A DEVELOPMENT OF ON-LINE STATISTICAL PROCESS CONTROL (SPC) CHART FOR CONTROLING MONITORING AND EVALUATING QUALITY OF GOODS TRANSPORTATION SERVICES

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ABSTRACT

This research is motivated by competition in the transportation and logistics business. The service providers are keen on finding a method to create competitive advantage and cut costs. From review, it was reported that many providers recorded statistics on operational process in the database. We then proposed to utilize such database by adopting a concept of so-called Statistical Process Control (SPC) with the extended on-line application through the computer network. The proposed system is coined on-line SPC. The idea is to give the management freedom to monitor and control the quality of operational process. In the case study, we applied the developed on-line SPC to a transportation and logistics service provider. The billing time is used as a control measure. We illustrated the on-line SPC in details and showed that it can be used to detect the special causes of the errors. In the future, we plan to test the on-line SPC to monitor and control other measures of the service quality.

KEY WORDS: STATISTICAL PROCESS CONTROL (SPC) / TRANSPORTATION / LOGISTICS

133 pages

การพัฒนา ON-LINE STATISTICAL PROCESS CONTROL (SPC) หรือแผนภูมิควบคุมแบบ ON-LINE สำหรับควบคุมติดตามและประเมินผลคุณภาพการให้บริการธุรกิจขนส่งสินค้า

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บทคัดย่อ

การวิจัยเรื่องนี้มีแรงจูงใจและปัญหามาจาก แข่งขันกันอย่างเข้มข้นในธุรกิจด้านขนส่งและโลจิสติกส์ ซึ่งผู้ประกอบการต่างหาวิธีการเพื่อสร้างความได้เปรียบทางการค้าและลดต้นทุนในการดำเนินกิจการ จากการสำรวจเบื้องต้นพบว่าบริษัทผู้ให้บริการด้านขนส่งและโลจิสติกส์หลายรายซึ่งมีสาขาที่ให้บริการอยู่มาก ได้มีการบันทึกข้อมูลสถิติการทำงานผ่านระบบเครือข่ายคอมพิวเตอร์ ซึ่งทุกสาขาจะสามารถเข้าถึงข้อมูลและรับทราบข้อมูลการทำงานโดยผ่านระบบนี้ได้ ผู้วิจัยจึงมีความคิดในการควบคุมคุณภาพกระบวนการทำงาน โดยนำแนวคิดการควบคุมคุณภาพเชิงสถิติที่สามารถวิเคราะห์ข้อมูลการทำงานได้อย่างทันทีหรือ On-line Statistical Process Control (SPC) มาใช้สำหรับประเมินการทำงานในกระบวนการต่างๆ ของธุรกิจธุรกิจด้านนี้ เพื่อรักษามาตรฐานการทำงาน และเป็นประโยชน์ในการหากลยุทธ์สำหรับพัฒนาองค์กร On-line SPC ที่พัฒนาขึ้นสามารถใช้เป็นเครื่องมือสำหรับตรวจจับความผิดปกติของกระบวนการทำงาน และลดปัญหาที่เกิดขึ้นในฝ่ายปฏิบัติการ โดยการพัฒนาแผนภูมิควบคุมให้สามารถใช้งานในระบบเครือข่ายคอมพิวเตอร์ โดยที่ผู้ประกอบการสามารถ วัด วิเคราะห์ ควบคุม ติดตาม การดำเนินงานต่างๆ ของฝ่ายปฏิบัติการ ได้ด้วยตัวเองผ่านระบบเครือข่ายคอมพิวเตอร์ในองค์กรได้ตลอดเวลา บทความนี้ได้อธิบายแนวคิดและการพัฒนาต้นแบบของระบบ On-line SPC พร้อมรายงานผลการทดสอบติดตามการดำเนินงานของบริษัทขนส่งและโลจิสติกส์ขนาดใหญ่แห่งหนึ่ง

133 หน้า

CONTENTS

CONTENTS (cont.)

CONTENTS (cont.)

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (cont.)

LIST OF FIGURES (cont.)

LIST OF FIGURES (cont.)

LIST OF FIGURES (cont.)

LIST OF FIGURES (cont.)

CHAPTER I
INTRODUCTION

1.1 Background and Problem Statement

Statistical Process Control (SPC) has been applied to the industrial products since after World War II (Foggin, 1984) to control, monitor, and assess the quality of goods to meet up with market as well as the consumers need in terms of quality worldwide such as acceptance of products from Japan and the United States. The application of SPC has been use widely (Scordaki & Psarakis, 2005). Basic usage of SPC is to apply Control Chart to control, monitor and improve the process on industrial business 65 years ago. Control chart is an instrument that enables operation team to have a closer look, monitor and control variation of statistics. Whenever we find out uncertainty values on products or quality, control chart is able to specify as well as to sort of the uncertainty. SPC techniques have been developed continuously in order to response to fastness, correctness and preciseness on calculation of values (Hossain et al, 1996). The change in technology also leads improvement in enhancing level of performance efficiency. In the past, the assessment of quality is spendthrift and lower in preciseness. The use of process control such as Real-time computer is an alternative to enhance credibility since its efficiency is relatively high, fast, the ability in collecting data is high and help to reduce the cost of entrepreneur (Hunt, 1989). The operation such as Real-time computer creates advantageous to user in terms of product quality control or bugging in the production process without relying on engineer. Further, controller becomes more closes to the operation officer or user (Young et al, 2007). Controller's duty is not necessary to monitor or to inspect during operation as well as from daily report. Controller is able to control the process from Real-time computer everywhere such as the office, manager's room or any place where computer is installed to the network effectively. This is the success in applying SPC technique to industrial business (Tyworth et al, 1989). Apart from that, the transportation industry is interested in applying the SPC technique by studying and experimenting in real

situation such as the Less-Than-Truckload transportation. The application is to help enhance the service quality in delivery control in order to deliver goods on time (Wood, 1994). Further, there is concern over Total Quality Management (TQM) at present in which helps to enhance SPC technique to become more interesting. Varieties of concept in applying SPC to other industrial productions have been developed such as in the service procedure, transportation business and several service industries. It is to help assess the indicator in terms of application to different kind of business other than the production aspect (Gerst, 2003). For example, the application of Control Chart which is the heart of SPC to control the percentage of on-time delivery to the transportation service and the control of customer's satisfaction in the health service industry. The assessment and control of violence in the community have been done in order to maintain the quality of life is used in the projection of the petrol production monthly. This is to control the quantity of petrol production to meet up with customer's demand. Apart from that, several other businesses have used SPC to apply with its industrial. This is the proof that during 65 years, SPC technique is one of the effective instruments used to control quality.

From the study on Statistical Process Control (SPC) technique, the researcher finds out that Thailand has not applied SPC to the process in the service industry. Hence, the researcher is going to develop the idea related On-line Control Chart to the transportation process of one of the biggest logistics agent in Thailand. The idea is to apply Statistical Process Control (SPC) with the service (Raymond & Dubuque, 1991). By developing SPC software that meets up with the customer's satisfaction, the package must be fast and effective when in use. This kind of development enables user to understand the software clearly. Therefore, it helps to enhance competency and efficiency of the software when applying in the business. The software should be able to response to the highly competitive working environment since every minute counts. Moreover, it should help reduce the cost as well as quickness. The information gained is precise as well as reliable. It is automatically started without the controller or engineer. This is to reduce the complexity on report since the control chart is easy to understand and very interesting. In the scope of developing the software, the researcher is going to apply the concept of monitoring and inspecting the heartbeat graph of patience which doctor and nurse keep

watching over ER patience. Whenever things gone wrong or problem occurs, there is going to be a search for cause as well as the process to assist in time. From this concept, the user is able to find out an unusual that occurs within the procedure immediately and will be able to solve the problem at the right direction. Apart from that, this can help prevent the recurrent of problems. The aim is to maintain the current working standard as well as to develop the new standard to offer to the market's acceptance.

1.2 Objective

This research has two main objectives as follow:

1.2.1 To develop instrument that can inspect working mistake as well as to help reduce the problems occurred during the operation by applying the concept of Statistical Process Control (SPC) and Six Sigma together.

1.2.2 To develop control chart that can be operate with the On-line Control Chart.

1.3 Scope of the study

The area of this research is to build the control instrument to monitor and notify whenever problems occur during the operation. The method is to sort out information occur during the operation to analyze in order to inspect the mistake and report the result in the form of control chart. This is to help the entrepreneur in the logistics industry to operate the process efficiently. This research obtains exact data from Nim See Seng Transportation1988 Company Limited which is the logistics service provider and the largest transportation of the country as the case study.

1.4 Research Result

The result gained from this research is the Control Chart that can be operate on-line to inspect and notify the mistake or unusual problems that occur during the procedure of the logistics transportation.

CHAPTER II
LITERATURE REVIEW

This chapter is going to explain the concept of Statistical Process Control or SPC (Foggin, 1984). Statistical Process Control technique can sometimes be confused of its concept with Statistical Quality Control. In fact, SPC is not a new concept since it is generally known in the early 1930s by Walter A. Shewart who has developed the control chart in order to improve the efficiency in the product industry (Tyworth et al, 1989). Control Chart is a heart of SPC. This research is going to study operation process that applies control chart with the logistics industry. It aims to enable entrepreneur to analyze each step of operation with the control chart which can be advantageous to the firm as well as it has been with the logistics industry. The elaboration of control chart from many companies around the world is presented here to show how control chart can enhance the development of the firm and can run smoothly.

2.1 Principle Control of Operation under the Control Chart

In the highly competitive period, Total Quality Management plays an important role in the industries (Hunt, 1989: Wood, 1994). Entrepreneur must find certain way to control quality in every step of operation to meet up with development, improvement and enhance efficiency in terms of working. Apart from that, reducing of defect in percentage as well as increasing of product quality or service is required. These are to respond to the consumer's demand on quality goods or better service.

Statistical Process Control is widely used in the production industry. This technique is used to increase product quality and standard to the maximum quality goods in order to meet up with the demand and satisfactory. It helps to reduce the return of unwanted goods due to the fact that goods cannot meet up with specified

quality. This is the reason to develop efficiency on goods and service in order to compete with other entrepreneur in the industrial circle.

2.1.1 Statistical Principle of Quality Control

Yuth (2005) has mentioned about statistical principle that it is mathematical technique that helps analyze, interpret and present collected data for making a decision. The procedure of statistical principle consists of four procedures that are:

1) Collection
2) Analysis
3) Interpretation
4) Presentation

From the above procedure, we are able to understand the process of applying statistical principle with quality control which is not complicated thoroughly. In this chapter, the researcher is going to emphasize on analysis and presentation of data gained from operation by using control chart to explain. Control chart is a tool presented through the line graph which is easy to understand. Further, it can be applied with several other industrial, not only just the product industrial.

The application of control chart on the firm's organization and other aspects has been used widely such as the assessment on quality of life of local administration community, the assessment on customer's satisfactory, and Digital Dashboard for small size bank and financial institution. The operation on many aspects shows that control chart is useful for efficiency development of effective process (Gerst, 2003).

2.1.2 Control Chart

Control Chart is statistics tool that differentiate variable from special cause of data from variable of natural cause through important agent that is control limit of the chart (Kitisak, 2007). It acts like an alarm bell when it detects unusual cause happens during operation. Control chart consists of upper control limit, central line, and lower control limit (UCL, CL, LCL). They exist to control and monitor the variation of process as well as to assess variation that occurs during the operation

whether it is normal or not. If unusual cause happens during the operation, at what state we are able to figure out. The chart can help to find out unusual cause easily and enable us to fix it fast and correct. It helps prevent the repetition of unusual cause according to the control chart of Figure 2.1 (Chidchai, 2008).

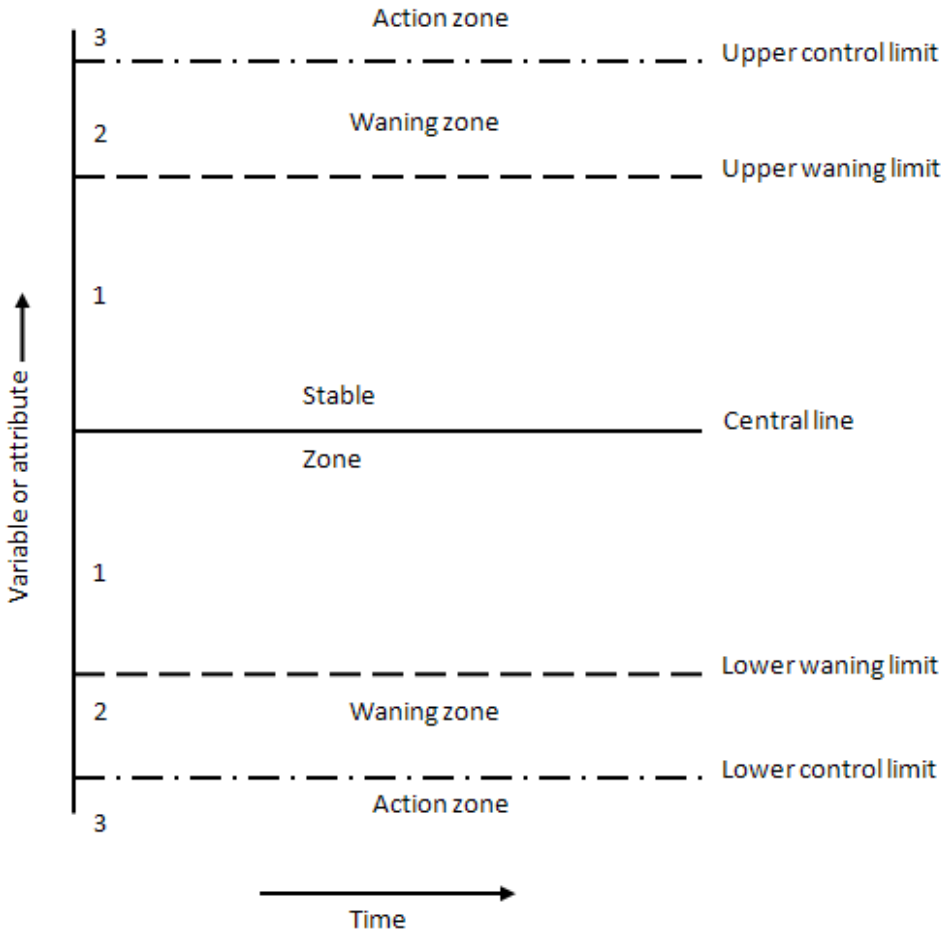


Figure 2.1 Characteristic of Control Chart

From the Figure

- Axis X = period of assessment
- Axis Y = control factor such as time spent on delivery of the truck
- Central Line = average
- Upper Waning Limit = variation at level +2 SD
- Lower Waning Limit = variation at level -2 SD
- Upper Control Limit = variation at level +3 SD
- Lower Control Limit = variation at level -3 SD
- SD = variable standard

The important part of control chart is control line that consists of upper control limit, central line and lower control limit which exist in between the range of ±3 SD (Chidchai, 2008) . If the data has been processed within this range, it means the process is under control. It means nothing unusual exists. If we find out that the data has been processed but spill over the control range, the process is unusual. We have to find out the cause of unusual in the operation and lead it back under control again. On the other hand, the variation at level ±2 SD is a notification at a certain level that variation has existed within the operation but still at a normal state.

2.1.3 Meaning and Concept of Control Chart

Process control starts from the standardization of process. From the quality solution process or process analysis, we are able to find out things we want to control. Whenever we find out that the control object has gone wrong, we should examine the part of the process.

Therefore, a good control for procedure should be set clearly on what to control. It is always necessary to study the limitation of control factor. For example, the process with two different standards such as different kind of service of delivery between weekdays and weekend. In this case, if we want to control everyday process, it might not yield good result. On the other hand, it is better to separate the process control into two parts that is weekday and weekend. This is to enhance the delivery service effectively. The main idea of control chart is to set the natural error of the total

variation on origin. If the variation of the origin is over the natural error, it means the process is out of control.

2.1.4 The Use of Control Chart

Control chart can be categorized into two types that are Variable Control Chart which consists of Control Chart, X-bar and R, X-bar and S, X – MR and Attribute Control Chart which consists of Control chart p, np, c, u. To select the proper control chart, user must consider data that need to control. Further, the selection of control chart is explained in Figure 2.2 below (Chidchai, 2008).

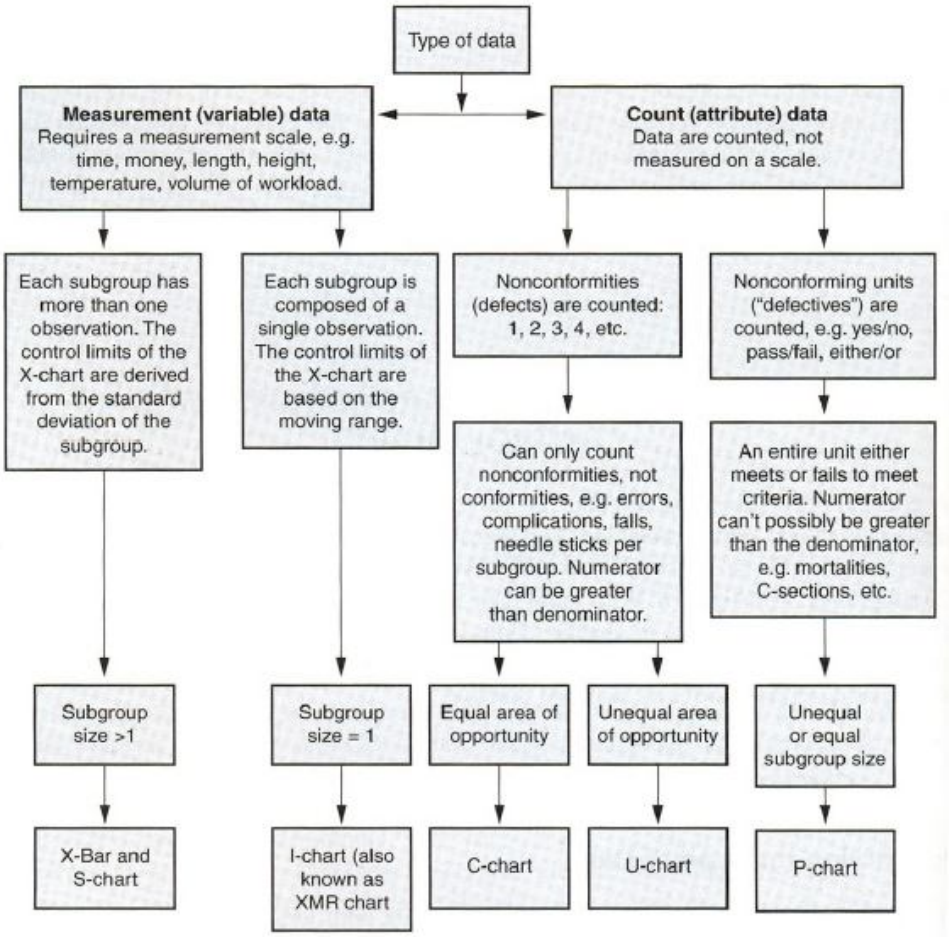


Figure 2.2 How to select the type of control chart

We are going to use the attribute control chart with the type of data that we get from counting such as spoil, unspoiled, present, absent, available, unavailable,

wrong, right; which is compatible with the selection of control chart. Apart from that, there should be a consideration of comparison on sample group. If the data gained from measurement such as time, height, weight, it is advised to use the variable control chart to explain the data. Apart from that, there should be a consideration of the sample group.

2.1.5 Statistical mechanism of control chart

Important mechanism on making decision that is related to statistics of the control chart is to set the value of Upper Control Limit (UCL) and the Lower Control Limit (LCL). We are going to use the mathematics calculation to se the UCL and LCL as followed:

If $\overline{X}$ = average value of sample of each subgroup

SD = standard deviation of population

The average chart we get is

Upper Control Limit : UCL = $\overline{X}$ +3 *SD*

Lower Control Limit :LCL = $\overline{X}$ -3 *SD*

2.1.6 Procedure Analysis

The use of Control chart is a test to revise data in order to consider whether the process can maintain its standard or not. Another important interest of control chart is to use it to analyze the variation of procedure to differentiate variable of special cause from variable of natural cause. This is to find prevention of repetitiveness.

2.1.7 Interpretation of Control Chart

Control chart can be interpreted into two main ideas that are the procedure under control limit and the procedure out of control limit. We can notify from Figure 2.3 where control chart is used to control the use of petrol of the heavy truck in the delivery business.

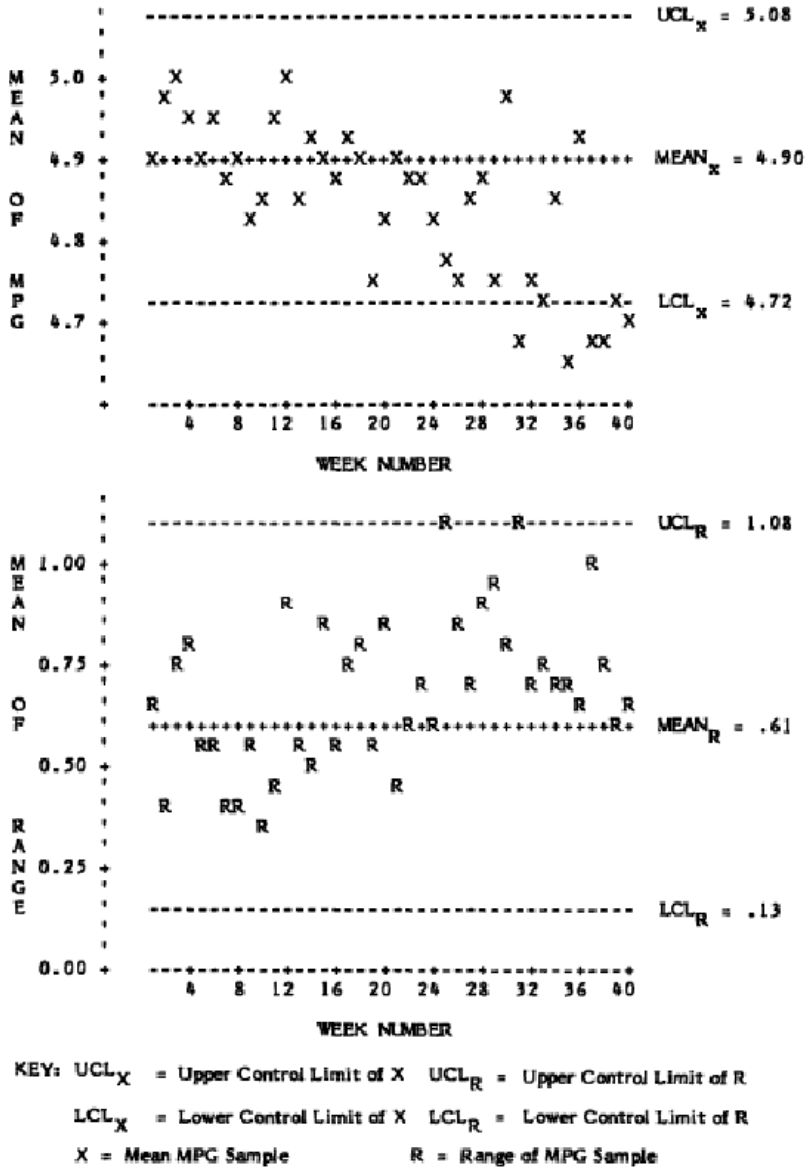


Figure 2.3 Control chart of weekly use of petrol of heavy truck

From Figure 2.3 Foggin (1984) has brought SPC technique to apply with the system of CMF Corporation. The use of control chart is to control average $\overline{X}$ (above Figure) and distribution chart (R below Figure). Generally, the R chart is used with the average control chart $\overline{X}$ as well as using the same set of data (Yuth, 2005).

If UCL = upper control limit

LCL = lower control limit

CL = average

Axis X is week number used to analyze here that is 40 weeks. Axis Y is average point of the use of petrol of heavy truck set at Mile Per Gallon, MPG which Foggin calculated from 34 trucks. If we notice from the above Figure, the control chart average $\overline{X}$ using of petrol between week 1-18 is set as the procedure under control state. From week 19 there is variation occurred and lead to uncontrolled procedure or out of control limit. The notification from below Figure tells us that there is change in Range and can be seen between week 25-31. The range that has changed and reached to the highest of the line limit can occur. The notification from the chart is a sign to look for variation that happens. It is necessary to find solution and get rid of variation that exists. Hence, the procedure can stay under control again.

Apart from variation of natural cause and variation of special cause, there are other forms that can pinpoint the unusual procedure which we can find from the use of control chart. For example, control chart with systematic of data enables the reader to identify when the procedure is slightly out of control limit of the control chart. Kenkel (1995) has explained the regulation of pattern analysis of the eight control charts shown in Figure 2.4.

