CHAPTER V

EVALUATION OF POS SYSTEM IN THE CASE STUDY

5.1 Introduction

The steps of the POS (Point of Sales) pilot project begins from studying and collecting users' requirements, designing system, programming, testing, conversion and implementation. Currently, the proposed system has been implemented under the real store operation environments at the pilot stores for eight months. During this period, the case study has monitored many aspects of the system.

The final activity of system implementation is evaluation. Most factors have been evaluated during the past eight months. However, some can not be evaluated because it would take much longer time to collect data.

5.1.1 Evaluation Objectives

The objectives of the evaluation should be clarified in order to formulate its direction. For this project, the objectives are ;

- To measure the performances of the proposed system.
- To identify the suitable environments for system implementation.
- To identify enhancements and to fine-tune the system.
- To collect information for making decision regarding the direction of the next phase of implementation.

This chapter will report the results of performance measurements of the proposed system and compare them with the performances of the existing system. This will be the information for the management team for decision making.

The identified enhancements or improvements will be reported in Chapter 6 on Conclusion and Recommendation.

5.2 Evaluation Factors and Procedure

The performances of the POS (Point of Sales) system can be measured by many factors. The suitable evaluation factors depend on the stand point of evaluators. For this project, the evaluation factors are identified from two main points of view.

Since the key success of service business comes from service mind, the first consideration for identifying evaluation factors should come from the customers' point of view. On the other hand, the evaluation should be able to identify what the impact of system is on service quality. The second consideration is the operation's point of view. Since the operation department is the major end-user of the proposed system. The evaluation has to identify the impacts of the system on the store performances to determine whether the system adequately supports the operation's requirements.

5.2.1 Evaluation Factors

There are two major factors that are evaluated and need to have data collection procedure, ie. Service Quality and Inventory Level. These two factors are always in conflict which need to be compromised.

1) Service Quality

The first evaluation factor called " Service Quality " is the factor which identifies the level of customer satisfaction. Customer satisfaction can be measured by many different ways. For this project, it will be measured by three items as follows :

- Service Level

Service level is measured by the proportion of time the item is available in the store. The store which has high service level means that the store has most kinds of products available at all times.

- Service Speed

Service speed for this case is identified by the operating time per transaction. The POS system implementation directly impacts service speed because it is used as a tool for checking out. The service time for this case begins counting after the customer puts the last item on the check out counter and the cashier begins to operate ECR (Electronic Cash Register) or POS (Point of Sales). The operating time is counted until the sales slip is printed completely. This counting period does not include the packing time because the latter depends on the speed of the cashier, not on the speed or performance of the POS system.

- Service Accuracy

The service accuracy for this case is measured by the percentage of the mistake billing such as incorrect price, incorrect quantity of each SKU (Stock Keeping Unit), incorrect quantity of each transaction, and incorrect type of product.

2) Inventory Level

The second evaluation factor is inventory level. Inventory level can be measured by the average quantity of the items over a period of time. It translates to the level of investment. For the existing ECR system, inventory management, especially ordering process, is hard to operate because it does not have itemized sales information. The proposed POS system, on the other hand, can capture itemized sales information so that sales data of individual items

will be available for the management of inventory. The inventory level is expected to be improved using this kind of information for forecasting the sales quantity. The order quantity is then based on this forecasting to order by the appropriate quantity.

5.2.2 Evaluation Procedure

Evaluation is done by measuring the performance of the existing ECR system and the proposed POS system. The evaluation uses the same evaluation factors for two systems and based on two factors : Service Quality and Inventory Level described in the previous topic.

The measurement results of the two systems are compared to consider the improvement of operations performances. The comparison is done by using appropriate statistical techniques.

There are three pilot stores. The data of each store are collected by the same procedure. The data of the existing ECR system are collected for two months before installing the proposed POS system. Likewise, the data of the POS system are collected for two months after installing the system.

The evaluation uses sample items to represent the 2,000 items available in each store. The samples consist of 15 items of each of the fast, medium, and slow moving items. Figure 5.1, 5.2, and 5.3 are forms that are used for data collection at the pilot stores.

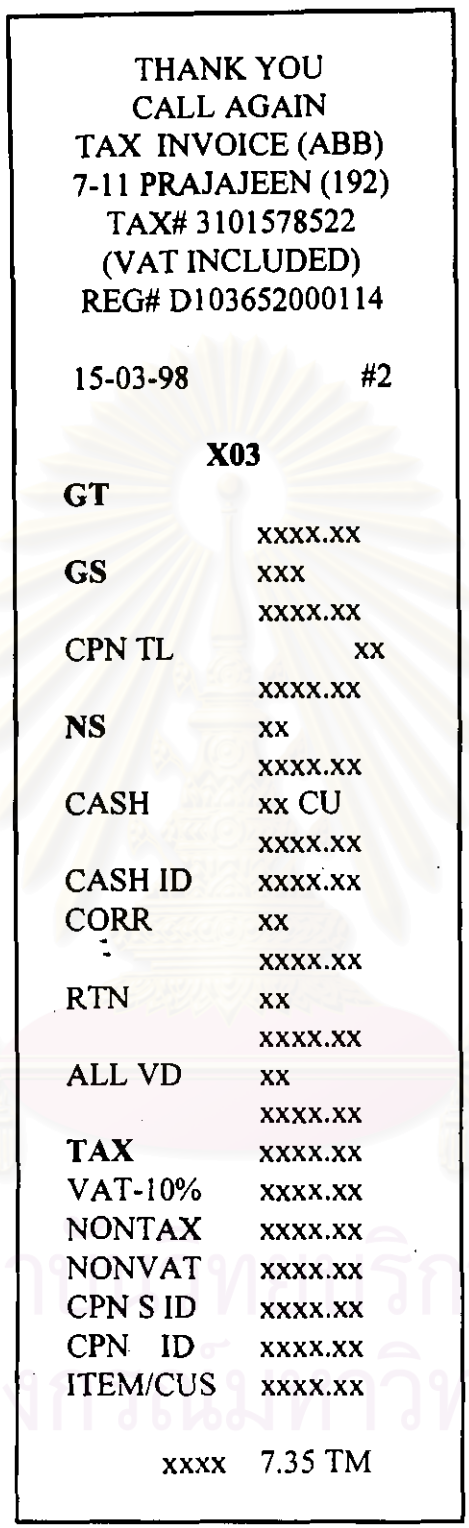
Inventory Counting Sheet											
Product Code	Product Description	Date.....			Date.....			Date.....			
		Front	Back	Rec.	Front	Back	Rec.	Front	Back	Rec.	
	Fast Moving Items										
F 01	XXXXXXXXXXX										
F 02	XXXXXXXXXXX										
F 03	XXXXXXXXXXX										
F 04	XXXXXXXXXXX										
F 05	XXXXXXXXXXX										
F 06	XXXXXXXXXXX										
F 07	XXXXXXXXXXX										
F 08	XXXXXXXXXXX										
F 09	XXXXXXXXXXX										
F 10	XXXXXXXXXXX										
F 11	XXXXXXXXXXX										
F 12	XXXXXXXXXXX										
F 13	XXXXXXXXXXX										
F 14	XXXXXXXXXXX										
F 15	XXXXXXXXXXX										
	Medium Moving Items										
M 01	YYYYYYYYYYYY										
M 02	YYYYYYYYYYYY										
M 03	YYYYYYYYYYYY										
M 04	YYYYYYYYYYYY										
M 05	YYYYYYYYYYYY										
M 06	YYYYYYYYYYYY										
M 07	YYYYYYYYYYYY										
M 08	YYYYYYYYYYYY										
M 09	YYYYYYYYYYYY										
M 10	YYYYYYYYYYYY										
M 11	YYYYYYYYYYYY										
M 12	YYYYYYYYYYYY										
M 13	YYYYYYYYYYYY										
M 14	YYYYYYYYYYYY										
M 15	YYYYYYYYYYYY										
	Slow Moving Items										
L 01	ZZZZZZZZZZZZZ										
L 02	ZZZZZZZZZZZZZ										
L 03	ZZZZZZZZZZZZZ										
L 04	ZZZZZZZZZZZZZ										
L 05	ZZZZZZZZZZZZZ										
L 06	ZZZZZZZZZZZZZ										
L 07	ZZZZZZZZZZZZZ										
L 08	ZZZZZZZZZZZZZ										
L 09	ZZZZZZZZZZZZZ										
L 10	ZZZZZZZZZZZZZ										
L 11	ZZZZZZZZZZZZZ										
L 12	ZZZZZZZZZZZZZ										
L 13	ZZZZZZZZZZZZZ										
L 14	ZZZZZZZZZZZZZ										
L 15	ZZZZZZZZZZZZZ										

Figure 5.1 A data collection form for inventory counting. The F,M,L in the product code represents fast, medium, and slow moving items, respectively. Product descriptions are omitted here for confidentiality.

Operating Time Recording Sheet

ECR (s)			POS (s)		
Pilot Store#1	Pilot Store#2	Pilot Store#3	Pilot Store#1	Pilot Store#2	Pilot Store#3

Figure 5.2 A form for collecting data on operating time (in seconds) at the cashier. The first three columes are used for recording ECR operating time while the next three are used for recording POS operating time, at the first, the second, and the third pilot stores respectively.



THANK YOU
CALL AGAIN
TAX INVOICE (ABB)
7-11 PRAJAJEEN (192)
TAX# 3101578522
(VAT INCLUDED)
REG# D103652000114

15-03-98 #2

X03

GT	
	xxxx.xx
GS	xxx
	xxxx.xx
CPN TL	xx
	xxxx.xx
NS	xx
	xxxx.xx
CASH	xx CU
	xxxx.xx
CASH ID	xxxx.xx
CORR	xx
	xxxx.xx
RTN	xx
	xxxx.xx
ALL VD	xx
	xxxx.xx
TAX	xxxx.xx
VAT-10%	xxxx.xx
NONTAX	xxxx.xx
NONVAT	xxxx.xx
CPN S ID	xxxx.xx
CPN ID	xxxx.xx
ITEM/CUS	xxxx.xx

xxxx 7.35 TM

Figure 5.3 End-of-day Sales Report Form

5.3 Data Collection and Result of System Implementation

5.3.1 Data Collection

The quality of data for this case study is important and requires to be collected carefully. It is used for evaluating the performances of the proposed system. The decision for further investment or cancellation will be based on this evaluation.

Due to the importance of data quality, the procedures, techniques, and worksheets for collecting data are established. Furthermore, the collectors are the staff of the project team who really understand the significance of quality of data. Before collecting data, the collectors are trained in order to understand the procedures, techniques, and methods of using the worksheets effectively.

Data collection for this evaluation concerns three types of information. First is the data of representative items used for evaluating service level and inventory level contributed by the old and the proposed systems. The three groups of pilot items are fast moving group, medium moving group, and slow moving group. Each group has 15 representative items.

The second type is the data of time study. This kind of data is collected from every pilot store. These data are used for evaluating service speed of the proposed system compared with the existing system.

The last type is the percentage of incorrect transaction. These data are used for evaluating service accuracy contributed by each system. They are available from the end-of-day sales report which all stores must report to the headquarters.

Each evaluation factor is unique and should be collected by the different procedures and techniques. It can be classified by evaluation factors as follows:

1) Service Quality

The evaluation factors for service quality are classified into three items as Service Level, Service Speed, and Service Accuracy. Each item uses different procedures as follows :

- Service Level

Since service level is measured by the proportion of time the item is available in the store, the procedure of data collection for evaluating this performance has to be created carefully. The concept of convenience store called "Self Service" that allows the customers to select the goods by themselves makes it difficult to measure service level. Most customers of convenience stores do not like to ask the operator for help. Thus when they cannot find the required item, they usually assume that it is not available and will not ask the operator if that item is available or not. Therefore, a store without real time inventory management system does not know exactly when an item in the store is sold out. The service level of an item is approximated as the proportion of the number of days the item is available in the store.

As described previously that the number of items in the case study's store are around 2,000 SKUs, it is impossible for the team to collect the service level of all items because there are too many items to collect. A large number of staff is required if the data of all these items should be collected. Thus, one possible way to evaluate this performance is to measure from the representative items.

The items sold in the case study's store can be classified by the sales volume in three groups : fast moving, medium moving, and slow moving items. The classification may be a little different among stores. For this evaluation, the first group which is fast moving items, is selected from the representatives of snacks. The second group, medium moving items, is selected from the representatives of liquors and cigarettes. The last group, slow moving items, is selected from the representatives of groceries.

For each group, 15 representative items are selected. The criteria for selecting the pilot items (except sales volume which is the first consideration criteria) is the location of product. The pilot items for each group are placed at the same shelf. If the pilot items are placed in many different shelves, the collecting procedure will be complicated and requires a large effort for collecting data. Furthermore it will generate mistakes in data collection which will directly impact the quality of the data.

Collectors of this kind of data are the operators at the pilot stores who are assigned daily to count the number of pilot items available on the shelves at a fixed time. The data are recorded in the data collection forms for inventory counting shown in figure 5.1.

- Service Speed

One of the objectives of this evaluation is to measure the performances of the proposed POS system, and compares it with the performances of the existing ECR system.

Service speed may be defined as the total time a customer has to spend at the checkout. However, there is a large amount of independent time which are not the results of the system's performances. For example, the time when

the operator greets the customer in order to create good relationships or when packing the purchased items for the customer. These impact the speed performance of the work station if the average customer's waiting time are measured. However, these kinds of time depend on the performances and the behavior of the operator. If we measure the speed of the system by including these time in the operating time, the result may be biased by the performance and behavior of the operator.

A suggestion to use the same operator while evaluating the two systems in order to reduce the bias from the performance and behavior of the operator was proposed. This idea seems reasonable but not practical for retail businesses. There are many other uncontrollable factors that will impact this measurement such as types of customer, seasons of sales, and etc.. If we apply the idea of using the same operator while evaluating the system, we may apply the idea of using the same customer at the same time, the same date, and etc. which will not be like the real operation environment.

In order to minimize the bias from performance of operators who operate each system and other uncontrolled factors, the project team have to study the work elements of each transaction performed and try to create a suitable procedure for evaluating the service speed of the system.

The evaluation of service speed for this case study uses stop-watch to record operating time before and after the installation of the POS system. Recording starts after the customer puts the last item on the check out counter, which is when the operator begins to operate the checkout machine. The operating time of each system is counted until the sales slip is printed completely. Data are collected from 40 samples for each of the ECR and the POS system at each pilot store.

