<b>7</b>	<b>0.35</b>
<b>Maintenance</b>	3Y	<b>0.10</b>	<b>8</b>	<b>0.80</b>
<b>Cost</b>	350,000 Baht	<b>0.20</b>	<b>7</b>	<b>1.40</b>
<b>Installation</b>	2 days	<b>0.05</b>	<b>7</b>	<b>0.35</b>
<b>Field upgrades</b>	Yes	<b>0.10</b>	<b>7</b>	<b>0.70</b>
<b>Financial Alternative</b>	Yes	<b>0.10</b>	<b>8</b>	<b>0.80</b>
<b>Total Scores</b>				<b>7.80</b>



Table 4.20. Summary Score .

Item	Description	SUN	HP
1	Database Server	7.65	7.6
2	Billing Server	7.65	7.75
3	Firewall Server	7.65	7.7
4	Application Server	7.65	7.7
5	Backup Server	7.65	7.7
6	Network server	7.65	7.7
7	PC Workstation (Entry Level)	7.7	7.9
8	PC Server (High End)	7.7	8.1
9	Printer	7.9	8.4
10	Scanner	7.3	7.3
11	Storage	7.5	7.8
	<b>TOTAL SCORE</b>	<b>84</b>	<b>85.65</b>

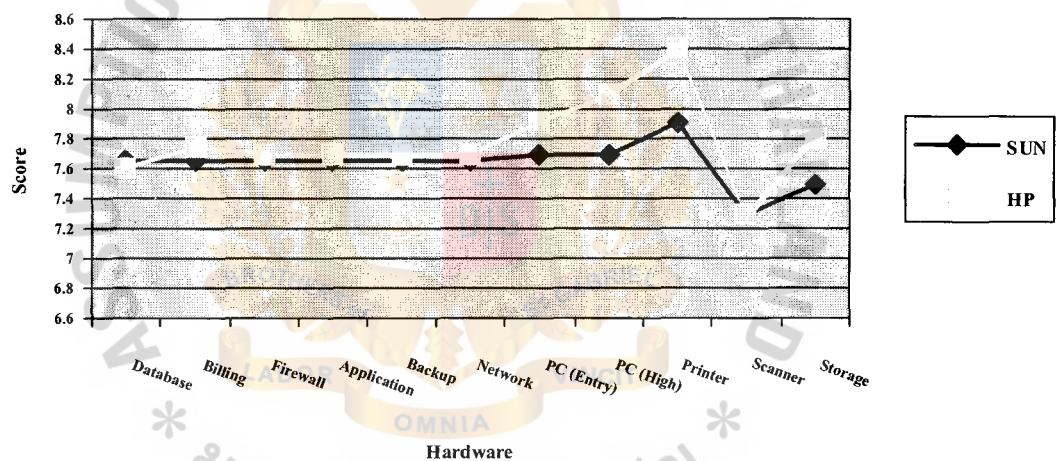


Figure 4.6. Summary Score for Vendors Selection.

After we compared three vendors above, we can see that the total score for SUN is 84, and HP is 85.65. For more details about each vendor's quotation and service level agreement , refer to Appendix.

## 4.2 Economic feasibility

### (a) Return On Investment and Break-Even Point Analysis

Total increased benefit is calculated from the following data

Total transaction increases from the old system to the new system. This number will get from running pilot test by using a system simulation program which will be detailed later under operational feasibility.

- (1) Total transactions from old system is 57 transactions per week
- (2) Total transactions that new system can support up to 106 transactions per week
- (3) Expect to get purchase order 70% from total transactions that the new system can support , total expected transactions per week is 74 transactions per week.
- (4) Increased transactions per week =  $74 - 57$  transactions  
= 17 transaction per week
- (5) Total revenue per year by using old system = 40,000,000 Baht
- (6) Revenue per week =  $40,000,000 / 48$  week
- (7) Then, revenue = 833,333 Baht/week
- (8) Then, revenue per transaction =  $833,333 / 57$   
= 14,620 Baht per transaction
- (9) Revenue increase from increased transaction  
=  $14,620 \times 17$   
= 248,540 Baht per week

Then increase in revenue per year is  $248,540 \times 48 = 11,929,920$  Baht per year

There are many factors that support this increase in revenue per year. From the table there will be a break through of each benefit.

Table 4.21. Total Benefit and Cost Break through.

<b>Benefit Worksheet</b>	<b>Baht</b>
A. Cost reduction or avoidance (2%)	238,598.40
B. Error reduction (10%)	1,192,992.00
C. Increased flexibility (2%)	238,598.40
D. Increased speed of activity (productivity) (20%)	2,385,984.00
E. Improvement in management planning (2%)	238,598.40
F. Increase in Sale Volume (30%)	3,578,976.00
G. Increase in competitive advantages (2%)	238,598.40
H. Increase in marketing share and acknowledgement (5%)	596,496.00
I. Increase in Customer/Employee satisfaction (15%)	1,789,488.00
J. Others, increase in employee knowledge..(12%)	1,431,590.40
<b>Total benefit</b>	<b>11,929,920.00</b>
<b>One-time costs worksheet as shown in Appendix D</b>	<b>Baht</b>
A. Development costs	200,000.00
B. New Hardware	5,604,000.00
C. New Purchased software	2,950,000.00
D. User training	50,000.00
E. Other (Site Preparation)	2,000,000.00
<b>Total One-time costs</b>	<b>10,804,000.00</b>
<b>Recurring Costs Worksheet</b>	<b>Baht</b>
A. Application software maintenance (as shown in Appendix D)	500,000.00
B. Incremental data storage (Budgetary)	500,000.00
C. Incremental computer (Budgetary)	100,000.00
E. Supplies (Budgetary)	100,000.00
F. Other	200,000.00
<b>Total recurring costs</b>	<b>1,400,000.00</b>

Table 4.22. Detail Hardware Cost.

Summary Hardware Cost Sheet					
Server Type	Application	QTY.	Model	Unit Price	Net Price
<b>UNIX Server for :-</b>					
	Database Server for clustering	2	HP rp5470	1,200,000.00	2,400,000.00
	Billing Server	1	HP rp5405	660,000.00	660,000.00
<b>Intel Base Server for :-</b>					
	Firewall Server 1 & 2-	2	HP DL380g3	140,000.00	280,000.00
	Application Server-	1	HP DL380g3	150,000.00	150,000.00
	Back up Server-	1	HP DL380g3	150,000.00	150,000.00
	Network Management Server	1	HP DL580g2	550,000.00	550,000.00
<b>PC Workstation (Entry Level) for :-</b>					
	Data Entry -	1	HP Pavilion a250n	40,000.00	40,000.00
	Branch PC (all)	8	HP Pavilion a250n	40,000.00	320,000.00
<b>PC Server (High Level) for :-</b>					
	Web Development -	1	HP XW4100 Workstation	90,000.00	90,000.00
	E-mail	1	HP XW4100 Workstation	120,000.00	120,000.00
<b>Peripheral -</b>					
	Scanner-	1	HP Scanjet 4570c	12,000.00	12,000.00
	Printer	2	HP Deskjet 9300	12,000.00	24,000.00
<b>Router</b>		1	Cisco	58,000.00	58,000.00
<b>SAN Switch</b>		1	3COM 8 port	300,000.00	300,000.00
<b>Storage</b>		1	MSA1000	350,000.00	350,000.00
<b>Rack</b>		2	HP Rack 42U	50,000.00	100,000.00
<b>GRAND TOTAL</b>					<b>5,604,000.00</b>
<b>Site Preparation</b>					<b>2,000,000.00</b>
<b>NET TOTAL HARDWARE</b>					<b>7,604,000.00</b>

Table 4.23. Summary Cost Sheet (as shown in Appendix D).

Item	Software Name	QTY	Unit Price	Net Price
1	Turnkey software package for Billing (AccPac Software)	1	1,500,000.00	1,500,000.00
2	Microsoft SQL Database Software	1	500,000.00	500,000.00
3	Check Point Firewall Software	1	400,000.00	400,000.00
4	Network Management Software	1	400,000.00	400,000.00
5	Java Language	1	25,000.00	25,000.00
6	Microsoft 2003 Server	5	25,000.00	125,000.00
<b>TOTAL</b>				<b>2,950,000.00</b>

Table 4.24. Economic Feasibility Analysis.