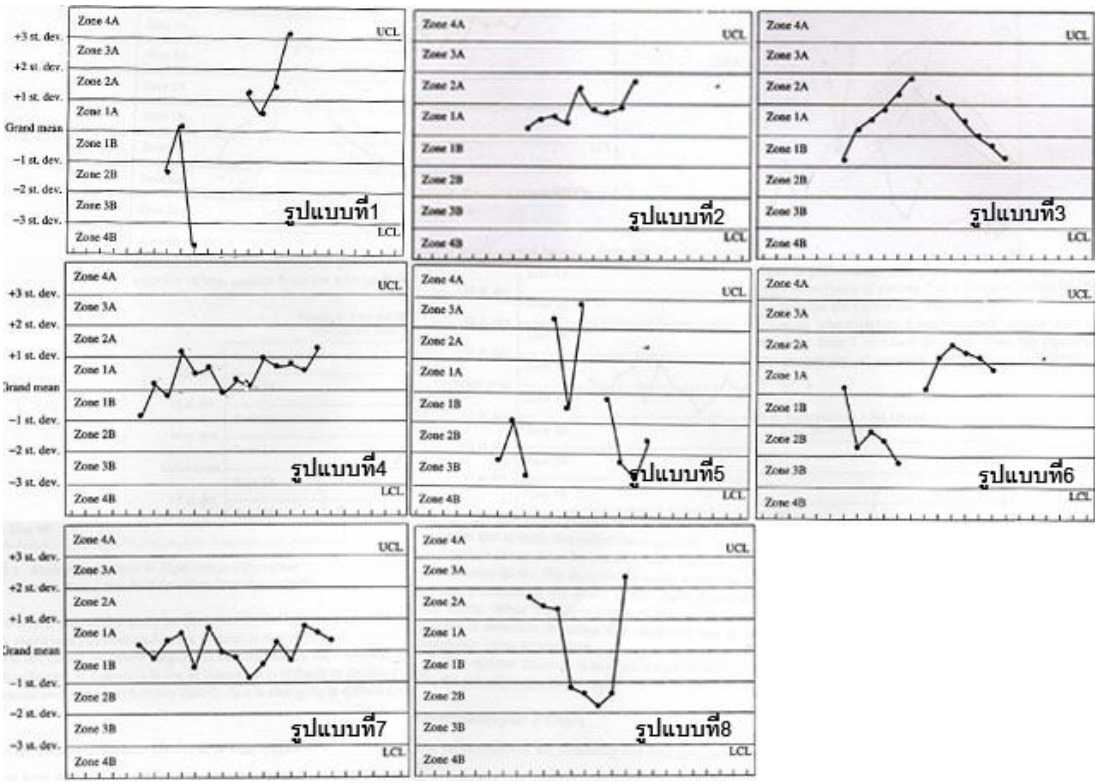


Figure 2.4 Eight different forms that Kenkel (1995) shows unusual type in the procedure

Figure 2.4 form of data from the control chart when data is formed hierarchical and systematical. These eight forms can be explained that there is something usual in the control procedure or something has existed out of the control limit.

Form 1 has any value which falls below 3 standard deviation (3SD)

Form 2 has value = 9 extensive value is on the central line

Form 3 has value = 6 points extensively whether it is upper or lower

Form 4 has value = 14 points

Form 5 has value = 2 out of 3 points above the line of 2 standard deviation (2SD)

Form 6 has value = 4 out of 5 points extensively above 1 standard deviation (1SD)

Form 7 has value = 15 extensive or less than 1 standard deviation (1SD)

Form 8 has value = 8 extensive or more than 1 standard deviation (1SD)

2.1.8 Six Sigma Concept

Six sigma is a reference of target aims to reduce spoiled or waste to number zero (Cavanaugh et al, 2005). It is to minimize the variation in order to eliminate defects of standard deviation (Sigma represents standard deviation). Moreover, it should add value to product or service to be compatible to or more for the customer specification (Chirayu and Chirapat, 2010). Six Sigma Methodology has five procedures that is DMAIC such as

1. D = Define. To define problem and target clearly on what and where to improve and at what level of improvement
2. M = Measure. To measure on how what when and where
3. A = Analyze. To analyze data is to gather figure and bring it to an analysis and find the cause of deviation and variability in the procedure and finally test the hypothesis to eliminate problem
4. I = Improve. To develop or improve capacity and efficiency of the procedure
5. C = Control. To control is to try to maintain the level of capacity of the improved procedure to reach satisfied level continuously

2.2 Related Research

2.2.1 The application of Statistical Process Control

Related research that the researcher refers here is research related to the Statistical Process Control (SPC) technique that can be applied to the logistics transportation. It enables readers to understand the use of the past statistic in operation as well as the analysis on operation by using control chart to watch over the operation of logistics transportation.

Tyworth et al (1989) has applied SPC technique with the Less-Than-Truckload (LTL) company, namely Yellow Freight System, Inc., a large company indeed. He applied the Statistical Process Control to the company system in order to improve the procedure as well as to control service quality. Yellow Freight needs to

control the on-time delivery since it is the most important factor of delivery service. They use the control chart to measure period of service. However, the result is not what they expect because there is not a clear cut on day of delivery. They use a seven days delivery to count without cutting the weekend. Since weekend is day off for most entrepreneurs, the problem is they cannot find recipient. Other problems such as they cannot set the date to deliver to customer and they cannot set clear route of delivery. These lead to the incomplete control chart shown in Figure 2.5.

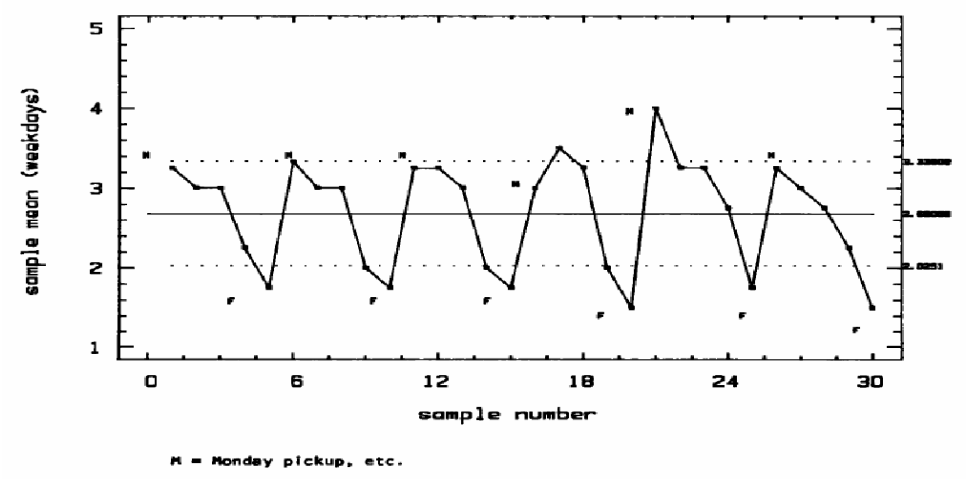


Figure 2.5 Control Chart for Satellite-Terminal Pairs and Three-day Service Standard

Figure 2.5 the use of Control Chart on the control of time of delivery of the company. It can be seen that there is no clear cut point on thing to measure. From this example, Yellow Freight System, Inc has not cut off the weekend so the measurement cannot meet up with expectation. The variation of delivery time has relatively high on variation.

There is suggestion and opinion on the use of SPC to apply with time control service that the company should be clear with the idea of office hour. It is required to cut off the weekend since it leads to high variation. If the company cut off the weekend, they are going to get the control chart that enable them to control time of delivery service as they have expected.

The use of SPC technique in the transportation industrial is not only the application of Variable Control Chart but also the application of Attribute Control Chart as well; CMF Corporation and Yellow Freight System, Inc rely on the Variable

Control Chart on their delivery service. Attribute Control Chart is used as instrument to find out error of truck's tools and auto parts in order to reduce the maintenance cost. Smith & Chaudhry (2005) are the pilot agent in applying SPC technique with public transport SEPTA (Southeastern Pennsylvania Transportation Authority's). They are able to examine the error of public bus's auto parts as well as the reduction of cost. In the past, the maintenance of public bus is done according to schedule only. They barely bring the other data to analyze on the cause of maintenance. However, the use of SPC technique has brought change to SEPTA. The authority is able to change and repair the items from the report on error of auto parts as well as able to control the limit as they want. Previous data from the factory is brought to analyze and show in a form of simple graph which is easy to understand and lead to decision making. The advantage that SEPTA gained from using SPC is the reduction of cost and the increasing of service quality. Moreover, it can solve the repetitive problems that occurred with the bus as well as the reduction of day-to-day maintenance. SEPTA uses the Control Chart c in finding out the error of public bus auto parts. Control Chart c or Control Chart u is a quality control chart of error or fault of products. It is the control chart of an error per unit (Yuth, 2548).

Table 2.1 The calculation of Control Chart c from data of SEPTA's several factories

Calculation of the Standard Deviations of the Distributions Per Shop

		a	*b*	*c*	*(a-b)/c*
			Mean of Distribution	No. of Std. Deviations	Std. Deviation of Distribution
Shop	LCL	UCL	$\overline{C}$	Z	$\sqrt{\overline{C}}$
Teardown	0.00000	7.76153	2.76923	3	1.66410
Rering	2.43182	24.41433	13.42308	3	3.66375
Body	5.58349	31.37651	18.48000	3	4.29884
Paint	0.08035	18.23965	9.16000	3	3.02655

Note: LCL=Lower Control Limit
UCL=Upper Control Limit
$\overline{C}$=Mean of Distribution

Table 2.1 the calculation of Control Chart c. Raw data from each maintenance factory of SEPTA has been calculated the value at upper control limit and lower control limit. The calculation of variable control chart is done in a different method. The result from the calculation is presented in the Control Chart c as shown in Figure 2.6.

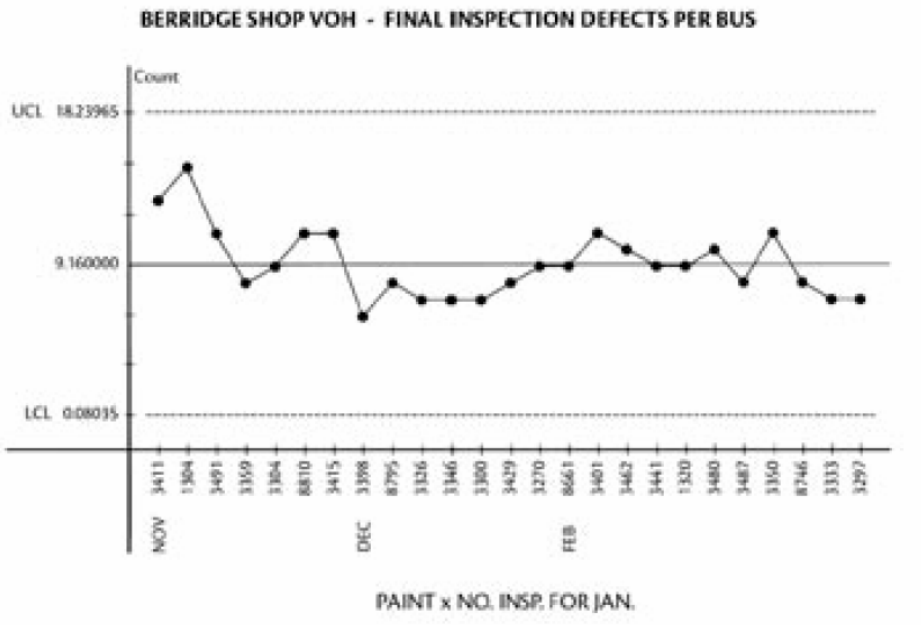


Figure 2.6 The application of Control Chart c at SEPTA's Paint Shop

Figure 2.6 the operation of SEPTA's paint shop. This chart is a good example to elaborate the slight variation that has existed. In December, the variation is occurred at 7 points but it is under the control line and its potential is getting better to the normal line.

Statistical Process Control is used widespread in the production industrial. It is used to examine the change of operation and to find the cause of variation. The example mentioned next has used the SPC technique in the textile industry to reduce the density of over standard weaved carpet.

Pornthep and Sivadol (2548) has studied the quality of hand-woven carpet from the carpet factory. They use both the statistic quality control and statistic instrument such as Pareto Chart and Control Chart to identify the problem as well as to find out the factor that caused all those problems. From the analysis on density of over standard weaved carpet, they have created the Control Chart with average $\overline{X}$ and the

Control Chart with range $\overline{R}$ of the stitch with the length of 5 centimeters. This is to control the density of carpet weaving and from the experiment they find out that both Control Charts are able to examine the change of operation well. This leads to the improvement of good quality carpet and helps to reduce the spoiled goods from the production.

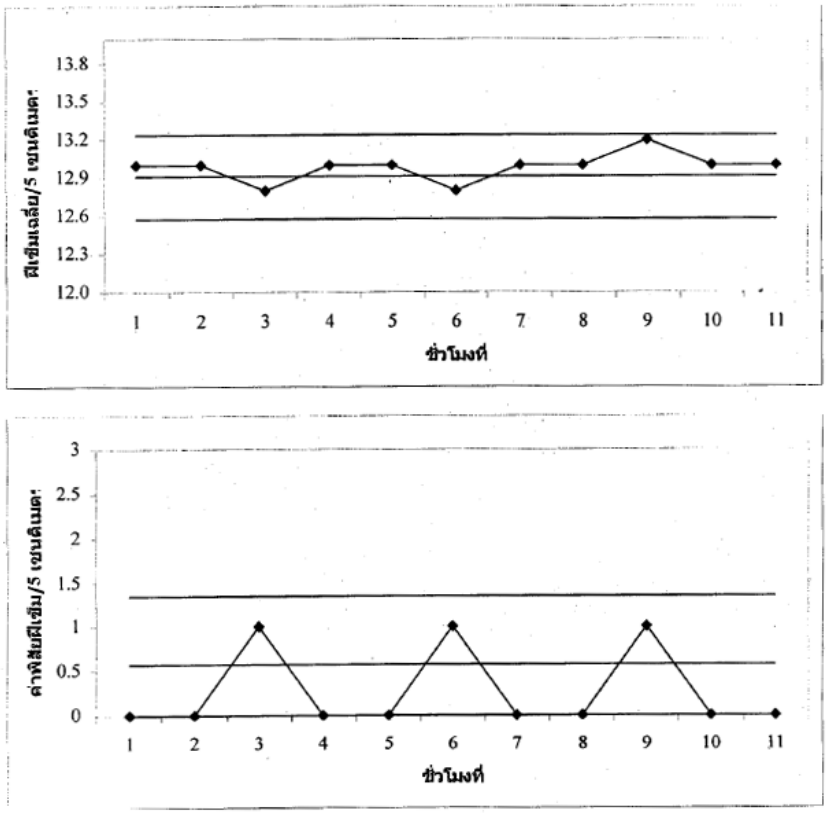


Figure 2.7 Control Chart Average and Control Chart Range of number of stitch at the length of 5 centimeters to control one piece of carpet weaving operation per hour

Figure 2.7 the Control Chart with Average $\overline{X}$ which has number of stitch with the length of 5 centimeters of one carpet weaving per hour. From the Figure, the variation of natural state is the value gained from each hour under control period. The point is not over the control limit while the attribute control chart range $\overline{R}$ shows the sign of variation that can be noticed at the 3^{th}, 6^{th}, and 9^{th} hour, respectively. The value gained from the chart signals the variation that occurs during the operation; however it

is still under control period. It does not spill over the control limit. In conclusion, this is a good operation indeed.

SPC technique that has been using with the Control Chart has become successful in the production industrial. Wood (1994) has studied the problem and the application of SPC technique in the service operation in order to create the quality service that is able to be response to a highly competitive business as well as to customer's satisfaction. This also helps to increase the company's income. For example, telephone line in waiting of customer at Call Center of complaints in the health department and the complaints at any Bank on defect of confirmation of product delivery. The study has suggested the procedure and method on applying the control chart to the service operation.

- Specify clearly on what to measure in order to reduce the number of error
- Prevention of problem repetition, study the problems, resolve and search for prevention
- Not only analyze the result, it is a must to analyze the operation from the starting point to the final step in order to get the right answer
- Randomly choose a group of data to test, it is not necessary to take all the data to test

  Each step in the method is important in applying the control chart to the service operation.

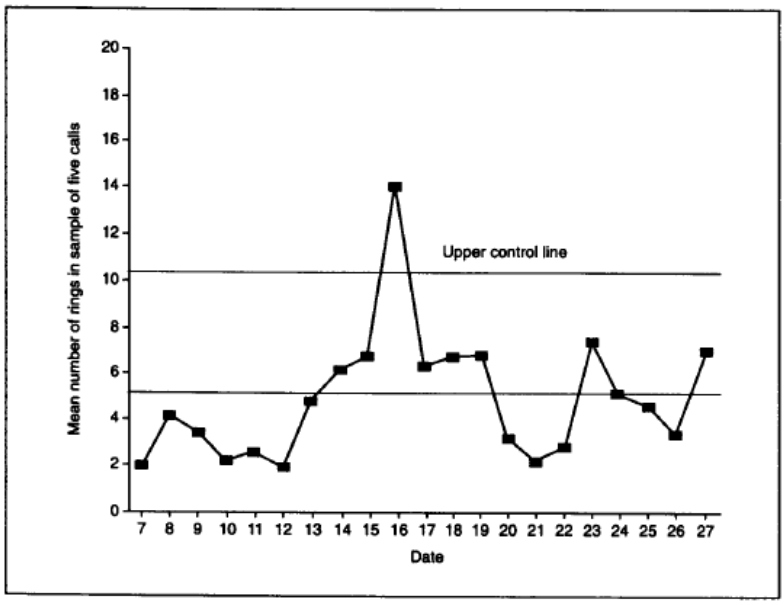
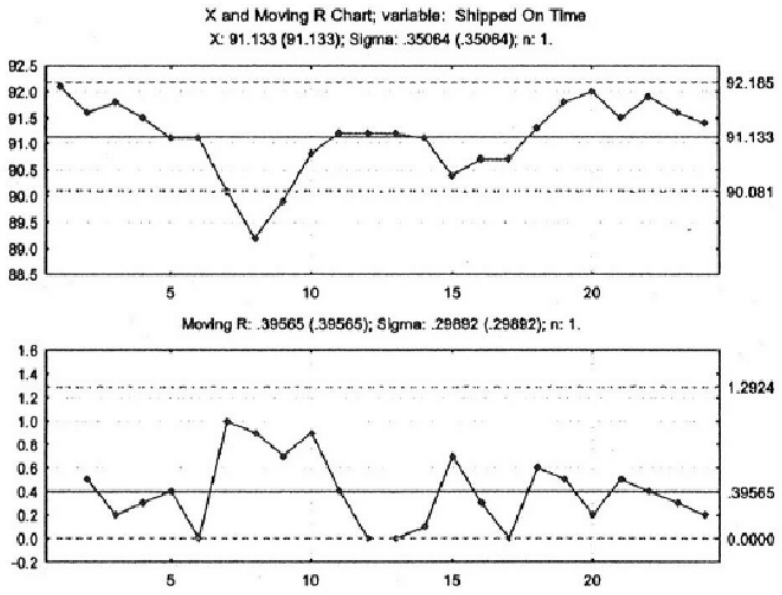


Figure 2.8 Measuring the count of telephone ring before picking up of the Call Center

The measurement of the count of telephone ring before picking up of the Call Center. Wood (1994) points out that the target is the ringing should not be over three times before the phone has been picked up. From the control chart, the average of telephone ring is five and on the 16th of the month there is something unusual because it is not under control period. It is urgent that manager should find out the special cause that happened.

From the study on control chart, many researchers have tried to apply the control chart to many other businesses and it has been widely used. The chart has enhanced a good chance in doing business among entrepreneurs and other business agents.

Gerst (2003) has tried to apply Control Chart to different kind of business other than the industrial. For example, the chart is used to measure customer's satisfaction, the on-time delivery, the forecast of petrol production, and the measurement of quality of life of people in the community. The result of buying and selling from banking reflects that at present the application of control chart on industrial as well as other business has been widely used continuously.



(Adapted from Wheeler 1993, p.46)

Figure 2.9 The use of Control Chart to measure the on-time shipping

The explanation of the graph on Figure 2.9 is rather exact, Gerst (2003). The dot of data under the control period shows the variation in the system as usual. The dot of data out of the control period shows the sign of special cause of variation. In this example, there are two dots in the eight and nine month, respectively. Manager should take a look and explain how it happens and get it correct when thing happens again.

Gerst (2003) mentions that banking system has used the control chart because the previous system is unable to explain the period of data; it explains only the whole Figure. Hence, when something has gone wrong with the data system, it is difficult to explain or assume how it happens.

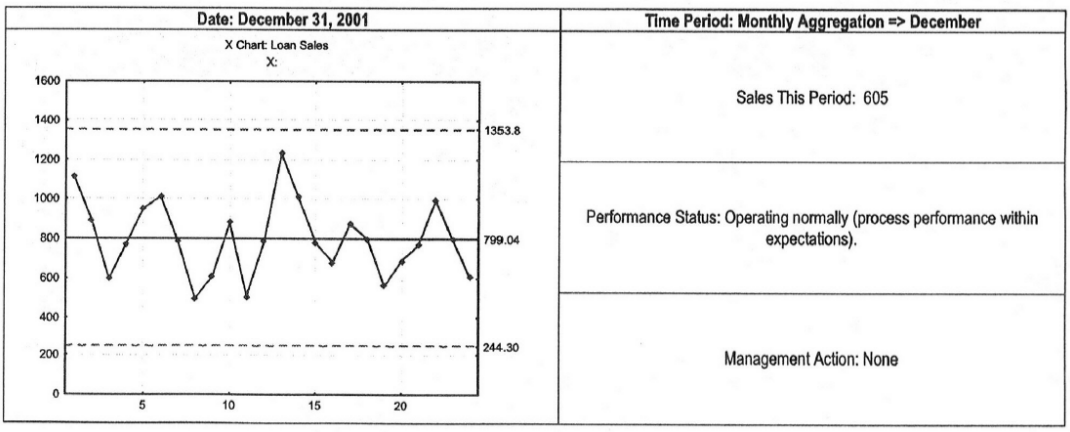


Figure 2.10 The application of control chart to the financial system of the bank

Figure 2.10 the application of control chart to the financial system of the bank (Gerst, 2003). It is to explain time period and special cause that happens. The measurement is to find out the revenue from saving account or from the loan in the banking system. From the Figure, the revenue of December 31, 2001 shows that the revenue or the banking service is at normal period.

Apart from that, the control chart is used to control ratio of crime and violence in order to measure the quality of life of people in the community as well (Gerst, 2003).

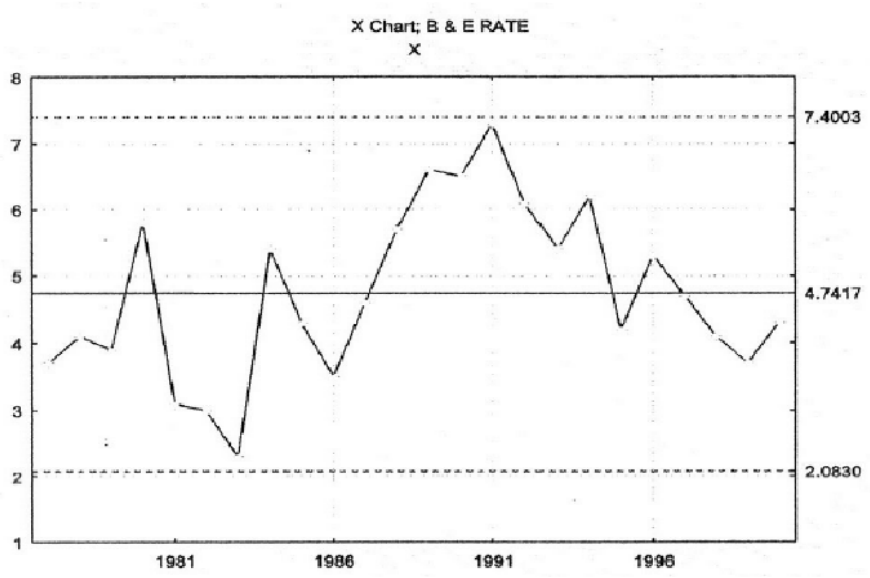


Figure 2.11 Control Chart elaborates the differences on ratio of crime and violence

Figure 2.11 the differences of data on crime and violence that gained from the police department. The survey from different year shows that in 1991 the ratio of crime and violence is extremely high but it tends to go down in the year after.

Gerst (2003) mentioned that a large public health service provider in Canada has set a yearly measurement to find out customer's satisfaction from their collected data. The objective is to learn about the level of customer's satisfaction related to the service. If the level of satisfaction goes down, the company can trace back and find out the cause of change.

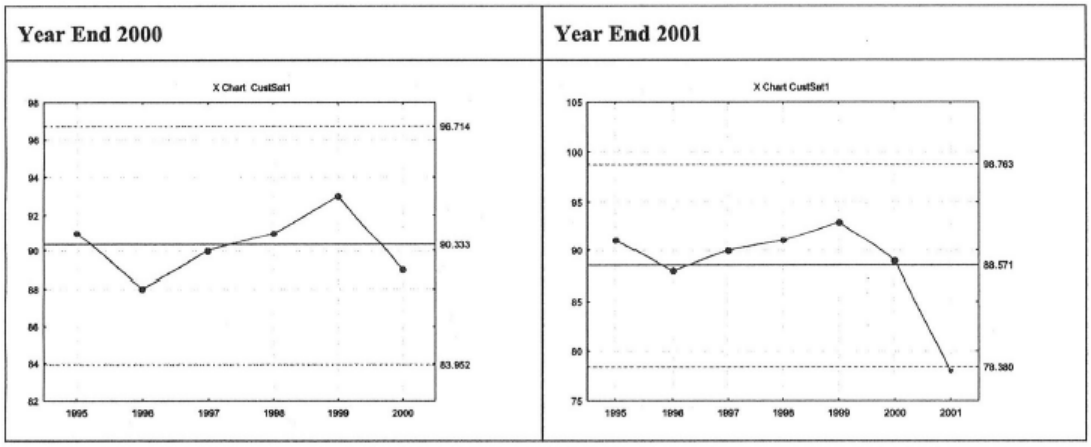


Figure 2.12 Control Chart of level of satisfaction on service each year

Figure 2.12 that customer's satisfaction in the year 2000 is at a good level of natural variation. In the year 2001, there is variation or change that affects level of satisfaction out of control line. It is necessary that executive or manager should find out the cause of this change. At this point, the control chart is used as instrument to find out what happens in each month and can notify the month that thing has gone wrong.