In this evaluation, it is assumed that there is no difference among performances of POS machines because they are new and have the same specification. In order to reduce the bias from the experiences of the operators, the time study which is used for this evaluation is performed after the learning curve is constant this means the data are collected after the operators are familiar with the proposed system.

In order to have the most realistic data under a real operational climate with the minimal bias, the data collectors are trained before collecting the data. They have to use the stop-watch technique by hiding the watch from the eyes of the operators thereby they do not know when the data are being collected.

In order to collect the data completely and conveniently, the operating time recording sheets are prepared as shown in figure 5.2.

- Service Accuracy

The service accuracy for this case is measured by the percentage of the mistake billing such as incorrect price, incorrect quantity of each SKU, incorrect quantity of each transaction, and incorrect type of product. These mistakes have to be recorded in the transaction file. For ECR, these kinds of mistakes consist of voids, items corrected, and items returned. For POS, it consists of lines voided, all voided, items returned, and all returned.

The mistake statistics can be found in two sources : in the daily report from the store and in the transaction file. For this case, the data from end-of-day sales report from the store will be used for both systems in order to maintain a single data collection procedure.

The number of incorrect activities corrected from each store will be divided by the number of total transactions in that day. The result of this calculation is the percentage of inaccuracy. Therefore, accuracy level is the opposite of this calculation.

2) Inventory Level

High service level is desirable in retail stores. In order to have high service level, most items in the inventory have to be available. However, inventory also adds costs to the operations. Therefore, there must be a balance between service level and inventory level.

To evaluate the proposed system, inventory level is another vital evaluation factor. If the proposed system can improve both service level and inventory level, then it can be concluded that the use of the POS system can improve the inventory performance of retail stores.

Normally, the inventory level of retail stores of the case study is measured by the total amount of inventory in that store. In order to know the total amount, the auditors who work for the Headquarters have to count the quantity of each item monthly at the store and then multiply by its price. The result of this calculation is the total amount of the inventory at that store.

Because there are three groups of products available at each store as fast moving, medium moving, and slow moving item, for this pilot project, the selected pilot items are 15 representatives from each group. Totally, the number of pilot items are 45 items for each store. Therefore, the inventory level which is performed by each system will be measured from the inventory level of the 45 pilot items. The normal and simple procedure for measuring the inventory

level of pilot items is done manually. The inventory level then will be calculated from the average quantity of each item in stock at the store.

The inventory of each store is kept at two locations : at the sales area and at the back room. Thus, the inventory counting sheet has two columns for recording the quantity of each item kept at different areas as shown in figure 5.1.

5.3.2 Impacts of the System on Service Quality

Service quality consists of three evaluation criteria as service level, service speed, and service accuracy.

- Service Level

Service level is one of the criteria for measuring the customers' satisfaction level by determining the proportion of time the item is available in the store. Data are collected by the procedure as described in the previous topic for four months, two before the installation of the new system, and two after. Table 5.1, 5.2, and 5.3 show the summarized data of the frequency of items not available at their shelves of pilot store#1, #2, and #3 respectively. The product codes and names are not shown due to the company's confidentiality. The data in columns fq. are the frequency of items not available at their shelves during daily checking. In order to know the service level of each item, the frequency of absent items is divided by the number of observation days and this percentage is subtracted from 100%. So the service level of each item is calculated and summarized as shown in table 5.4, 5.5, and 5.6.

Table 5.1 Summarized Data of the Frequency of Absent Items at Pilot Store#1 The percent (%) of absence is the proportion of absent days over the observation days.

Service Level (Pilot Store#1)									
Product		Before				After			
Code	Name	August, 1997		September, 1997		March, 1998		April, 1998	
		fq.	%	fq.	%	fq.	%	fq.	%
	Medium Moving								
M01	*Not Shown*	0	0.00	0	0.00	0	0.00	0	0.00
M02	*Not Shown*	0	0.00	0	0.00	0	0.00	0	0.00
M03	*Not Shown*	0	0.00	0	0.00	0	0.00	2	0.07
M04	*Not Shown*	2	0.06	0	0.00	0	0.00	3	0.10
M05	*Not Shown*	4	0.13	1	0.03	2	0.06	4	0.13
M06	*Not Shown*	1	0.03	1	0.03	0	0.00	0	0.00
M07	*Not Shown*	2	0.06	1	0.03	0	0.00	0	0.00
M08	*Not Shown*	0	0.00	1	0.03	0	0.00	0	0.00
M09	*Not Shown*	0	0.00	0	0.00	0	0.00	0	0.00
M10	*Not Shown*	0	0.00	0	0.00	0	0.00	0	0.00
M11	*Not Shown*	0	0.00	0	0.00	0	0.00	0	0.00
M12	*Not Shown*	1	0.03	0	0.00	0	0.00	2	0.07
M13	*Not Shown*	0	0.00	0	0.00	0	0.00	4	0.13
M14	*Not Shown*	0	0.00	0	0.00	0	0.00	3	0.10
M15	*Not Shown*	0	0.00	0	0.00	0	0.00	0	0.00
	Slow Moving								
S01	*Not Shown*	0	0.00	1	0.03	0	0.00	0	0.00
S02	*Not Shown*	0	0.00	1	0.03	0	0.00	0	0.00
S03	*Not Shown*	0	0.00	3	0.10	0	0.00	0	0.00
S04	*Not Shown*	0	0.00	4	0.13	0	0.00	0	0.00
S05	*Not Shown*	0	0.00	0	0.00	1	0.03	0	0.00
S06	*Not Shown*	0	0.00	2	0.07	0	0.00	0	0.00
S07	*Not Shown*	0	0.00	2	0.07	1	0.03	0	0.00
S08	*Not Shown*	0	0.00	4	0.13	0	0.00	0	0.00
S09	*Not Shown*	0	0.00	3	0.10	0	0.00	0	0.00
S10	*Not Shown*	1	0.03	2	0.07	0	0.00	0	0.00
S11	*Not Shown*	0	0.00	1	0.03	0	0.00	0	0.00
S12	*Not Shown*	0	0.00	1	0.03	0	0.00	0	0.00
S13	*Not Shown*	0	0.00	2	0.07	0	0.00	0	0.00
S14	*Not Shown*	0	0.00	3	0.10	0	0.00	0	0.00
S15	*Not Shown*	0	0.00	3	0.10	0	0.00	0	0.00
	Fast Moving								
F01	*Not Shown*	2	0.06	1	0.03	0	0.00	0	0.00
F02	*Not Shown*	4	0.13	0	0.00	2	0.06	0	0.00
F03	*Not Shown*	3	0.10	0	0.00	0	0.00	1	0.03
F04	*Not Shown*	5	0.16	1	0.03	1	0.03	0	0.00
F05	*Not Shown*	3	0.10	2	0.07	0	0.00	1	0.03
F06	*Not Shown*	5	0.16	3	0.10	1	0.03	2	0.07
F07	*Not Shown*	4	0.13	2	0.07	2	0.06	1	0.03
F08	*Not Shown*	5	0.16	4	0.13	4	0.13	2	0.07
F09	*Not Shown*	3	0.10	1	0.03	0	0.00	1	0.03
F10	*Not Shown*	4	0.13	2	0.07	2	0.06	2	0.07
F11	*Not Shown*	1	0.03	0	0.00	0	0.00	1	0.03
F12	*Not Shown*	4	0.13	2	0.07	1	0.03	2	0.07
F13	*Not Shown*	2	0.06	1	0.03	2	0.06	3	0.10
F14	*Not Shown*	3	0.10	1	0.03	1	0.03	3	0.10
F15	*Not Shown*	4	0.13	3	0.10	1	0.03	2	0.07

Table 5.2 Summarized Data of the Frequency of Absent Items at Pilot Store#2 The percent (%) of absence is the proportion of absent days over the observation days.

Service Level (Pilot Store#2)									
Product		Before				After			
Code	Name	August, 1997		September, 1997		March, 1998		April, 1998	
		fq.	%	fq.	%	fq.	%	fq.	%
	Medium Moving								
M01	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M02	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M03	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M04	*Not Shown*	0.00	0.00	0.00	0.00	1.00	0.03	0.00	0.00
M05	*Not Shown*	2.00	0.06	1.00	0.03	0.00	0.00	2.00	0.07
M06	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M07	*Not Shown*	1.00	0.03	2.00	0.07	0.00	0.00	1.00	0.03
M08	*Not Shown*	0.00	0.00	5.00	0.17	0.00	0.00	1.00	0.03
M09	*Not Shown*	1.00	0.03	1.00	0.03	0.00	0.00	2.00	0.07
M10	*Not Shown*	3.00	0.10	4.00	0.13	7.00	0.23	17.00	0.57
M11	*Not Shown*	4.00	0.13	4.00	0.13	9.00	0.29	10.00	0.33
M12	*Not Shown*	2.00	0.06	2.00	0.07	0.00	0.00	4.00	0.13
M13	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M14	*Not Shown*	1.00	0.03	2.00	0.07	0.00	0.00	0.00	0.00
M15	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Slow Moving								
S01	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S02	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S03	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S04	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S05	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S06	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S07	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S08	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S09	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S10	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S11	*Not Shown*	0.00	0.00	7.00	0.23	5.00	0.16	2.00	0.07
S12	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.07
S13	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S14	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S15	*Not Shown*	0.00	0.00	0.00	0.00	3.00	0.10	0.00	0.00
	Fast Moving								
F01	*Not Shown*	0.00	0.00	0.00	0.00	1.00	0.03	2.00	0.07
F02	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.13
F03	*Not Shown*	3.00	0.10	7.00	0.23	3.00	0.10	8.00	0.27
F04	*Not Shown*	4.00	0.13	12.00	0.40	8.00	0.26	2.00	0.07
F05	*Not Shown*	1.00	0.03	6.00	0.20	6.00	0.19	6.00	0.20
F06	*Not Shown*	3.00	0.10	4.00	0.13	7.00	0.23	2.00	0.07
F07	*Not Shown*	4.00	0.13	2.00	0.07	11.00	0.35	2.00	0.07
F08	*Not Shown*	3.00	0.10	11.00	0.37	11.00	0.35	3.00	0.10
F09	*Not Shown*	5.00	0.16	7.00	0.23	10.00	0.32	6.00	0.20
F10	*Not Shown*	4.00	0.13	9.00	0.30	10.00	0.32	10.00	0.33
F11	*Not Shown*	5.00	0.16	11.00	0.37	11.00	0.35	6.00	0.20
F12	*Not Shown*	15.00	0.48	15.00	0.50	12.00	0.39	2.00	0.07
F13	*Not Shown*	7.00	0.23	11.00	0.37	11.00	0.35	2.00	0.07
F14	*Not Shown*	18.00	0.58	22.00	0.73	14.00	0.45	3.00	0.10
F15	*Not Shown*	20.00	0.65	26.00	0.87	14.00	0.45	5.00	0.17

Table 5.3 Summarized Data of the Frequency of Absent Items at Pilot Store#3 The percent (%) of absence is the proportion of absent days over the observation days.

Service Level (Pilot Store#3)									
Product		Before				After			
Code	Name	August, 1997		September, 1997		March, 1998		April, 1998	
		fq.	%	fq.	%	fq.	%	fq.	%
	Medium Moving								
M01	*Not Shown*	0.00	0.00	2.00	0.07	0.00	0.00	2.00	0.07
M02	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M03	*Not Shown*	1.00	0.03	1.00	0.03	0.00	0.00	0.00	0.00
M04	*Not Shown*	0.00	0.00	1.00	0.03	0.00	0.00	0.00	0.00
M05	*Not Shown*	2.00	0.06	4.00	0.13	4.00	0.13	5.00	0.17
M06	*Not Shown*	3.00	0.10	1.00	0.03	0.00	0.00	0.00	0.00
M07	*Not Shown*	2.00	0.06	1.00	0.03	0.00	0.00	0.00	0.00
M08	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M09	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M10	*Not Shown*	0.00	0.00	3.00	0.10	2.00	0.06	0.00	0.00
M11	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M12	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.03
M13	*Not Shown*	0.00	0.00	1.00	0.03	0.00	0.00	0.00	0.00
M14	*Not Shown*	0.00	0.00	1.00	0.03	0.00	0.00	1.00	0.03
M15	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Slow Moving								
S01	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S02	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S03	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S04	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S05	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S06	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S07	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S08	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S09	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S10	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S11	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S12	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S13	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S14	*Not Shown*	2.00	0.06	2.00	0.07	3.00	0.10	0.00	0.00
S15	*Not Shown*	2.00	0.06	2.00	0.07	3.00	0.10	0.00	0.00
	Fast Moving								
F01	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.07
F02	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F03	*Not Shown*	0.00	0.00	0.00	0.00	2.00	0.06	0.00	0.00
F04	*Not Shown*	0.00	0.00	0.00	0.00	1.00	0.03	0.00	0.00
F05	*Not Shown*	0.00	0.00	0.00	0.00	3.00	0.10	0.00	0.00
F06	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F07	*Not Shown*	1.00	0.03	0.00	0.00	1.00	0.03	1.00	0.03
F08	*Not Shown*	0.00	0.00	0.00	0.00	1.00	0.03	0.00	0.00
F09	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F10	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F11	*Not Shown*	0.00	0.00	0.00	0.00	1.00	0.03	0.00	0.00
F12	*Not Shown*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F13	*Not Shown*	1.00	0.03	1.00	0.03	4.00	0.13	2.00	0.07
F14	*Not Shown*	0.00	0.00	0.00	0.00	2.00	0.06	1.00	0.03
F15	*Not Shown*	0.00	0.00	0.00	0.00	2.00	0.06	0.00	0.00

Table 5.4 Summarized Service Level of Each Representative Item at Pilot Store#1 Percentage show in colume 'Before' are the service level performed by the ECR system while 'After' are performed by the POS system.