	Year Project						
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Net economic benefit	0	11,929,920	11,929,920	11,929,920	11,929,920	11,929,920	
irr 2%	1.0000	0.4465	0.3986	0.3559	0.3178	0.2837	
PV of benefit	0.00	5,326,113	4,755,266	4,245,859	3,790,732	3,384,518	
NPV of all BENEFITS	0.00	5,326,113	10,081,379	14,327,237	18,117,970	21,502,488	21,502,487.81
One-time COSTS	(10,804,000)						
Recurring Costs	0	(1,400,000.00)	(1,400,000.00)	(1,400,000.00)	(1,400,000.00)	(1,400,000.00)	
irr 2%	1.0000	0.4465	0.3986	0.3559	0.3178	0.2837	
PV of Recurring Costs		(625,030)	(558,040)	(498,260)	(444,850)	(397,180)	
NPV of all COSTS	(10,804,000)	(11,429,030)	(11,987,070)	(12,485,330)	(12,930,180)	(13,327,360)	(13,327,360.00)
Overall NPV							8,175,127.81
Overall ROI							0.61
Break-even Analysis							
Yearly NPV Cash Flow	(10,804,000)	4,701,083	4,197,226	3,747,599	3,345,882	2,987,338	
Overall NPV Cash Flow	(10,804,000)	(6,102,917)	(1,905,691)	1,841,907	5,187,790	8,175,128	
Project break-even occur between year 2 and 3							
Use first year of position cash flow to calculate break-even traction			0.545964155				
Actual break-even occurred at 2.545 Year							



After we calculate for the break even point, it is found that Return On Investment (ROI) Rate is 61% which is Break Even Point (BEP) period is within 2.5 years. It's very fast and not over than the hardware life cycle. It means that the company can get more benefit from the data center in at least 2.5 years until it is obsolete.

(b) Hardware and Software Acquisition Method

Not only calculating for ROI and BEP, we also need to find out the hardware and software acquisition payment method, and see which way will be the best solution for Thaveerung Company.

There are 2 types of payment methods that vendors offer to Thaveerung company. The first is a purchase program and the second is a lease program. We need to find out which types will give the higher net present value (NPV).

(1) Purchase Program

Payment 100% of selling price after invoicing within 30 days (Single-Payment compound amount factor) so the net present value will be equal to the cost of both hardware (including site preparation) and software.

$$P = 10,554,000 \text{ Baht}$$

(2) Leasing program (The lease to ownership plan)

- (a) Installment period is 3 years (Equal Payment Series Compound Amount Factor)
- (b) After 3 years, Thaveerung Co., is the owner of all equipment
- (c) Installment is 390,000 Baht per month, totally is 36 months
- (d) Annual interest rate is 2%
- (e) Salvage value is 15% from total price, Useful Life is 5 years.

Calculation :

$$P = (390,000 \times 12) \left( \frac{P}{A}, 2\%, 3 \right) - (10,554,000 \times 15\%) \left( \frac{P}{F}, 2\%, 3 \right)$$



$$P = 4,680,000 (2.8839) - 1,583,100(0.9635)$$

$$P = 11,971,336 \text{ Baht}$$

So the total cost for leasing program is 11,971,336 Baht

From the above calculation, we can see that actual total cost for leasing a program is 11,971,336 Baht which is higher than a purchase program whose actual present cost is only 10,554,000 Baht. Anyway, other factors should be considered in selecting the alternatives such as company cash flow , budget allocation etc.

### 4.3 Operational Feasibility

After technical and economical feasibility is completed, the next is operational feasibility. In operational feasibility, the sales and order processing system is selected to operate a pilot testing by using the system simulation technology, called, Arena Program.

#### (a) Process Work Flow

Understanding on process work flow is a must for conducting the pilot test.

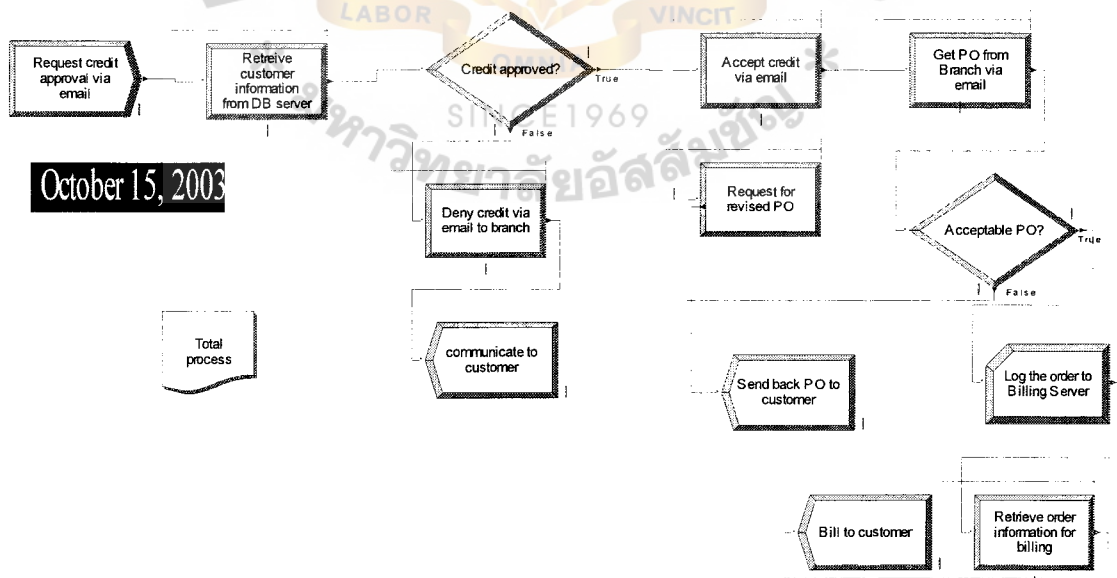


Figure 4.7. Sales and Order Processing Flow Chart.

(b) Information Gathering

In order to compare the old process and the new process, the information for both processes have to be consolidated. Below are required information for conducting a pilot test.

- (1) Average/Min/Max Process Time for each process.
- (2) Estimated Holding Cost, Initial Variable Cost, Initial Non Variable Cost and Waiting Cost
- (3) Estimated Busy Hour Cost, Idle Hour Cost for resources.
- (4) Probability for decision process.
- (5) Pilot Test Run Range

From observation 15 transactions for each process for both old and new processes, and record them in a table in order to find out the average/minimum/maximum process time. The tables of data are shown below.

Table 4.25. Average Process Time for Retrieve Customer Information Process.

Item	Average Process Time	
	Old Process	New Process
1	2.5	1.3
2	3	2.1
3	3.5	1.1
4	2.4	1.2
5	1.5	0.5
6	5.2	0.4
7	3.4	2.1
8	4.1	0.4
9	4.4	2.1
10	3.1	1.2
11	2.2	1.1
12	1.3	1
13	5.2	0.3
14	6.4	1.5
15	6.4	1.2
<b>Total</b>	<b>54.6</b>	<b>17.5</b>
<b>MIN</b>	<b>1.3</b>	<b>0.3</b>
<b>MAX</b>	<b>6.4</b>	<b>2.1</b>
<b>Average</b>	<b>3.64</b>	<b>1.16</b>

Table 4.26. Average Process Time for Credit Approval.

Item	Average Process Time	
	Old Process	New Process
1	2.2	1.5
2	4.3	2
3	4.2	3.1
4	3.5	2.2
5	4.1	1.4
6	4	2
7	5.3	0.5
8	3.5	1.2
9	4.4	0.3
10	3	2.1
11	4.1	0.2
12	4.5	1.3
13	4.2	1.1
14	3.5	2
15	3.4	1.2
<b>Total</b>	<b>58.2</b>	<b>22.1</b>
<b>MIN</b>	<b>2.2</b>	<b>0.2</b>
<b>MAX</b>	<b>5.3</b>	<b>3.1</b>
<b>Average</b>	<b>3.88</b>	<b>1.47</b>

Table 4.27. Average Process Time for Getting Purchase Order from Branch.

Item	Average Process Time	
	Old Process	New Process
1	3.2	1.2
2	22.3	2.4
3	3.2	1.4
4	4.5	0.5
5	33.3	1.3
6	4.1	1.5
7	27.4	2
8	9.5	1.2
9	5.4	2.5
10	19.5	2.1
11	14.4	1
12	2.1	1.5
13	4.4	0.3
14	30.5	1.5
15	2.3	2
<b>Total</b>	<b>186.1</b>	<b>22.4</b>
<b>MIN</b>	<b>2.1</b>	<b>0.3</b>
<b>MAX</b>	<b>33.3</b>	<b>2.5</b>
<b>Average</b>	<b>12.4</b>	<b>1.49</b>

Table 4.28. Average Process Time for Denied Credit.

Item	Average Process Time	
	Old Process	New Process
1	3.2	1.4
2	4.1	2.1
3	5.4	2.5
4	3.3	2.1
5	2.1	0.5
6	6.5	0.2
7	4.5	2.2
8	1.2	1.2
9	5	2.1
10	7.5	2
11	3.2	2.1
12	1.3	1.3
13	3.5	1.2
14	4.3	1.3
15	2.2	0.5
<b>Total</b>	<b>57.3</b>	<b>22.7</b>
<b>MIN</b>	<b>1.2</b>	<b>0.2</b>
<b>MAX</b>	<b>7.5</b>	<b>2.5</b>
<b>Average</b>	<b>3.82</b>	<b>1.51</b>

Table 4.29. Average Process Time for Request for Revised Purchase Order .