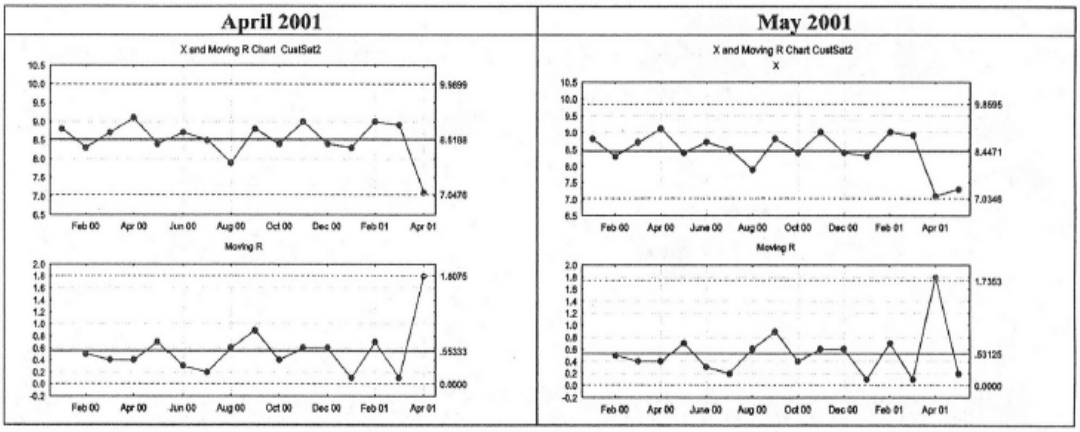
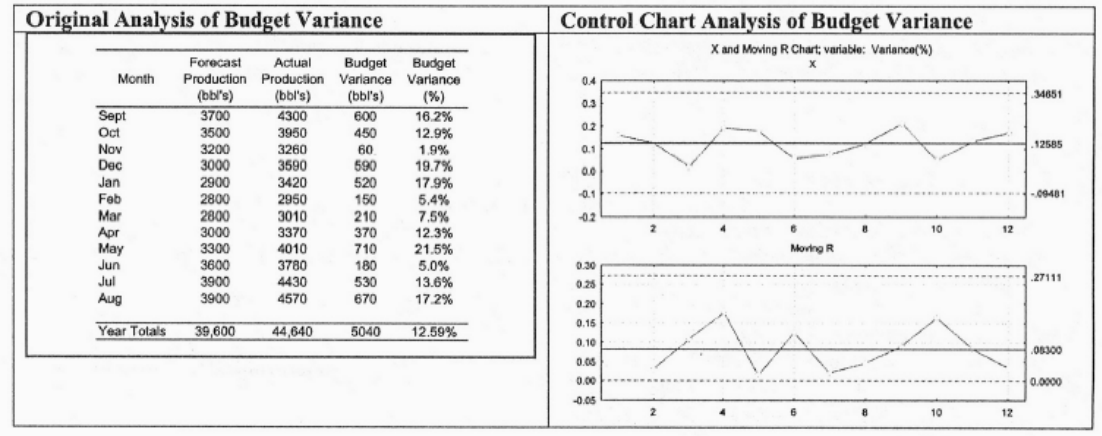


Figure 2.13 Customer's satisfaction for each month of the year 2001

Figure 2.13 is an explanation of special variation that occurs in August 201. Executives can trace back on what has been changed in terms of service. When they find out the real cause of change, they have changed the pattern of service in order to bring back customer's satisfaction to a better level.

Apart from that, control chart is used to forecast the oil or petrol production of the oil company (Gerst, 2003). The company has applied the chart as means to forecast production and to set schedule of open-close the pipeline fuel.



Month	Forecast Production (bbl's)	Actual Production (bbl's)	Budget Variance (bbl's)	Budget Variance (%)
Sept	3700	4300	600	16.2%
Oct	3500	3950	450	12.9%
Nov	3200	3260	60	1.9%
Dec	3000	3590	590	19.7%
Jan	2900	3420	520	17.9%
Feb	2800	2950	150	5.4%
Mar	2800	3010	210	7.5%
Apr	3000	3370	370	12.3%
May	3300	4010	710	21.5%
Jun	3600	3780	180	5.0%
Jul	3900	4430	530	13.6%
Aug	3900	4570	670	17.2%
Year Totals	39,600	44,640	5040	12.59%

Figure 2.14 Control Chart variance of oil forecast of each month

Figure 2.14 is control chart showing percentage of variance of oil producing which has been forecasted. The advantageous of the forecast is to be able to project on how to produce oil higher or lower than the previous month. Moreover, the data can be use in terms of production management.

SPC technique is not just used only in the industrial factory but also in any service operation. Apart from that, there are plenty of researches on how to apply this technique to control manufacture procession effectively. It is used as guideline to find out preliminary screening test of HIV contagious in the hospital as well.

Rattana (2545) has done a study on applying statistics quality control to find out preliminary test of HIV (Human Immunodeficiency Virus) by using Control Chart t. This is to enhance efficiency of control and as a guideline in using. This research is a study on ration of HIV density and Antibody or as it is generally known as Optical Density (OD). The method is to test type 1 HIV by using ELISA method together with GENELAVIA MIX fluid done by staffs at Chophaya Abhaibhubhejhr Hospital, Prachinburi Province. The test is by bringing OD values from different group of patience such as Weakly Positive Control, Positive Control and Negative Control to create the quality control chart $\bar{X}$ and Control chart R. The experiment is to estimate the standard deviation that relies on the Range and to estimate the standard deviation of average from the sample group. The study finds out that control chart, according to the second type, can control the average of any group and can be used to help separate three different groups with control chart t.

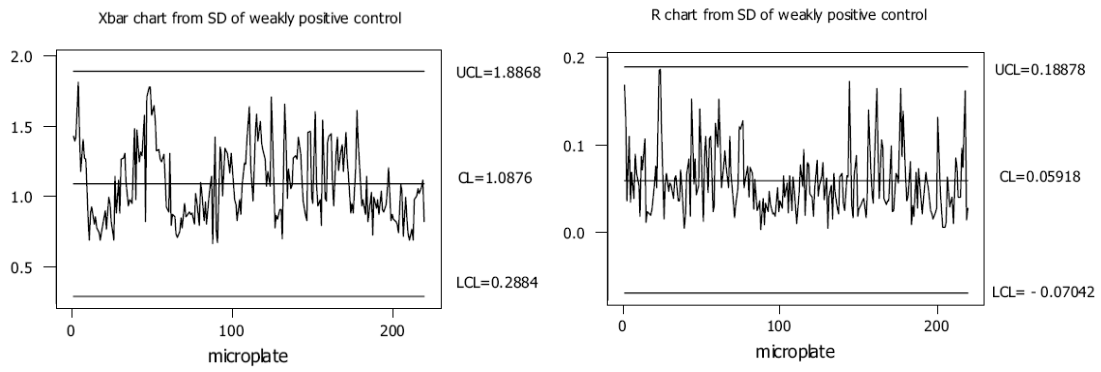


Figure 2.15 Control Chart $\bar{X}$ and R, an estimate on standard deviation of Positive Control group

Figure 2.15 that Control Chart $\bar{X}$ and R are constructed from the standard deviation of Weakly Positive Control. There is not any dot fall out of control line. It is obvious that every dot falls under control line and the average is still under the

regulation of Microplate (instrument on testing of HIV) production company. This shows that the control chart has used to control average of Weakly Positive Control.

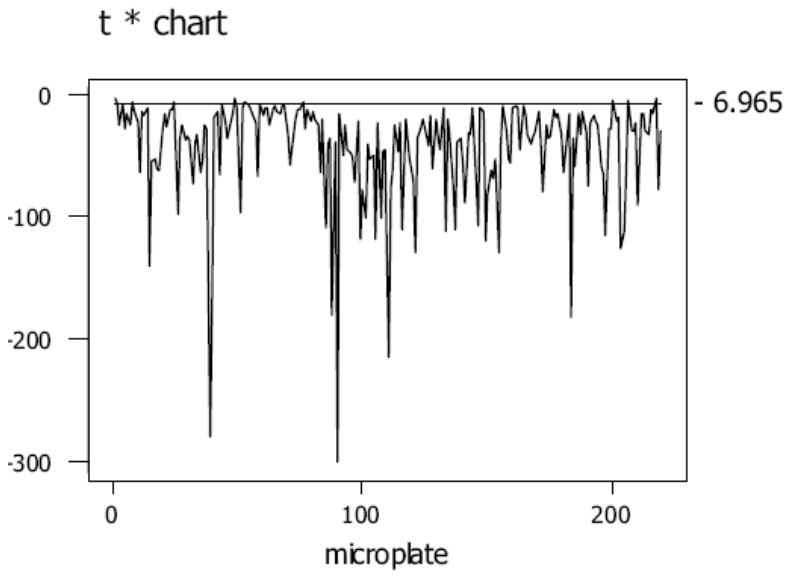


Figure 2.16 Control Chart t

Figure 2.16 the control chart t that plots from the test on ELISA. We can see that the meaning of t in each microplate is lower than the upper control limit or the acceptable highest point that is -6.965. This means that there is separation between Weakly Positive Control group and Positive Control group according to regulations of the production company. There is exceptional microplate which has t relatively higher than the upper limit. This can be explained that the regulations on separating between the two groups are imbalance. They need to be rechecked.

2.2.2 The concept of On-line SPC

The concept of on-line SPC originates from the observation of heartbeat by transferring the heartbeat into the electrical line and shows it in the graphic form in front of the monitor. The graph is instrument for doctor or nurse to use as a monitor of patience in the ICU closely. Therefore, researcher is taking this idea to develop the On-line Control Chart program to observe, monitor and control of operations in the logistics transportation industry. It helps the entrepreneur to observe, monitor and control the operation by reserving the same standard as well as developing the new

standard in response to the need of customers. It is to create self service satisfaction and can be compared to the incident when doctor keeps watching the patience. Whenever patience shows sign of unusual, the doctor is able to find out the cause and start the cure immediately.

Control chart has been used widely in the industry, service, and public health. There is certain idea to develop and enhance efficiency of control chart to be even better by finding model of control chart that is able to exhibit the result Real-time. The interesting point of the Real-time control chart is its ability to observe and monitor the variation immediately or all the time in order to find out the cause and able to resolve problem immediately.

Hunt (1989) has studied to find out how to develop the model of control chart to be more effective. The development helps to enhance the data analysis effectively without relying on the engineer. It helps reduce the complication of operation as well as the cost reduction. From the study and development at that time, IBM has more than 600 control charts and becomes number one in the market in terms of quality goods. Hunt has defined the development of model into six methods as followed:

1) Stick to the rules seriously in terms of development
   - Control chart must be used
   - Control chart is able to present Real-time operation
   - Control chart should be apply with the industry only
   - Personnel must be trained continuously
   - Control chart must be used under the production management
2) Control chart is used in terms of administration
3) The establishment of Statistical Process Control Center
4) Choose the right person to manage software
5) Manager and staffs should study the industrial operation continuously
6) Build up the SPC Real-time control chart

Other than Hunt (1989), there are Raymond & Dubuque (1991) who studied the SPC Real-time control chart. They have studied on the preference of users about SPC software so they are able to realize the need of users since they have

discussed about software operation in detail. The important of this development is to enable user to operate the software themselves. The development relies on users' basic knowledge of computer skills and statistics. If the users overlook or lack of understanding about this basic stuffs, the development is going to fail. Raymond & Dubuque have suggested many rules and principles such as the development is not the development of operation system, just the development of applied software. Moreover, the development should rely on the rules set by users. It is going to be easy from users since they have divide the development into three phases; the first phase is variation of the chart, the second phase is input data and the third phase is viewpoint of applied control chart.

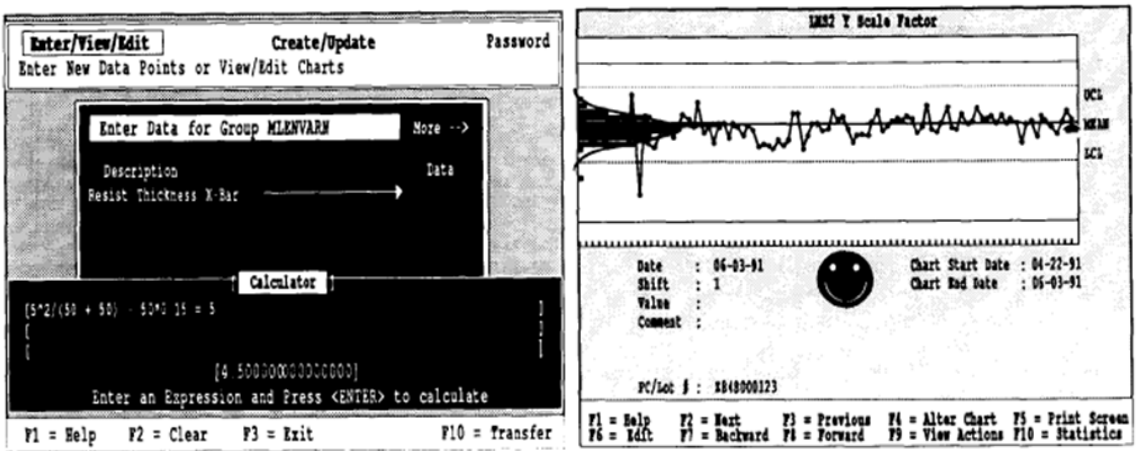


Figure 2.17 The calculation of control period and analytical part or control chart of software

Figure 2.17 some part of Real-time SPC software. The data is put in both automatically and input manually. The Figure on the right hand side is analytical procedure or the control chart together with the Pareto chart. From this chart, the result is at a satisfied level since it is not only the chart presented here. There are suggestions on several details together with animation insertion that makes the users understand easily.

At present, the development of Real-time SPC is increasing and whenever people has mentioned SPC control chat it is a must to mention Real-time SPC together. The following example is the use of SPC in a giant wood industry in the United States. From the study, the use of SPC is effective in this company. It helps to

reduce the number of wood board with oversize thickness without manager or controller to be at the saw mill. They can do this form the control room or manage it from the lab with computer network.

Young et al (2007) has suggested the idea and has developed the control chart of Real-time Statistical Process Control to use in the wood industry to control variation in wood board cutting in the sawmill. The wood board that is too thick costs the lost of over 20,000 – 250,000 $ a year. Young and his member have taken around 5 years to study and finally set the thickness of the wood board. They can find way to reduce the existence of variation and increase the benefit. After using the Real-time Control Chart with the industry, they find that 5 of out 10 cutting wood board have approximate size close to the wanted thickness. In the long run, they are able to control variation of the cutting wood board pretty well.

Figure 2.18 The use of Real-time Control Chart in the sawmill

Figure 2.18 the use of Real-time Control Chart in the sawmill industry. The upper left Figure is the photo of a saw man measuring thickness of the wood board with wireless equipment and transfers the data digitally to the machine of the recipient. The lower left Figure is the photo of controller or manager who monitors and controls the thickness of wood board through computer screen at the office

without showing up at the operation site. The right Figure shows the Real-time SPC program consisting of control chart and pareto chart.

The research finds out that SPC technique has been used widely, not only in the production industry but also in several other industries such as logistics transportation, service operation or even in the public health sector. Moreover, there are those who have developed SPC software that processes good result. This enables the industry that applies the software to be at the top of quality control. However, the study shows that there is still no SPC developer in Thailand. Apart form the application of SPC in the production industry, it is barely used or applied in other kind of service.

Hence, this has lead the researcher to become more interested in developing the On-line Control Chart software which resembles the same characteristic of the monitor machine of heartbeat use by the doctor to use in the logistics transportation. This is rather a new technique for entrepreneur to use effectively without relying on engineer or other controller. User can analyze, observe, and monitor the operation through computer screen by himself from anywhere as long as user has connected to the network system. In chapter III, researcher is going to elaborate in detail how to manage the system.

CHAPTER III
RESEARCH AND METHODOLOGY

In this chapter, the researcher is going to explain operation procedure starting from study of data, data selection, nature of operation, equipment used to develop the system and clear cut work plan in order to get the right, appropriate and complete work on timeline.

3.1 Work Flow of the operation system

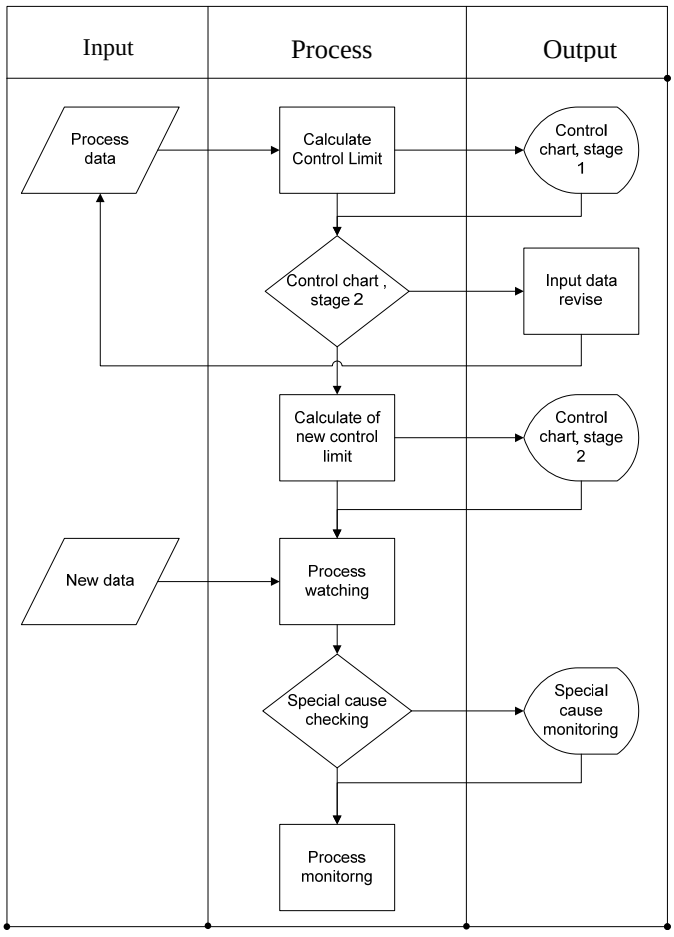


Figure 3.1 Work flow of working systems

System operation starts from choosing the procedure and timeline to create the control chart. After that there is an installment of program to the database. The calculation is done by choosing necessary data to create the first phase control chart of the revision of operation. After getting the first phase control chart, the program is going to check whether this control chart is going to lead the second phase control chart or control phase or not. The principle of the program is if the program detects more than two special causes, it is assumed that the operation is out of control. There should be the process of revising input of data. If one or two special causes or even non special cause exists, it is assumed that the operation in under control. User is able to revise operation as well as to create the control chart in the long run. After that, whenever new data exists during the operation of control chart under the control period, the program is going to input the data into the control chart. This is to test the existence of different types of special cause. The program will notify of finding the special cause or waits until the new data is being input to observe the operation continuously.

3.2 Data

The application of the control chart to operation process such as transportation service or logistics requires as much data as it can since data is an important input in running the process in this kind of business. Normally, characteristic of each existing data is unstable and rather inconsistent. It is not the same data as in the production operation where mechanic is working consistently and data is more stable. Therefore, if user prefers the application of control chart with this kind of operation, it is suggested to revise the analytical process of data cautiously.

3.2.1 Type of data

From the study of various kind of operation in the logistics business, there are plenty of statistics values. The researcher is going to bring this data to analyze by the control chart. From the meeting with entrepreneur and branch manager, they have agreed on using the error on statistic billing data and the product distribution ratio for consideration. These two operation processes have faced with certain kind of problems

since they are operation based on day-to-day ration that relies on counting process. For example, today there are 45 errors of billing out of 1,200 billing per day which is calculated in ratio is $\frac{45}{1{,}200} * 100 = 3.75\%$. In the meantime, the distribution of products today is counting at 185 billings out of 240 billings which means the calculation on error of billing is $\frac{185}{240} * 100 = 77.08\%$.

3.2.2 Data Collection

This logistics service company has collected many different operation processes statistics in the database where entrepreneur is able to retrieve operation statistics of the subsidiaries. Therefore, data collection process is only to randomly analyze day-to-day data.

3.3 Data Analysis

To analyze the data of the two operation processes, the researcher is going to apply the concept of statistical process control by using the control chart as means to explain in details. In the meantime, the researcher is developing the On-line SPC program to control operation quality of data-to-data in order to enable the entrepreneur to assess, observe, monitor and control the operation from connected network computer anywhere.

3.3.1 Instruments for system development

In order to develop the On-line SPC system, an essential part of the process, the program is brand new. It is a program to response to user's need as much as it could be as well as it is meant to be compatible with the usage. The researcher has select equipments to develop the system consist of the following items:

- Two computer laptops
- Microsoft Windows XP SP3
- Visual Basic 6 program
- Microsoft Access 2007

- Adobe Photoshop CS2

In order to design and develop the system, the researcher has chosen Visual Basic 6 program to develop the system under the operation system Microsoft Windows XP SP3 to use with two computer laptops. One laptop is used to develop the On-line Control Chart system under the Client Server network system structure. The other laptop is used as Application Server of Database Server by using Microsoft Access as database and applying Adobe Photoshop CS2 for producing beautiful decoration. Apart from that, the researcher has developed the system development life cycle (SDLC) program to use in order to process systematically, to correct mistakes and to quicken the operation.

3.3.2 System Development Life Cycle

To develop SPC software system, it is necessary to study the System Development Life Cycle (SDLC). This is to make the development step by step and to help reduce mistake as well as to quicken the system. The choice in choosing appropriate system development has different patterns such as Waterfall and Evolutionary. Those patterns have four main parts as followed:

1) Project Planning
2) System Analysis
3) System Design
4) System Implementation

From previous study, the prototype of Rapid Application Development-based methodology (RAD) is the best way to develop system development (Kittisak and Panida, 2546). It is the methodology developed in early 1990s to develop weak point of structured design methodology. System analyst is able to analyze design process together with of system development. After that, analyst should develop system prototype that is able to work in reality. The prototype is then presented or experimented to trial the design according to user's suggestion in order to improve and develop the second additional prototype, the item with more capability. The advantageous usage of prototype-base methodology is spending less time in development.

It is because every step can be done at the same time by constructing only one prototype. However, there is disadvantageous of developing to fast since it also brings about negligence, unable to discover problems and the system has not been completely developed.

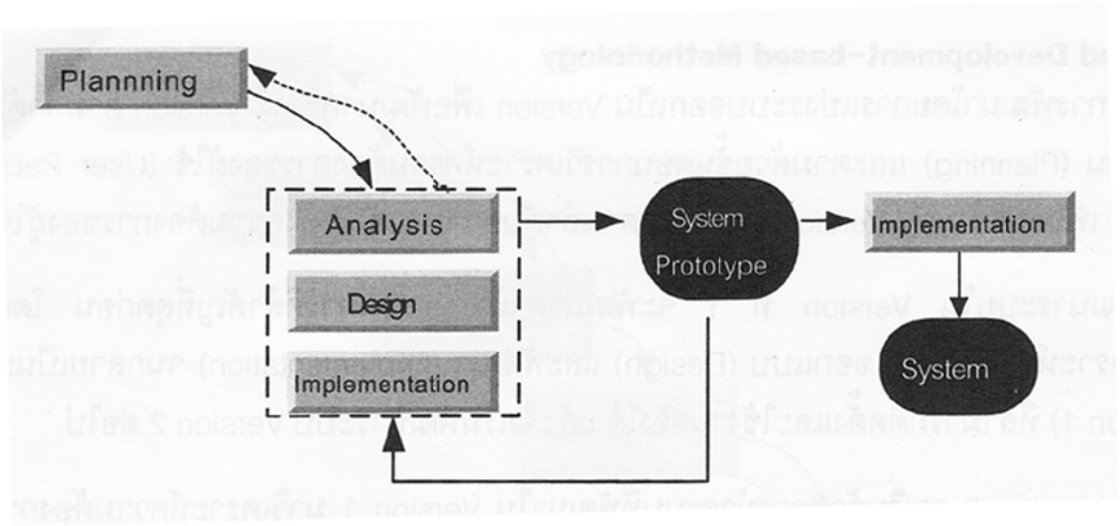


Figure 3.2 System development by using Prototype RAD Methodology

Circle of development by using prototype RAD Methodology. The step of development starts from planning then go to system analysis, system design and system implementation all together as the first prototype. After that, give it to the user as trial system and asks for suggestion and additional capacity to become the second prototype. Then keep on experimenting to meet up with user's satisfaction and finally develop it to become actual system. The complete work has to be connected with the database system in order to retrieve system operation to use immediately. The part related to Client Server network system is going to elaborated further.

3.3.3 Client Server network system

Since the case study firm is a large company with many scattered branches, the current system is the client server. The application server that collects program data is used as Database Server. In order to develop the operation system, the researcher is going to withhold to the current network system which is easy for the entrepreneur to develop and implement.