Service Level (Pilot Store#1)			
Product		Service Level	
Code	Name	Before	After
	Medium Moving		
M01	*Not Shown*	100.00%	100.00%
M02	*Not Shown*	100.00%	100.00%
M03	*Not Shown*	100.00%	96.72%
M04	*Not Shown*	96.72%	95.08%
M05	*Not Shown*	91.80%	90.16%
M06	*Not Shown*	96.72%	100.00%
M07	*Not Shown*	95.08%	100.00%
M08	*Not Shown*	98.36%	100.00%
M09	*Not Shown*	100.00%	100.00%
M10	*Not Shown*	100.00%	100.00%
M11	*Not Shown*	100.00%	100.00%
M12	*Not Shown*	98.36%	96.72%
M13	*Not Shown*	100.00%	93.44%
M14	*Not Shown*	100.00%	95.08%
M15	*Not Shown*	100.00%	100.00%
	Slow Moving		
S01	*Not Shown*	98.36%	100.00%
S02	*Not Shown*	98.36%	100.00%
S03	*Not Shown*	95.08%	100.00%
S04	*Not Shown*	93.44%	100.00%
S05	*Not Shown*	100.00%	98.36%
S06	*Not Shown*	96.72%	100.00%
S07	*Not Shown*	96.72%	98.36%
S08	*Not Shown*	93.44%	100.00%
S09	*Not Shown*	95.08%	100.00%
S10	*Not Shown*	95.08%	100.00%
S11	*Not Shown*	98.36%	100.00%
S12	*Not Shown*	98.36%	100.00%
S13	*Not Shown*	96.72%	100.00%
S14	*Not Shown*	95.08%	100.00%
S15	*Not Shown*	95.08%	100.00%
	Fast Moving		
F01	*Not Shown*	95.08%	100.00%
F02	*Not Shown*	93.44%	96.72%
F03	*Not Shown*	95.08%	98.36%
F04	*Not Shown*	90.16%	98.36%
F05	*Not Shown*	91.80%	98.36%
F06	*Not Shown*	86.89%	95.08%
F07	*Not Shown*	90.16%	95.08%
F08	*Not Shown*	85.25%	90.16%
F09	*Not Shown*	93.44%	98.36%
F10	*Not Shown*	90.16%	93.44%
F11	*Not Shown*	98.36%	98.36%
F12	*Not Shown*	90.16%	95.08%
F13	*Not Shown*	95.08%	91.80%
F14	*Not Shown*	93.44%	93.44%
F15	*Not Shown*	88.52%	95.08%

Table 5.5 Summarized Service Level of Each Representative Item at Pilot Store#2 Percentage show in colume 'Before' are the service level performed by the ECR system while 'After' are performed by the POS system.

Service Level (Pilot Store#2)			
Product		Service Level	
Code	Name	Before	After
	Medium Moving		
M01	*Not Shown*	100.00%	100.00%
M02	*Not Shown*	100.00%	100.00%
M03	*Not Shown*	100.00%	100.00%
M04	*Not Shown*	100.00%	98.36%
M05	*Not Shown*	95.08%	96.72%
M06	*Not Shown*	100.00%	100.00%
M07	*Not Shown*	95.08%	98.36%
M08	*Not Shown*	91.80%	98.36%
M09	*Not Shown*	96.72%	96.72%
M10	*Not Shown*	88.52%	60.66%
M11	*Not Shown*	86.89%	68.85%
M12	*Not Shown*	93.44%	93.44%
M13	*Not Shown*	100.00%	100.00%
M14	*Not Shown*	95.08%	100.00%
M15	*Not Shown*	100.00%	100.00%
	Slow Moving		
S01	*Not Shown*	100.00%	100.00%
S02	*Not Shown*	100.00%	100.00%
S03	*Not Shown*	100.00%	100.00%
S04	*Not Shown*	100.00%	100.00%
S05	*Not Shown*	100.00%	100.00%
S06	*Not Shown*	100.00%	100.00%
S07	*Not Shown*	100.00%	100.00%
S08	*Not Shown*	100.00%	100.00%
S09	*Not Shown*	100.00%	100.00%
S10	*Not Shown*	100.00%	100.00%
S11	*Not Shown*	88.52%	88.52%
S12	*Not Shown*	100.00%	96.72%
S13	*Not Shown*	100.00%	100.00%
S14	*Not Shown*	100.00%	100.00%
S15	*Not Shown*	100.00%	95.08%
	Fast Moving		
F01	*Not Shown*	100.00%	95.08%
F02	*Not Shown*	100.00%	93.44%
F03	*Not Shown*	83.61%	81.97%
F04	*Not Shown*	73.77%	83.61%
F05	*Not Shown*	88.52%	80.33%
F06	*Not Shown*	88.52%	85.25%
F07	*Not Shown*	90.16%	78.69%
F08	*Not Shown*	77.05%	77.05%
F09	*Not Shown*	80.33%	73.77%
F10	*Not Shown*	78.69%	67.21%
F11	*Not Shown*	73.77%	72.13%
F12	*Not Shown*	50.82%	77.05%
F13	*Not Shown*	70.49%	78.69%
F14	*Not Shown*	34.43%	72.13%
F15	*Not Shown*	24.59%	68.85%

Table 5.6 Summarized Service Level of Each Representative Item at Pilot Store#3 Percentage show in colume 'Before' are the service level performed by the ECR system while 'After' are performed by the POS system.

Service Level (Pilot Store#3)			
Product		Service Level	
Code	Name	Before	After
	Medium Moving		
M01	*Not Shown*	96.72%	96.72%
M02	*Not Shown*	100.00%	100.00%
M03	*Not Shown*	96.72%	100.00%
M04	*Not Shown*	98.36%	100.00%
M05	*Not Shown*	90.16%	85.25%
M06	*Not Shown*	93.44%	100.00%
M07	*Not Shown*	95.08%	100.00%
M08	*Not Shown*	100.00%	100.00%
M09	*Not Shown*	100.00%	100.00%
M10	*Not Shown*	95.08%	96.72%
M11	*Not Shown*	100.00%	100.00%
M12	*Not Shown*	100.00%	98.36%
M13	*Not Shown*	98.36%	100.00%
M14	*Not Shown*	98.36%	98.36%
M15	*Not Shown*	100.00%	100.00%
	Slow Moving		
S01	*Not Shown*	100.00%	100.00%
S02	*Not Shown*	100.00%	100.00%
S03	*Not Shown*	100.00%	100.00%
S04	*Not Shown*	100.00%	100.00%
S05	*Not Shown*	100.00%	100.00%
S06	*Not Shown*	100.00%	100.00%
S07	*Not Shown*	100.00%	100.00%
S08	*Not Shown*	100.00%	100.00%
S09	*Not Shown*	100.00%	100.00%
S10	*Not Shown*	100.00%	100.00%
S11	*Not Shown*	100.00%	100.00%
S12	*Not Shown*	100.00%	100.00%
S13	*Not Shown*	100.00%	100.00%
S14	*Not Shown*	93.44%	95.08%
S15	*Not Shown*	93.44%	95.08%
	Fast Moving		
F01	*Not Shown*	100.00%	96.72%
F02	*Not Shown*	100.00%	100.00%
F03	*Not Shown*	100.00%	96.72%
F04	*Not Shown*	100.00%	98.36%
F05	*Not Shown*	100.00%	95.08%
F06	*Not Shown*	100.00%	100.00%
F07	*Not Shown*	98.36%	96.72%
F08	*Not Shown*	100.00%	98.36%
F09	*Not Shown*	100.00%	100.00%
F10	*Not Shown*	100.00%	100.00%
F11	*Not Shown*	100.00%	98.36%
F12	*Not Shown*	100.00%	100.00%
F13	*Not Shown*	96.72%	90.16%
F14	*Not Shown*	100.00%	95.08%
F15	*Not Shown*	100.00%	96.72%

These sets of data of each pilot store consisted of 15 items from each group of products : fast moving, slow moving and medium moving. It is important to determine whether there are improvements in service level. This is done by statistical tests for each group of items at each store. For this situation where it is uncertain that the population is a normal distribution or not, the non-parametric statistic namely " Sign Test " is selected. This test is based on the number of " + " and " - " signs performed in order to know whether there is a significant difference between the two population means. The sign test begins by specifying null hypothesis and alternative hypothesis for testing as follows :

H_0 = Assume there is no difference between population means of service level while using the POS system and the ECR system.

H_1 = Assume there is a difference between population means of service level while using the POS system and the ECR system.

X_{1i} = Service level of item number i while using the ECR system

X_{2i} = Service level of item number i while using the POS system

The difference in service level while using the ECR system and the POS system ($X_{2i} - X_{1i}$) indicated with the positive or negative signs are shown as follows :

Table 5.7 Sign Test of Service Level of Each Representative Item at Pilot Store#1

The positive(+) sign shows that the service level of that item is improved.

The negative(-) sign shows that the service level of that item is reduced.

Zero (0) shows that the service level is not improved nor reduced.

Service Level (Pilot Store#1)				
Code	Name	Before	After	Sign Test
	Medium Moving			
M01	*Not Shown*	100.00%	100.00%	0
M02	*Not Shown*	100.00%	100.00%	0
M03	*Not Shown*	100.00%	96.72%	-
M04	*Not Shown*	96.72%	95.08%	-
M05	*Not Shown*	91.80%	90.16%	-
M06	*Not Shown*	96.72%	100.00%	+
M07	*Not Shown*	95.08%	100.00%	+
M08	*Not Shown*	98.36%	100.00%	+
M09	*Not Shown*	100.00%	100.00%	0
M10	*Not Shown*	100.00%	100.00%	0
M11	*Not Shown*	100.00%	100.00%	0
M12	*Not Shown*	98.36%	96.72%	-
M13	*Not Shown*	100.00%	93.44%	-
M14	*Not Shown*	100.00%	95.08%	-
M15	*Not Shown*	100.00%	100.00%	0
	Slow Moving			
S01	*Not Shown*	98.36%	100.00%	+
S02	*Not Shown*	98.36%	100.00%	+
S03	*Not Shown*	95.08%	100.00%	+
S04	*Not Shown*	93.44%	100.00%	+
S05	*Not Shown*	100.00%	98.36%	-
S06	*Not Shown*	96.72%	100.00%	+
S07	*Not Shown*	96.72%	98.36%	+
S08	*Not Shown*	93.44%	100.00%	+
S09	*Not Shown*	95.08%	100.00%	+
S10	*Not Shown*	95.08%	100.00%	+
S11	*Not Shown*	98.36%	100.00%	+
S12	*Not Shown*	98.36%	100.00%	+
S13	*Not Shown*	96.72%	100.00%	+
S14	*Not Shown*	95.08%	100.00%	+
S15	*Not Shown*	95.08%	100.00%	+
	Fast Moving			
F01	*Not Shown*	95.08%	100.00%	+
F02	*Not Shown*	93.44%	96.72%	+
F03	*Not Shown*	95.08%	98.36%	+
F04	*Not Shown*	90.16%	98.36%	+
F05	*Not Shown*	91.80%	98.36%	+
F06	*Not Shown*	86.89%	95.08%	+
F07	*Not Shown*	90.16%	95.08%	+
F08	*Not Shown*	85.25%	90.16%	+
F09	*Not Shown*	93.44%	98.36%	+
F10	*Not Shown*	90.16%	93.44%	+
F11	*Not Shown*	98.36%	98.36%	0
F12	*Not Shown*	90.16%	95.08%	+
F13	*Not Shown*	95.08%	91.80%	-
F14	*Not Shown*	93.44%	93.44%	0
F15	*Not Shown*	88.52%	95.08%	+

The sign test will not consider the pair of data which is not different in quantity or $(X_{2i} - X_{1i}) = 0$. By sign test statistic, assume that :

S(P) = The number of positive signs with the binomial distribution and the probability to succeed (positive sign) = 0.5

S(N) = The number of negative signs with the binomial distribution and the probability to succeed (negative sign) = 0.5

C = The critical value that makes the probability of $S \geq C$

For Pilot Store #1

The medium moving products :

The number of positive signs (+)		=	3
The number of negative signs (-)		=	6
The number of "0"		=	6
Sample size (n)	= 15 - 6	=	9

By using 5% significant level, refer to the binomial distribution function while n = 9 and p = 0.5

Prob ($S \geq 6 / p = 0.5$)	=	0.0898
Prob ($S \geq 7 / p = 0.5$)	=	0.0195

For this case, C = 7 because it makes the probability nearest but not more than the significant level (0.05). It means for this case, H_0 is rejected and H_1 is accepted while the number of positive or negative signs $S(P) \geq 7$ or $S(N) \geq 7$.

The number of positive signs (+) = 3

The number of negative signs (-) = 6

Both sides are not equal or more than 7 [S(P) and S(N) < 7], that means H_0 is accepted or there is no difference between the population means of service level while using the POS system and the ECR system.

So the service level of this case is not significant to be increased or decreased.

By applying the same statistical test to all groups of data of three pilot stores, the results of sign tests are summarized and shown in table 5.7. The details of the tests are shown in Appendix A.

	Service Level		
	Medium Moving	***Slow Moving***	***Fast Moving***
Pilot Store#1	Not Significant	Improved	Improved
Pilot Store#2	Not Significant	Reduced	Not Significant
Pilot Store#3	Improved	Improved	Reduced

Table 5.8 Summarized Results of Sign Tests for Service Level

The result of the evaluation shows that for nine groups, service level of four groups are improved, two groups are reduced, and another three groups are not significant to be improved or reduced. However, it can not be concluded that the proposed POS system implementation can improve the service level of convenience store. Nevertheless, there is a tendency for improvement since the proportion of the improved groups are the majority result of this evaluation.

There are several factors behind this result that should be mentioned. The first factor is the learning period for the proposed system. The POS system implementation is installed the stores for several months (eight months for the first store and five months for the third), but the product analysis application

has just been implemented in the stores for a few months. The product analysis application requires long learning period before the operators can understand and be able to perform good results. The operators need to do trials and errors with the itemized information in order to capture the factors that impact the movement of the merchandises. Thus, in such a short period of system implementation, the operators may not be able to perform good results. This period may be the period for tuning the application to suit with the store environments.

The next factor is the employee turnover situation. The employee turnover of the case study is high, this situation impacts the system learning period due to the changed of operators. New operators require a period of time to learn the use of application.

The economic recession also impacts the service level of the store. The operators will find it hard to forecast the demand which occurred during inconsistency situation. The customers' behavior may changed in this situation. Some customers who used to purchase a merchandise in big sizes may change their behavior to purchase smaller ones. On the other hand for some products, the customers may increase the purchase quantity for fear of the rising price which usually occurs during this testing period. These inconsistency activities give the operators a hard time to maintain the service level. Furthermore, under this situation, it generates the chain effect to the distribution centers and the suppliers. The goods shortage from the distribution centers and the suppliers also increase and generate the same effect to the stores.