Item	Average Process Time	
	Old Process	New Process
1	6	2.1
2	3.2	1.2
3	3	1
4	4.3	2.1
5	2.1	1.1
6	6.5	2.2
7	4	2
8	3.3	0.5
9	3.5	1.4
10	5.4	2.3
11	2.5	1.1
12	5	2.3
13	3.2	1
14	5.4	2.1
15	2.2	0.3
<b>Total</b>	<b>59.6</b>	<b>22.7</b>
<b>MIN</b>	<b>2.1</b>	<b>0.3</b>
<b>MAX</b>	<b>6.5</b>	<b>2.3</b>
<b>Average</b>	<b>3.97</b>	<b>1.51</b>

Further data that we need to record is the estimated cost. We need to find out the cost per hour because each transaction take a very short period, not more than a hour. The table below shows the estimated cost summary.

Table 4.30. Estimated Cost Summary.

Item	Description	Cost (Baht/Hour)
1	Holding Cost	100
2	Initial Variable Cost	250
3	Initial Non Variable Cost	600
4	Waiting Cost	100

Table 4.31. Estimated Resources Cost Summary

Item	Description	Busy Cost (Baht/Hour)	Idle Cost (Baht/Hour)	Per Use Cost (Baht/Hour)
1	Database	200	75	100
2	Billing System	150	50	75
3	E-mail System	100	35	75

90% probability for two decision processes are first, credit approval and Acceptable Purchase Order, because most of the customers are loyal customer who have run the business together with Thaveerung for a long time. And the range for a pilot test is 150 hours, covering the whole week on working days.

(f) Simulating the work flow

These costs are assigned to each process and then run the simulation. The result report will be done. The result will show Queue Summary, Resources Summary, Process Summary

## V. EVALUATION

User Satisfaction Survey Result shows that 52% of employees are not happy with the information system at Thaveerung Company with a sample size of 50 persons. 26 persons are not happy with technical expertise, timeliness of service and quality of hardware. So feasibility study for implementation a new data center was conducted.

### 5.1 Evaluation for technical feasibility study

#### (a) Physical Environment

We decided to use the existing building at Phatumwan Office on 2<sup>nd</sup> Floor to be a data center because

- (1) Still has empty space. So there is no need for extra cost to rent the building.
- (2) It is close to other company facilities.
- (3) There are reliable public utilities especially telephone and electrical power.
- (4) It's far from high probability of natural disaster

#### (b) Hardware and Software Acquisition

New data center architecture was designed based on the user requirements and the company's current problems. The problems information that we gathered is about current hardware which is not reliable enough, there are no linkage between the branch offices and headquarters, no e-mail communication between branch offices and headquarters and no database to record the customer and billing information.

Vendors selection process was conducted, score rating method was used, compliant table was settled to determine the mandatory and desirable attributes. Not only the highest score vendor will be the winner, other support information can also be added to help the committee for decision making.



- (1) HP Vendor gets the highest score at 85.65 when compared with SUN which gets the score at 84 for more information about hardware specification, See from Appendix D about hardware specification comparison.
- (2) Moreover, HP can provide us with the turnkey solution both hardware (including other peripheral such as printer, scanner), software and maintenance.
- (3) Good financial status See Appendix D.
- (4) Better in Benchmark Result See Appendix D.

## **5.2 Evaluation for Economic Feasibility Study**

Return On Investment and Break Even Point Analysis are calculated to evaluate whether Thaveerung Co., should invest in this new data center. The result shows that

- (1) Return On Investment is 61%. It means that it has 61% of an opportunity to get the return on investment for this new data center which is a good chance to get it back soon.
- (2) Break Even Point is 2.5 years. It means that if Thaveerung Co., invests in a new data center, it can get the benefit return in 2.5 years after the implementation. It is very fast and because the useful life of the hardware is 5 years, it means that Thaveerung Co., can get benefits from the new data center in another 2.5 years before it needs to invest more to upgrade the hardware.
- (3) Hardware and Software Acquisition Method. There are 2 methods for acquisition, purchasing or leasing. After calculating the Net Present Value (NPV), we need to pay for interest rate for the leasing option so

Net Present Value for cost is higher which is up to 11,971,336 Baht when compared with a purchase option whose Net Present Value at Cost is only 10,554,000 Baht. But not only this amount, other factors also need to be considered such as the company's cash flow. After discussion with high management team and company's financial team, the company decides to invest in a purchase option because the company has a good cash flow.

### 5.3 Evaluation for Operational Feasibility Study

Next is Operational Feasibility Study in order to make sure that this system can work and prove that this system will create benefits to the company. A pilot test is conducted for 150 hours for 6 days per week ,by using the system simulation program, which shows the result below.

#### (a) Entity Summary Report

Table 5.1. Entity Summary Report for Sales and Order Processing.

	Number In	Number Out
Entity 1 for Old System	53	4
Entity 1 for New System	61	45

Table 5.2. Entity Average Cost Report .

	NVA Cost	VA Cost	Wait Cost	Total
Entity 1 for Old System	500	2,917.42	8,103.03	11,520.45
Entity 1 for New System	600	1,159.99	1,502.42	3,262.41

Entity Summary Report shows that one entity (including processes such as accept credit or deny credit , get PO. , Request for revised PO., retrieve customer information,

retrieve order information) can be generated into the old system with only 53 transactions and only 4 has a high cost at 11,520.45 Baht per transaction while the new system can generated 61 entity and 45 transaction with very lower cost at 3,262.41 Baht.

(b) Process Summary Report

Table 5.3. Process Throughput for the Old System.

	Number In	Number Out	Total
Accept credit via fax	32	12	44
Deny Credit via fax	1	1	2
Get PO from Branch via fax or by hand	12	6	18
Request for revised PO via phone or fax	0	0	0
Retrieve customer information from file	53	33	86
Retrieve Order Information from file	6	3	9
Total	104	55	159

Table 5.4. Process Throughput for the New System.

	Number In	Number Out	Total
Accept credit via fax	55	47	102
Deny Credit via fax	5	5	10
Get PO from Branch via fax or by hand	47	40	87
Request for revised PO via phone or fax	3	3	6
Retrieve customer information from file	61	60	121
Retrieve Order Information from file	37	37	74
Total	208	192	400

Table 5.5. Process Cost for the Old System.

	NVA Cost	VA Cost	Wait Cost	Total
Accept credit via fax	-	5,522.05	58,104.51	63,626.56
Deny Credit via fax	-	490.68	8,819.06	9,309.74
Get PO from Branch via fax or by hand	-	10,184.93	24,032.98	34,217.91
Request for revised PO via phone or fax	-	-	-	-
Retrieve customer information from file	-	17,094.44	130,343.30	147,437.74
Retrieve Order Information from file	-	2,123.00	15,293.89	17,416.89
Total	-	35,415.99	236,593.74	272,009.73

Table 5.6 Process Costs for the New System.

	NVA Cost	VA Cost	Wait Cost	Total
Accept credit via fax	-	11,222.71	33,381.31	44,604.02
Deny Credit via fax	-	1,166.08	4,019.16	5,185.24
Get PO from Branch via fax or by hand	-	8,926.76	27,735.02	36,661.78
Request for revised PO via phone or fax	-	648.45	1,811.93	2,460.38
Retrieve customer information from file	-	13,393.62	5,272.76	18,666.38
Retrieve Order Information from file	-	10,757.48	1,921.60	12,679.08
Total	-	46,115.10	74,141.78	120,256.88

When entity is broken down into each process, the process summary report shows that total processes are generated from the old system is process in 104 and process out 55 with total process cost at 272,009.73 while total processes from new system is process in 208 and can generated process out at 192 with total process cost only 120,256.88. It means that the company can save the process cost at 151,752.90 Baht per week.

(c) Queue Summary Report

Table 5.7. Waiting Cost for Old Systems.

	Average	Maximum
Accept credit via fax	4,469.58	9,494.55
Deny Credit via fax	8,819.06	8,819.06
Get PO from Branch via fax or by hand	4,005.50	8,684.15
Request for revised PO via phone or fax	-	-
Retrieve customer information from file	3,833.63	7,017.54
Retrieve Order Information from file	5,097.96	6,522.93

Table 5.8. Waiting Cost for the New System.

	Average	Maximum
Accept credit via fax	695.44	1,397.58
Deny Credit via fax	803.83	1,182.30
Get PO from Branch via fax or by hand	693.38	1,289.25
Request for revised PO via phone or fax	603.98	1,428.66
Retrieve customer information from file	86.44	464.64
Retrieve Order Information from file	51.94	464.64

The queue summary report shows that the total cost for waiting has dropped when new system is used.

#### 5.4 Evaluation for implementation plan

Below is summary implementation plan for new data center.

Table 5.9. Implementation Plan Summary.

Task Name	Duration	Start	Finish
Evaluation current systems	3 days	Mon 8/4/03	Wed 8/6/03
Gathering user requirement	4 days	Thu 28/7/03	Tue 8/12/03
Define requirements	4 days	Tue 8/12/03	Fri 8/15/03
Develop project plan	17 days	Mon 8/18/03	Tue 9/9/03
Design System	4 days	Wed 9/10/03	Mon 9/15/03
Implementation	21 days	Fri 10/7/03	Fri 11/14/03
Evaluation process	2 days	Tue 10/21/03	Wed 10/22/03
Close Project	1 days	Mon 11/17/03	Mon 11/17/03

Implementation plan is 56 man days, which starts from evaluation of the current system until closing this project. Each task is identified as subtasks and descriptions.