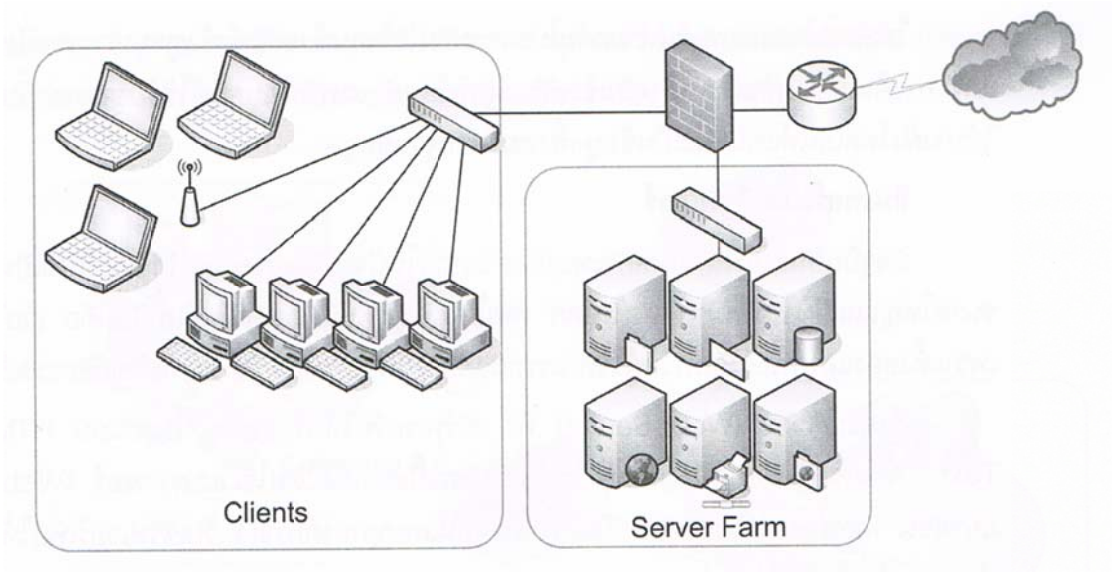


Figure 3.3 Client server network system structure

The operation of the Client Server network system structure is to provide server to collect the whole data to serve other computer or work station to retrieve data. For example, the provision of database server that gather statistics operation of logistics transportation is in every branch with service provider. The data is reserved at the server or main network for the client server or work station to retrieve and analyze statistical data installment in the connected network anywhere.

3.4 Operation Procedure

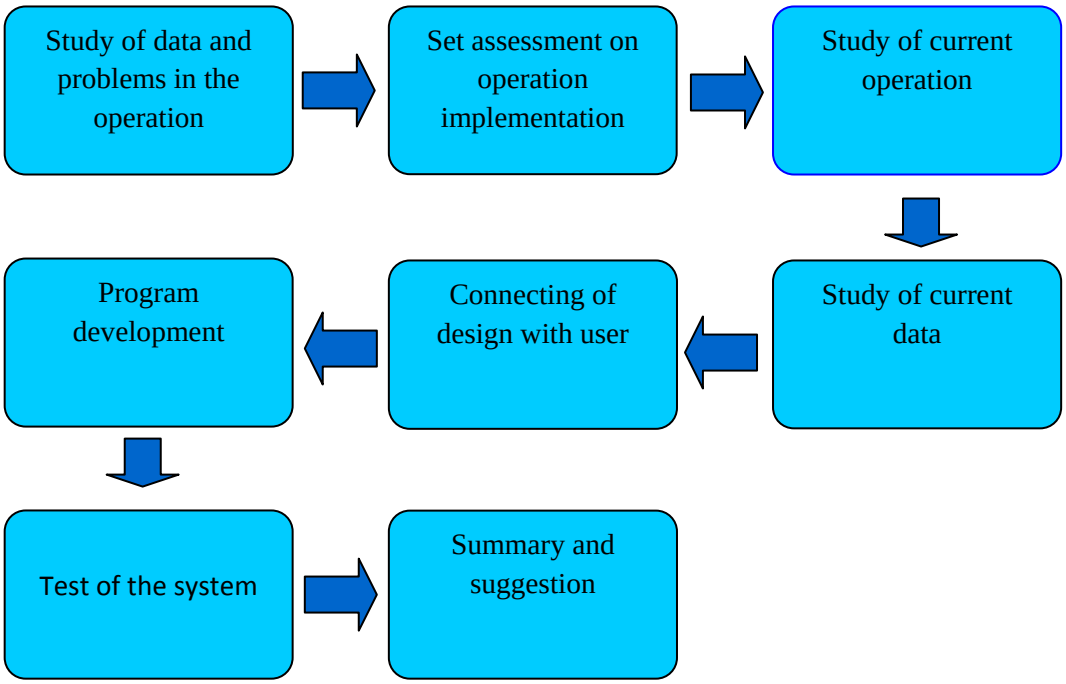


Figure 3.4 The procedures of operation

The researcher has planned to develop the procedure up to eight steps in order to accomplish the objective in time. The first step is to study data and problems in the operation exist in the procedure of logistics transportation business. It is to study problems in the case study firm. The next step is to set assessment on operation implementation and set the operation control with the entrepreneur and branch manager. After setting the operation implementation, the researcher is going to study the current working system from the report, operation form, database, channel to insert data, type of input data, and frequency of data. After that the researcher is going to develop the program which is installed to necessary agents and users. Then the researcher is supposed to test the program as well as revise the errors. The final step is to summarize and offer useful suggestions after the program trial.

3.5 Operation Planning

In order to accomplish the operation under the timeframe objective, the researcher has set operation planning clearly. This is to help reduce number of errors and build up the operation step by step. The details and timeframe of each activity is shown in Table 3.1.

Table 3.1 Operation Planning

Research Procedure	**2552**				**2553**							
	Month											
	7	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**
study of related theories and research	◄	———	———	——►								
project proposal		◄	———	———	——►							
presentation of proposal				◄	►							
training at the firm					◄	———	———	———	———	———	———	►
study of problems and operation					◄	►						
set assessment for operation implementation					◄	►						
study of current system					◄	►						
study of current database					◄	►						
connecting of design with user						◄ ►						
program development						◄	———	———	———	———	►	
test of developing program								◄	———	►		
summary and suggestion												◄ ►

CHAPTER IV
RESEARCH RESULT AND COMMENT

4.1 Cast Study

NIM See Seng Transport 1988 Co., Ltd is the case study firm which the researcher has a chance to participate in resolving of existing problems. The company itself has many branches offering service on goods delivery and goods distribution with heavy truck. There are several branches in the Northern part of the country while there are only four branches in Bangkok. By permission of the entrepreneur after discussion problem at the meeting, the researcher is allowed to do the research at Bhuddhamonthon 5 road branch.

4.1.1 Background of NIM Transport 1988 Co., LTD

Nim See Seng is a family business of the Suwitsakdanondh family. It is established by three brothers: Mr.Uthat, Mr.Uthan and Mr.Udom Suwitsakdanondh. The business started from fruit selling at Waroros Market. After that, they began to transport fruit and goods between Chiang Mai province and other regions. In 2514, the three brothers had established the partnership company. However, with spelling mistake during the submission of document, the partnership's name had changed from "Neem See Seng", which is the former name of grocery store owned by their father, to "Nim See Seng". Thus, the three brothers had used this name onward. In the same year, Nim See Seng company limited had expanded the first branch in Bangkok at Mahanak junction. During the first two years, Mr.Udom the youngest brother tended the branch himself as branch manager. In the meantime, the two elder brothers were taking care of the business in Chiang Mai province. The decision to switch into the business service of the three brother was the right decision indeed. After they were keen on doing transportation goods, the name of Nim See Seng became more popular. They had to expand the branch to Thali district, Chomthong district, Pasang district and Fang district years later. In the meantime, from small number of truck at the start,

other heavy truck owner had asked for permission to join in under the name of Nim See Seng network service. In the year 2527, Thailand had faced with financial crises from the devaluation of Baht currency. However, it was a good chance for the firm since exporter had turned to rely more on the delivery service. This is because the devaluation helped to expand and promote export of goods of Thailand. In the year 2531, the company has established as NIM Transport 1988 Co., LTD. Two years later the company had moved its headquarter from downtown to the present location on the superhighway Chiang Mai- Lampang road on the seventy rais land. These days, Nim See Seng network including of transportation and leasing had covered the whole area of the Upper Northern Region. It has seven branches in the North and the expansion of the branch in Bangkok from Mahanak branch to Bhuddhamonthon Sai 2 and 5 road branch. Therefore, Nim See Seng already has 10 branches with heavy trucks under the same network around 500 trucks together with employees and drivers around 1,000 people.

4.1.2 The Office at Bhuddhamonthon 5 Road Branch

The branch was opened for service in the year 2543, situated at local transportation center Bhuddhamonthon of 133 Moo 1, Tambon Bangtoey, Sampran District, Nakhonpathom Province.

Figure 4.1 The location on NIM Transport 1988 Co., LTD at Bhuddhamonthon 5 road branch, transportation center

The operation of Nim See Seng at Bhuddhamonthon 5 road branch is divided into two main parts which are the upstream section and the downstream section. The upstream section is where sender sends goods from the departure at Bhuddhamonthon 5 road to the destination of the Northern region of Thailand. The destination located in Chiang Mai province, Fang district, Thali district, Phrae province, Nan province, Lamphun province, Lampang province, Chiang Rai province and Phayao province. On the other hand, the downstream section is a service of transport goods sending from the Northern region to Bhuddhamonthon 5 road center. All the goods being delivered will be stored at the branch for the customer to pick up or to deliver goods with the firm's heavy truck as a service. The two sections that deliver the service to be runned by head of the team to control the procedure of each other together with employees from other section. The two sections are under supervision of branch manager. The administrative chart of Bhuddhamonthon 5 road service center is shown in Figure 4.2.

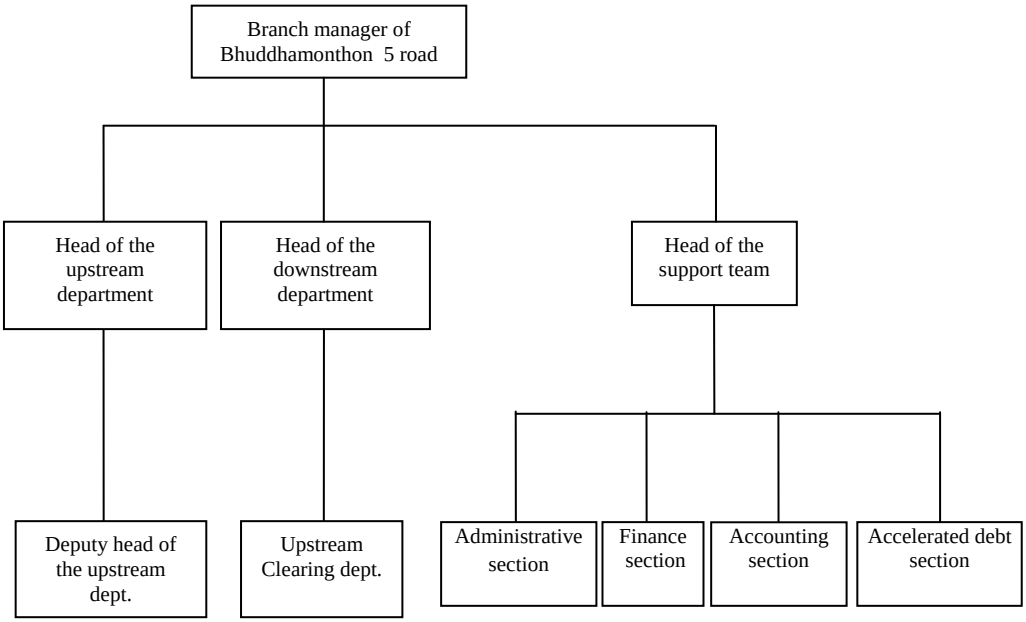


Figure 4.2 The administrative chart of NIM Transport 1988 Co., LTD at Bhuddhamonthon 5 road branch

NIM Transport 1988 Co., Ltd at Bhuddhamonthon 5 road branch has Mr. Nikom Srivichai as branch manager. The branch has divided into three main administrative teams, the upward department, the downward department and the support department. The upward department runs by head of team and assists by the subhead since the upward department provides the main service. The transfer of goods starts from Bhuddhamonthon 5 road branch to the destination in the Northern region where there are many users and plenty of goods. The downward department runs by head to team and assists by employees from goods clearing section. The goods clearing section has its duty of clearance and correction of goods when the service has faced with problem such as goods cannot be deliver on time, damage occurs with goods, or number of goods is not complete. The support department consists of head of the department, administrative section, finance section, accounting and accelerated debt section.

4.1.3 Goods Delivery Service (The upstream department)

Figure 4.3 The area of upward department or goods delivery

The upstream section provides service of delivery from sender to the destination of any provinces mostly the provinces of the Northern region. The area of the upstream section is about 62.5% of the branch. There are nine service counters being categorized to districts or provinces. The first counter's destination is for goods

send to Phrae Province, Nan Province and the whole country. The second and third counters destination is Chiang Mai Province. The fourth counter is Fang district. The fifth counter is Thali district. The sixth counter is Lamphun Province. The seventh counter is Lampang Province. The eighth counter is Chiang Rai Province. The ninth counter is Phayao Province. The upstream section's duty is taking goods from sender to deliver at the destination. On the right hand side of the Figure is where the department receives goods from sender and issues the bill. The center of the Figure is waiting area before upload goods to the truck. This area is used for goods arrangement.

4.1.4 Delivery Procedure

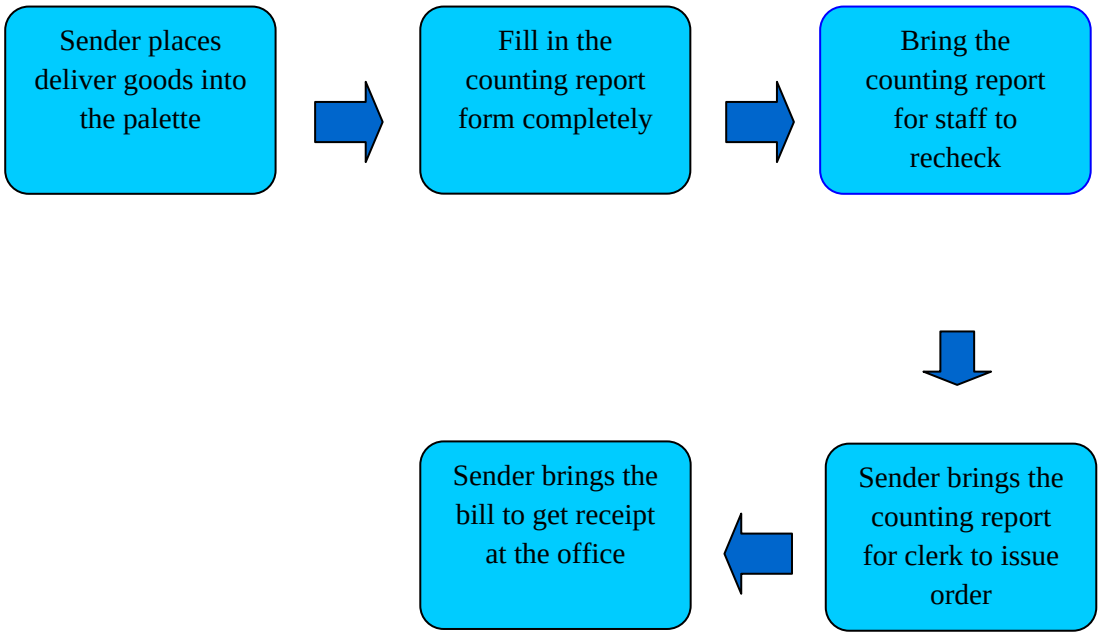
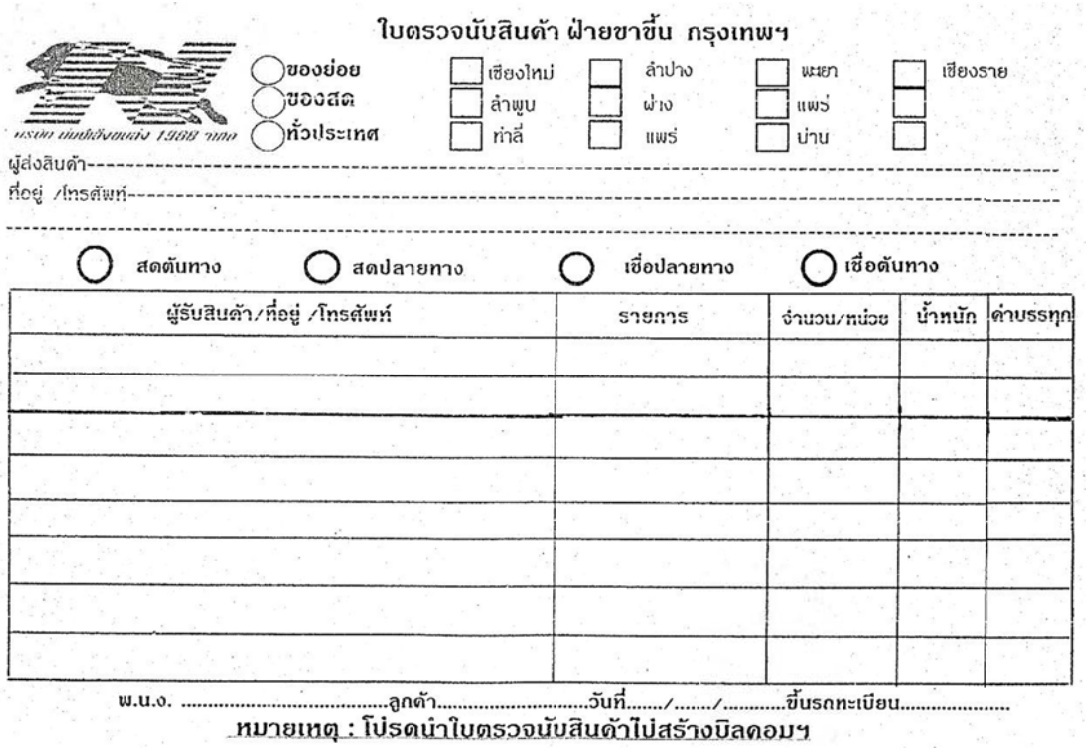


Figure 4.4 The delivery procedure

Delivery procedure consists of five steps. It starts when sender or customer arrives at the Bhuddhamonthon 5 road delivery center and upload goods to the counter according to district or province of destination. Sender is supposed to place goods into the provided palette. After that takes the counting report to fill in information such as sender, receiver, detail, amount, and unit of goods correctly and completely. The verify count stock is important to sender because if the sender fills in the wrong

information, the bill issuing for confirmation will be wrong as well. The counting report is shown is Figure 4.5. After filling in all the details, the sender brings the counting report to checker to check the goods. Then, bring the counting order for the clerk to issue billing. After that, if sender intends to pay cash at departure, sender should ask for receipt at the office. The step of delivery procedure is shown from Figure 4.6 to 4.10.


ใบตรวจนับสินค้า ฝ่ายขาขึ้น กรุงเทพฯ

ของย่อย ของสด ทั่วประเทศ

เชียงใหม่ ลำพูน ท่าลี่ ลำปาง ฝาง แพร่ แม่ยา แพร่ น่าน เชียงราย

ผู้ส่งสินค้า----------

ที่อยู่ /โทรศัพท์----------

สดต้นทาง สดปลายทาง เชื่อปลายทาง เชื่อต้นทาง

ผู้รับสินค้า/ที่อยู่ /โทรศัพท์	รายการ	จำนวน/หน่วย	น้ำหนัก	ค่าบรรทุก

พ.น.ง. .....ลูกค้า.....วันที่...../...../.....ขึ้นรถทะเบียน.....

หมายเหตุ : โปรดนำใบตรวจนับสินค้าไปสร้างบิลคอมฯ

Figure 4.5 Example of counting report upward department

Counting report is a document that sender needs to fill in information of goods to be delivered by the company. The details to fill in are types of goods such as minor goods, fresh goods, or sending to the whole country; destination province; name, address and phone number of sender; method of payment such as cash at departure, cash at destination, credit at destination, credit at departure; name, address and phone number of recipient; list of goods such as amount, weight and upload fee. The clerk is using all those details in the counting report to issue the purchase order again.

Figure 4.6 The first delivery procedure when customer places goods on the palette

When customer or sender arrives at the delivery center, he is supposed to place goods on the palette provide by the company.

Figure 4.7 The second delivery procedure where sender fills in detail of the counting report

After placing the goods in the palette, customer should fill in the counting report by giving details of goods completely such as recipient's name, sender, type of goods, amount and unit of goods, destination, and payment status.

Figure 4.8 The third delivery procedure when sender handling the counting report for staff to check the detail

When customer or sender fills in the verify stock count completely, the customer should bring the counting report to checker a recheck and sign the name for confirmation before handling it to the clerk.

Figure 4.9 The fourth delivery procedure when customer submits the verify stock count to the clerk

After checker checks the verify stock count, the customer should bring the counting report for the clerk to issue billing by fill in the information into the computer.

Figure 4.10 The fifth delivery procedure when customer asks for receipt at the office

After the clerk issues billing, the customer who wants to pay cash or rather cash at destination should ask for receipt from the staff at the upstream department office.

The above Figures show the delivery procedures to customer of the upstream department. The department offers service for customer who wants to deliver goods from Bhuddhamonthon 5 road delivery center to the Northern region as well as to the whole country.

4.1.5 Deporting Service (The Downstream Department)

Figure 4.11 The area of downstream department or the deporting service

The downstream department of Bhuddhamonthon 5 road delivery center is used as resting space for goods from Northern departure waiting for customer to pick up. The area of the downstream department is about 25% of the branch. There are three service counters. The first counter or counter A which handles goods receiving from Chaing Fa district, Lampang Province and Phrae Province. The second counter or counter B handles good receiving from Phayoa Province, San Kamphaeng district, Thali district and Lamphun Province. The third counter or counter C handles goods receiving form Chaing Mai Province. The space at the middle is used to store goods according to the provinces or districts on the shelf for it is easy to search. The front of the area is used as the office form contact. The rest of the area is divided into two counters, about 12.5%, using for storing the company's flour.

4.1.6 Deporting Procedure

The procedure to deport goods consists of six steps as followed:

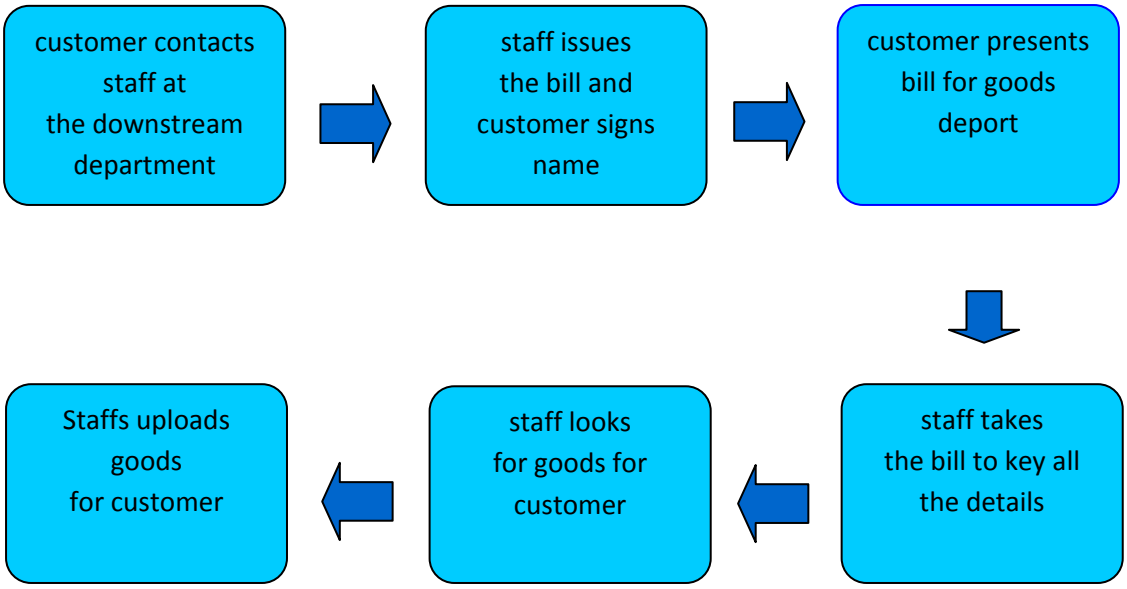


Figure 4.12 The procedure in deporting goods of the downward department consists of six steps.

The first step is when customer comes to pick up goods by contacting staff the downstream department. After that, staff is going to issue the bill for customer and asks the customer for signature as a confirmation of pick up. The customer then presents the bill to another staff for searching of goods. The staff is filling in the information as evidence for picking up and search for goods for customer. Finally, the deporting goods is placed in the customer's car which is the last step to complete the procedure of the downstream department. The step of deporting procedure is shown from Figure 4.13 to 4.18.

Figure 4.13 The first deporting procedure when customer contacts with staff at the downstream department

The first step starts when goods arrive and staff informs the customer by phone. When the customer first arrives, he should present I.D. card for confirmation with the staff at the downstream department.