Another factor is the quality of information. At the beginning, the information's quality was not as good as the present. The itemized information presented to the operators was not accurate so the operators may be misled and

feel unconfident about the itemized information. Thus the use of itemized information to perform product management will not be effective.

All mentioned factors have impacts to the service level of the store. The system implementation will be more effective if the case study can manage the above crisis together with developing the product management procedure in order to increase service level.

- Service Speed

The purpose of this evaluation is to capture the service speed of the existing ECR system and the proposed POS system. 40 sets of data on operating time are collected for each system at each pilot store using the procedure described in **5.2.3.** The data are shown in table 5.9.

Table 5.9 : Summarized Data of Operating Time (in seconds) at the Cashier The data of operating time (in seconds) using different systems at each store. 40 samples are taken for each case.

ECR (s)			POS (s)		
Pilot Store#1	Pilot Store#2	Pilot Store#3	Pilot Store#1	Pilot Store#2	Pilot Store#3
11.12	25.15	10.51	14.27	15.42	8.97
23.33	20.41	16.95	8.99	9.05	9.99
22.10	21.05	20.78	9.52	19.03	11.07
12.24	14.01	10.21	10.14	15.66	19.18
8.91	11.66	11.46	18.37	12.64	11.02
14.66	18.42	17.93	10.99	23.07	12.06
17.99	10.54	9.07	16.02	17.89	15.35
12.35	17.01	14.10	10.62	10.65	24.44
11.19	16.69	9.55	17.18	16.58	19.77
12.90	12.49	11.16	10.24	16.37	10.31
21.16	12.93	10.03	12.46	18.62	22.38
9.87	16.64	9.52	23.96	14.24	26.02
14.21	12.73	12.31	10.21	13.54	13.18
19.99	12.51	12.98	9.55	13.93	11.02
13.45	16.64	9.02	11.74	11.50	11.36
18.59	15.95	9.65	9.33	10.99	12.17
23.46	21.24	12.97	9.68	26.10	10.20
14.41	13.27	12.76	10.02	14.29	20.94
14.25	13.52	11.12	16.09	9.96	9.02
17.27	22.41	10.75	10.80	9.82	19.79
16.59	10.49	17.01	17.24	13.13	16.93
15.00	10.62	17.02	10.71	10.97	12.16
13.15	16.48	13.30	12.68	11.31	15.78
11.30	10.58	16.98	10.37	12.12	19.61
23.10	12.18	23.49	12.08	10.15	10.71
12.23	11.38	13.08	10.30	19.99	14.76
13.56	23.22	10.00	11.43	11.49	15.14
16.89	22.60	11.85	9.86	15.79	12.54
12.87	23.01	23.48	22.49	16.97	13.56
14.67	12.70	12.08	19.03	9.10	9.07
12.34	18.11	18.56	21.67	18.80	17.49
14.76	12.79	11.30	9.49	9.77	9.60
12.76	13.74	23.13	22.89	9.62	9.81
12.56	26.81	11.43	9.52	23.49	18.94
13.78	21.39	12.00	11.93	12.08	16.44
15.49	17.50	13.70	17.97	22.67	12.22
9.84	13.01	10.51	12.75	9.49	15.51
9.53	16.71	21.12	24.49	11.93	24.84
14.56	23.45	14.08	13.49	14.33	18.94
13.42	10.55	10.87	8.34	11.24	9.58

In order to determine whether there are improvements in service speed, several statistical tests are performed. Firstly, the quality of the data are tested with the box-plot technique. Then, F-ratio tests are performed to know whether there is a significant difference between two populations' variance. Finally, the

test whether the two systems perform differently is done with Student t-test. The details of the statistical tests are shown in Appendix B.

In determining whether the POS system performs better service speed than the ECR system, the following hypothesis is tested

H_0 : Assume there is no difference between population mean of operating time while using the POS system and the ECR system. ($\mu 1 = \mu 2$)

H_1 : Assume there is a difference between population mean of operating time while using the POS system and the ECR system. ($\mu 1 \neq \mu 2$)

The result of Student's t-Test of three pilot stores shows that H_0 are accepted while H_1 are rejected. This implies that there is no evidence of difference between two population means of operating time while using the POS system and the ECR system. The statistical testing result concludes that the use of the POS system for our current environment is not significant to improve the service speed of the case study.

The reasons behind this result, in my opinion and observation, are the unsuitable operation environments of the case study. Firstly, the proportion of products with bar-codes or source markings is not high enough. There are around 60-70 percent of the products available in the store which have bar-codes. Secondly, the quality of the bar-code is not good for some products. Thirdly, the accuracy of the database is not high enough at the beginning of the project. Lastly, there is a lake of skilled operators due to employee turnover.

The proportion of bar-code products is a critical factor for service speed improvement. The operating time is expected to reduced by using electronic scanner which reads the bar-code instead of keying-in two digits of PMA and around four digits of price (including decimal number) for each item. The

operating time of each scanning activity is around one second at the maximum while operating time of six key strokes is not less than two or three seconds. The low percentage of bar-code products makes this expectation changed. The operators are unable to know which items have bar-codes or not, thus they have to pick each item up and search for a bar-code. If there is a bar-code on the product then they must use a scanner, otherwise they will key in the PMA and price of that item. This situation directly impacts the service speed. The idea of applying internal bar-code or in-house code is then suggested not practical when considering the case study's environments. This idea is suitable for supermarkets or departments stores which are in larger scale than convenience stores. Other reasons concern the number and size of the outlets. Unlike supermarkets or departments stores which have a fewer number but larger in size of outlets, it is worth to invest the bar-code printer than in convenience stores which are much smaller in size though with more outlets. The concept of utilizing one printer for many small outlets will be practical if there is a center for labeling the bar-code to the items or a good plan for distributing these bar-codes to the outlets. However, this activity adds cost to the outlet and hard to test for this small and limited budget as in this pilot project.

The quality of the bar-code is another factor which reduces the speed of operating time while using an electronic scanner. Some products with poor quality bar-code require skilled operators to adjust the direction of the scanner while scanning. Moreover, some operators may use the key-in procedure instead of scanning this kind of bar-code. This will reduce the speed of operating time.

The accuracy of the database is not high enough in the beginning of the project which is a third factor that reduces service speed. Operators who are uncertain of the accuracy of database try to avoid scanning the bar-code even

the accuracy of the database is better than in the last. It requires a period of time to prove that scanning is better than key-in procedure.

Even the service speed of the POS system is not better than the ECR system at this time, it will be improved if the above obstacles are eliminated or reduced. Furthermore, there are plans to solve these problems which will be reported in Chapter 6 Conclusion and Suggestion.

- Service Accuracy

The last criteria for evaluating service quality of this case study is service accuracy. Considering the operating procedure of the two systems : the ECR (Electronic Cash Register) system and the POS (Point of Sales) system, the percentage of mis-registration transaction should be different. The chances of inaccuracy using the ECR system is higher than the POS system. However in order to confirm this assumption, the data of mis-registration transaction per day were collected by the procedure that is described in **5.2.3.** The data of the two systems performed at each pilot stores shown in Table 5.10, 5.11, and 5.12.

These data are extracted from end-of-day sales report of pilot stores. The number of mis-registration transactions are presented in "Missing" column while the number of customers or transactions at that day are presented in the next column named "Customer". After that the percentage of mis-registration transaction are calculated as shown in table 5.13.

Table 5.10 Number of Mis-Registration Transaction at Pilot Store#1 Number of mis-registration transaction at pilot store#1 with ECR and with POS system.

ECR# 1			ECR# 2			POS# 1			POS# 2		
Missing	Customer	(%)	Missing	Customer	(%)	Missing	Customer	(%)	Missing	Customer	(%)
22	1272	1.73%	15	391	3.84%	1	835	0.12%	0	175	0.00%
19	1168	1.63%	17	359	4.74%	2	805	0.25%	0	669	0.00%
20	1146	1.75%	13	489	2.66%	1	858	0.12%	2	197	1.02%
16	1109	1.44%	9	366	2.46%	1	1408	0.07%	1	542	0.18%
10	1082	0.92%	5	352	1.42%	1	785	0.13%	0	369	0.00%
7	749	0.93%	4	131	3.05%	1	1238	0.08%	1	573	0.17%
26	1177	2.21%	9	293	3.07%	1	1050	0.10%	3	636	0.47%
11	1048	1.05%	5	331	1.51%	1	1199	0.08%	0	517	0.00%
8	1213	0.66%	3	351	0.85%	1	1073	0.09%	1	777	0.13%
11	1259	0.87%	4	383	1.04%	1	926	0.11%	0	234	0.00%
17	1076	1.58%	6	375	1.60%	0	1879	0.00%	1	1351	0.07%
15	1000	1.50%	2	319	0.63%	1	1606	0.06%	0	954	0.00%
14	1012	1.38%	1	212	0.47%	1	1264	0.08%	1	594	0.17%
13	1073	1.21%	10	268	3.73%	1	1206	0.08%	0	380	0.00%
14	1078	1.30%	7	284	2.46%	2	1164	0.17%	0	469	0.00%
9	1260	0.71%	5	381	1.31%	3	1394	0.22%	0	753	0.00%
14	1165	1.20%	11	494	2.23%	1	804	0.12%	1	596	0.17%
13	940	1.38%	9	300	3.00%	1	865	0.12%	0	618	0.00%
10	880	1.14%	3	184	1.63%	1	909	0.11%	0	723	0.00%
14	961	1.46%	4	261	1.53%	1	686	0.15%	0	378	0.00%
7	897	0.78%	1	194	0.52%	0	782	0.00%	1	188	0.53%
17	910	1.87%	4	280	1.43%	1	742	0.13%	2	355	0.56%
11	1096	1.00%	4	296	1.35%	0	918	0.00%	1	336	0.30%
23	1154	1.99%	3	428	0.70%	1	689	0.15%	0	251	0.00%
10	979	1.02%	5	302	1.66%	1	1179	0.08%	0	276	0.00%
9	826	1.09%	5	202	2.48%	0	829	0.00%	0	304	0.00%
9	887	1.01%	0	275	0.00%	0	859	0.00%	0	271	0.00%
9	914	0.98%	5	176	2.84%	1	741	0.13%	0	261	0.00%
15	928	1.62%	6	225	2.67%	0	1007	0.00%	0	207	0.00%
8	957	0.84%	5	348	1.44%	0	894	0.00%	1	348	0.29%
6	917	0.65%	4	375	1.07%	1	867	0.12%	0	264	0.00%

Table 5.11 Number of Mis-Registration Transaction at Pilot Store#2 Number of mis-registration transaction at pilot store#1 with ECR and with POS system.

ECR# 1			ECR# 2			POS# 1			POS# 2		
Missing	Customer	(%)	Missing	Customer	(%)	Missing	Customer	(%)	Missing	Customer	(%)
12	1248	0.96%	5	284	1.76%	4	1333	0.30%	2	531	0.38%
6	1238	0.48%	11	467	2.36%	1	1449	0.07%	0	379	0.00%
27	1174	2.30%	14	360	3.89%	1	1232	0.08%	1	563	0.18%
27	1193	2.26%	12	298	4.03%	3	1413	0.21%	0	396	0.00%
23	1065	2.16%	6	250	2.40%	1	1229	0.08%	1	527	0.19%
27	1023	2.64%	4	226	1.77%	2	1388	0.14%	2	398	0.50%
39	1159	3.36%	10	323	3.10%	0	1406	0.00%	0	494	0.00%
19	1194	1.59%	4	276	1.45%	1	1320	0.08%	1	414	0.24%
40	1189	3.36%	2	272	0.74%	0	1296	0.00%	1	425	0.24%
20	1198	1.67%	8	253	3.16%	2	1199	0.17%	1	463	0.22%
24	1144	2.10%	5	281	1.78%	0	1358	0.00%	0	399	0.00%
18	1054	1.71%	7	284	2.46%	0	1385	0.00%	0	552	0.00%
25	916	2.73%	14	360	3.89%	0	1287	0.00%	2	542	0.37%
47	1045	4.50%	4	251	1.59%	1	1396	0.07%	0	395	0.00%
42	1290	3.26%	5	158	3.16%	1	1394	0.07%	0	515	0.00%
34	1310	2.60%	12	415	2.89%	2	1376	0.15%	0	453	0.00%
21	1207	1.74%	12	283	4.24%	1	1321	0.08%	1	525	0.19%
24	997	2.41%	5	286	1.75%	0	1281	0.00%	1	496	0.20%
15	698	2.15%	6	392	1.53%	0	1280	0.00%	0	298	0.00%
19	1057	1.80%	6	300	2.00%	2	1357	0.15%	0	420	0.00%
22	1026	2.14%	3	218	1.38%	0	1324	0.00%	0	376	0.00%
19	1164	1.63%	1	191	0.52%	2	1280	0.16%	2	320	0.63%
41	1253	3.27%	2	170	1.18%	5	1244	0.40%	1	440	0.23%
18	1261	1.43%	15	382	3.93%	0	1066	0.00%	3	661	0.45%
13	1048	1.24%	4	282	1.42%	1	1011	0.10%	2	774	0.26%
21	753	2.79%	6	291	2.06%	0	916	0.00%	1	649	0.15%
14	1072	1.31%	6	196	3.06%	0	977	0.00%	1	797	0.13%
13	980	1.33%	9	235	3.83%	2	1180	0.17%	0	371	0.00%
14	999	1.40%	2	202	0.99%	3	1048	0.29%	0	667	0.00%
20	1122	1.78%	3	302	0.99%	0	1171	0.00%	1	363	0.28%
46	1153	3.99%	3	258	1.16%	1	1281	0.08%	0	312	0.00%

Table 5.12 Number of Mis-Registration Transaction at Pilot Store#3 Number of mis-registration transaction at pilot store#1 with ECR and with POS system.