## VI. CONCLUSIONS AND RECOMMENDATIONS

The company's objectives is to be the leader of paint industry. Thaveerung Company needs to improve its working process and infrastructures more efficiently with reasonable investment.

In order to complete this objective, the current system and problems have to be investigated and it is found out that the most critical problems is information system which has low response in timeliness of services, lack of technical expertise, low quality of hardware and software and more problems about working process in both tangible problems including document losts, transaction losts and intangible problems including human errors, and communication errors.

After analysing the exact problems, the solution planning and feasibility study including technical, economical and operational studies are prepared to solve the problems.

For technical feasibility study, we start with physical environment selection and preparation. The 2<sup>nd</sup> Floor of headquarters office is selected for implementation of the new data center because there is no extra cost to rent a building and it is close to the company's facilities. Next is hardware and software acquisition, HP is selected to be a vendor which provides turnkey solution for the new data center infrastructure including hardware, software, site preparation and maintenance with the highest score of rating at 85.45 while another vendor, SUN's score is 84.

For economical feasibility study, Thaveerung should invest in this solution because Return On Investment Rate is 61% and Break Even Point is 2.5 years. Moreover, high management level is recommended to select a purchasing program for hardware and software acquisition because of good cash flow of the company. Cash



payment with 30 days credit term is better than paying the interests which make higher cost of another 1,417,336 Baht.

In operational feasibility study after running a pilot test, the result shows that the new system can reduce waiting time and cost so the number of transactions can be increased. From the old system to the new system, the process cost is reduced to 151,752 Baht per week. It means that it can save the cost at 7,284,096 Baht per year and process transactions increase from 57 to 106 transactions per week which can generate more revenue at 11,929,920 Baht per year.

In conclusion , Thaveerung Co., should decide to implement a new data center because the new system can not only help to generate more revenue but also can help to reduce the cost.

Recommendations to Thaveerung Co., to implement a new data center.

(1) Communication with company's employees

High management team has to communicate to all employees about decision and planning for implementation of a new data center, so employees can co-operate with the implementation team and understand the direction of the company's information system.

(2) Setting a committee to take care of the project

The committee may come from IT department and someone from business departments such as sales or marketing department in order to prepare the information about the business process. The committee will have responsibilities to monitor the process time frame, co-ordinate with vendors and other employees, prepare the weekly report to management team and consolidate the document.

### (3) Training employees

Before implementation of the new data center is completed , training should be provided to all employees concerned. Training not only provides knowledge to employees but also protects errors or mistakes that may happen at the new data center.

### (4) Signing Contract with Vendor

The contract will cover the legal statement to the vendor according to the agreement between Thaveerung Co., and that vendor.

### (5) Upgrading hardware and software regularly

Because technology is always changing, both hardware and software have to be obsolete , so upgrade planning should be provided.

### (6) Documentation

All of the documents should be kept at a secure place both from unauthorized person and from disasters . It should be kept at least 5 years because if some changes such as changing new management team or some legal occur, we can use that document for reference.



## APENDDIX A

### USER SATISFACTION SURVEY

# User Satisfaction Survey

This survey is designed to measure the level of user satisfaction for various services offered by information systems. Your cooperation and frankness in completing this questionnaire will help us to supply even higher quality service in the future.

The first section of the questionnaire deals with a description of your department and your function within that department. The second part of questionnaire deals with services you use and your satisfaction with these services.

## SECTION 1 : User information

**Department :**

Accounting \_\_\_\_\_  
Sales & Marketing \_\_\_\_\_  
Operation & Administration \_\_\_\_\_  
IT \_\_\_\_\_  
Finance \_\_\_\_\_  
Production \_\_\_\_\_

**Function within Department (check only one)**

High Level Management \_\_\_\_\_  
Middle Management \_\_\_\_\_  
Staff \_\_\_\_\_

**Use of information system : (check all that apply)**

Data input \_\_\_\_\_  
Problem solving \_\_\_\_\_  
Program development \_\_\_\_\_  
Work Processing, Spreadsheet \_\_\_\_\_  
Electronic Mail \_\_\_\_\_  
Data Inquiries \_\_\_\_\_  
Decision Support \_\_\_\_\_  
Other (please specify) \_\_\_\_\_

**Type of Computer System Used : (check all that apply)**

Personal Computer/Notebook \_\_\_\_\_  
Microcomputer or workstation \_\_\_\_\_  
Mainframe or Server \_\_\_\_\_  
Disk Storage/ Tape Drive \_\_\_\_\_  
Other (please specify) \_\_\_\_\_

## SECTION 2 : Satisfaction Levels

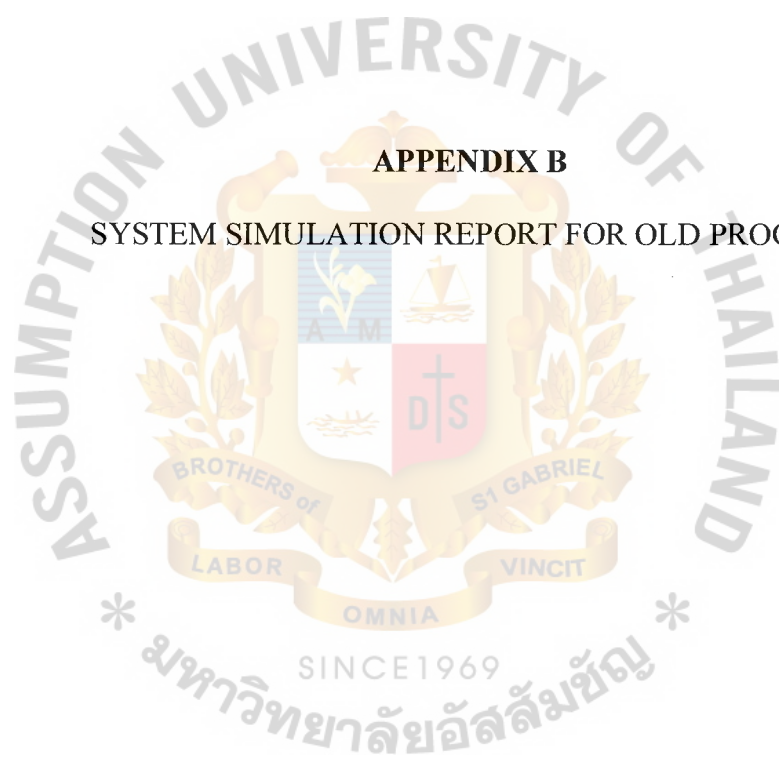
For each of the following questions, check the appropriate area if you use the given facility and then rate the quality of the service for that facility by circling the appropriate number. The rating system is from 1 to 5, where 1 represents the worst service and 5 is the best service. There is space at the end of each section for written comments. We strongly encourage you to express your feelings more completely by entering written comments.

Do you use the Information Center ? Yes \_\_\_\_\_ No \_\_\_\_\_

How do you rate each of the following measures of service provided by the information center?

Technical expertise of employees	1	2	3	4	5
Timeliness of service	1	2	3	4	5
Quality of documentation/report provided	1	2	3	4	5
Quality of hardware	1	2	3	4	5
Quality of software and application	1	2	3	4	5
Overall level of service	1	2	3	4	5

If you have any comments you wish to add, please enter them here. If the space here is insufficient, attach an additional sheet with your comments.



## **APPENDIX B**

### **SYSTEM SIMULATION REPORT FOR OLD PROCESS**



Oct-19-2003

# Entity Summary Report

2:12:42P

## Total process

Replication 1 of 1

Replication 1

Sun Oct, 19, 2003

### Entity Throughput

	Number In	Number Out
Entity 1	61.00	45.00
Total	61.00	45.00

### Average Costs

	NVA Cost	VA Cost	Wait Cost	Total
Entity 1	600.00	1,159.99	1,502.42	3,262.41
Total	600.00	1,159.99	1,502.42	3,262.41

Figure B.1. Entity Summary Report.

**Total process**

Replication 1 of 1

Average Time

	NVA Time	VA Time	Wait Time	Total
Entity 1	<b>0.00</b>	<b>5.05</b>	<b>14.02</b>	<b>19.08</b>
Total	<b>0.00</b>	<b>5.05</b>	<b>14.02</b>	<b>19.08</b>



Figure B.1. Entity Summary Report (Continued).

Oct-19-2003

## Process Summary Report

2:14:4

Total process

Replication 1

Replication 1

Sun Oct, 19,

Process Times

	Total NVA Time	Total VA Time	Total Wait Time	Total
Accept credit via fa	0.00	45.46	581.05	<b>626.51</b>
Deny credit via fax c	0.00	4.09	88.19	<b>92.28</b>
Get PO from Branch	0.00	95.75	240.33	<b>336.08</b>
Request for revised	0.00	0.00	0.00	<b>0.00</b>
Retreive customer i	0.00	133.49	1,303.43	<b>1,436.93</b>
Retrieve order infor	0.00	15.11	152.94	<b>168.05</b>
Total	<b>0.00</b>	<b>293.91</b>	<b>2,365.94</b>	<b>2,659.84</b>

Figure B.2. Process Summary Report.