Figure 4.14 The second deporting procedure when staff issuing the bill for customer to sign as confirmation

The second step is when staff is issuing the bill or searching for the bill for customer to give it to another staff for deporting goods. Then the customer signs the name as confirmation.

Figure 4.15 The third deporting procedure when customer presents the bill for staff to search for goods

The third step is for customer to present the bill to staff to search for goods according to bill order.

Figure 4.16 The fourth deporting procedure when staff writes down all the details

The fourth step is for staff to write down all the details after receiving the bill from the customer.

Figure 4.17 The fifth deporting procedure when staff searches for goods of customer

The fifth step is after staff has written down all the details, he is searching for goods which have been categorized on the shelf according to district or province.

Figure 4.18 The final deporting procedure when staff placing goods into customer's car

After the staff found the goods, the staff is going to place goods into customer's car to complete the procedure of deporting of the downward department.

The above Figures show the service for deporting procedures to customer of NIM Transport 1988 Co., LTD at Bhuddhamonthon 5 road delivery center. It is the center of goods distribution as well as goods deporting from the Northern departure to the destination at Bhuddhamonthon 5 road delivery center for customer to pick up.

4.2 Statistics Report and the Company's Assessment

The company has recorded many statistics reports as well as has assessed the performance every month in order to summarize the operation in many aspects. The statistic has been processed and collected by branch manager of each branch every month and presents it in the form of figure. For example, there is nonconforming bill of the upward department about 3.84% in June. This does not mean that nonconforming bill occurs at the rate of 3.84% every month. The nonconforming bill can be 1.5% or 5.8% or any figure that branch manager is unable to acknowledge of variation or cause. Hence, branch manage is failed to solve the error or even starts to add up percentage of error. The following example is a report of monthly performance of Bhuddhamonthon 5 road branch shown in table 4.1.

Table 4.1 The report of performance in every aspects of Bhuddhamonthon 5 road branch

ลำดับ	งานประจำ (0-60):	เกณฑ์	มค	กพ	มีค	เมย	พค	มิย	กค	สค	กย	ตค	พย
1	สถิติอุบัติเหตุขึ้นหยุดงาน(FA1)	<0.3 ครั้ง/	0	0	0	0	0	0	0	0	0	0	0
2	สถิติอุบัติเหตุทั้งหมด(FA2)	<0.3 ครั้ง/	0	1	0	0	0	0	0	0	0	0	0
3	ความรุนแรงการเกิดอุบัติเหตุ(GA1)	<0.8 วัน/	0	1	0	0	0	0	0	0	0	0	0
4	ประสิทธิภาพการกระจายสินค้า(DR)	>80%	72%	73%	72.00%	72.00%	76.00%	73.00%	73.00%	70.49%	68.89%	68.97%	69.88%
5	อัตราบิลผิดปกติ%(NCB)	1.50%	3.02%	2.85%	3.05%	2.87%	2.99%	3.03%	2.93%	3.60%	5.6%	3.1%	4.2%
6	อัตราบิลผิดปกติขาขึ้น%(NCB1)	1%	2.44%	2.27%	2.68%	2.46%	2.71%	2.72%	2.72%	3.60%	5.6%	3.1%	4.2%
7	อัตราบิลผิดปกติขาล่อง%(NCB2)	0.50%	0.58%	0.58%	0.37%	0.41%	0.28%	0.31%	0.21%	0.00%	0.0%	0.0%	0.0%
8	ค่าเสียหาย(CQ1+CQ2)	<1750	362	434	205	261	270	359	332	614	141	225	172
9	ค่าเสียหายขาขึ้น(CQ1)		2,355	2,881	2,015	2,078	2,738	2,917	2,755	5,916	1,524	2,337	1,740
10	ค่าเสียหายขาล่อง(CQ2)		847	904	-	-	-	698	602	-	-	-	-
11	ประสิทธิภาพการใช้รถเล็ก(TU2)	> 80%	75%	72%	80%	83%	81%	76%	73%	75%	79%	84%	92%
12	ค่าประสิทธิภาพการใช้น้ำมัน	>100%	90%	93%	108%	95%	105%	93%	103%	107%	94%	102%	110%

branch manager may not be able to realize the cause of reduction or increasing of the figure. Hence, branch manager may not know exact way to solve problem or may miss a chance to invent strategic management in the branch. This leads to rising rate of error. For example, there is increasing number of nonconforming bill at Bhuddhamonthon 5 road branch.

From the meeting with the entrepreneur and branch manager of Bhuddhamonthon 5 road, the deal is made on solving the two KPI which are unable to meet up with the target. Bhuddhamonthon 5 road delivery center has faced with two problems that are nonconforming bill (upward department) and distribution rate (downward department). These two procedures are unable to meet up with expected target of the firm and have been known as continuous cause.

From the problem mentioned above, there is a study on finding method to reduce the number of nonconforming bill at Bhuddhamonthon 5 road branch. The study has tried on bringing Statistical Process Control and Control Chart P (P Chart) to apply with the service quality control. For the part dealing with nonconforming bill, the researcher has chosen Attribute Control Chart in which its quality to be control can be found from counting or when sample group is unequal. For example, the count is to find fine good or spoiled goods, damaged or perfect goods, goods with marked or sublime goods, and goods with defect or complete.

Therefore, the control value and ratio of error are to calculate from the following equation.

When $\bar{p}$ = total number of nonconforming bill/ total number of bill

$\bar{n}$ = mean of sample group

Upper Control Limit $UCL = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{\bar{n}}}$

Mean of ratio $\bar{p}$

Lower Control Limit $LCL = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{\bar{n}}}$

4.3 The On-line SPC Program Development

In order to develop On-line SPC program to be relevant to concept of watching patient's heartbeat, the researcher intends to use the Visual Basic 6 computer program to develop the program and uses Microsoft Access 2007 program to build up the database. Further, the SQL language is used to retrieve database. The operation of the program is run by two connecting computer by the cable line of Local Area Network. One computer is used to collect data as network database for another computer to retrieve data from the database or as we generally known as Client Server network system. Since the company is the largest delivery service with many branches, the researcher intends to develop On-line SPC program of the company in the form of Client Server system.

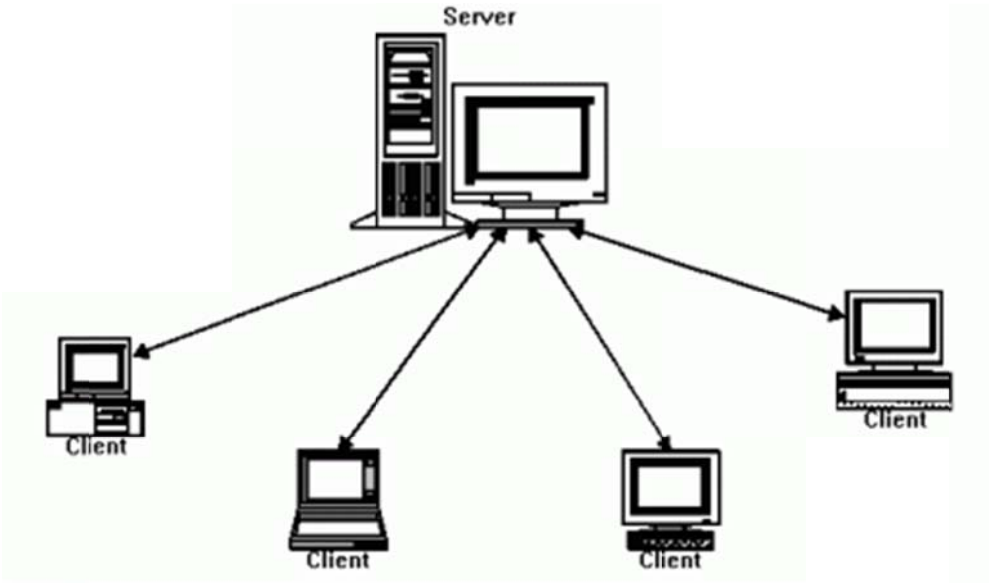


Figure 4.19 The connected pattern of Client Server Network System

The connection of Client Server system is to have one main computer act as Server to collect and manage data and it has to open all the time in order to allow the rest of the connected computer to retrieve program or information. The important equipment used to connect those computers together is LAN Card and Cable line.

4.3.1 Design of User Interface

Connection part and user are important parts that influence the design because most user feels satisfy with the design system. For this part, the researcher is using Adobe Photoshop CS2 to create visual to make it more interesting and leads to system development later.

Figure 4.20 Format of Program Introductory

Figure 4.20 is the introduction of the program. This is the first page of the program which appears on the screen for two second then brings the user to the operation page with information on branch and assessment period.

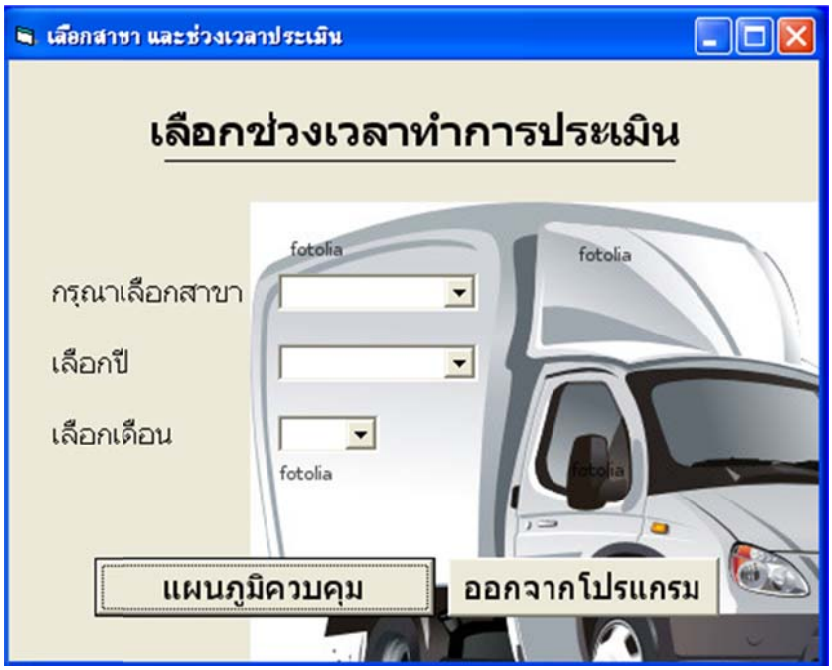


Figure 4.21 Branch and assessment period form

Figure 4.21 the form page for user to fill in branch of assessment and period of assessment such as choosing January 2010 since this program is using under the same network system and retrieving the data from the same database.

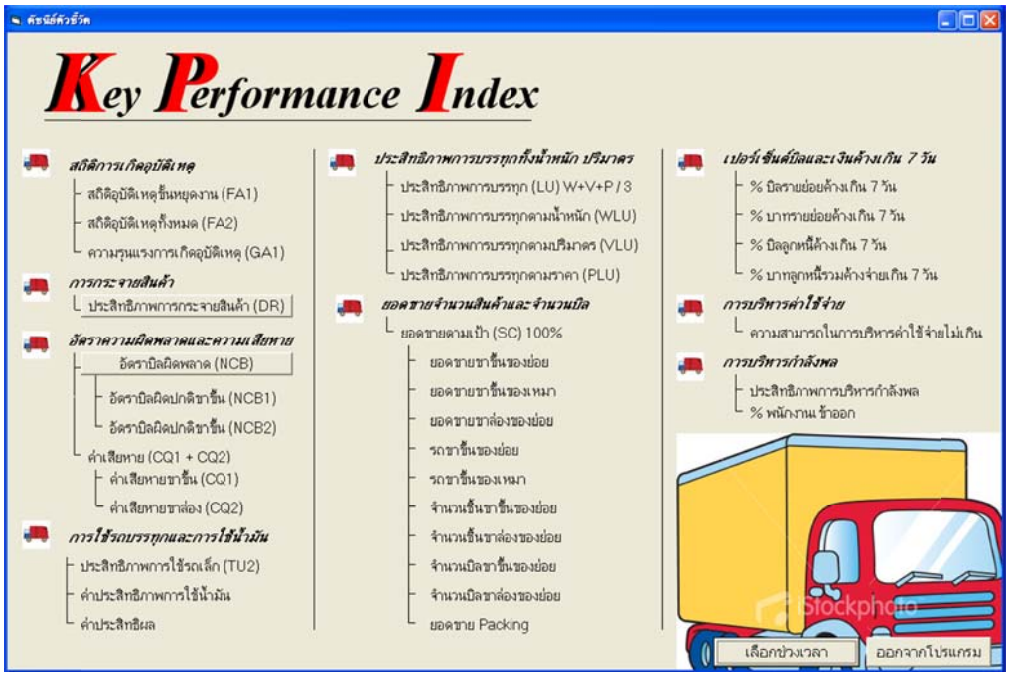


Figure 4.22 Form page of KPI for assessment

Figure 4.22 the part where system user refers in the page of KPI assessment and chooses which KPI should be assessed. The list of KPI appears in the page comes from performance report of every branch. KPI using in the assessment is to be processed in the form of Control Chart.

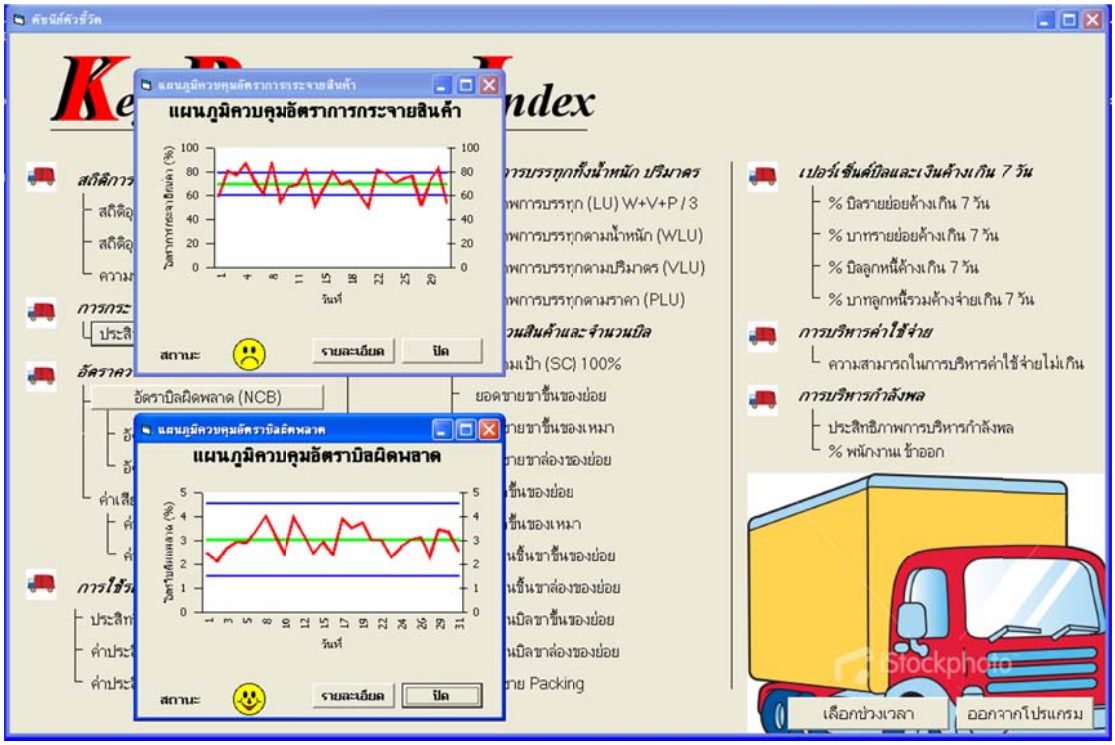


Figure 4.23 The whole Figure of system operation by Control Chart

Figure 4.23 the whole Figure of system operation by Control Chart. It does not show any other detail. The visual graph shows how the system operation is together with whether it is good or should be improve. The page is meant for user to view different operation he or she wants to observe or monitor. If user wants to view more details, he or she can view it by clicking on the icon “Detail” which presents in the form of MR Control Chart.

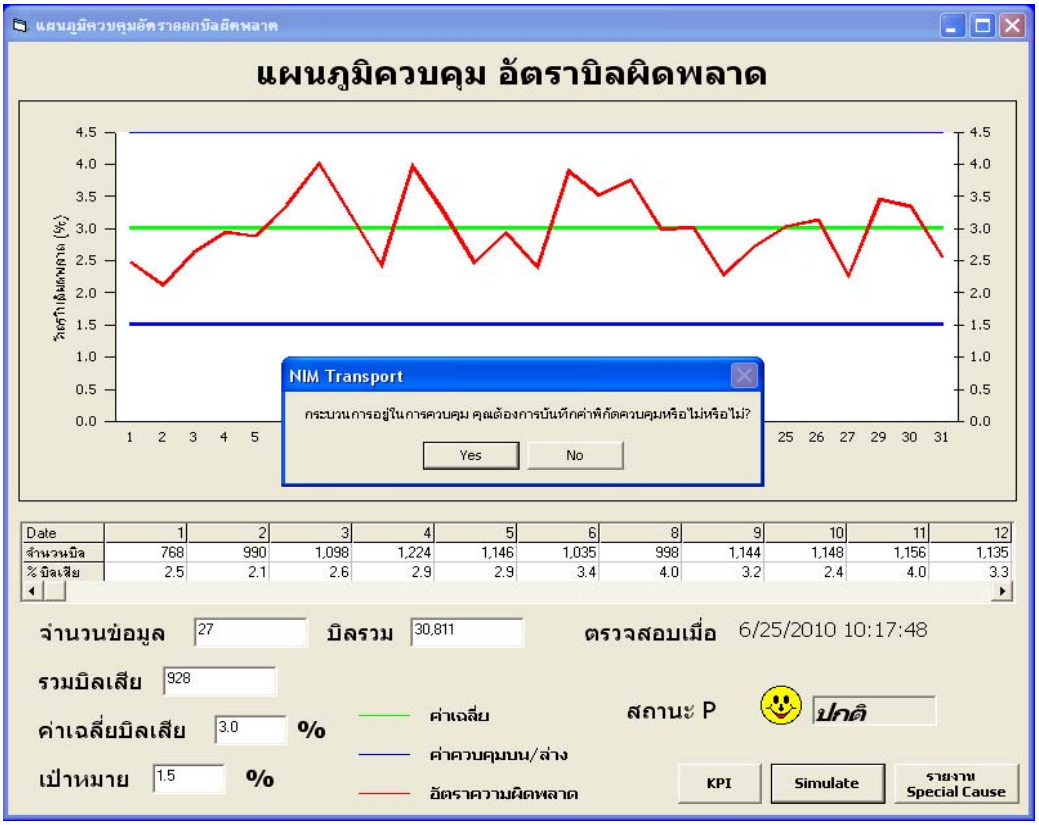


Figure 4.24 Detail and part of operation in the form of control chart

From the Figure

- Axis X is assessment period
- Axis Y is ration of nonconforming bill
- Green line is Central line (CL) calculated from nonconforming bill/ total number of bill = 928/30,811 = 0.03 or 3%
- Blue line is Upper Control Limit and Lower Control Limit (UCL/ LCL)
- Red line is ration of nonconforming bill per day

Details of procedure in the form of control chart which consists of name of control chart, detail of data in control chart such as the amount of data, number of nonconforming bill, average, the set target, and status of the control chart that has two statuses: normal and improving. Apart from that, the page shows the animation of emoticon signalizes operation status whether it is good or not as well as assessment period. In the case of detecting special cause within the procedure, there is message box pops up as a notification which will be explained in the next heading. If, by

chance, the procedure is not under control when there is point comes out of the control limit over 2, the message box will pop up as a reminder for revision of original data. This notification is shown in the following chapter. If the procedure is under the control period, there will be message box for user to record the value of existing control limit. Another capacity of the program is to report special cause by pressing button Special Cause report. The type of report is shown in Table 4.2. The operation of the control chart is to manage KPI data that user chooses from the database to calculate the control limit. The procession is working as Real-time report that is whenever new data has been introduced, the system is working automatically by just switching the computer on.

Table 4.2 Report on the test of Special Cause in the program

Report on Special Cause case

Date/ Time	**KPI**	**Branch**	**Type of Error**
6/23/2010 2:52:26 PM	NCB	Bhuddhamonthon 5 road	Out of Control Limit
6/23/2010 2:52:58 PM	NCB	Bhuddhamonthon 5 road	Out of Control Limit
6/24/2010 6:37:51 PM	NCB	Bhuddhamonthon 5 road	Out of Control Limit
6/24/2010 6:37:51 PM	NCB	Bhuddhamonthon 5 road	8 points more than 1 SD

End Report

Table 4.2 consists of the following explanation:

- The 1st column is Date and Time. For example, 6/23/2010 2.52.26 PM is the day 23 of June, 2010 or the year 2553 B.E. at 14 hour 52 minutes and 26 seconds.
- The 2nd column is KPI (Key Performance Indicator) and NCB (Nonconforming Bill)
- The 3rd column is the branch offering service
- The 4th column is type of special cause consisting of 8 types (see details in page 11-12)

The report of Special Cause after testing is done by using hypothetical data randomly. The purpose is to raise the falsity of data to the highest error of special cause. The test starts from June 23 to June 24, 2553 with the factors consist of date, time, KPI, branch, type of error, and cause. The procedure is processed when the program detects error within any operation and gives notification for user to record that error. For user's convenience, he can retrieve procedure assessment report from this part. In the meantime, manager or controller should find the cause of special cause himself because the program is unable to analyze the cause.

4.3.2 Revision of Procedure for the Control Limit Calculation under the Control Period

The application of the control chart can be divided into two steps. The first step or the revision of procedure state is the test to find out variation of the procedure. If user finds out that the variation appears sway and unstable, the use of control chart to control the procedure is meaningless. On the other hand, if user tries on the procedure revision and finds out that the existing variation of the procedure is relatively small and under control extensively, the control limit is to be used in the second step or the control step.

The interpretation of the control chart is to consider whether the procedure is under control or not. If p stands for falsity rate or every p value that is used for plotting is under the control range or the maximum value of the control range is 2, the value of p is then variants under natural cause. The value can be brought to calculate

the control limit of the second step or the control step. If maximum value of p of the control range is 2, the data is error and need to be revise.

In the case that the maximum value of p is over the control limit but not over 2, user has to cut off p from the consideration and calculated the $\overline{p}$ again from the equation.

$$\overline{p}_{revise} = \frac{\sum np_{old} - \sum np_{delete}}{\sum n_{old} - \sum n_{delete}}$$

- $\overline{p}_{revise}$ is the new calculated $\overline{p}$ dervied from the equation
- np_{old} is falsity value before the revision of procedure
- n_{old} is the samples before revision of procedure
- np_{delete} is number of falsity value to be deleted
- n_{delete} is the sample to be deleted

From the interpretation of the control chart, the researcher has revised the procedure to calculate the control limit of the second step or the control step. It is the procedure that allows user to apply the control value of the control step to verify. The revision of procedure development is divided into three following cases.

Case study 1 Program detects any value out of control limit over 2 values

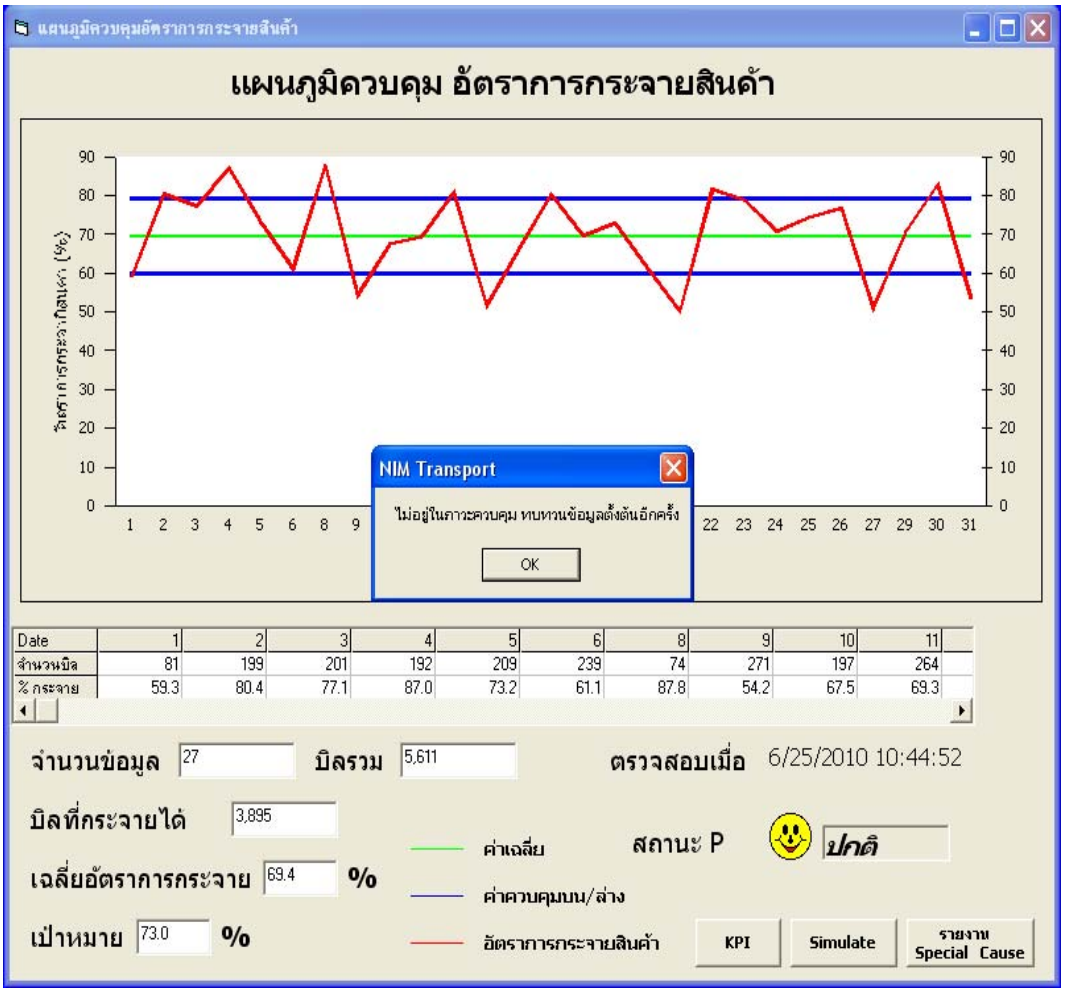


Figure 4.25 Pop up which notifies user to recheck original data

From the Figure

- Axis X is assessment period
- Axis Y is distribution rate
- Green line is Central line (CL) calculated from distribution bill per day/ total number of bill = 3,896/5,611 = 0.694 or 69.4%
- Blue line is Upper Control Limit and Lower Control Limit (UCL/ LCL)
- Red line is distribution rate per day

Figure 4.25 is a page after the program has been examined the variation of the procedure and finds out that the procedure under the assessment has high variant

and out of control. This can be assumed that if the program finds out that the value is over the control limit more than two control values, this procedure is out of control. It is necessary for user to review the data since the procedure is having high variant. Moreover, when the procedure cannot be control, the control chart is useless when applies with the operation. However, if the review of the procedure comes out as under control; that is no other value is over the control limit or not over the two control values. This control value will be used as criteria by method of review on operation equation.