ECR# 1			ECR# 2			ECR# 3			POS# 1			POS# 2			POS# 3		
Missing	Customer	(%)	Missing	Customer	(%)	Missing	Customer	(%)	Missing	Customer	(%)	Missing	Customer	(%)	Missing	Customer	(%)
70	1691	4.14%	1	39	2.56%	6	151	3.97%	3	1381	0.22%	2	793	0.25%	0	213	0.00%
52	1576	3.30%	0	29	0.00%	9	217	4.15%	5	994	0.50%	1	1223	0.08%	0	280	0.00%
57	1538	3.71%	0	14	0.00%	6	268	2.24%	2	1484	0.13%	3	602	0.50%	0	135	0.00%
32	1479	2.16%	12	297	4.04%	3	87	3.45%	2	1771	0.11%	2	668	0.30%	0	105	0.00%
68	1552	4.38%	4	203	1.97%	0	20	0.00%	4	1496	0.27%	0	474	0.00%	1	119	0.84%
36	1454	2.48%	14	227	6.17%	4	42	9.52%	0	1601	0.00%	3	576	0.52%	0	58	0.00%
54	1378	3.92%	15	372	4.03%	1	32	3.13%	1	1623	0.06%	1	585	0.17%	0	165	0.00%
51	1588	3.21%	1	285	0.35%	3	16	18.75%	3	1849	0.16%	1	608	0.16%	1	75	1.33%
33	1482	2.23%	2	211	0.95%	3	91	3.30%	2	1625	0.12%	0	479	0.00%	1	200	0.50%
21	1269	1.65%	7	372	1.88%	5	116	4.31%	0	1410	0.00%	1	514	0.19%	1	198	0.51%
36	1361	2.65%	0	15	0.00%	1	34	2.94%	0	1479	0.00%	3	463	0.65%	0	29	0.00%
31	1330	2.33%	20	339	5.90%	5	47	10.64%	3	1712	0.18%	1	626	0.16%	0	127	0.00%
51	1368	3.73%	13	258	5.04%	1	55	1.82%	2	1613	0.12%	1	479	0.21%	0	117	0.00%
57	1503	3.79%	4	210	1.90%	2	72	2.78%	6	1681	0.36%	0	668	0.00%	1	35	2.86%
35	1553	2.25%	8	252	3.17%	0	20	0.00%	4	1828	0.22%	2	568	0.35%	2	102	1.96%
41	1381	2.97%	23	367	6.27%	1	101	0.99%	3	1676	0.18%	1	571	0.18%	0	139	0.00%
51	1497	3.41%	13	247	5.26%	0	38	0.00%	0	1423	0.00%	1	367	0.27%	1	127	0.79%
44	1297	3.39%	5	257	1.95%	2	40	5.00%	1	1602	0.06%	2	480	0.42%	0	105	0.00%
55	1221	4.50%	4	214	1.87%	0	20	0.00%	5	1546	0.32%	3	547	0.55%	0	99	0.00%
46	1415	3.25%	4	198	2.02%	2	69	2.90%	1	1652	0.06%	1	516	0.19%	0	57	0.00%
34	1504	2.26%	4	140	2.86%	0	22	0.00%	6	1724	0.35%	1	409	0.24%	0	104	0.00%
32	1376	2.33%	5	239	2.09%	1	20	5.00%	5	1806	0.28%	1	568	0.18%	0	122	0.00%
51	1446	3.53%	4	220	1.82%	0	49	0.00%	1	1689	0.06%	2	540	0.37%	1	155	0.65%
30	1390	2.16%	14	294	4.76%	2	41	4.88%	2	1672	0.12%	1	276	0.36%	0	53	0.00%
61	1282	4.76%	6	188	3.19%	1	129	0.78%	1	1795	0.06%	0	458	0.00%	0	43	0.00%
34	1117	3.04%	7	243	2.88%	4	44	9.09%	1	1539	0.06%	0	368	0.00%	0	63	0.00%
24	1200	2.00%	23	407	5.65%	1	60	1.67%	3	1827	0.16%	1	509	0.20%	0	91	0.00%
38	1162	3.27%	1	230	0.43%	4	115	3.48%	1	1770	0.06%	2	411	0.49%	0	99	0.00%
40	1271	3.15%	9	221	4.07%	9	171	5.26%	0	1742	0.00%	1	374	0.27%	0	164	0.00%
31	1350	2.30%	3	186	1.61%	2	125	1.60%	5	1504	0.33%	0	318	0.00%	0	52	0.00%
47	1289	3.65%	6	115	5.22%	3	191	1.57%	1	1459	0.07%	0	368	0.00%	0	14	0.00%

Table 5.13 Percentage of Mis-Registration

ECR System (Total)			POS System (Total)		
Missing	Customer	(%)	Missing	Customer	(%)
131	5076	2.58%	12	5261	0.23%
114	5054	2.26%	9	5799	0.16%
137	4989	2.75%	10	5071	0.20%
111	4829	2.30%	9	6303	0.14%
116	4524	2.56%	8	4999	0.16%
96	3852	2.49%	9	5832	0.15%
154	4734	3.25%	6	5959	0.10%
94	4738	1.98%	8	5982	0.13%
91	4809	1.89%	6	5875	0.10%
76	4850	1.57%	6	4944	0.12%
89	4286	2.08%	4	6958	0.06%
98	4373	2.24%	5	6962	0.07%
119	4181	2.85%	7	5896	0.12%
137	4422	3.10%	9	5761	0.16%
111	4635	2.39%	11	6040	0.18%
125	5215	2.40%	9	6362	0.14%
122	4931	2.47%	6	5163	0.12%
102	4117	2.48%	5	5447	0.09%
93	3609	2.58%	9	5402	0.17%
95	4261	2.23%	5	5066	0.10%
71	4001	1.77%	8	4907	0.16%
79	4180	1.89%	13	5193	0.25%
113	4530	2.49%	11	5322	0.21%
105	4950	2.12%	7	4668	0.15%
100	4210	2.38%	5	5536	0.09%
86	3476	2.47%	2	4668	0.04%
77	4097	1.88%	5	5331	0.09%
79	3812	2.07%	6	4833	0.12%
95	4017	2.36%	4	5209	0.08%
72	4390	1.64%	7	4650	0.15%
115	4298	2.68%	3	4565	0.07%
3203	**137446**	**2.33%**	**224**	**169964**	**0.13%**

The percentage of miss-registration transaction performed by the ECR system is **2.33 %** while **0.13 %** performed by the POS system. The result of this calculation shows that the service accuracy performed by POS is more accurate than performed by ECR. This means the use of the POS system can improve the service accuracy of retail stores.

Looking back at the reasons for this improvement, there are several factors that should be recorded accordingly such as the quality of information, the operating procedure and the auxiliary function of the POS.

The quality of information is a critical factor that causes the success or failure of many projects especially those that use the advantages of information technology to improve operations like this project. At the beginning of the project, the inaccurate information of the case study is ten percent. Through observation, the service accuracy of the proposed system at that time was not good so the operators had to correct the transactions frequently. The main inaccurate service is concerned with price. Since the POS system uses the price from the database, whenever the quality is low, the service accuracy will be low. At the evaluation period, the quality of information has been improved so the service quality is better.

Operation is also an important factor that impacts service accuracy. Considering the operating procedure and the operators' learning curve of the two systems, it can be justified that the POS system has an easier operating procedure. It also reduces the probability of human errors while performing sales activity. By using ECR, most of the products (except using one-touch function) are sold by keying in at least six key strokes. Each key stroke contains the probability of failure or error due to human error. So there is a probability of miss-registration of each transaction. The use of the POS system, on the other hand, reduces such kind of error by using a bar-code scanner or a bar-code reader. For this case study, by using the POS system, the key-in activity is reduced by 60% to 70% depending on the proportion of the merchandise with bar-codes. However, it should be kept in mind that the use of POS system requires both the quantity of the merchandises with bar-codes and the quality of bar-code information.

The other benefit of the ease of operating procedure is that it shortens the learning period of new operators. As described previously that the case study faces high employee turnover situation so if the firm implements the POS

system throughout the organization, it can reduce the probability of poor service accuracy due to the inexperience operators. They require only a few hours to learn the operating procedure of the POS system before being able to perform accurate sales activity.

The third factor which makes the service accuracy of the POS system better than the ECR system is the auxiliary functions of the POS system. Examples of this kind of function are " Suspend " and " Resume " functions. They are used whenever the customers change their minds at the check out. They may want to buy other things while the cashier is performing the transaction. For this situation, in the ECR system, the cashiers have two choices to operate. One way is to wait for the customer and stop the service of other customers. This will somewhat annoy other customers and may cause loss in sales. The other way is to cancel this transaction and serve other customers. This will however generate many problems. For example, the transaction cancel method for ECR is not easy and this will confuse the cashier. If the cancellation fails then cash will not be balanced and solutions have to be reached. One way to solve this problem is cheating some customers in order to balance cash which will impact service accuracy. This problem will be reduced with the use of the POS system which has " Suspend " and " Resume " functions. For example, the cashier can use " Suspend " function to suspend that transaction and then serve other customers. Whenever the previous customer whose transaction was suspended returns, the cashier can recall that transaction by using the " Resume " function and then continue the suspended transaction.

From the above reasons, it can be concluded that the use of the POS system under suitable operation environments will generate better service accuracy than using the ECR system.

5.3.3 Impacts of the System on Inventory Level

Inventory level of the stores translates to the level of investment at each store. As mentioned previously that in order to have high service level, most items in the inventory have to be available. However, inventory also adds costs to the operation. Therefore, the optimized way is the balancing between service level and inventory level. The data of each store are collected and summarized as shown in table 5.14, 5.15, and 5.16.

These sets of data of each pilot store consist of 15 items from each group of products : fast moving, slow moving and medium moving. It is important to determine whether there are improvements in inventory level. This is done by statistical tests for each group of items at each store.

The summarized data of the inventory are presented as monthly in the first column and in daily in the next. The product codes and names are not shown due to the company's confidentiality. For easy analysis, the inventory level is calculated and presented before and after implementing the proposed system at the pilot store#1 and summarized as shown in table 5.17.

Table 5.14 Summarized Inventory Level of Pilot Store#1 The data in column 'Before' are the inventory level using the ECR system and 'After' are the inventory level using the POS system

Inventory Level (Pilot Store#1)									
Product		Before				After			
Code	Name	August, 1997		September, 1997		March, 1998		April, 1998	
	Medium Moving								
M01	*Not Shown*	437	14.10	352	11.73	404	13.03	393	13.10
M02	*Not Shown*	341	11.00	322	10.73	362	11.68	249	8.30
M03	*Not Shown*	260	8.39	268	8.93	294	9.48	278	9.27
M04	*Not Shown*	709	22.87	1010	33.67	1441	46.48	801	26.70
M05	*Not Shown*	1063	34.29	1574	52.47	1247	40.23	1173	39.10
M06	*Not Shown*	573	18.48	362	12.07	461	14.87	358	11.93
M07	*Not Shown*	619	19.97	618	20.60	902	29.10	556	18.53
M08	*Not Shown*	1332	42.97	2134	71.13	2311	74.55	1160	38.67
M09	*Not Shown*	2346	75.68	2070	69.00	2254	72.71	2092	69.73
M10	*Not Shown*	13142	423.94	11712	390.40	9797	316.03	12679	422.63
M11	*Not Shown*	14935	481.77	6102	203.40	12031	388.10	9131	304.37
M12	*Not Shown*	23611	761.65	24482	816.07	26422	852.32	18550	618.33
M13	*Not Shown*	4254	137.23	3826	127.53	3948	127.35	2111	70.37
M14	*Not Shown*	11277	363.77	6905	230.17	5917	190.87	4189	139.63
M15	*Not Shown*	4221	136.16	2246	74.87	3029	97.71	2578	85.93
	Slow Moving								
S01	*Not Shown*	437	14.10	259	8.63	344	11.10	224	7.47
S02	*Not Shown*	298	9.61	154	5.13	403	13.00	270	9.00
S03	*Not Shown*	357	11.52	383	12.77	323	10.42	383	12.77
S04	*Not Shown*	347	11.19	658	21.93	479	15.45	231	7.70
S05	*Not Shown*	354	11.42	253	8.43	316	10.19	251	8.37
S06	*Not Shown*	544	17.55	422	14.07	702	22.65	289	9.63
S07	*Not Shown*	1656	53.42	1778	59.27	1529	49.32	1159	38.63
S08	*Not Shown*	604	19.48	366	12.20	598	19.29	454	15.13
S09	*Not Shown*	299	9.65	228	7.60	396	12.77	317	10.57
S10	*Not Shown*	507	16.35	318	10.60	339	10.94	368	12.27
S11	*Not Shown*	356	11.48	260	8.67	351	11.32	270	9.00
S12	*Not Shown*	354	11.42	286	9.53	263	8.48	270	9.00
S13	*Not Shown*	483	15.58	575	19.17	365	11.77	598	19.93
S14	*Not Shown*	381	12.29	288	9.60	229	7.39	283	9.43
S15	*Not Shown*	273	8.81	213	7.10	684	22.06	371	12.37
	Fast Moving								
F01	*Not Shown*	2666	86.00	2226	74.20	2026	65.35	1836	61.20
F02	*Not Shown*	2641	85.19	2972	99.07	1638	52.84	1816	60.53
F03	*Not Shown*	2241	72.29	2480	82.67	1817	58.61	1741	58.03
F04	*Not Shown*	1959	63.19	2147	71.57	1427	46.03	1863	62.10
F05	*Not Shown*	1378	44.45	1303	43.43	1279	41.26	1193	39.77
F06	*Not Shown*	1174	37.87	1471	49.03	1385	44.68	1034	34.47
F07	*Not Shown*	1127	36.35	1676	55.87	1550	49.98	1406	46.87
F08	*Not Shown*	1172	37.81	1568	52.27	1381	44.55	1155	38.50
F09	*Not Shown*	898	28.97	1306	43.53	1167	37.65	874	29.13
F10	*Not Shown*	888	28.65	1026	34.20	858	27.68	921	30.70
F11	*Not Shown*	1651	53.26	1487	49.57	1361	43.90	1165	38.83
F12	*Not Shown*	1270	40.97	1399	46.63	1128	36.39	1117	37.23
F13	*Not Shown*	1479	47.71	1607	53.57	1479	47.71	1154	38.47
F14	*Not Shown*	901	29.06	861	28.70	846	27.29	757	25.23
F15	*Not Shown*	1085	35.00	774	25.80	662	21.35	748	24.93

Table 5.15 Summarized Inventory Level of Pilot Store#2 The data in column 'Before' are the inventory level using the ECR system and 'After' are the inventory level using the POS system