Oct-19-2003

## Process Summary Report

2:14:48

Total process

Replication 1 of

Replication 1

Sun Oct, 19, 2

Process Throughput

	Number In	Number Out	Total
Accept credit via fa	32.00	12.00	44.00
Deny credit via fax c	1.00	1.00	2.00
Get PO from Branch	12.00	6.00	18.00
Request for revised	0.00	0.00	0.00
Retreive customer i	53.00	33.00	86.00
Retrieve order infor	6.00	3.00	9.00
Total	104.00	55.00	159.00



Figure B.2. Process Summary Report (Continued).

Oct-19-2003

## Process Summary Report

2:14:

Total process

Replication 1

Replication 1

Sun Oct, 19,

Process Costs

	Total NVA Cost	Total VA Cost	Total Wait Cost	Total
Accept credit via fa	0.00	5,522.05	58,104.51	<b>63,626.56</b>
Deny credit via fax c	0.00	490.68	8,819.06	<b>9,309.73</b>
Get PO from Branch	0.00	10,184.93	24,032.98	<b>34,217.91</b>
Request for revised	0.00	0.00	0.00	<b>0.00</b>
Retreive customer i	0.00	17,094.44	130,343.30	<b>147,437.74</b>
Retrieve order infor	0.00	2,123.90	15,293.89	<b>17,417.79</b>
Total	<b>0.00</b>	<b>35,415.99</b>	<b>236,593.74</b>	<b>272,009.73</b>



Figure B.2. Process Summary Report (Continued).

**Total process**

Replication 1 of 1

Replication 1

Thu Oct, 23, 2003

**Queue Throughput**

	Number In	Number Out
Accept credit via	32.00	13.00
Deny credit via f	1.00	1.00
Get PO from Bra	12.00	6.00
Request for rev	0.00	0.00
Retreive custome	53.00	34.00
Retrieve order i	6.00	3.00
<b>Total</b>	<b>104.00</b>	<b>57.00</b>

**Waiting Costs**

	Average	Maximum
Accept credit via fax or phone	4,469.58	9,494.55
Deny credit via fax or phone	8,819.06	8,819.06
Get PO from Branch via fax or by l	4,005.50	8,684.15
Retreive customer information fr	3,833.63	7,017.54
Retrieve order information for bil	5,097.96	6,522.93

Figure B.3. Queue Summary Report.



**Total process**

Replication 1 of 1

Waiting Time	Average	Maximum
Accept credit via fax or phone	44.70	94.95
Deny credit via fax or phone	88.19	88.19
Get PO from Branch via fax or by i	40.05	86.84
Retreive customer information fr	38.34	70.18
Retrieve order information for bil	50.98	65.23



Figure B.3. Queue Summary Report (Continued).

**Total process**

\* Replication 1 of 1

**Replication 1**

Thu Oct, 23, 2003

**Resource Costs**

	Busy Cost	Idle Cost	Usage Cost	Total
Customer Database	500.00	0.00	3,700.00	<b>4,200.00</b>
Email System	243.38	2.32	1,500.00	<b>1,745.69</b>
Order Database	37.77	112.41	225.00	<b>375.18</b>
Total	<b>781.15</b>	<b>114.73</b>	<b>5,425.00</b>	<b>6,320.87</b>

**Number Busy**

Average

Maximum

Customer Database	1.00	1.00
Email System	0.97	1.00
Order Database	0.10	1.00



Figure B.4. Resource Summary Report.

Oct-23-2003

## Resource Summary Report

4:19:15PM

Total process

Replication 1 of 1

Replication 1

Thu Oct, 23, 2003

Utilization	Average	Maximum
Customer Database	1.00	1.00
Email System	0.97	1.00
Order Database	0.10	1.00



Figure B.4. Resource Summary Report (Continued).



## APPENDIX C

### SYSTEM SIMULATION REPORT FOR NEW PROCESS

**Total process**

Replication 1 of 1

Replication 1

Sun Oct, 19, 2003

**Entity Throughput**

	Number In	Number Out
Entity 1	53.00	4.00
Total	53.00	4.00

**Average Costs**

	NVA Cost	VA Cost	Wait Cost	Total
Entity 1	500.00	2,917.42	8,103.03	11,520.45
Total	500.00	2,917.42	8,103.03	11,520.45



Figure C.1. Entity Summary Report.

**Total process**

Replication 1 of 1

Average Time

	NVA Time	VA Time	Wait Time	Total
Entity 1	0.00	22.45	80.03	102.48
Total	0.00	22.45	80.03	102.48



Figure C.1. Entity Summary Report (Continued).



Oct-19-2003

## Process Summary Report

2:12:52PM

## Total process

Replication 1 of 1

## Replication 1

Sun Oct, 19, 200

## Process Throughput

	Number In	Number Out	Total
Accept credit via em	55.00	47.00	102.00
Deny credit via ema	5.00	5.00	10.00
Get PO from Branch	47.00	40.00	87.00
Request for revised	3.00	3.00	6.00
Retreive customer i	61.00	60.00	121.00
Retrieve order infor	37.00	37.00	74.00
Total	208.00	192.00	400.00



Figure C.2. Process Summary Report.

**Total process**

Replication 1 of 1

**Replication 1**

Sun Oct, 19, 200

**Process Costs**

	Total NVA Cost	Total VA Cost	Total Wait Cost	Total
Accept credit via em	0.00	11,222.71	33,381.31	<b>44,604.01</b>
Deny credit via ema	0.00	1,166.08	4,019.16	<b>5,185.25</b>
Get PO from Branch	0.00	8,926.76	27,735.02	<b>36,661.78</b>
Request for revised	0.00	648.45	1,811.93	<b>2,460.39</b>
Retreive customer i	0.00	13,393.62	5,272.76	<b>18,666.38</b>
Retrieve order infor	0.00	10,757.48	1,921.60	<b>12,679.08</b>
Total	<b>0.00</b>	<b>46,115.10</b>	<b>74,141.79</b>	<b>120,256.88</b>



Figure C.2. Process Summary Report (Continued).

Oct-19-2003

## Process Summary Report

2:12:52P

**Total process**

Replication 1 of

**Replication 1**

Sun Oct, 19, 200

**Process Times**

	Total NVA Time	Total VA Time	Total Wait Time	Total
Accept credit via em	0.00	75.72	333.81	<b>409.53</b>
Deny credit via ema	0.00	7.78	40.19	<b>47.97</b>
Get PO from Branch	0.00	58.30	277.35	<b>335.65</b>
Request for revised	0.00	4.17	18.12	<b>22.28</b>
Retreive customer i	0.00	71.55	52.73	<b>124.28</b>
Retrieve order infor	0.00	40.46	19.22	<b>59.68</b>
Total	<b>0.00</b>	<b>257.97</b>	<b>741.42</b>	<b>999.39</b>



Figure C.2. Process Summary Report (Continued).

<b>Total process</b>	Replication 1
Replication 1	Sun Oct, 19,

## Queue Throughput

	Number In	Number Out
Accept credit via	55.00	48.00
Deny credit via e	5.00	5.00
Get PO from Bra	47.00	40.00
Request for rev	3.00	3.00
Retreive custome	61.00	61.00
Retrieve order i	37.00	37.00
<b>Total</b>	<b>208.00</b>	<b>194.00</b>

Waiting Costs	Average	Maximum
Accept credit via email	695.44	1,397.58
Deny credit via email to branch	803.83	1,182.30
Get PO from Branch via email	693.38	1,289.25
Request for revised PO	603.98	1,428.66
Retreive customer information fr	86.44	464.64
Retrieve order information for bil	51.94	321.27

Figure C.3. Queue Summary Report.

**Total process**

Replication 1 of 1

Waiting Time	Average	Maximum
Accept credit via email	6.95	13.98
Deny credit via email to branch	8.04	11.82
Get PO from Branch via email	6.93	12.89
Request for revised PO	6.04	14.29
Retrieve customer information fr	0.86	4.65
Retrieve order information for bil	0.52	3.21



Figure C.3. Queue Summary Report (Continued).

Oct-19-2003

## Resource Summary Report

2:13:13

Total process

Replication 1 of

Replication 1

Sun Oct, 19, 200

## Resource Costs

	Busy Cost	Idle Cost	Usage Cost	Total
Customer Database	378.05	45.73	9,800.00	<b>10,223.78</b>
Email System	246.06	1.38	7,200.00	<b>7,447.44</b>
Order Database	101.16	91.28	2,775.00	<b>2,967.44</b>
Total	<b>725.27</b>	<b>138.39</b>	<b>19,775.00</b>	<b>20,638.66</b>

Number Busy	Average	Maximum
Customer Database	0.76	1.00
Email System	0.98	1.00
Order Database	0.27	1.00



Figure C.4. Resource Summary Report.



---

**Total process**

Replication 1 c

**Replication 1**

Sun Oct, 19, 200

Utilization	Average	Maximum
Customer Database	0.76	1.00
Email System	0.98	1.00
Order Database	0.27	1.00



Figure C.4. Resource Summary Report (Continued).