Case Study 2 Program finds out that no value is out of the control limit

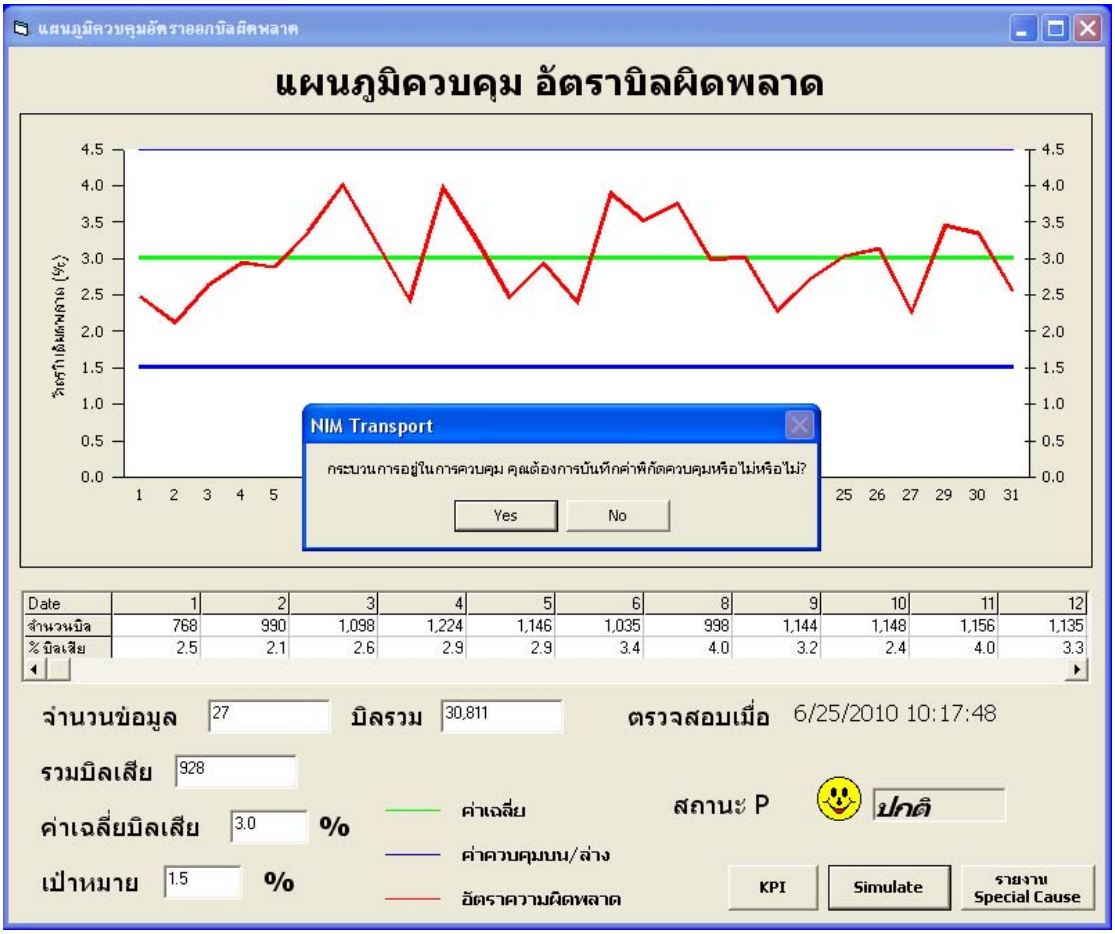


Figure 4.26 Pop up box to mark the control value

From the Figure

- Axis X is assessment period
- Axis Y is ration of nonconforming bill
- Green line is Central line (CL) calculated from nonconforming bill/ total number of bill = 928/30,811 = 0.03 or 3%
- Blue line is Upper Control Limit and Lower Control Limit (UCL/ LCL)
- Red line is ration of nonconforming bill per day

After the program examines and finds out that there is no value out of the control limit, it is assumed that the procedure under the assessment has little variation and under control most of the time. The pop up is showing the procedure status when it is under control and user is able to utilize the control limit value all the time. If user wants to mark the control value, just presses the icon 'yes', the program will mark the control value into the database immediately.

Case Study 3 Program detects data out of the maximum value of 2 but not over control limit

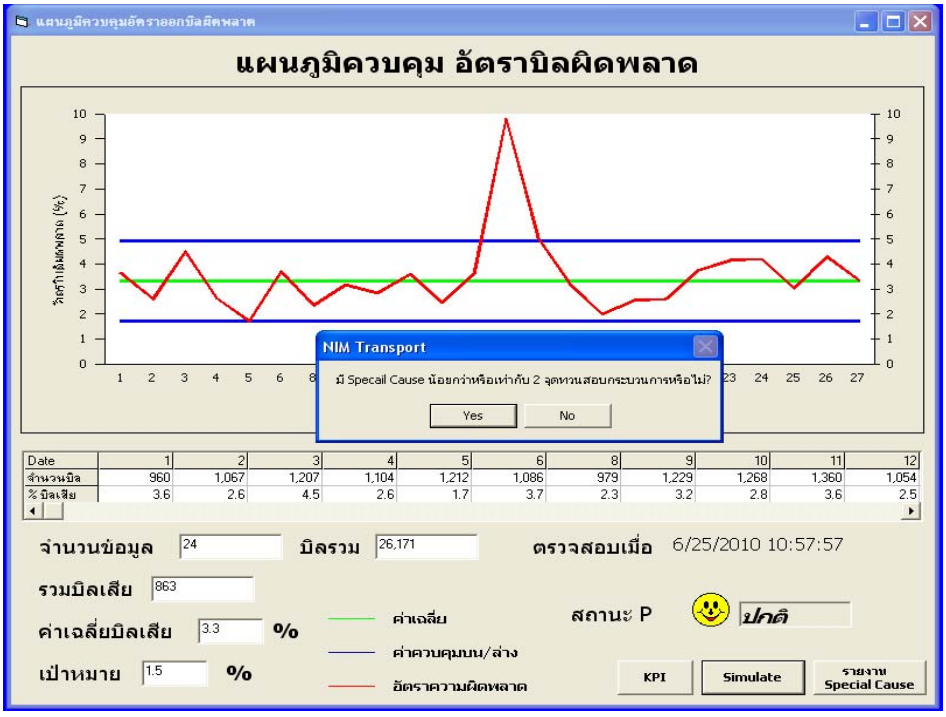


Figure 4.27 Pop up of procedure revision

From the Figure

- Axis X is assessment period
- Axis Y is ration of nonconforming bill
- Green line is Central line (CL) calculated from nonconforming bill/ total number of bill = 930/26,690 = 0.031 or 3.1%
- Blue line is Upper Control Limit and Lower Control Limit (UCL/ LCL)
- Red line is ration of nonconforming bill per day

When the program examines the procedure and finds out that there is one or another value out of the control limit but over than two values. It means the procedure of the assessment is under control with little variants. The control limit is then used in the second step or the control step (in this case the value has to undergone the procedure revision equation). Consequently, the pop up box appears to ask the for the procedure revision to calculate the control limit again. If user wants to calculate the control value, just presses the icon ‘yes’, the program is revising the procedure by substitute the value in the procedure revision equation.

The substitution of the equation

$$\bar{p} = \frac{930 - 4}{29{,}690 - 367}$$

$$\bar{p} = \frac{926}{29{,}323}$$

$$\bar{p} = 0.032$$

After getting the new $\bar{p}$ value, it is going to be substitute in the equation to calculate the control limit..

When $\bar{p}$ = total number of nonconforming bill/ total number of bill

= 0.032

$\bar{n}$ = total number of bill/ total assessment date

= 1,127.8

Upper Control Limit (UCL)

$$UCL = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{\bar{n}}}$$

$$UCL = 0.032 + 3\frac{\sqrt{0.032\,(0.968)}}{1127.8}$$

$$UCL = 0.048$$

Lower Control Limit (LCL)

$$LCL = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{\bar{n}}}$$

$$LCL = \bar{p} - 3\sqrt{\frac{0.032\,(0.968)}{1127.8}}$$

$$LCL = 0.016$$

The program itself will calculate the control value of both the revision procedure state and the control period. User only just chooses the preference. After revising the procedure, user will get the control value of the control chart to apply to the control period later.

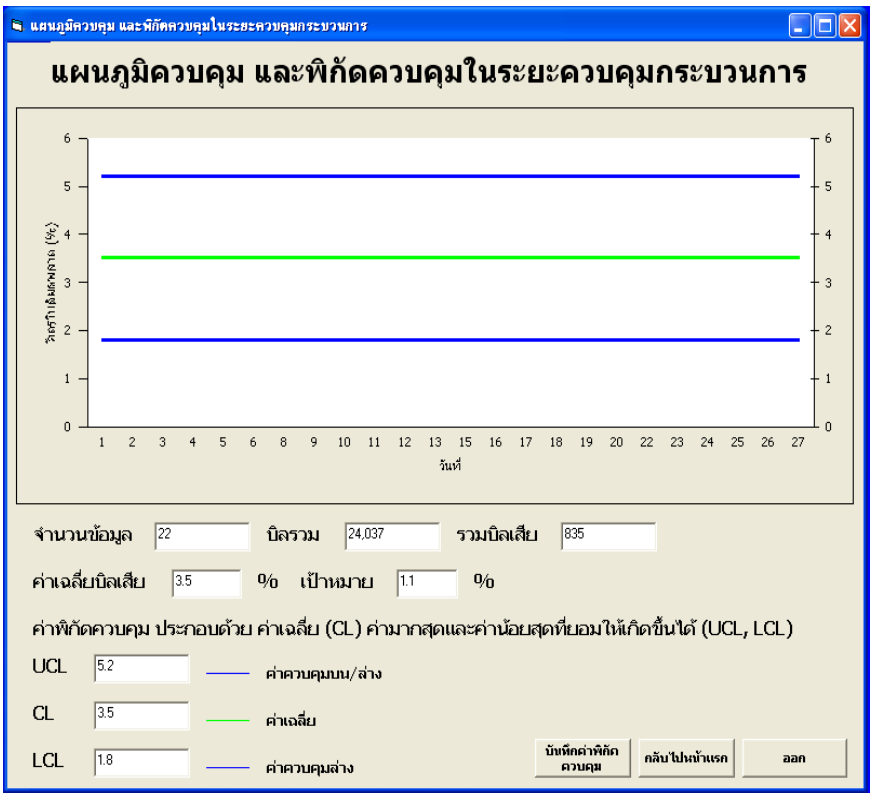


Figure 4.28 Control Chart after the procedure revision

From the Figure

- Axis X is assessment period
- Axis Y is ration of nonconforming bill
- Green line is Central line (CL) calculated from nonconforming bill/ total number of bill = 926/29,323 = 0.032 or 3.2%
- Blue line is Upper Control Limit and Lower Control Limit (UCL/ LCL)

The Control Chart and details using in calculation such as control limit, upper control limit, lower control limit, mean, and buttons. The buttons on the screen consists of memorizing control limit button, back to front page button, and exit button. After getting control value of the control period, user is able to memorize control value by pressing the memorizing control limit button. Then the program will record the control value in the database in order to be retrieved in the next operation.

4.3.3 The Development of Setting up the Control Limit under the Control Period

When user gets the control limit from the calculation of the first phase or revision of operation step, the control limit is recorded in the database and can be retrieved in the operation from the program. The researcher himself has developed the set up of the control limit for use to input the set control limit to construct the second step control chart or control period.

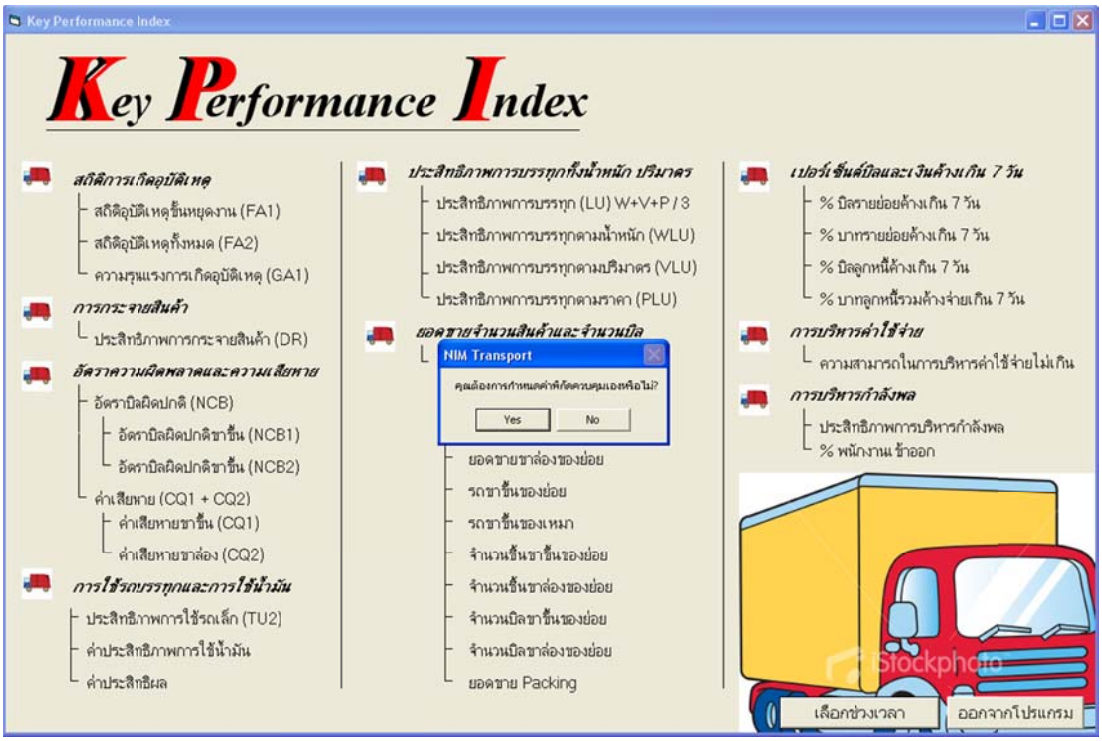


Figure 4.29 Pop up box asking for self setting control limit

When user chooses the branch and the month for an assessment, the next step is to choose the form with the list of KPI. After choosing KPI category such as KPI of nonconforming bill (NCB), there is a pop up box asking for self setting control limit. If user wants to set the control limit himself, then presses the “Yes” button. After that the form will allow user to fill in the preference control limit. If user press the “No” button, the next step is the operation revision.

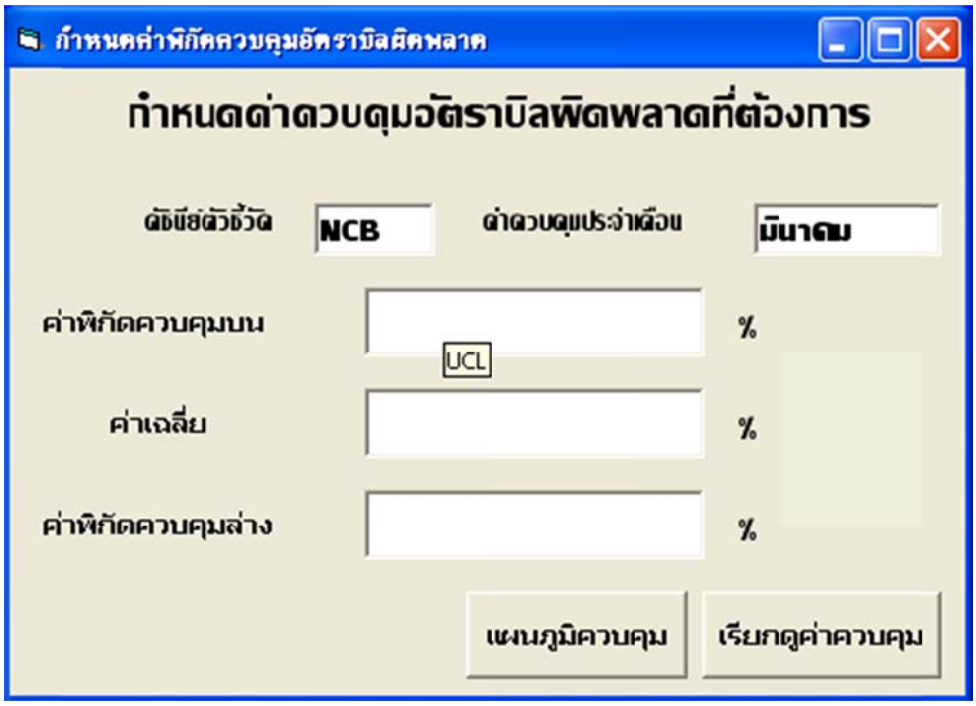


Figure 4.30 Form of self setting control limit

After user decides to set the control limit, presses the Control Chart button. The program is then utilizing the control limit with the control period. If user cannot remember the control limit, it is advised to press the retrieve control limit button. The program will retrieve the recorded control limit for user to see and make a decision on the setting of control limit.

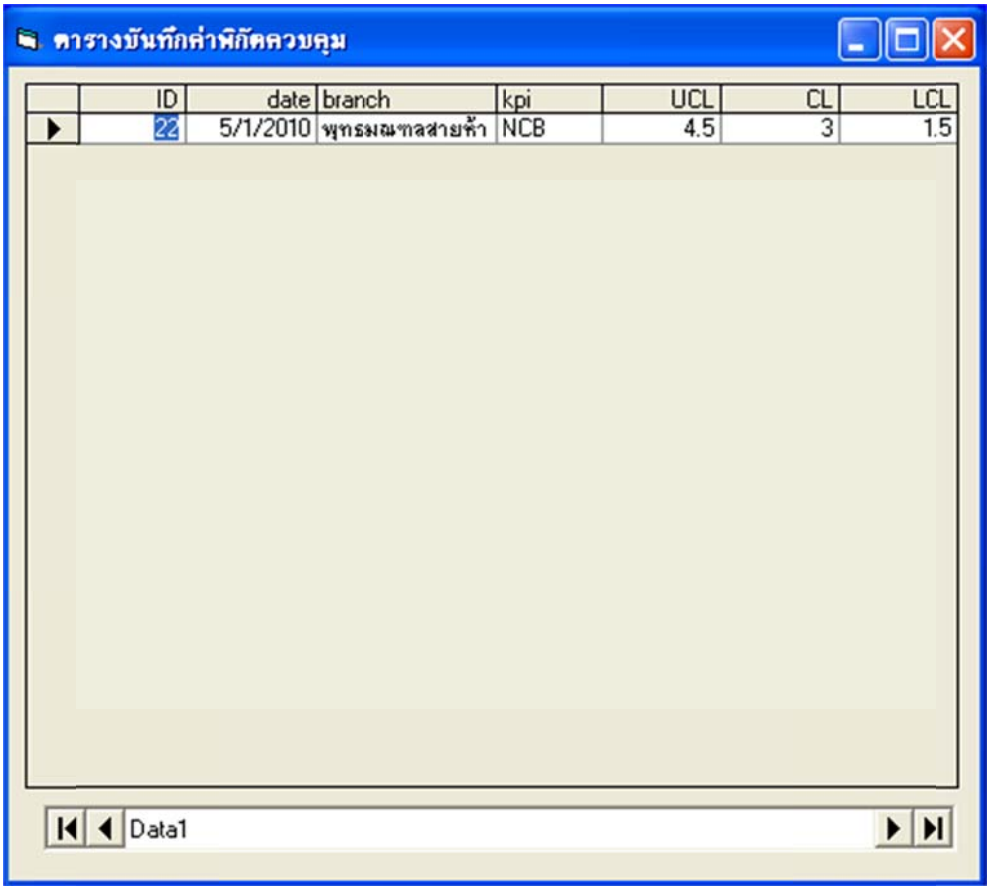


Figure 4.31 Table of recorded control limit by user

Table of recorded control limit is designed for user to retrieve the recorded control limit just by pressing the button. It will show the information which consists of the following detail.

- ID is Identification of recorded control limit
- Date is day of recording
- Branch in this case is Bhuddhamonthon 5 road branch which is number 4
- UCL is … or Upper Control Limit
- CL is Central Line
- UCL is …. or Lower Control Limit

User should be certain of and remember the recorded control limit because it will be used to set the control limit in the next step itself.

4.3.4 The Development of Special Cause Notification Procedure

In using the control chart, one of the most important procedures is the notification of special cause within the operation. It is to inform user to be aware of special cause immediately. Apart from that, the notification is simply to find period that special cause occurs and helps to find solution. Special cause occurring within the procedure of the control chart is divided into eight categories which can be seen in details of Table 4.32 – 4.39.

Pattern 1 any value which is lower or higher than 3 or ± 3 Standard Deviation (± 3SD)

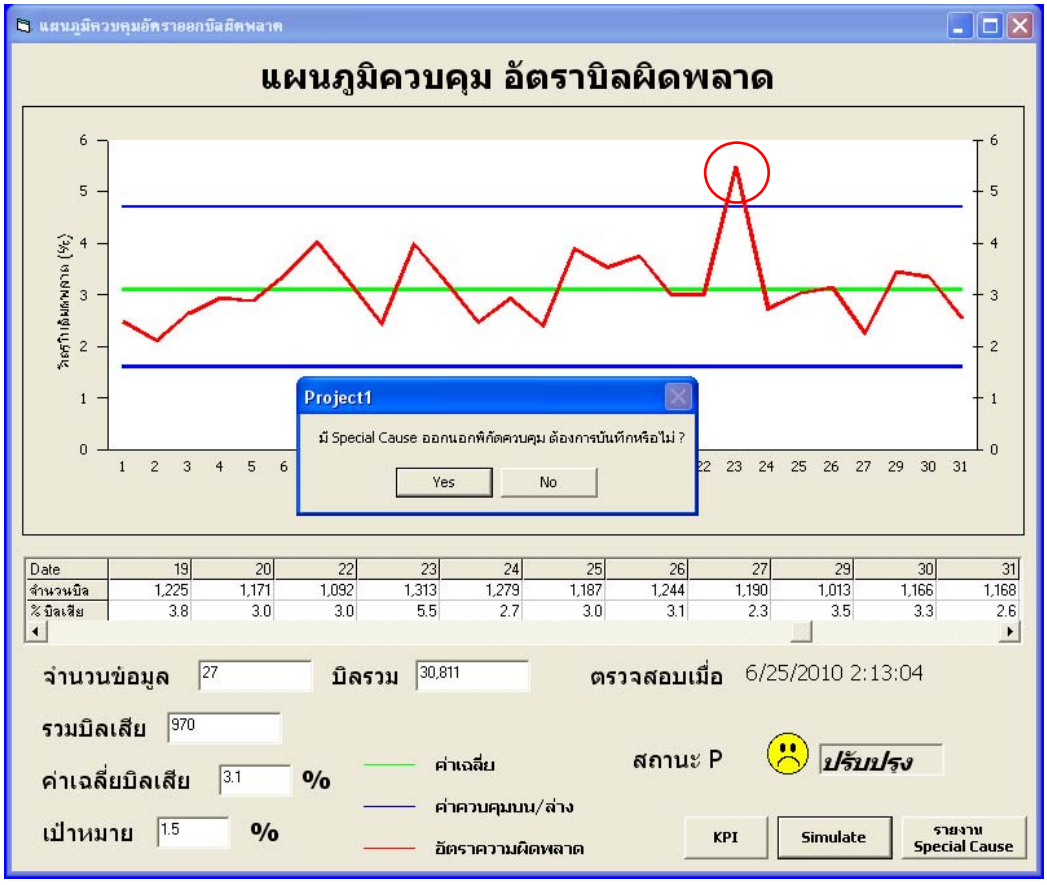


Figure 4.32 Notification of Special cause when any value is out of the control limit

From the Figure

- Axis X is assessment period
- Axis Y is ration of nonconforming bill
- Green line is Central line (CL) calculated from nonconforming bill/ total number of bill = 970/30,811 = 0.031 or 3.1%
- Blue line is Upper Control Limit and Lower Control Limit (UCL/ LCL)
- Red line is rateion nonconforming bill per day

The line that spills out of the ± 3 SD on the twentieth day. In this case, special cause occurs or there is defect within the procedure. When the program detects special cause, there is pop up box to notify and defines type of special cause. Moreover, it will ask user to record the special cause.