Inventory Level (Pilot Store#2)									
Product		Before				After			
Code	Name	August, 1997		September, 1997		March, 1998		April, 1998	
	Medium Moving								
M01	*Not Shown*	163	5.26	257	8.57	220	7.10	378	12.60
M02	*Not Shown*	250	8.06	216	7.20	224	7.23	254	8.47
M03	*Not Shown*	278	8.97	233	7.77	275	8.87	222	7.40
M04	*Not Shown*	310	10.00	363	12.10	267	8.61	252	8.40
M05	*Not Shown*	406	13.10	277	9.23	404	13.03	379	12.63
M06	*Not Shown*	167	5.39	208	6.93	217	7.00	111	3.70
M07	*Not Shown*	416	13.42	314	10.47	454	14.65	424	14.13
M08	*Not Shown*	829	26.74	568	18.93	1141	36.81	894	29.80
M09	*Not Shown*	928	29.94	764	25.47	954	30.77	827	27.57
M10	*Not Shown*	1282	41.35	1586	52.87	1476	47.61	875	29.17
M11	*Not Shown*	1842	59.42	1602	53.40	1676	54.06	1345	44.83
M12	*Not Shown*	3037	97.97	2397	79.90	2826	91.16	2689	89.63
M13	*Not Shown*	807	26.03	617	20.57	2832	91.35	1487	49.57
M14	*Not Shown*	1197	38.61	899	29.97	1472	47.48	2022	67.40
M15	*Not Shown*	372	12.00	243	8.10	242	7.81	478	15.93
	Slow Moving								
S01	*Not Shown*	335	10.81	380	12.67	333	10.74	316	10.53
S02	*Not Shown*	437	14.10	429	14.30	419	13.52	379	12.63
S03	*Not Shown*	654	21.10	509	16.97	668	21.55	487	16.23
S04	*Not Shown*	239	7.71	360	12.00	277	8.94	248	8.27
S05	*Not Shown*	661	21.32	484	16.13	226	7.29	347	11.57
S06	*Not Shown*	429	13.84	1006	33.53	1111	35.84	801	26.70
S07	*Not Shown*	560	18.06	407	13.57	458	14.77	376	12.53
S08	*Not Shown*	325	10.48	293	9.77	367	11.84	411	13.70
S09	*Not Shown*	507	16.35	593	19.77	304	9.81	500	16.67
S10	*Not Shown*	630	20.32	1375	45.83	665	21.45	480	16.00
S11	*Not Shown*	230	7.42	124	4.13	135	4.35	151	5.03
S12	*Not Shown*	1255	40.48	1889	62.97	480	15.48	1088	36.27
S13	*Not Shown*	695	22.42	850	28.33	422	13.61	360	12.00
S14	*Not Shown*	357	11.52	986	32.87	690	22.26	975	32.50
S15	*Not Shown*	374	12.06	332	11.07	239	7.71	210	7.00
	Fast Moving								
F01	*Not Shown*	2680	86.45	2040	68.00	1304	42.06	1084	36.13
F02	*Not Shown*	3719	119.97	2566	85.53	1138	36.71	977	32.57
F03	*Not Shown*	1862	60.06	1193	39.77	1259	40.61	1085	36.17
F04	*Not Shown*	1882	60.71	1112	37.07	1177	37.97	1269	42.30
F05	*Not Shown*	1455	46.94	843	28.10	1252	40.39	1007	33.57
F06	*Not Shown*	1106	35.68	775	25.83	783	25.26	625	20.83
F07	*Not Shown*	857	27.65	940	31.33	629	20.29	597	19.90
F08	*Not Shown*	777	25.06	472	15.73	502	16.19	576	19.20
F09	*Not Shown*	767	24.74	359	11.97	704	22.71	627	20.90
F10	*Not Shown*	1199	38.68	721	24.03	680	21.94	848	28.27
F11	*Not Shown*	1316	42.45	821	27.37	670	21.61	1152	38.40
F12	*Not Shown*	614	19.81	573	19.10	618	19.94	1814	60.47
F13	*Not Shown*	1082	34.90	552	18.40	606	19.55	1814	60.47
F14	*Not Shown*	615	19.84	174	5.80	713	23.00	1364	45.47
F15	*Not Shown*	541	17.45	100	3.33	693	22.35	929	30.97

Table 5.16 Summarized Inventory Level of Pilot Store#3 The data in column 'Before' are the inventory level using the ECR system and 'After' are the inventory level using the POS system

Inventory Level (Pilot Store#3)									
Product		Before				After			
Code	Name	August, 1997		September, 1997		March, 1998		April, 1998	
	Medium Moving								
M01	*Not Shown*	744	24.00	570	19.00	558	18.00	466	15.53
M02	*Not Shown*	483	15.58	425	14.17	594	19.16	615	20.50
M03	*Not Shown*	465	15.00	451	15.03	562	18.13	561	18.70
M04	*Not Shown*	433	13.97	327	10.90	723	23.32	403	13.43
M05	*Not Shown*	1334	43.03	1261	42.03	1079	34.81	1170	39.00
M06	*Not Shown*	647	20.87	924	30.80	1022	32.97	942	31.40
M07	*Not Shown*	433	13.97	491	16.37	759	24.48	877	29.23
M08	*Not Shown*	409	13.19	329	10.97	675	21.77	446	14.87
M09	*Not Shown*	295	9.52	240	8.00	280	9.03	255	8.50
M10	*Not Shown*	2803	90.42	2471	82.37	2402	77.48	2709	90.30
M11	*Not Shown*	2306	74.39	2297	76.57	2588	83.48	3222	107.40
M12	*Not Shown*	22780	734.84	21285	709.50	19894	641.74	20445	681.50
M13	*Not Shown*	1542	49.74	1774	59.13	2490	80.32	2547	84.90
M14	*Not Shown*	4668	150.58	4345	144.83	14386	464.06	3595	119.83
M15	*Not Shown*	1200	38.71	1686	56.20	1968	63.48	1804	60.13
	Slow Moving								
S01	*Not Shown*	378	12.19	395	13.17	508	16.39	271	9.03
S02	*Not Shown*	367	11.84	319	10.63	415	13.39	428	14.27
S03	*Not Shown*	368	11.87	247	8.23	422	13.61	418	13.93
S04	*Not Shown*	384	12.39	299	9.97	442	14.26	372	12.40
S05	*Not Shown*	256	8.26	216	7.20	264	8.52	206	6.87
S06	*Not Shown*	254	8.19	246	8.20	294	9.48	266	8.87
S07	*Not Shown*	252	8.13	249	8.30	252	8.13	295	9.83
S08	*Not Shown*	367	11.84	356	11.87	429	13.84	443	14.77
S09	*Not Shown*	300	9.68	305	10.17	467	15.06	549	18.30
S10	*Not Shown*	361	11.65	272	9.07	333	10.74	319	10.63
S11	*Not Shown*	332	10.71	315	10.50	442	14.26	361	12.03
S12	*Not Shown*	372	12.00	329	10.97	373	12.03	600	20.00
S13	*Not Shown*	372	12.00	337	11.23	384	12.39	630	21.00
S14	*Not Shown*	323	10.42	311	10.37	351	11.32	370	12.33
S15	*Not Shown*	301	9.71	320	10.67	389	12.55	316	10.53
	Fast Moving								
F01	*Not Shown*	3251	104.87	2679	89.30	2480	80.00	1656	55.20
F02	*Not Shown*	2433	78.48	2422	80.73	1929	62.23	1456	48.53
F03	*Not Shown*	2837	91.52	2852	95.07	1929	62.23	1513	50.43
F04	*Not Shown*	2207	71.19	2325	77.50	1621	52.29	1480	49.33
F05	*Not Shown*	2528	81.55	2340	78.00	1899	61.26	1617	53.90
F06	*Not Shown*	2440	78.71	2274	75.80	1612	52.00	1370	45.67
F07	*Not Shown*	2918	94.13	3537	117.90	2258	72.84	1818	60.60
F08	*Not Shown*	1970	63.55	1757	58.57	1698	54.77	1536	51.20
F09	*Not Shown*	1957	63.13	1660	55.33	1212	39.10	1418	47.27
F10	*Not Shown*	2024	65.29	1524	50.80	1540	49.68	1184	39.47
F11	*Not Shown*	2211	71.32	2221	74.03	1421	45.84	1626	54.20
F12	*Not Shown*	2184	70.45	1687	56.23	1451	46.81	1305	43.50
F13	*Not Shown*	4222	136.19	4017	133.90	2509	80.94	2764	92.13
F14	*Not Shown*	3296	106.32	2759	91.97	2094	67.55	1730	57.67
F15	*Not Shown*	2989	96.42	2402	80.07	1699	54.81	1744	58.13

Table 5.17 Calculated Inventory Level of Pilot Store#1 The data in column 'Before' are the inventory level using the ECR system and 'After' are the inventory level using the POS system

Inventory Level (Pilot Store#1)			
Code	Name	Before	After
	Medium Moving		
M01	*Not Shown*	25.83	26.13
M02	*Not Shown*	21.73	19.98
M03	*Not Shown*	17.32	18.75
M04	*Not Shown*	56.54	73.18
M05	*Not Shown*	86.76	79.33
M06	*Not Shown*	30.55	26.80
M07	*Not Shown*	40.57	47.63
M08	*Not Shown*	114.10	113.22
M09	*Not Shown*	144.68	142.44
M10	*Not Shown*	814.34	738.67
M11	*Not Shown*	685.17	692.46
M12	*Not Shown*	1577.71	1470.66
M13	*Not Shown*	264.76	197.72
M14	*Not Shown*	593.94	330.50
M15	*Not Shown*	211.03	183.64
	Slow Moving		
S01	*Not Shown*	22.73	18.56
S02	*Not Shown*	14.75	22.00
S03	*Not Shown*	24.28	23.19
S04	*Not Shown*	33.13	23.15
S05	*Not Shown*	19.85	18.56
S06	*Not Shown*	31.62	32.28
S07	*Not Shown*	112.69	87.96
S08	*Not Shown*	31.68	34.42
S09	*Not Shown*	17.25	23.34
S10	*Not Shown*	26.95	23.20
S11	*Not Shown*	20.15	20.32
S12	*Not Shown*	20.95	17.48
S13	*Not Shown*	34.75	31.71
S14	*Not Shown*	21.89	16.82
S15	*Not Shown*	15.91	34.43
	Fast Moving		
F01	*Not Shown*	160.20	126.55
F02	*Not Shown*	184.26	113.37
F03	*Not Shown*	154.96	116.65
F04	*Not Shown*	134.76	108.13
F05	*Not Shown*	87.88	81.02
F06	*Not Shown*	86.90	79.14
F07	*Not Shown*	92.22	96.85
F08	*Not Shown*	90.07	83.05
F09	*Not Shown*	72.50	66.78
F10	*Not Shown*	62.85	58.38
F11	*Not Shown*	102.82	82.74
F12	*Not Shown*	87.60	73.62
F13	*Not Shown*	101.28	86.18
F14	*Not Shown*	57.76	52.52
F15	*Not Shown*	60.80	46.29

For this situation where it is uncertain that the population is a normal distribution or not, the non-parametric statistic namely " Sign Test " is selected. This test is based on the number of " + " and " - " signs and performed in order to know whether there is a significant difference between the two population means. The sign test begins by specifying null hypothesis and alternative hypothesis for testing as the following :

H_0 = Assume there is no difference between population means of inventory level while using the POS system and the ECR system.

H_1 = Assume there is a difference between population means of inventory level while using the POS system and the ECR system.

X_{1i} = Inventory level of item number i while using the ECR system

X_{2i} = Inventory level of item number i while using the POS system

The difference in inventory level while using the ECR system and the POS system ($X_{2i} - X_{1i}$) indicated with the positive or negative signs are shown as follows :

Table 5.18 Sign Test of Inventory Level of Each Representative Item at Pilot Store#1

The positive(+) sign shows that the inventory level of that item is increased.

The negative(-) sign shows that the service level of that item is decreased.

Zero (0) shows that the service level is not increased nor decreased.

Inventory Level (Pilot Store#1)				
Code	Name	Before	After	Sign Test
	Medium Moving			
M01	*Not Shown*	25.83	26.13	+
M02	*Not Shown*	21.73	19.98	-
M03	*Not Shown*	17.32	18.75	+
M04	*Not Shown*	56.54	73.18	+
M05	*Not Shown*	86.76	79.33	-
M06	*Not Shown*	30.55	26.80	-
M07	*Not Shown*	40.57	47.63	+
M08	*Not Shown*	114.10	113.22	-
M09	*Not Shown*	144.68	142.44	-
M10	*Not Shown*	814.34	738.67	-
M11	*Not Shown*	685.17	692.46	+
M12	*Not Shown*	1577.71	1470.66	-
M13	*Not Shown*	264.76	197.72	-
M14	*Not Shown*	593.94	330.50	-
M15	*Not Shown*	211.03	183.64	-
	Slow Moving			
S01	*Not Shown*	22.73	18.56	-
S02	*Not Shown*	14.75	22.00	+
S03	*Not Shown*	24.28	23.19	-
S04	*Not Shown*	33.13	23.15	-
S05	*Not Shown*	19.85	18.56	-
S06	*Not Shown*	31.62	32.28	+
S07	*Not Shown*	112.69	87.96	-
S08	*Not Shown*	31.68	34.42	+
S09	*Not Shown*	17.25	23.34	+
S10	*Not Shown*	26.95	23.20	-
S11	*Not Shown*	20.15	20.32	+
S12	*Not Shown*	20.95	17.48	-
S13	*Not Shown*	34.75	31.71	-
S14	*Not Shown*	21.89	16.82	-
S15	*Not Shown*	15.91	34.43	+
	Fast Moving			
F01	*Not Shown*	160.20	126.55	-
F02	*Not Shown*	184.26	113.37	-
F03	*Not Shown*	154.96	116.65	-
F04	*Not Shown*	134.76	108.13	-
F05	*Not Shown*	87.88	81.02	-
F06	*Not Shown*	86.90	79.14	-
F07	*Not Shown*	92.22	96.85	+
F08	*Not Shown*	90.07	83.05	-
F09	*Not Shown*	72.50	66.78	-
F10	*Not Shown*	62.85	58.38	-
F11	*Not Shown*	102.82	82.74	-
F12	*Not Shown*	87.60	73.62	-
F13	*Not Shown*	101.28	86.18	-
F14	*Not Shown*	57.76	52.52	-
F15	*Not Shown*	60.80	46.29	-

Assumed that :

S(P) = The number of positive signs with the binomial distribution and the probability to succeed (positive sign) = 0.5

S(N) = The number of negative signs with the binomial distribution and the probability to succeed (negative sign) = 0.5

C = The critical value that make the probability of $S \geq C$

For Pilot Store #1

The medium moving products :

The number of positive signs (+) = 5

The number of negative signs (-) = 10

Sample size (n) = 15

By using 5% significant level, refer to the binomial distribution function while n = 15 and p = 0.5

Prob ($S \geq 10 / p = 0.5$) = 0.0916

Prob ($S \geq 11 / p = 0.5$) = 0.0417

For this case, C = 11 because it makes the probability nearest but not more than the significant level (0.05). It means for this case, H_0 is rejected and H_1 is accepted while the number of positive or negative signs S(P) $\geq$ 11 or S (N) $\geq$ 11

The number of positive signs (+) = 5

The number of negative signs (-) = 10

S(P) < 11 and S(N) < 11, that means H_0 is accepted or there is no difference between the population means of inventory level while using the POS system and the ECR system.