## APPENDIX D

### VENDOR QUOTATION AND DATA SHEET

# Comparison between HP MSA1000 and SUN 3510



	HP - StorageWorks MSA 1000	Sun - StorEdge 3300 Series Model 3510
<b>Product Type</b>	Storage Array	Storage Array
<b>Manufacturer</b>	Hewlett Packard	Dot Hill
<b>Announced</b>	29-Nov-01	10-Feb-03
<b>Packaging</b>	Rackmount	Desktop, Rackmount
<b>Storage Enclosure</b>	Max Drives: 14 Max Capacity (raw): 2044 GB	Max Drives: 12 Max Capacity (raw): 1752 GB
<b>Storage Subsystem</b>	Max Drives: 42 Max Capacity (raw): 6132 GB	Max Drives: 36 Max Capacity (raw): 5256 GB
<b>Storage Overall / Per Rack</b>	Max Drives: 168 Max Capacity (raw): 24528 GB	Max Drives: 216 Max Capacity (raw): 31536 GB
<b>Drives Supported</b>	18.2GB, 36.4GB, 72GB, 146GB - 10,000rpm; 18.2GB, 36.4GB, 72GB - 15,000rpm	36GB - 15,000rpm; 73GB, 146GB - 10,000rpm
<b>Device Interfaces</b>	Ultra3 SCSI	2Gb/s FC-AL
<b>Host Interface Qty</b>	10	8
<b>Host Interfaces</b>	2Gb/s FC-Switch, 1Gb/s FC-Switch	2Gb/s FC-Switch, 2Gb/s FC-AL
<b>Host Platforms Supported</b>	Linux (Red Hat, SuSE), Windows NT, Windows 2000, Windows Server 2003, Novell NetWare	Sun Solaris, HP-UX, IBM AIX, Linux, Windows NT, Windows 2000
<b>RAID Support</b>	0, 0+1, 5	JBOD, 0, 0+1, 1, 3, 5
<b>Storage Processors/Controllers</b>	Single or Dual Controller Configurations available	Single or dual redundant RAID controllers
<b>Max Cache Size (MB)</b>	1024	1024
<b>Cache Details</b>	256MB read/write battery backed (up to 3 days) & mirrored; Expandable to 512MB per controller	1GB per controller (fixed)
<b>Hot Swap Components</b>	Cooling, Power	Controllers, Drives
<b>Redundant Components</b>	Cooling, Drives, Power, Controllers	Power, Cooling
<b>Physical Characteristics</b>	Enclosure - Rack Units: 4 U - Dimensions (H x W x D): 17.5 x 48.3 x 52.1 cm - Weight: 38.56 kg	Enclosure - Rack Units: 2 U - Dimensions (H x W x D): 8.8 x 44.7 x 53.3 cm - Weight: 22.7 kg
<b>Site Planning</b>	Input Voltage (AC): 100 to 240 V Frequency (Hz): 50 to 60 Power Consumption (W): 549  Operating Temperature: 10 to 35 degrees C (50 to 95 degrees F) Humidity: 10% to 90%	Single Phase Input Voltage (AC): 100 to 240 V Frequency (Hz): 47 to 63  Operating Temperature: 5 to 40 degrees C (41 to 104 degrees F) Humidity: 10% to 90% Altitude: -30 to 3,048 meters (-100 to 10,000 feet)

Figure D.1. Comparison between HP MSA1000 and SUN 3510.

## Comparison Between HP rp5405 and SUN Fire V480

	HP - hp server rp5405	Sun - Fire V480 Server
<b>Product Type</b>	Entry-Level Server	Entry-Level Server
<b>Architecture</b>	RISC	RISC
<b>Platform</b>	UNIX	UNIX
<b>Form Factor</b>	Rack	Rack, Tower
<b>Manufacturer</b>	Hewlett Packard	Sun Microsystems
<b>Announced</b>	03-Sep-02	19-Jun-02
<b>CPU</b>	PA-8700 (650MHz)	UltraSPARC-III Cu (900MHz), UltraSPARC-III Cu (1.2GHz), UltraSPARC-III Cu (1.05GHz)
<b>Max CPUs</b>	4	4
<b>Cache</b>	0.75MB instructional, 1.5MB data	8MB L2
<b>Memory Minimum (GB)</b>	4	4
<b>Memory Maximum (GB)</b>	16	32
<b>Memory Options</b>	512MB, 1GB, 2GB ECC SDRAM	1GB (4 x 256MB), 2GB (4 x 512MB), 4GB (4 x 1GB) SDRAM DIMMs
<b>Storage Minimum (GB)</b>	18	36
<b>Storage Max Int (GB)</b>	584	146
<b>Storage Options</b>	36GB, 73GB Ultra320 SCSI 15,000 rpm hot swap  146GB Ultra320 SCSI 10,000rpm hot swap	36GB, 73GB FC-AL 10,000rpm 1" hot swap
<b>Bus Technology</b>	PCI	PCI
<b>I/O Notes</b>	10 x 64-bit, 66MHz PCI slots	2 x 64-bit 66MHz 3.3V  4 x 64-bit 33MHz 5V
<b>Max Slots</b>	10	6
<b>Std Slots</b>	10	6
<b>Operating System</b>	HP-UX 11i	Solaris
<b>Rack Units</b>	7	5
<b>Total Bays</b>	4	3
<b>Physical Characteristics</b>	Enclosure - Dimensions (H x W x D): 31.1 (7U) x 48.2 x 77.4 cm - Weight: 68 kg - Heat: 4380 BTU/hr (max)	Enclosure - Dimensions (H x W x D): 22.2(5U) x 44.6 x 61.0 cm - Weight: 44 Max. kg
<b>Site Planning</b>	AC Input Power: 100-240V 50/60 Hz Typical and Maximum power: 880W and 1283W Temperature: 5 to 35 degrees C Humidity: 15% to 80% non condensing Maximum altitude: 3km (10,000 feet) Noise: <6.7 Bels LwA	Power: 100 - 240 VAC, 47 - 63Hz Maximum AC input: 1440 W per power supply Maximum DC output: 1184 W per power supply Operating Temp: 5° - 35° (41° - 95°F) Operating humidity: 20% - 80% relative temperature

Figure D.2. Comparison between HP rp5405 and SUN Fire V480.

# Comparison between HP rp5470 and Sun Fire V480

	HP - hp server rp5470	Sun - Fire V480 Server
<b>Product Type</b>	Entry-Level Server	Entry-Level Server
<b>Architecture</b>	RISC	RISC
<b>Platform</b>	UNIX	UNIX
<b>Form Factor</b>	Rack, Tower	Rack, Tower
<b>Manufacturer</b>	Hewlett Packard	Sun Microsystems
<b>Announced</b>	28-Nov-00	19-Jun-02
<b>CPU</b>	PA-8700+ (875MHz), PA-8700 (750MHz)	UltraSPARC-III Cu (900MHz), UltraSPARC-III Cu (1.2GHz), UltraSPARC-III Cu (1.05GHz)
<b>Max CPUs</b>	4	4
<b>Cache</b>	2.25MB	8MB L2
<b>Memory Minimum (GB)</b>	0.5	4
<b>Memory Maximum (GB)</b>	16	32
<b>Memory Options</b>	512MB, 1GB, 2GB ECC SDRAM	1GB (4 x 256MB), 2GB (4 x 512MB), 4GB (4 x 1GB) SDRAM DIMMs
<b>Storage Minimum (GB)</b>	36	36
<b>Storage Max Int (GB)</b>	584	146
<b>Storage Options</b>	36GB, 73GB Ultra320 SCSI 15,000rpm  146GB Ultra320 SCSI 10,000rpm	36GB, 73GB FC-AL 10,000rpm 1" hot swap
<b>Bus Technology</b>	PCI	PCI
<b>I/O Notes</b>	64-bit PCI slots	2 x 64-bit 66MHz 3.3V  4 x 64-bit 33MHz 5V
<b>Max Slots</b>	10	6
<b>Std Slots</b>	10	6
<b>Operating System</b>	HP-UX	Solaris
<b>Rack Units</b>	7	5
<b>Total Bays</b>	4	3
<b>Physical Characteristics</b>	Enclosure - Dimensions (H x W x D): 31.1 (7U) x 48.2 x 77.5 cm - Weight: 68 kg - Heat: 4380 BTU/hr	Enclosure - Dimensions (H x W x D): 22.2(5U) x 44.6 x 61.0 cm - Weight: 44 Max. kg
<b>Site Planning</b>	AC Input Power - 100-240V 50/60 Hz Typical and Maximum power - 880W and 1283W Maximum heat BTUs/hour - 4380 (3000 - typical) Operating Temperature - 5 to 35 degrees C Operating relative Humidity - 15% to 80% non condensing Operating Altitude above sea level - 3KM (10,000 feet)	Power: 100 - 240 VAC, 47 - 63Hz Maximum AC input: 1440 W per power supply Maximum DC output: 1184 W per power supply Operating Temp: 5° - 35° (41° - 95°F) Operating humidity: 20% - 80% relative temperature

Figure D.3. Comparison between HP rp5470 and SUN Fire V480.