Even though there is special cause appears on the screen, the procedure seems normal and under control all through the operation. There can be any other type of special cause even if the procedure is under control. There are seven more types of special cause to be notified of its variation and they are exhibited from pattern 2 to pattern 8.

Pattern 2 there is nine dots of special cause lining continuously above the central line

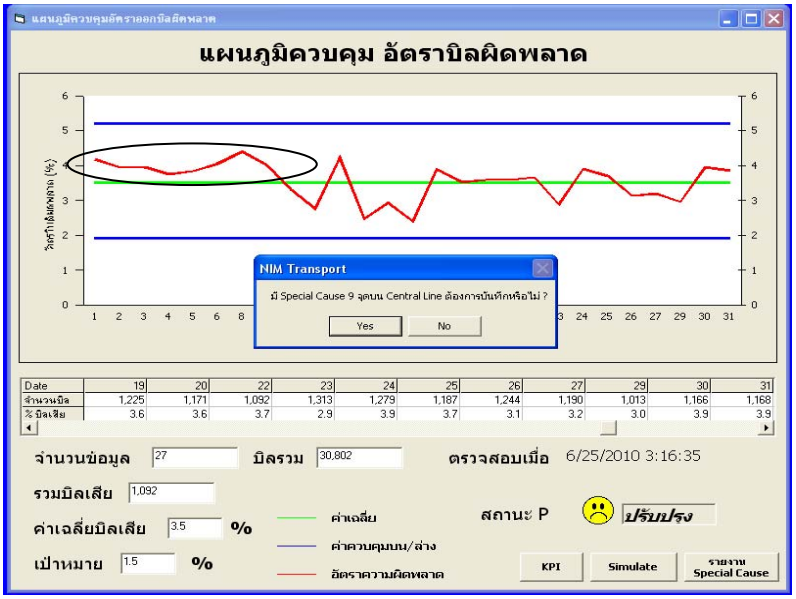


Figure 4.33 Notification of nine special cause lining continuously above the central line

From the Figure

- Axis X is assessment period
- Axis Y is ration of nonconforming bill
- Green line is Central line (CL) calculated from nonconforming bill/ total number of bill = 1,092/30,802 = 0.035 or 3.5%
- Blue line is Upper Control Limit and Lower Control Limit (UCL/ LCL)
- Red line is ration of nonconforming bill per day

From Figure 4.33, there seems to be no special cause since every value is under the control limit. However, there are nine special causes lining continuously above the central line.

It means there is special cause occurring within the procedure. When the program detects the special cause, there is pop up box to notify type of special cause as well as the preference to record the error.

Pattern 3 there is six dots lining continuously up or down

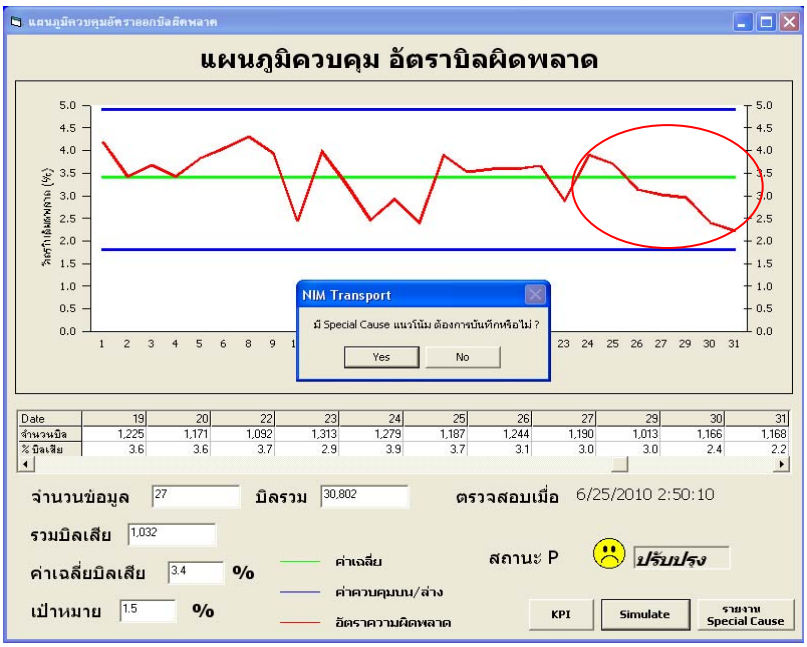


Figure 4.34 Notification of six special cause lining continuously above the central line

From the Figure

- Axis X is assessment period
- Axis Y is ration of nonconforming bill
- Green line is Central line (CL) calculated from nonconforming bill/ total number of bill = 1,032/30,802 = 0.034 or 3.4%
- Blue line is Upper Control Limit and Lower Control Limit (UCL/ LCL)
- Red line is ration of nonconforming bill per day

From Figure 4.34, there are dots plotting continuously up or down. This type of lining can be interpreted as special cause occurs within the procedure. When the program detects the special cause, there is pop up box to notify type of special cause as well as the preference to record the error.

Pattern 4 there are 14 dots lining up and down continuously

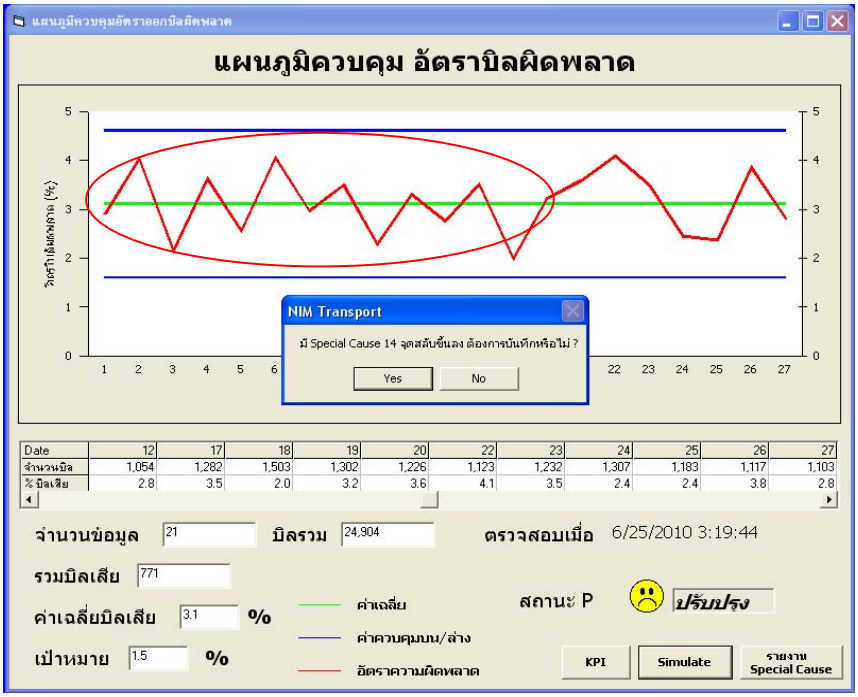


Figure 4.35 Notification of 14 special cause lining up and down continuously

From the Figure

- Axis X is assessment period
- Axis Y is ration of nonconforming bill

- Green line is Central line (CL) calculated from nonconforming bill/ total number of bill = 771/24,904 = 0.031 or 3.1%
- Blue line is Upper Control Limit and Lower Control Limit (UCL/ LCL)
- Red line is ration of nonconforming bill per day

From Figure 4.35, there are total of 14 dots lining continuously up or down. This type of lining can be interpreted as special cause occurs within the procedure. When the program detects the special cause, there is pop up box to notify type of special cause.

Pattern 5 there are two out of three dots spill over the level of ± 2SD

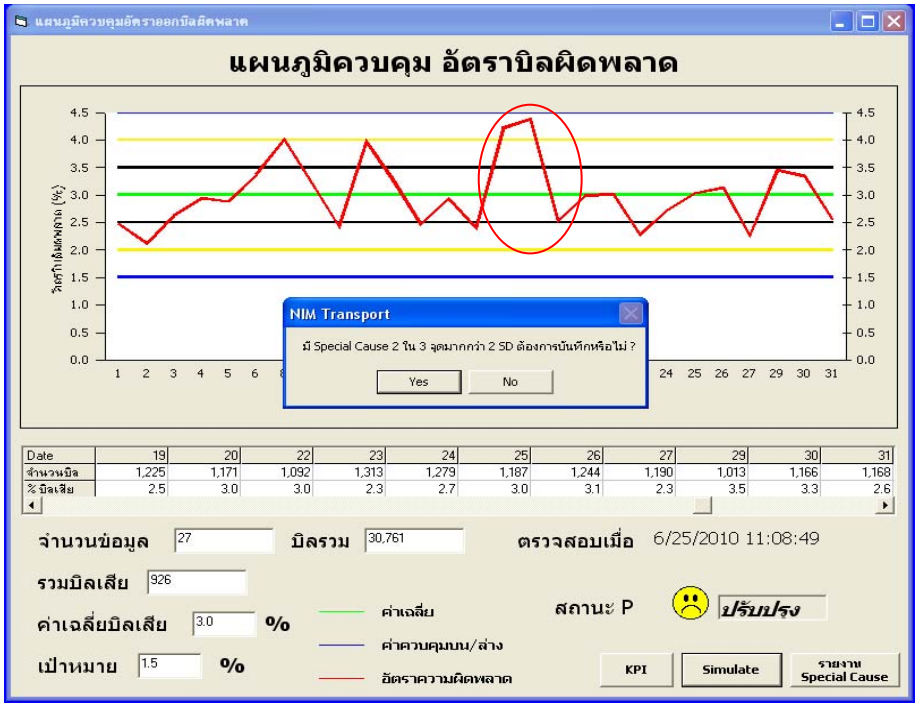


Figure 4.36 Notification of special cause when two out of three dots spill over the level of ± 2SD

From the Figure

- Axis X is assessment period
- Axis Y is ration of nonconforming bill
- Green line is Central line (CL) calculated from nonconforming bill/ total number of bill = 926/30,761 = 0.030 or 3.0%

- Blue line is Upper Control Limit and Lower Control Limit (UCL/ LCL)
- Black line is standard deviation at level ± 1SD
- Yellow line is standard deviation at level ± 2SD
- Red line is ration of nonconforming bill per day

Figure 4.36 is showing type of special cause with two out of three dots spill over the level of ± 2SD which means there is special cause occurs within the procedure. When the program detects the special cause, there is pop up box to notify type of special cause as well as the preference to record the error.

Pattern 6 there are four out of five dots lining continuously above the level of more than ± 1SD

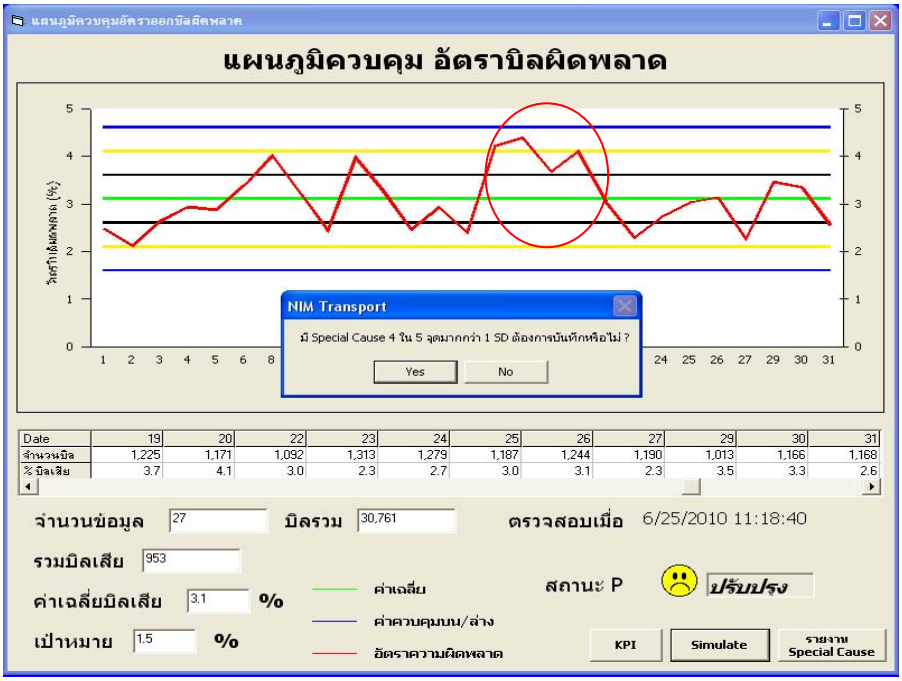


Figure 4.37 Notification of special cause when four out of five dots spill over the level of ± 1SD

From the Figure

- Axis X is assessment period
- Axis Y is ration of nonconforming bill

- Green line is Central line (CL) calculated from nonconforming bill/ total number of bill = 963/30,671 = 0.031 or 3.1%
- Blue line is Upper Control Limit and Lower Control Limit (UCL/ LCL)
- Black line is standard deviation at level ± 1SD
- Yellow line is standard deviation at level ± 2SD
- Red line is ration of nonconforming bill per day

Figure 4.37 Special Cause occurs when four out of five dots lining continuously above the level of more than ± 1SD. This means that the procedure has special cause within. When the program detects the special cause, there is pop up box to notify type of special cause as well as the preference to record the error.

Pattern 7 there are 15 dots lining continuously at level ± 1SD

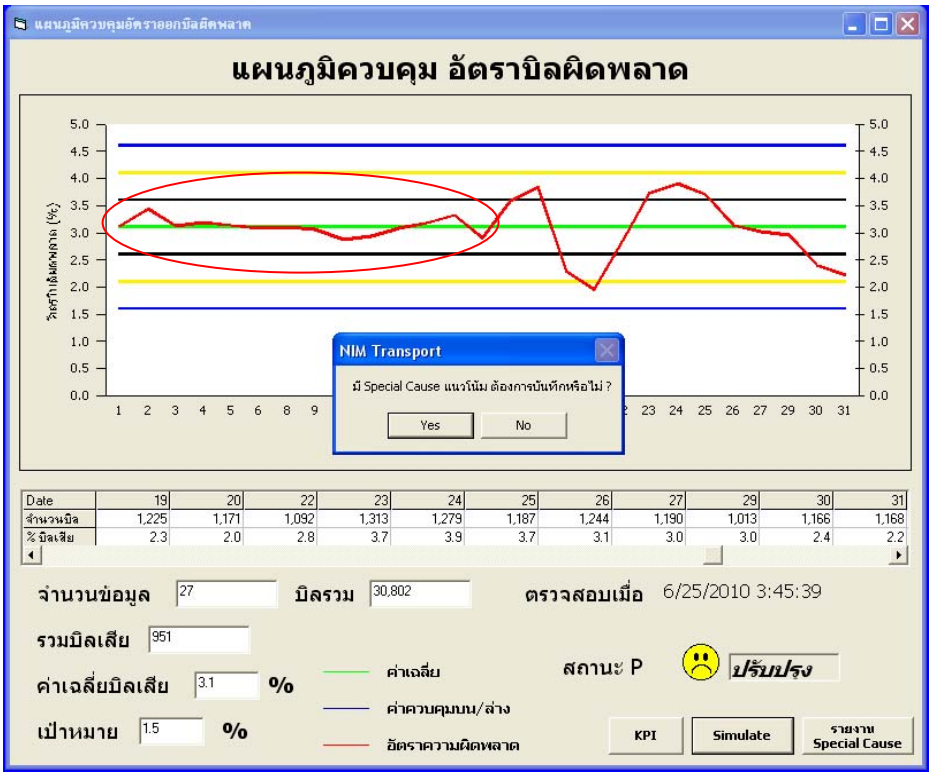


Figure 4.38 Notification of special cause where there are 15 dots lining continuously at level ± 1SD

From the Figure

- Axis X is assessment period

- Axis Y is ration of nonconforming bill
- Green line is Central line (CL) calculated from nonconforming bill/ total number of bill = 951/30,802 = 0.031 or 3.1%
- Blue line is Upper Control Limit and Lower Control Limit (UCL/ LCL)
- Black line is standard deviation at level ± 1SD
- Yellow line is standard deviation at level ± 2SD
- Red line is ration of nonconforming bill per day

Figure 4.38 that when 15 dots lining continuously at level ± 1SD, it means theprocedure has special cause within. When the program detects the special cause, there is pop up box to notify type of special cause as well as the preference to record the error.

Pattern 8 there are 8 dots lining continuously above level ± 1SD

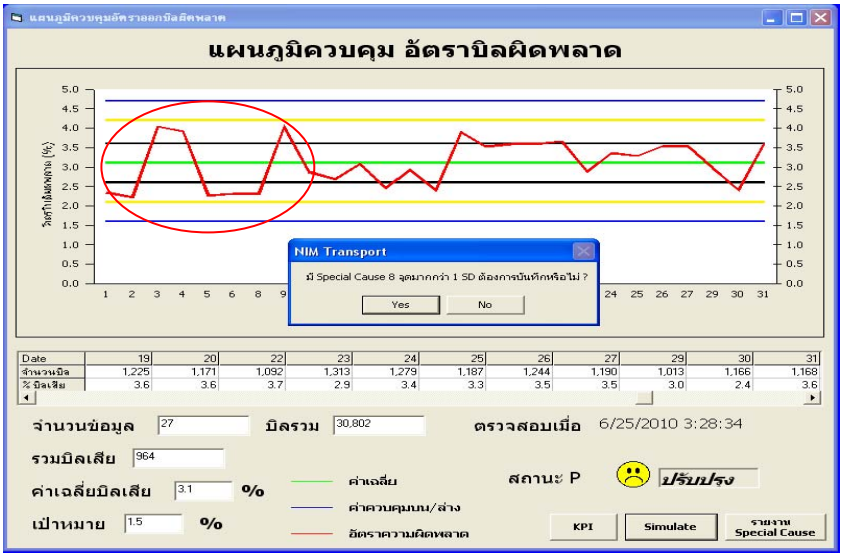


Figure 4.39 Notification of special cause where there are 8 dots lining continuously above level ± 1SD

From the Figure

- Axis X is assessment period

- Axis Y is ration of nonconforming bill
- Green line is Central line (CL) calculated from nonconforming bill/ total number of bill = 964/30,802 = 0.031 or 3.1%
- Blue line is Upper Control Limit and Lower Control Limit (UCL/ LCL)
- Black line is standard deviation at level ± 1SD
- Yellow line is standard deviation at level ± 2SD
- Red line is ration of nonconforming bill per day

Figure 4.39 that when 8 dots lining appears continuously above level ± 1SD, it means the procedure has special cause within. When the program detects the special cause, there is pop up box to notify type of special cause as well as the preference to record the error.

Special Cause which exists in eight different patterns had led the researcher to develop program efficiency in order to detect or notify any special cause that can occur during the procedure. It is to enable users to notify any special cause immediately and lead to the process of correction and prevention of incident repetition.

4.3.5 The Development of On-line Program

One objective of this research is to develop the On-line SPC program to use within the network in order to retrieve, control, monitor and assess the procedure from any computer connected within the network system. Moreover, the program is supposed to recall data for the same database. Hence, the researcher has developed and tested this part of the program in the following discussion.

Figure 4.40 Testing of On-line program

On-line SPC program shown on the screen of computer on the right hand side is database server while the computer on the left hand side is a client server. The two computers connected to each other through the LAN line network. Whenever the data is recorded or any changes of data occur within the database system, the program must check the cause that exists and exhibits the result on the On-line program immediately.

4.4 The Application of Control Chart with the Quality Control of Delivery Service

After the researcher has developed the prototype of On-line SPC program, the researcher has applied the program to control monitor and assess the transportation procedure of the case study firm. The firm has many forms of transportation procedure so the researcher chooses only two important procedures that are bill issuing and goods distribution. These two procedures are the problems that Bhuddhamonthon 5 road branch has faced with in terms of meeting up with the target set by the firm.

To apply the program to bill issuing procedure is to try to control error in the procedure. It is one KPI which the firm has set the target for each branch to meet up with the criteria. However from September 2552 onward, statistical number of errors has doubled at Bhuddhamonthon 5 road branch. Therefore, branch manager has

to find ways to reduce number of errors to meet up with target of the firm as soon as possible. This is urgent problem that need fixation at the highest level.

To apply the program to goods distribution is to try to control rate of goods distribution per day to meet up with the target the firm has set. However this procedure is one problem that Bhuddhamonthon 5 road branch has faced with, in trying to meet up with the criteria of the firm and it is the problem which branch manager must find solution immediately.

These two procedures are urgent matters for branch manager to find solution in order to meet up with the firm's criteria. The researcher has chosen these two procedures to enhance a chance to develop the On-line SPC program to control and assess procedure operation. Moreover, the concept of Six Sigma is used to find cause and help improve the means to implement the two procedures to reduce problems as well as to enable the procedures to meet up with the projected target. From the characteristic of data of these two procedures, the researcher chooses Control Chart p which is a kind of Attribute Control Chart; the chart that can control error, mistake or any defects.

4.4.1 Bill Issuing Procedure

Nonconforming bill procedure means there is error occur with the bill. For example, incomplete sender or recipient name, wrong name, incorrect detail of bill such as number of goods, unit of goods such as bag, pack or box, these are counted as nonconforming bill. The calculation of nonconforming bill is done by nonconforming bill/ total number of bill. Nonconforming bill can be found when the clerk who issues the bill made mistake in typing but the data has been saved in the database already. The clerk will bring that error billing to the bill clearing officer in order to correct the mistake in the database. That billing is count as one bill and the nonconforming bill that exist include the counting of working hour from the beginning to the end. Normally the assessment has done monthly and branch manager is retrieving the error information from the company database. For example, in March 2553 there is total number of bill around 30,811 bills and there are 928 nonconforming bills. The percentage of nonconforming bill of the branch is at 3.0 %. The assessment on percentage of error is raised to compare with the firm's target. Therefore when the

operation is unable to meet with the set target, branch manager has to resolve the problems immediately.

Procedure of issuing the bill

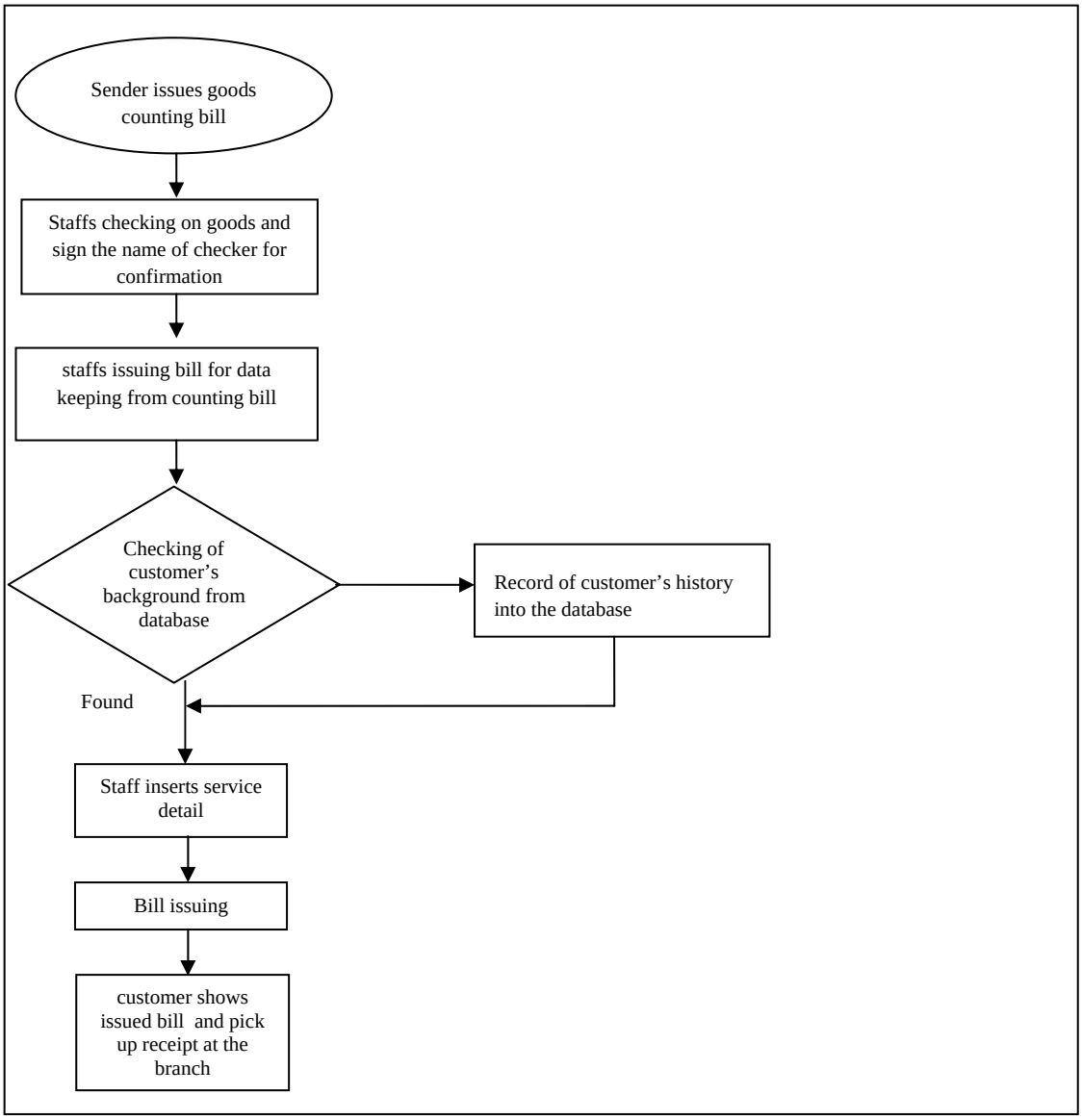


Figure 4.41 The procedure of bill issuing

From the procedure of bill issuing show in Figure 4.41, the process can be explained as followed:

1) Sender places goods on the palette then sender writes the counting bill consists of

- Type of goods, retail goods, fresh goods or the whole country

- Destination province
- Name, address, phone number, name of sender
- Payment, cash at departure, cash at destination, credit at destination, credit at departure
- Name, address, phone number of recipient
- List of goods
- Number/ unit of goods

2) Staff checking the list of goods and signing to confirm as checker

3) staff issuing the bill and recording data from counting bill

4) check customer's background from database system, if no record on the database then start input data

5) Staff issue the bill including detail of service, type of goods and amount

6) Issuing of bill

7) Customer shows the bill at the branch for receipt (in case of paying cash at departure)

During the procedure of issuing the bill, Bhuddhamonthon 5 road branch of Nim See Seng 1998 company limited has faced with relatively high in number of nonconforming bill from midyear onward. The company has set the target of nonconforming bill at not higher than 1.1 % of total bill. However, this branch has reached higher than what the company has set. From this problem, the controller has applied On-line SPC program which has been developed earlier to use with the procedure. It is used to control, observe and monitor the procedure in order to reduce the error. Apart from that, the program is used to define the cause of the problems effectively on the basis of real time data retrieving everyday especially the issuing of nonconforming bill.