So the inventory level of this case is not significant to be increased or decreased.

By applying the same statistical test to all groups of data of three pilot stores, the results of sign tests are summarized and shown in table 5.19. The details of the tests are shown in Appendix C.

Table 5.19 Summarized Results of Sign Tests for Inventory Level

	Inventory Level		
	Medium Moving	***Slow Moving***	***Fast Moving***
Pilot Store#1	Not Significant	Not Significant	Decreased
Pilot Store#2	Not Significant	Decreased	Not Significant
Pilot Store#3	Increased	Increased	Decreased

The result of the evaluation shows that for nine groups, inventory level of three groups are improved or are significant to reduced, two groups are poor or are significant to increased, and another four groups are not significant to improved or reduced. However, it can not be concluded that the proposed POS system implementation can improve the inventory level of convenience store. Nevertheless, considering the proportion of the number of stores which the inventory level is decreased and increased it may be improved in the future if the case study can adjust or manage several factors that affect the inventory level. Most of these factors may be common to those impacting the service level of the store.

The first factor is the learning period for the proposed system. Even the POS system implementation is installed in the stores for eight months at the first store, the product analysis application has just been implemented in the stores for a few months. The operators need longer period to do trials and errors with the itemized information in order to capture the factors that impact the movement of the merchandises. Then the operators have to apply this information to the ordering procedure in order to suit with the ordering conditions.

There are several ordering conditions which impact the inventory level such as pack size, minimum order quantity, delivery cycle, and shelf space. Merchandises which have large pack size usually have large minimum order quantity. The reason is due to the delivery capacity that is the responsibility of the distribution center not mentioned in this report. The inventory level of this kind of merchandise is hard to improve. For example, a minimum order quantity of some products is 72 pieces while only two or three pieces are sold in a day. This means it can be sold for a month for one order. The order is made once a month which may be easy to forget. On the other hand if the operators are afraid of forgetting to order, they may order before a suitable time causing store overstock.

Ordering is a task that needs both skilled and experienced of the operators. With the case study's situation having high employee turnover situation, the ordering task may not be performed effectively which may cause overstock or goods shortages. New operators require a period of time to learn how to perform this task effectively.

The economic recession also impacts the inventory level of the store. The operators will find it hard to forecast the demand occurred during

inconsistency situation. The customer behavior may changed in this situation. Some customers who used to purchase the merchandise in big sizes may change their behavior to purchase smaller ones. On the other hand for some products, the customers may increase the purchase quantity for fear of the rising price that usually occurs during this testing period. These inconsistency activities give the operators a hard time to maintain the inventory level. So they may prevent goods shortage by ordering too much that causes store overstock. Furthermore, under this situation, it generates the chain effect to the distribution centers and the suppliers. Excessive orders at the same time cause goods shortage from the distribution centers (DC) and the suppliers.

An other factor is the quality of information. At the beginning, the information's quality was not as good as the present. The itemized information presented to the operators was not accurate so the operators may be misled and feel unconfident about the itemized information. Therefore, the use of itemized information to perform product management will not be effective.

5.3.4 Impacts of the System on Quality of Information

The critical key success of the use of the POS system is that the organization is able to utilize the itemized information provided by the POS system. The POS system will be able to generate the quality of sales information if it possesses good quality database.

The case study began processing information on a small scale with a small number of stores. After a period of time, the number of stores increased rapidly and the supporting departments also grew and expanded. However, the systems tend to grow independently rather than according to the growth of the firm. The departments within the case study usually develop their own applications and data entry procedures. So the database of the firm is handled

by many persons and many procedures with multiple programs and applications. By this situation, the data entry persons may not know the importance of the data they maintain, what data are used, and who will use the data.

After that the firm establishes the Management Information System Department (MIS) which is responsible for improving the effectiveness of using information within the case study. In order to reduce many problems generated by the traditional information management procedures, the database are pulled together and collected to serve many applications efficiently by centralizing the data in order to be shared among the departments having the authorization. However, there are many persons from many departments responsible for data entry. The database especially the itemized information of the case study before having the POS system is used as a reference which is not directly used for daily sales activities. So the frequency and the volume of using itemized information are quite low which mean the mistakes or inaccurate itemized information have little impact to a few persons. Furthermore, some fields of database such as bar-codes may not be directly used by any department.

The implementation of the POS system which uses the itemized information to perform sales activity indicates the quality of information. The bar-code information, product price, product effective date, and etc. are used for every transaction every day. If ten percentage of product information are incorrect, it means 200 products information are incorrect. These incorrect data will be used a thousand times a day at each store. After implementing the POS system, the case study has found that there are many incorrect or inaccurate itemized information. There are many causes of incorrect database or information that confuse the case study and difficult to correct. It can be

classified as two sources of error. The first source is from the error within the case study called internal causes while the second cause is from vendors or suppliers called external causes.

There are many internal causes that generate poor quality database. The first cause is human error that is usually found in many situations. It is known that the database composes of many fields. For instance a product file may consist of 25 characteristics of product description, seven digits of in-house product code, 13 digits of standard bar-code or source marking (the bar-code labeled at the package of the products from manufacturing), eight digits of product cost (including decimals), eight digits of product price (including decimals), eight digits of product effective and product suspend date, and etc.. These kinds of detailed database are maintained manually which mean that every time the case study decides to launch new products, cancel the slow moving products, or change the products' details, the staff responsible for those changes have to manually enter that data. Sometimes there are twenty new items launched at the same time having almost similar product codes, bar-codes, or sizes, and all have to be maintained by one operator making the mistake of data entry possible. This kind of task requires very accurate input. But due to human nature, the mistake can occur by many factors such as the background of the operator, working procedures, working environments, and etc..

Furthermore, some fields of data such as bar-codes require to be maintained by the staff who have the knowledge about the standard of those data. For example, each digit of the EAN bar-code has its own meaning as shown in figure 5.4.

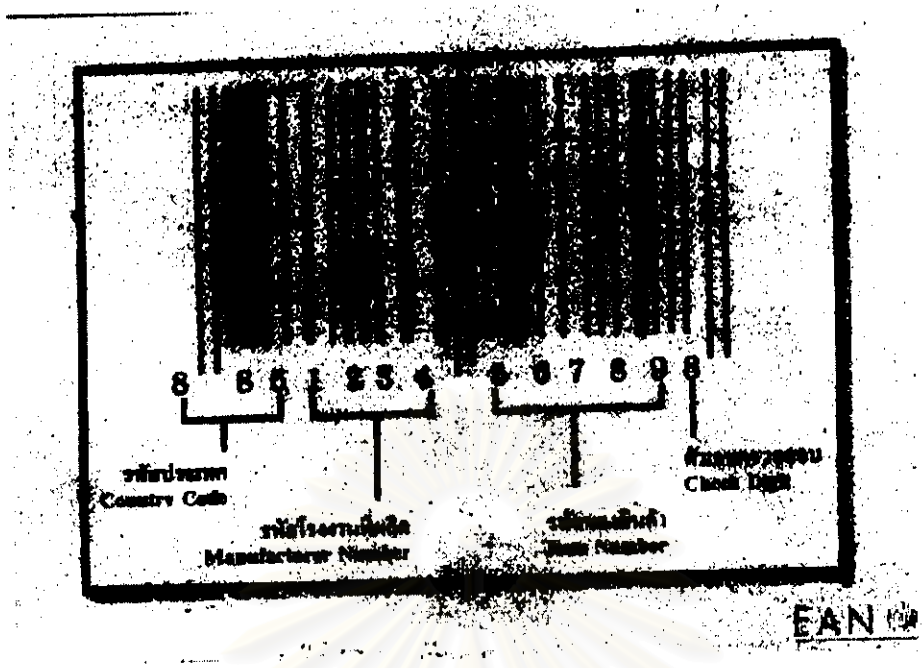


Figure 5.4 Meaning of fields in an EAN bar-code

An example of the error when entering the bar-code to the database is that certain standards of the bar-code put zero (0) as the first digit. Some operators key in this digit while others ignore it. In the past, the bar-code information is not directly used so this kind of error occurred from misunderstanding still appears in the database. The cases of error of data entry generate incorrect data such as mismatching among products description, in-house product code, bar-code or source marking (the bar-code labeled at the package of the products from manufacturing), product cost, product price, product effective and product suspend date, and etc..

Other errors of database are generated by the external causes. This case usually occurs at the bar-code of the products because there is no standard procedure for updating or informing the bar-code information. Some vendors or suppliers who have good discipline and understanding of the importance of bar-code information have to update this information to the firm correctly and timely while others don't. If the suppliers do not inform the changed of bar-

code information to the case study, when their products are sold by the ECR system there will be no problem. But after implementing the POS system, this information has to be used frequently and timely, so the quality of information is indicated by the system.

After implementing the POS system, the case study found that there are around 200 items or ten percents of the items with incorrect itemized information generated from many incorrect data entry procedures and the misunderstanding of database maintenance or updates. The case study has been trying to correct this problem for ten months. The correction procedure began from setting a small working group for solving this problem, surveying the incorrect information, investigating the cause of the problem, correcting the incorrect information, and verifying the new coming information. *The result of this activity shows that the incorrect product information percentage is reduced from* ***ten*** *percent in August 1997 to* ***one*** *percent in April 1998.*

5.3.5 Impacts of the System on Store Image and other Intangibles

Generally, the implementation of the new technology or new system which tends to be computerized or automated will impact the organization both on the internal and external. Moreover the impacts can be both positive and negative. Furthermore some of the impacts of the system are easy or possible to quantify while others not. The tangible impacts were quantified by many criteria as presented previously. This topic will mention about the intangible impacts which are difficult or impossible to quantify immediately but may lead to quantifiable gains in the future. *This is the positive conclusion and is on the assumption that there is no or less incorrect database. On the other hand, whenever the proportion of incorrect database is high, the result will be negative or contrary to this conclusion.*

The first criteria that the operation considers when introducing the new system or changing any store operation is the impacts to the customers. The customer satisfaction level can be considered by many points of view. The *image* is one criteria that is hard to quantify but may generate high impact to customer satisfaction. The implementation of the POS system impacts the image of the case study due to the effort of the firm to provide better customer service by implementing a higher technology which requires more investment. This indicates that the case study always cares for the customer. By using the POS, the customers can recheck the corrections of the transaction easier than when using the ECR. The names of the purchased items are listed for every item while the ECR can only list the names of the groups of that items.

The next issue that usually is a problem to the organization which tries to implement a new computerized or automated technology or system is the understanding of the *employees* about the unemployment situation. The objective of this POS system implementation is clarified to the employee at the beginning of the project. The implementation of this system is not aimed to reduce the number of employees but to improve their efficiency. The system will help the staff to serve the customers easily and to prepare financial reports and other paperworks effectively. The store manager will have more information, more accurate information, and more timely information to manage their stores. This will enable the store manager to have more time to concentrate on improving customer service in order to increase sales rather than waste time in doing routine or paperwork. Furthermore, this system is easier to use than the ECR system so the training period is shorter. The impacts of the system implementation will not have any negative impact to the employees. On the other hand, it will increase employees' job satisfaction and enhance employees' goodwill. Also, it will reduce employees fraud because every transaction can be tracked back easily.

The POS system implementation provides better *management of price changes* which the firm has quicker response to the market. By using ECR, when the price of the product is changed, there are a lot of activities the store staff must perform. For example, the staff have to re-label the price tags, set up the key board of the ECR manually, do inventory physical count in order to mark up or mark down the inventory amount, and etc.. By using POS, most tasks will be done automatically and can be performed by the headquarters.The price is changed at the headquarters and sent to every store through a telephone line. An extensive job of a thousand stores can be performed by a few staff at the headquarters.

The system also increases *organizational flexibility*. The firm can launch new customer service types easily. The new customer service types include the acceptance of any payment types (credit cards, debit cards, smart cards, member cards, etc.), the selling of various tickets (movies, travels, concerts, sports, etc.), and the selling by catalog media, and etc.. The POS has the capability to perform most kinds of service because it is programmable and easy to modify. This will make the firm more competitive than the competitors and very convenient for consumers.

The ability to satisfy *fiscal requirements* is another benefit from the implementation. The inventory control will be more accurate and the sales information will be clearer and easy to track back. Thus, the government or Revenue Department will be able to audit easily. Through this, the image of the organization is also improved.

5.3.6 Major Factors Affecting Implementation of the System

1) Database

The database of the case study is used in many activities, of various departments. It is used by the purchasing department, distribution centers, accounting, marketing, operation, and etc.. For the existing system, information such as PMA (Product Movement Analysis) code (two digits), product code (seven digits), product description (name, size, color, etc.), product cost, product price, status (effective date, suspend date) is usually used.

The structure of the database was designed several years ago in order to support future use. There are many departments responsible for data entry. For example, the product cost is recorded by the purchasing department while the product price is assigned and recorded by the marketing department. The database is kept in the central server and can be shared among many users. Each department uses these information for different purposes. The quality of information will also impact the users at different levels.

The use of the POS system requires one important database which is the bar-code information. The quality of this kind of information will be one of the critical factors for the proposed system. The poor quality of database reduces the performances of the proposed system. It directly impacts service speed. For example, whenever the database of bar-code is incorrect or incomplete then the operators have to perform sales activity manually. The speed of manual process is lower than the automatic process so the service speed of the proposed system will be reduced. It also impacts service accuracy. For example, if the database of product price is incorrect then the service accuracy is reduced. Furthermore, the use of incorrect data will lead to misunderstanding when analyzing the itemized information. Then service level and inventory level will be impacted

too. It can be said that if the poor quality database is used, the poor system performance is performed.