	HP - ProLiant DL380 G3	Sun - V65x Server
<b>Product Type</b>	Entry-Level Server	Entry-Level Server
<b>Architecture</b>	32-bit Intel	32-bit Intel
<b>Platform</b>	LINUX, Windows	UNIX, LINUX
<b>Form Factor</b>	Rack	Rack
<b>Manufacturer</b>	Hewlett Packard	Sun Microsystems
<b>Announced</b>	16-Oct-02	07-May-03
<b>CPU</b>	Xeon (3.06GHz), Xeon (3.2GHz), Xeon (2.8GHz), Xeon (2.4GHz)	Xeon (2.8GHz), Xeon (3.06GHz)
<b>Chipset</b>	ServerWorks GC -LE	E7501
<b>Max CPUs</b>	2	2
<b>Cache</b>	512KB L2, 1MB L3	512KB L2
<b>Memory Minimum (GB)</b>	0.5	0.5
<b>Memory Maximum (GB)</b>	12	12
<b>Memory Options</b>	512MB (2 x 256MB), 1GB (2 x 512MB), 2GB (2 x 1GB), 4GB (2 x 2GB) ECC PC2100 DDR SDRAM	512MB (2 x 256MB), 1GB (2 x 512MB), 2GB (2 x 1GB), 4GB (2 x 2GB) DDR-266 ECC SDRAM RDIMMs
<b>Storage Minimum (GB)</b>	18	36
<b>Storage Max Int (GB)</b>	881	438
<b>Storage Options</b>	36GB, 72GB, 146GB Ultra320 SCSI 10,000 hot swap drives  18GB, 36GB, 72GB Ultra320 SCSI 15,000 hot swap drive	36GB, 72GB Ultra320 SCSI 10,000rpm
<b>Bus Technology</b>	PCI-X	PCI-X
<b>I/O Notes</b>	2 x 64-bit/100MHz PCI-X hot-plug slots  1 x 64-bit/133MHz PCI-X slot	3 x 64-bit, 100MHz PCI-X slots (full height)  3 x 64-bit, 100MHz PCI-X slots (half height)
<b>Max Slots</b>	3	6
<b>Std Slots</b>	3	6
<b>Operating System</b>	Windows NT/2000, Novell NetWare, Linux, OpenUNIX	Solaris x86, Red Hat Linux 7.3/Advanced Server 2.1
<b>Rack Units</b>	2	2
<b>Total Bays</b>	8	7
<b>Physical Characteristics</b>	Enclosure - Dimensions (H x W x D): 8.59 (2U) x 44.45 x 65.45 cm - Weight: 27.22 (max) kg - Heat: 1,475 BTU/hr	Enclosure - Dimensions (H x W x D): 8.7 (2U) x 43.0 x 64.8 cm - Weight: 22.7 kg

Figure D.4. Comparison between HP DL380 G3 and SUN V65x.



<b>Site Planning</b>	Power: 400W hot plug Power Supply Temperature: 50° to 90° F/ 10° to 35° C Relative Humidity: 10° to 90° (non-condensing) Acoustic Noise: 7 L Wad (BELS), LpAm (dBA) 55	Power: Dual redundant power supplies optional, one power supply standard: 100 V to 240 V, 50/60 Hz, 500 W PFC supply Operating temperature: 10° C to 35° C (50° F to 95° F) Operating vibration: 0.15 G z-axis; 0.10 G x- and y-axis; 5 to 500 Hz sine
<b>Reliability &amp; Servicability</b>	ECC memory, Hot Plug redundant disk drives, Hot Plug Fans (optional redundancy), Hot Plug PCI slots, Hot plug, redundant power supply, RAID	ECC memory, dual redundant power and fans, tool-free case
<b>System Management</b>	Insight Manager 7, Integrated Lights Out Support, Management Agent, Automatic Server Recovery (ASR), Integrated Management Log, Drive Parameter Tracking (with Smart Array Controllers),  Dynamic Sector Repairing (with Smart Array Controllers), Off-Line Backup Processor capability	IPMI (Intelligent Platform Management Interface), Lights Out Management (LOM), DMI (Desktop Management Interface)
<b>Capacity On Demand</b>	No	No
<b>Clustering</b>	Yes	No

Figure D.4. Comparison between HP DL380 G3 and SUN V65x (Continued).

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processor	Intel® Pentium® 4 processor 2.60GHz with HyperThreading Technology
operating system	Microsoft® Windows® XP Home
memory	512MB DDR SDRAM memory (expandable to 1GB)
hard drive	120GB Ultra DMA hard drive (gigabyte is defined as 1,000,000,000 bytes, accessible capacity may vary)
multimedia drive	DVD+RW/CD-RW combo drive; 48x CD-ROM
display	sold separately
communications	10/100Base-T Fast Ethernet Interface
video	nVidia® GeForce4™ MX 440 AGP 8x graphics card (with 64MB DDR video memory and TV-Out)
sound	Integrated AC '97, 6-channel configurable audio
weight	38 lbs
dimensions	7.5" x 15.2" x 16.5"

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Figure D.5. HP pavilion a250n desktop pc.



datasheet

## key specifications

Microprocessor	Intel® Pentium® 4 processor 2.60GHz with HyperThreading Technology™
Front-side Bus	800MHz
Memory	512MB DDR SDRAM memory (expandable to 1GB)
Hard Drive	120GB Ultra DMA hard drive™
Multimedia Drive	DVD+RW/CD-RW drive (DVD writer and CD-writer combo drive)
CD-ROM	CD-ROM drive 48x max. speed
Video Graphics	nVidia GeForce4 MX 440 AGP 8x graphics card (with 64MB DDR video memory and TV-Out)
Network Card	10/100 Base-T Fast Ethernet Interface
Sound	Integrated AC '97, 6-channel configurable audio
Fax/Modem	High-speed V.90 data/fax modem
Front Mounted Ports	Front access 6-in-1 media card reader - supports Compact Flash I/II, SmartMedia, Memory Stick, MultiMediaCard, Secure Digital (SD), iBM Microdrive; (1) FireWire (IEEE 1394); (2) USB 2.0 ports
Total Drive Bays	External: (2) 5.25"; (1) 3.5"; Internal: (2) 3.5"
Available Drive Bays	Internal: (1) 3.5"
Total Expansion Slots	(3) PCI; (1) AGP
Available Slots	(2) PCI; (1) AGP
Total External Ports	(6) USB 2.0; (1) serial; (1) parallel; (2) PS/2; (2) FireWire (IEEE 1394) ports; (1) 6-in-1 media card reader; (1) headphone; (2) microphone; (1) line out; (2) line in; (1) VGA monitor port; (1) S video out port; (1) composite video port
Available External Ports	(6) USB 2.0; (1) serial; (1) parallel; (2) FireWire (IEEE 1394) ports; (1) 6-in-1 media card reader; (1) headphone; (2) microphone; (1) line out; (2) line in; (1) VGA monitor port; (1) S video out port; (1) composite video port
Total Memory Slots	(4) DIMM (184pin, DDR)
Available Memory Slots	(2) DIMM (184 pin, DDR)
Memory Speed	2700 MB/sec (PC 2700)
Primary Cache (L1)	L1 Cache = 8KB Data + 12,000 uOps Trace
Secondary-Level Cache (L2)	L2 Cache = 512KB
Keyboard	hp multimedia keyboard
Mouse	hp optical scroller mouse
Diskette Drive	(1) 3.5" (1.44MB)
Warranty and Support	Warranty Coverage: Hardware - One-year limited hardware warranty, 24 hours, 7 days a week toll-free phone support; Software - 30 days replacement of defective application media, 1 year technical toll-free phone assistance. Service Delivery Options: Customer Replacement Parts, Return to HP for repair or Authorized Service Provider

## bundled software

Operating System	- HP Recommends Microsoft® Windows® XP Home Edition	Music Software	- Play DVD movies with InterVideo WinDVD SE - Burn music CDs/DVDs and back-up your data to CDs/DVDs with RecordNow - Rip, organize, and listen to your music with MusicMatch jukebox - includes 100 mp3 selections from Emusic.com
Productivity	- Create impressive documents and spreadsheets with WordPerfect Productivity Pack 2002: WordPerfect 10 and Quattro Pro 10	Finance	- Get started tracking your home finances and investments with Intuit Quicken New User's Edition 2003
Photo	- Edit and print your digital photos with ArcSoft PhotoImpression and HP Print Creator - Back-up digital photos to CD/DVD with Simple Backup for My Pictures - Create photo slideshows, greeting cards, and other projects with HP Memories Disk Creator, ArcSoft Funhouse and Greeting Card Creator	PC Security	- Protect your PC with Symantec Norton Antivirus 2003 - includes 60 days of complimentary live updates
Video	- Edit and record your digital home videos to DVD with ArcSoft ShowBiz DVD	Post-purchase Promotion	- Visit www.myhpclub.com: the destination web site for hp pavilion desktop PC owners
Online Services	Easy sign-up to major dial-up and broadband Internet Service Providers: - AOL dial-up (3 months trial service included); - MSN dial-up (6 months trial service included); - Earthlink dial-up (3 months trial service included) - AOL - DSL & Cable - Earthlink - DSL, Cable, & Satellite - SBC Yahoo! DSL		

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Monitor sold separately. Speakers included with monitor

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Figure D.5. HP pavilion a250n desktop pc (Continued).



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Figure D.6. DELL 4600 Series System.



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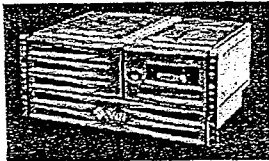


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- » Sun Fire V440
- ☒ Sun Fire V480
- » Sun Fire V60x
- » Sun Fire V65x
- » Sun Fire V880
- » Sun Fire V880z

**Select a Base Configuration**

	SMALL	MEDIUM	LARGE	EXTRA LARGE
UltraSPARC III Cu Processor	2 @ 1.05 GHz	4 @ 1.05 GHz	4 @ 1.05 GHz	4 @ 1.2 GHz
External Cache per Processor	8 MB	8 MB	8 MB	8 MB
Memory	4 GB (16 @ 256-MB DIMMS)	8 GB (32 @ 256-MB DIMMS)	16 GB (32 @ 512-MB DIMMS)	16 GB (32 @ 512-MB DIMMS)
10000 RPM FC-AL Disk Drive	2 @ 73 GB	2 @ 73 GB	2 @ 73 GB	2 @ 73 GB
DVD-ROM 10 Drive	1	1	1	1
Gigabit Ethernet Port	2	2	2	2
RJ45 Serial Port	1	1	1	1
USB Port	2	2	2	2
Power Supply	2 @ 1440 Watt	2 @ 1440 Watt	2 @ 1440 Watt	2 @ 1440 Watt
Operating System	Solaris 8 or Higher	Solaris 8 or Higher	Solaris 8 or Higher	Solaris 8 or Higher
Ships Within	8 business days	8 business days	8 business days	8 business days
List Price	\$19,995.00	\$34,995.00	\$42,995.00	\$42,995.00
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Figure D.8. SUN Fire V480 Server.



**Bill of Materials Maintenance, Component Detail**

BOM Number:  Revision Level:

Description:

Line Number:  Active:  Inactive:

Item Number:

Item Revision:

Loc ID:

Work Center:

Qty Used:  Usage U/M:  Offset Days:  ☐ Auto BO

Qty Scrap:   ☐ Is scrap per unit?

Drawing Number:  Balloon Item Number:

Processing Instructions

Figure D.9. Bill of Materials Maintenance, Component Detail.

**WIP Tracking**

Select Ewd Back Edit History

Cust No: MFGW0 Name: \_\_\_\_\_

Work Order: 1003 Work Order Date: 03/23/01

Finished Good: WIDGET Required Date: 03/23/01

Description: Widget Manufactured Item

Total Qty: 100,000 Open Qty: 100,000 Remain to Apply: 0,000

Work Center	Operation	Current Qty	Updated Qty	Total Time	Add Time	Done
AREA1	PREP		73,000		10,000	<input type="checkbox"/>
AREA2	CUT		20,000		4,500	<input type="checkbox"/>
AREA3	SAND1		7,000		3,750	<input type="checkbox"/>
AREA4	FINISH					<input type="checkbox"/>

Figure D.10. WIP Tracking.

**Change Work Orders**

Select Fwd Back Appr Edit Delete Lines Close

Work Order: 1003 Work Order Date: 03/23/01

Sales Order #: Sales Order Date:

Finished Good: WIDGET Required Date: 03/23/01

Description: Widget - Manufactured Item

Cust No: MFGWO Status: Exploded Required Qty: 100.000

Company: Stock U/M: EA

BOM Number: WIDGET Revision Level:

Description: Widget - Manufactured Item

Finish Loc: WH1 Route: WIDGET

Description: Warehouse 1 Job:

Store: Bin:

Serial Number: Lot Number:

On Hand: 6.000 Allocated: 0.000 On Order: 100.000

Work Order Exploded

Figure D.11. Change Work Orders.



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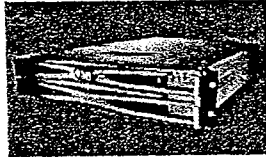


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» A-Z Store Index  
» Training Classes  
» Sun System Handbook  
» Third Party Products  
» Sales Terms  
» Sun Logo Merchandise

**Other Entry-Level Servers**

- » Sun Fire 280R
- » Sun Fire B1600 Blade Platform
- » Sun Fire V100
- » Sun Fire V120
- » Sun Fire V210
- » Sun Fire V240
- » Sun Fire V250
- » Sun Fire V440
- » Sun Fire V490
- » Sun Fire V60x
- » Sun Fire V65x
- » Sun Fire V880
- » Sun Fire V890z

Learn More ☐ Upgrade Tool ☐**Select a Base Configuration**

	SMALL	LARGE
Intel Xeon Processor	1 @ 2.8 GHz	2 @ 3.06 GHz
Memory	512 MB (2 @ 256-MB DIMMS)	1 GB (2 @ 512-MB DIMMS)
10000 RPM Ultra320 SCSI Disk Drive	1 @ 36 GB	1 @ 36 GB
Ethernet Port	2 @ 10/100/1000	2 @ 10/100/1000
USB Port	3	3
Serial Port	1 RS-232 RJ45	1 RS-232 RJ45
PCI-X Slot	6	6
CD/Floppy Drive	1	1
Operating System	Linux or Solaris 9 x86	Linux or Solaris 9 x86
Ships Within	8 business days	8 business days
List Price	\$2,550.00	\$3,995.00
	<b>Select</b>	<b>Select</b>

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Figure D.12. SUN Fire V65x Server.



**APPENDIX E**  
**IMPLEMENTATION PLAN**

ID	Task Name	Duration	Start	Finish	31 '03	Sep
1	Evaluate current systems	4 days	Wed 9/3/03	Mon 9/8/03	T W T F S S M	
2	survey the process	2 days	Wed 9/3/03	Thu 9/4/03		
3	interview user	2 days	Fri 9/5/03	Mon 9/8/03		
4	Gathering user requirement	3 days	Tue 9/9/03	Thu 9/11/03		
5	interview high level management	1 day	Tue 9/9/03	Tue 9/9/03		
6	sent questionnaire to end-user	2 days	Wed 9/10/03	Thu 9/11/03		
7	Define requirements	4 days	Fri 9/12/03	Wed 9/17/03		
8	Identify required resources and budget	2 days	Fri 9/12/03	Mon 9/15/03		
9	Evaluate system requirement	2 days	Tue 9/16/03	Wed 9/17/03		
10	Develop project plan	17 days	Thu 9/18/03	Fri 10/10/03		
11	Prepare document	1 day	Thu 9/18/03	Thu 9/18/03		
12	Create plan	1 day	Fri 9/19/03	Fri 9/19/03		
13	feasibility study	14 days	Mon 9/22/03	Thu 10/9/03		
14	Technical Feasibility	6 days	Mon 9/22/03	Mon 9/29/03		
15	Economic Feasibility	2 days	Tue 9/30/03	Wed 10/1/03		
16	Operation Feasibility	2 days	Thu 10/2/03	Fri 10/3/03		
17	Legal Feasibility	2 days	Mon 10/6/03	Tue 10/7/03		
18	Schedule Feasibility	2 days	Wed 10/8/03	Thu 10/9/03		
19	Present to management team and get approval	1 day	Fri 10/10/03	Fri 10/10/03		
20	Design system	4 days	Mon 9/22/03	Thu 9/25/03		
21	Design hardware section	2 days	Mon 9/22/03	Tue 9/23/03		
22	Design software section	2 days	Wed 9/24/03	Thu 9/25/03		
23	Implementation	56 days?	Tue 9/16/03	Tue 12/2/03		
24	Site Preparation	3 days	Tue 9/16/03	Thu 9/18/03		
25	Site Survey	1 day?	Fri 9/19/03	Fri 9/19/03		
26	Hardware Installation	7 days?	Mon 11/10/03	Tue 11/18/03		
27	Database Server	2 days	Mon 11/10/03	Tue 11/11/03		
28	Backup Server	2 days	Wed 11/12/03	Thu 11/13/03		
29	E-mail Server	1 day?	Fri 11/14/03	Fri 11/14/03		
30	Web and Application Server	1 day?	Mon 11/17/03	Mon 11/17/03		
31	Other PC and Peripherals	1 day?	Tue 11/18/03	Tue 11/18/03		
32	Software Installation	10 days	Wed 11/19/03	Tue 12/2/03		
33	Billing Software	3 days	Wed 11/19/03	Fri 11/21/03		
34	Database Software	3 days	Mon 11/24/03	Wed 11/26/03		
35	Network management Software	2 days	Thu 11/27/03	Fri 11/28/03		
36	Java and C Language	2 days	Mon 12/1/03	Tue 12/2/03		
37	Evaluation Process	2 days	Wed 12/3/03	Thu 12/4/03		
38	Close project	1 day?	Wed 12/3/03	Wed 12/3/03		
Project: Project1 Date: Fri 10/17/03		Task	Progress			
		Split	Milestone			

Figure E.1. Implementation Plan.



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