2) Software

The firm is always improving its technological efficiency. This is indicated in the existing system which already uses a personal computer to perform store tasks such as product ordering task. The applications on the store computer are developed by an internal programmer. Most applications were run under the DOS base because the beginning of the application had been developed many years ago. At that time, the application which run on DOS base is practical due to easy coding program and compatible with its hardware.

The software of the proposed system is the modification of the software package which is used in other businesses. It was modified in order to match the case study's requirements. The application package has been created recently. It runs on Microsoft Windows base with the original package on Microsoft Windows Version 95.

The problem was discovered when the store controller application for the proposed system requires Microsoft Windows Version 95 (Win 95) while the existing store computer system runs on DOS. The two computer systems are not compatible. Firstly because the trend of computer software will go to Windows base, so the case study's programmers try to convert or modify the existing system in order to be compatible with the proposed system, but it is not successful. However, it can be modified to be compatible with Microsoft Windows Version 3.11 (Win 3.11). So the vendor's programmers have to modify the software to be compatible with Win 3.11 then the incompatible problems seem to disappear.

Unfortunately the new incompatible problem is generated because of the solution of the previous problem. The remote access software of the package which is used for Win 95 is not compatible with Win 3.11.

Remote access software is the application used in order to make the programmer or the technical support person get access into the users' computer through communication lines (such as a telephone line) without going to the site. Then the programmer may be able to correct the application errors through this communication channel. This remote access software of the proposed package requires Win 95 for some technical problems. When the store controller is modified to run on Win 3.11, this remote access software still works but generates problems to other applications.

The case of incompatible application is the case study for the firm wishing to modify some applications to fit with certain applications. However it may consume more time and more expenses than redesigning the total system. This issue should be considered carefully.

3) Hardware

The same hardware of the proposed system was implemented to other retail businesses such as department stores, health care stores, and etc., but never to convenience stores like the case study. Comparing the hardware configuration of the proposed system with the hardware of the existing system, some disadvantages or some unfamiliar features which impact the system implementation should be mentioned as a reference for the new hardware selection.

This set of the proposed POS hardware is a new technology equipment which seems more convenient to use but less durable and reliable compared

with the existing ECR hardware. This proposed hardware may work and have enough durability and reliability properties at other retail businesses. However the durability and reliability of this proposed hardware may be insufficient for this case study. This is not a conclusion, but should be observed for further consideration.

4) Procedure, Operation Environment, and Business Environment

The procedure and operation environment of the case study are unique, and affect the implementation of the proposed system. After installing the proposed system to the pilot store, many procedures are created in order to reduce some problems.

Since the pilot stores are operated 24 hours a day, the POS system has to be operated at the same period which frequently generates error files. The programmer found that the cause of this error is that the central processing unit (CPU) is operated 24 hours a day without shutting down. The system requires a short shut down period in order to clear or reset some memory so as to operate normally. Thus, the procedure for daily shut down has to be implemented.

The next change or modification due to the procedure and operation environment is the sales function. At the beginning, a mix and match sales function is designed in order to reduce human error. The mix and match function is used in case of a set of products is purchased together which will automatically be discounted according to the promotional campaign. By using this function, the operators will not necessary have to remember which product is in promotional campaign when selling together with other products. They can scan each product independently and then the mix and match function will automatically be discounted for promotional products. This seems to make the

operators more comfortable when they sell the promotional items. Furthermore, the inventory of each item will be easy to control.

After implementing this function to the operation environment, the result is that the use of one touch key for each promotional set is required. There are many reasons for this requirement. Firstly, the operators are familiar with the traditional procedure which uses one touch key for selling promotional set. Secondly, the different procedures make the supervisor, the trainer, or even the operator handles it differently for the same sales activity. The last and important reason causing the change is in the real operation environment in which the customer usually buys the set of promotional items rather than individually. For customers who do not know the promotional campaign or are not interested in this promotion, the operator is assigned to inform about the promotional campaign to the customer in order to increase sales. So most promotional items are sold as promotional sets. This makes the operators do more activities using the proposed mix and match function. For example, if the customer buys a set which consisted of three different items then the operators have to scan three times if using the proposed mix and match function. On the other hand, the operators can key one touch key for selling this set of promotion. For these reasons, the function is modified in order to support this requirement.

The last issue that affects the implementation of the proposed system is the business environment. At this moment, some stores in the case study provide a counter service business which uses the POS for billing the customer. This billing system requires to key in the text in case the customer would like to apply for membership. In the near future, it is decided to merge the POS system of counter service and the store. For this plan, the proposed system has to provide a keyboard which is able to key in the text. So the keyboard of the

proposed system looks like a keyboard for normal personal computer. It is not the most suitable hardware for convenience store but it has to be a normal keyboard. This has an impact on the performance of the system too.

5) Bar Code (Source Marking)

The POS system has to scan the bar-code to identify the items. After implementing the system, many problems of the physical bar-code usage are discovered. These problems impact the performances of the system directly in reducing the service speed and service accuracy. It also impacts service level and inventory level using incomplete information. The problems of bar-code usage can be classified in two categories.

The first category concerns problems of products with the bar-code printed at the package of the product from the suppliers. The second is the problems of the products without the bar-code printed from the suppliers.

The bar-code which is printed on the products' packages from the supplier is called " Source Marking ". After implementing the POS system, the problems about the quality and the standard of source marking are found. There are several issues that should be recorded in a list of potential problems that may be found in the future when the case study implements the total system.

The poor quality and standard of some source markings that the scanner can not read are due to many issues such as the quality of printing, the use of low contrast color, the inappropriate surface of package, the misunderstanding or poor knowledge of bar-code standard, and etc.. The quality of printing is a problem because if the bar-code is poorly printed then the normal or standard scanner may be unable to read. Some high quality scanners may be able to read but they are costly and unsuitable for the case study. The selection of two

colors that can be used together for printing the bar-code impacts the quality of the bar-code. The contrast of the dark bar and the light bar should be appropriate in order to make it easy for scanning.

The case of poor quality bar-code such as the marketing purpose. Sometimes the color of the bar-code is designed by the designers who do not have the knowledge or consideration about the quality of the bar-code. This is an example of inappropriate color of the bar-code.

The surface of the package is another problem. Two normal examples usually found will be mentioned in this report. The first case is the too small printing area. Examples are products such as candies, pens, pencils, and etc.. The second case is the shape of the package particularly the cyclic surface which is the most inappropriate shape for printing and scanning bar-codes.

The second category is products without bar-codes. This kind of products are handled by other procedures. Some products which is fast moving and/or generate high gross profit (GP) such as hot food, fountain carbonate beverage (FCB) are assigned to one touch key. But other products which is slow moving and/or generate low GP are hard to handle and cause reduction in system performances. The alternative ways to solve this problem have been discussed for several years, but no conclusions have been reached. This problem still exists and will be the issue in the future that requires solution in order to improve system performances.

6) Economic Recession

Thailand's economic recession in this year (1998) impacts the system implementation. At the beginning of the case study's project, it was decided to have a POS pilot project in order to study the impacts of the system when

applied to the store operations. Furthermore, if the bargaining result is not acceptable, the firm still has the alternative way to develop the pilot project and apply through the organization.

During the bargaining and the pilot period, there was an economic recession in Thailand. This causes the firm to postpone the decision to implement the total project. The firm also reduces the budget for the pilot project which lacks of resources for further development. Furthermore, in order to survive in this economic situation, the firm would like to continue improving the efficiency with the minimal cost, thereby changing the direction to focus on improving the existing system in this economic recession period. The pilot project will then become the lab for studying the potential problems and impacts of the system to a few store operations. The firm will collect this experience and information together with adjusting the company's environment to support the total project implementation which may be implemented in a few years. This situation impacts the progress of the pilot project due to budget, resource, and timing.

7) Government Regulation

The government regulation impacts the implementation due to the hardware issue. The Revenue Department requires hard copies of sales slip and assigns the firm to keep this huge volume of hard copies for five years. This impacts the implementation because the case study decides to use the thermal printer which is higher in performance than the dot matrix printer. However thermal paper is not accepted by the Revenue Department due to its unreliability. Even though the suppliers guarantee that the paper can be kept for five years without damaged, the Revenue Department claims that for Thailand 's climate and temperature, the thermal paper can not perform its capability

completely. So the suppliers are requested to avoid using the thermal printer at any site.

Electronic journal is another issue that the case study tries to apply to the firm, but is still rejected from the Revenue Department. This hinders the firm to improve performance and reduce cost.

8) Employee Turnover Rate

The employee turnover situation of the firm directly impacts the system implementation. At the beginning of the project, the project team request the operation department to avoid changing staff of the pilot stores. The operation department in turn tries to offer good cooperation by minimizing the staff rotation of the pilot stores. However, with the firm's situation such as cost savings, staff carrier paths, and etc., the operation department found it hard to avoid this situation. Thus the employee turnover rate still occurs even in the pilot stores.

This can impact the project because new employees need to be trained. Though the learning period is shorter than the existing system, new operators may perform inaccurately and slowly that impact the image of the store. Thus transaction is different from the existing system which has a different condition. The ECR operators can be rotated from the close by stores, but the operators of POS have a limited number.

The employee turnover rate impacts not only the quality of service but also more importantly the ordering task which requires long term skills. Since product analysis from an experienced operator is an important process before placing order, there will be no experienced person in those stores who can perform a good analysis for ordering task if the turnover rate is high.

5.3.7 The potential problems of bar-code information

During the POS pilot project, there are some problems about bar-code information. Possible causes of bar-code or source marking problems should be listed as a guideline for the case study when investigating the correction of bar-code or when the case study requires to set a standard procedure for updating or informing the bar-code information to the firm.

1) The bar-code of the same product is changed

- Repackaging

There are many reasons for changing or repackaging. Some products are fashionable products which always require the new look, so the suppliers have to frequently change the packages. After repackaging, the bar-code is also changed. If the suppliers do not request for any additional cost then they may not inform the retailers about this change. Other reasons for repackaging are reducing packaging cost, changing package material, etc..

- Changing Product Shape

When the physical shape of the product is changed, it usually requires new package shape. The reasons of reshaping the products are similar to repackaging.

- Promotional Campaign

Some promotional campaigns have an impact to the package. The suppliers may pack the premium together with the product for convenient delivery and easy control of their inventory. Furthermore, the products may look more attractive when displayed on the shelf. For these reasons, the package may be changed or wrapped together with the premium. However, this activity requires a different bar-code in order to make the product unique.

2) One product has many bar-codes.

• Bar-codes of individual item and of multi-packs.

Bar-codes of individual item and of multi-packs such as pasteurized milk are packed together. Normally, it is sold both as an individual item and multi-packs. Some vendors assign the new bar-code for multi-packs while others do not. This issue impacts the sales operating procedure and requires the firm to set a standard procedure for handling this kind of products.

• Various versions of the same products at the same time.

The same products may be repacked as described previously. This kind of products is available at stores as many packaging versions.

• Inner and outer labels

Some products such as liquor have labels at the bottles and the outer boxes. These two labels are printed with different bar-codes. It can confuse the operators while scanning.

3) One bar-code is assigned to a different product.

This case is found from the package of fresh eggs. The vendor uses the same wrapping material for packing any package size of the eggs. For example, six packs and twelve packs use the same packing material and they are printed with the same bar-code.

5.4 Cost of the System

The POS system implementation requires a quite high investment. Normally any projects which the firm decides to invest must contribute an appropriate level of return on invested capital. It is well known that the

investment in technology like the POS system may generate the benefits in the long-term rather than in the short-term. It is quite hard to analyze the benefits and costs of the system from implementing a short term pilot test. However, the costs of the system and system implementation should be recorded in order to compare with the benefits generated by the system. So in this situation, this report will present only the estimated costs of the proposed system.

Before analyzing the cost of the system, it is important to keep in mind that the level of investment is the approximate cost based on the conditions at the pilot test period (the fourth quarter of 1997 to the first quarter of 1998). The actual cost of the system will be known after a vendor is selected and the implementation schedule set up. At that time, the cost may be different from this estimation because of many factors such as the level of automation of the firm at that time, the exchange rate (in case of importing the equipment), the requirements, and the contract.

In order to analyze the cost systematically, the cost of the system should be classified into two categories. The first category is the cost associated with developing and purchasing the system. The second category is the cost which is associated with operating the system. The details of this cost estimation are shown in Appendix D.

The cost estimation of this pilot project uses the cost worksheets shown in Appendix D as a guideline because of the difference in implementation environment and contract. The cost of this pilot project is associated with two categories as fixed costs and variable costs. The cost for three pilot stores and one supporting system at the headquarters are summarized as follows :

Cost Summary Report

POS Pilot Project (Three Pilot Stores)

Hardware

Sales Area

2 Store needing 2 Point of Sales Terminals

= 2 x 2 x @ 140,000 = 560,000 Baht

1 Store needing 3 Point of Sales Terminals

= 1 x 3 x @ 140,000 = 420,000 Baht

Store Controller

3 Store needing 1 Store Controller Terminal

= 3 x 1 x @ 40,000 = 120,000 Baht

3 Store needing 1 set of Facility and Installation

= 3 x 1 x @ 5,000 = 15,000 Baht

Headquarters

1 Personal Computer (Headquarters Controller) needed at HQ

= 1 x 1 x @ 35,000 = 35,000 Baht

1 HQ needing 1 Store Controller Terminal

= 1 x 1 x @ 40,000 = 40,000 Baht

1 HQ needing 1 Point of Sales Terminal

= 1 x 1 x @ 140,000 = 140,000 Baht

Total Hardware Cost = 1,330,000 Baht

Annual Cost

Software*	=	159,600	Baht
Maintenance**	=	119,700	Baht
Training***	=	15,000	Baht
Total Annual Cost	=	**294,300**	**Baht**

Note

* Software cost charged from 12% rate of the cost of hardware annually.

** Maintenance costs charged from 9% rate of the cost of hardware annually.

*** Training cost including cost of trainers, training materials, training facilities, etc.

Remarks

- Based on exchanged rate at $ 1 = 39 Baht.

- This cost summary report does not include the cost of existing hardware and software which are currently used in the case study. For example, cost of modems, cost of telephone lines, cost of software for financial reports, etc..