However, the purpose of applying control chart to the procedure as a notification of special cause in the procedure is to find out, correct, and prevent the repetition of special cause. Therefore, the applications of control chart to control, monitor, and assess the procedure everyday will enable user to understand the nature of the procedure thoroughly. Hence, this will lead to improvement of procedure to meet up with the target of the firm.

4.4.1.1 Nonconforming Bill

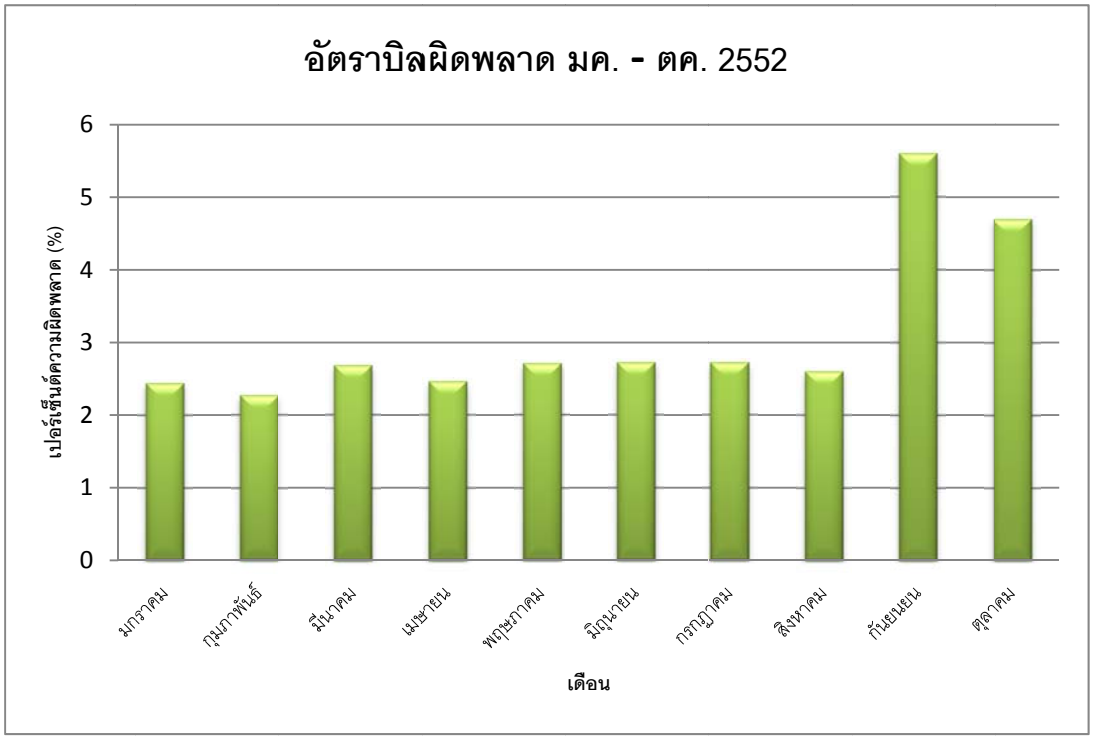


Figure 4.42 Nonconforming Bill of Bhuddhamonthon 5 road branch

Figure 4.42 that from January to August 2552, there is relatively small variation of nonconforming rate, average of only 2.7%. In September, the rate of nonconforming bill has reached up to 5.6% while the rate in October is still high. From the past 10 months, the statistics of nonconforming bill is rather high, average of 3.19% when compare to the target set by the firm for nonconforming bill at 1.5%. The existing percentage is 100% higher than what has been set by the firm. Hence, branch manager has to find ways to solve this problem immediately.

4.4.1.2 Type of Error in Nonconforming Bill

Figure 4.43 Sample of nonconforming bill with incomplete name of sender-recipient

The error occurs when typing name of sender-recipient incomplete. From this sample, the clerk mistypes the name of sender from T.G. Prohygrade toT.G.Frohygrade. This mistake is acknowledged in the branch and need correction. Thus, this is count as one nonconforming bill.

Figure 4.44 Sample of nonconforming bill with incomplete unit of goods

The error occurs when typing wrong unit of goods. From Figure 4.44, the unit of goods is issuing previously in a form of box, ordering for three boxes; which is actually wrong. The customer wants to order in a form of bucket. This mistake is acknowledged in the branch and need correction. Thus, this is count as one nonconforming bill.

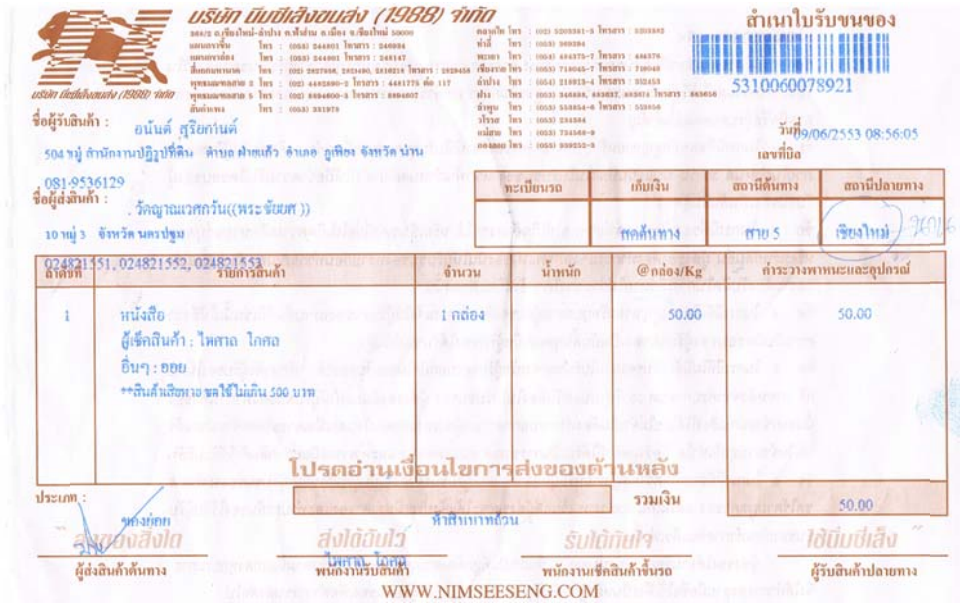


Figure 4.45 Sample of nonconforming bill with unclear delivery destination

The error occurs when typing unclear delivery destination. From Figure 4.45, delivery spot is previously thought of at Chiang Mai Province while actual destination to deliver is to Nan Province. This mistake is acknowledged in the branch and need correction. Thus, this is count as one nonconforming bill.

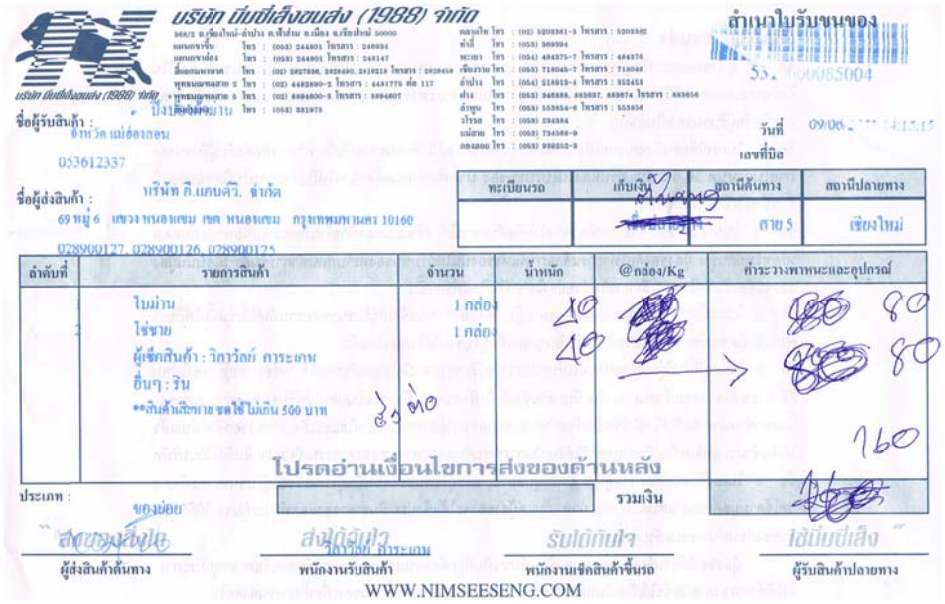


Figure 4.46 Sample of nonconforming bill with unclear status of payment

The error occurs when typing unclear status of payment. From Figure 4.46, if we check the payment status, it is previously mentioned that the payment is done by credit at destination while actual status of payment is done by cash at departure. This mistake is acknowledged in the branch and need correction. Thus, this is count as one nonconforming bill.

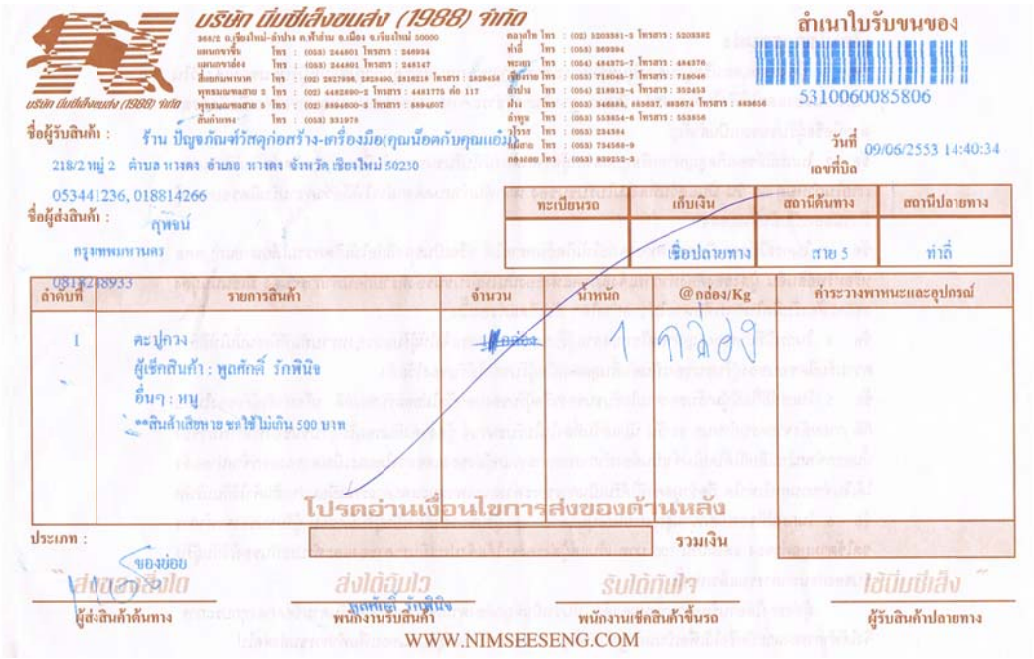


Figure 4.47 Sample of nonconforming bill with excessive number of goods

The error occurs when typing excessive number of goods. From Figure 4.47, previously the number of goods is typed as 10 which is actually order only one box. This mistake is acknowledged and to correct the mistake the destination is asking for a renew bill then send the bill to destination. Thus, this does not count and will not be record in the database.

From various types of error occurs in the procedure, it is necessary to reduce and control the nonconforming rate. The mistake has direct influence on customer's satisfaction. It is the duty of branch manager and control team to work together in order to improve and reduce the nonconforming rate to meet up with the firm's target.

Nonconforming bill can be categorized into 11 types as followed:

1) damaged goods from departure which is goods that have been damaged since departing such as goods in distorted form, broken or ripped off package

2) damaged goods at destination which is goods that have been damaged at destination such as goods distorted in distorted form, broken or ripped off package

3) lost goods from departure which is goods that have been lost from departure such as goods cannot be delivered according to order , goods with unidentified recipient, deliver wrong goods, customer get wrong type of goods or no goods to deliver

4) lost goods at destination which is goods that have been lost at the destination such as goods cannot be delivered according to order , goods with unidentified recipient, deliver wrong goods, customer get wrong type of goods or no goods to deliver

5) overload of goods such as extra goods from other bill

6) name of sender or recipient is incomplete such as incorrect, misspell or incomplete of sender or recipient

7) incomplete order of goods which is incorrect in terms of order such as the number of goods previously order only 5 boxes while the bill issuing for 8 boxes

8) incomplete unit of goods which is incorrect unit of goods such as goods has been ordered as package while the bill issuing as box

9) unclear status of payment which is incorrect of amount such as incorrect amount of payment or missing out of figure

10) unclear delivery destination which is unclear delivery spot such as mistype of district or province

11) repetition of bill which is issuing the same bill

From 11 types of nonconforming bill mentioned above, the responsibility in resolving the problem can be divided into two parts. The first part is done at the departure and the other part is done at the destination. The correction at the departure consists of incomplete name of sender or recipient, incomplete order of goods, incomplete unit of goods, unclear status of payment, unclear delivery destination and repetition of bill. The correction at the destination consists of damaged goods from departure, damaged goods at destination, lost goods from departure and lost goods at destination.

From the agreement with branch manager, it is necessary to assess and improve the procedure operation of the clerk who issues the bill. This is because the data about the bill issuing by the clerk is appropriate and relevant to the need to assess and control day-to-day performance procedure. The improvement and correction should be done at the departure which withholds data everyday and the data is available to assess every day. It is urgent problem for branch manager to correct this problem to meet up with the firm’s target. On the other hand, the correction at the destination has to wait for many days before the acknowledgement of errors to be informed. There are only five types of nonconforming bill to assess at the destination. If the case like excessive of goods exists at the destination, the correction is done at the departure by issuing the new bill and sending the bill to the destination again. The previous bill is cancelled without record of nonconforming bill in the system.

4.4.1.3 The Application of Control Chart with Rate of Nonconforming Bill

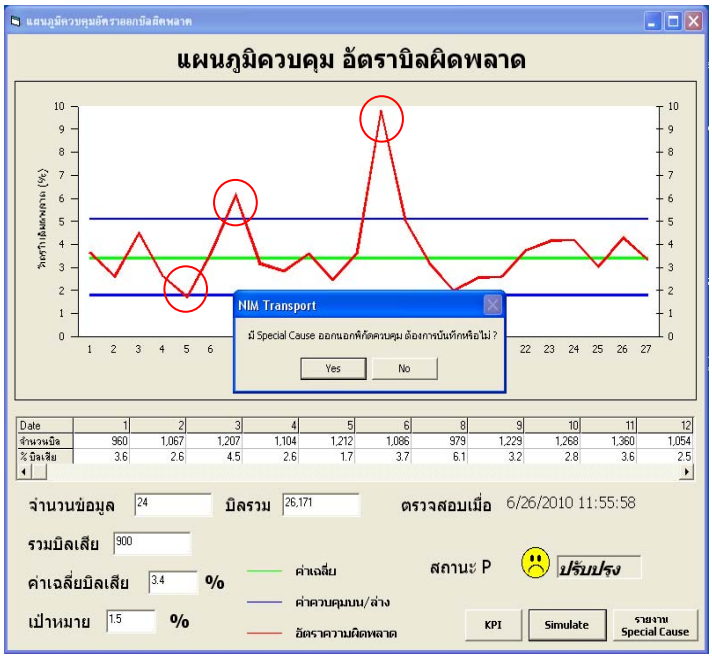


Figure 4.48 Control Chart of nonconforming bill of February 2553

From the Figure

- Axis X is days for assessment = 27 days
- Axis Y is ration of nonconforming bill calculated from nonconforming bill/ total number of bill
- Blue line is Upper Control Limit and Lower Control Limit (UCL, LCL)
- Green line is mean of nonconforming bill per day calculated from total number of nonconforming bill/ total number of bill = 0.034 or 3.4%
- Red line is ration of nonconforming bill per day

From the day that has been assessed, the researcher does not count Sunday since the number of billing on that day is relatively small. From the control chart shown in Figure 4.47, Special Cause has existed more than 2 points. According to the theory, the data here is unusual. The researcher has to recheck the whole data starting from choosing of example and form of assessment. Then, the process for correction starts. The result from revision of data turns out that between days 11-15 of the month is Chinese New Year. These can cause problem to delivery service business in terms of short off heavy truck while goods to deliver are plenty. The problem is it leads to overstock bill which is nonconforming bill of the next day. The sample of

nonconforming bill is randomly searched next month to calculate the Control Limit and Control Chart of the control period. However, from the preliminary assessment, the average of nonconforming bill is relatively high at 3.4 % which is extremely higher than the firm's target. Hence, the researcher is applying the concept of Six Sigma (details are explained in Chapter II) to use in order to reduce error and improve the procedure operation to be better. The researcher has started the procedure by collect data from observation, conducts survey on issuing bill staff, interviews head of the team, exchanges idea with related staff to find out the cause of issuing nonconforming bill and finally processes the information in the form of Fish Bone Diagram in Figure 4.49.

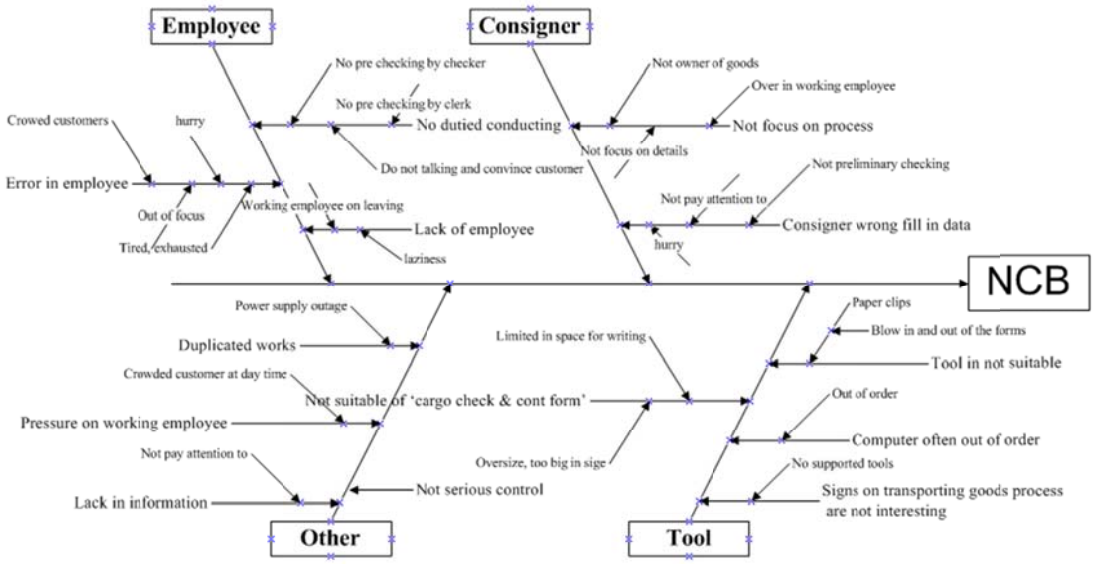


Figure 4.49 Fish Bone Diagram of Nonconforming Bill

From the Fish Bone Diagram shown in Figure 4.49, the researcher finds out that factors related to issuing nonconforming bill consists of sender, staff, equipment and others. The researcher chooses to improve firstly, in terms of information for sender to realize the importance of correct and exact counting bill as well as the step of goods delivery.

4.4.1.4 Procedure Improvement to Reduce Nonconforming Bill

According to the firm procedure, it is obvious that it has been standardize with appropriate step as well as clear regulations and practice. Many mistakes occur because of human error such as staff who issues the wrong bill, customer fills in wrong detail and checker is negligence on counting. From the problems mentioned previously, the researcher has improved the information area for customer, firstly. It is to create understanding between agents who deliver goods and clerk to realize the importance of verify count stock bill. Moreover, the improvement is to help reduce mistake by using stronger clip to install the verify count stock bill for billing officer.

1) improvement of information area on delivery step

Figure 4.50 Information area, before and after the improvement

Figure 4.50 the Figure of before and after the improvement. This station is the area where customer or sender is to understand the procedure of delivery,

important, and to show the sample of correct verify count stock bill for sender to see. After the installment of sample to eight station, the result is both staff

s and senders pay more attention to the improvement post and read the information. After that, the branch has checked the nonconforming bill rate of the following month and find out that nonconforming bill rate reduce from 3.4% to 3.0%.

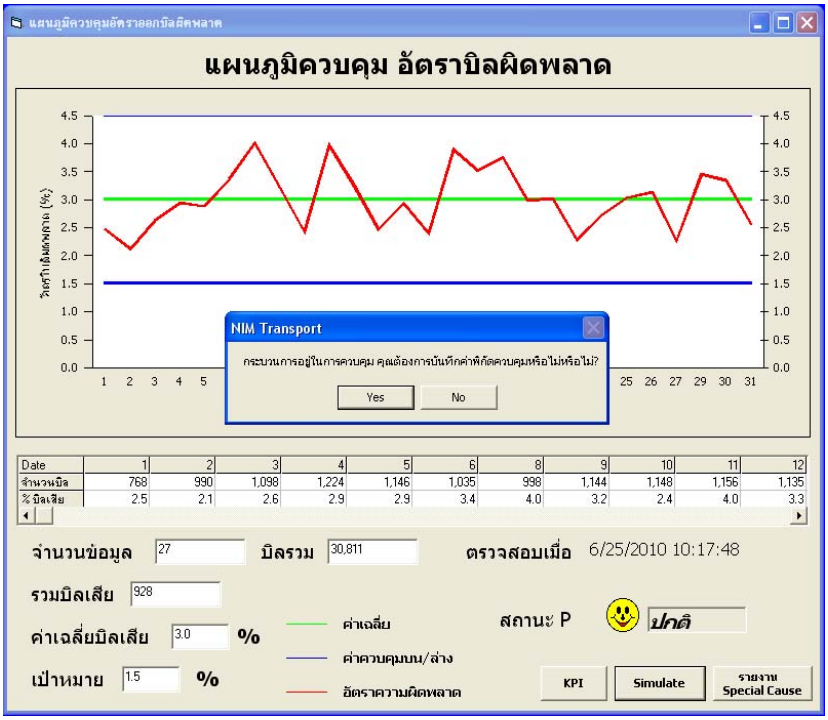


Figure 4.51 Control Chart of nonconforming bill of March 2553

From the Figure

- Axis X is assessment period
- Axis Y is ration of nonconforming bill calculated from nonconforming bill/ total number of bill
- Blue line is Upper Control Limit and Lower Control Limit (UCL, LCL)
- Green line is mean of nonconforming bill per day calculated from total number of nonconforming bill/ total number of bill = 3.0%
- Red line is ration of nonconforming bill per day

From Figure 4.51, it is obvious that the number of nonconforming bill of this month has gone down about 0.4% from that in February which has rate of nonconforming bill at 3.4%. The procedure has been control for the whole month

without Special Cause. Therefore, we are able to apply the control limit to the second phase or the control phase where UCL = 0.045, CL = 0.030 and LCL = 0.015. This control phase figure is to be used in the following month.

Apart from this, the researcher has improved the clip of the verify count stock bill by installing at 3 out of 8 stations service along with the installment of information area for customer and staffs to realize the importance of counting bill in March. This is to reduce error in issuing the bill since the previous clip is easily blow by the wind which causes the bill to sway back and forth and distract the concentration of billing officer. Hence, it can cause error in the procedure.

2) improvement of clip installment on verify count stock bill to help reduce mistake

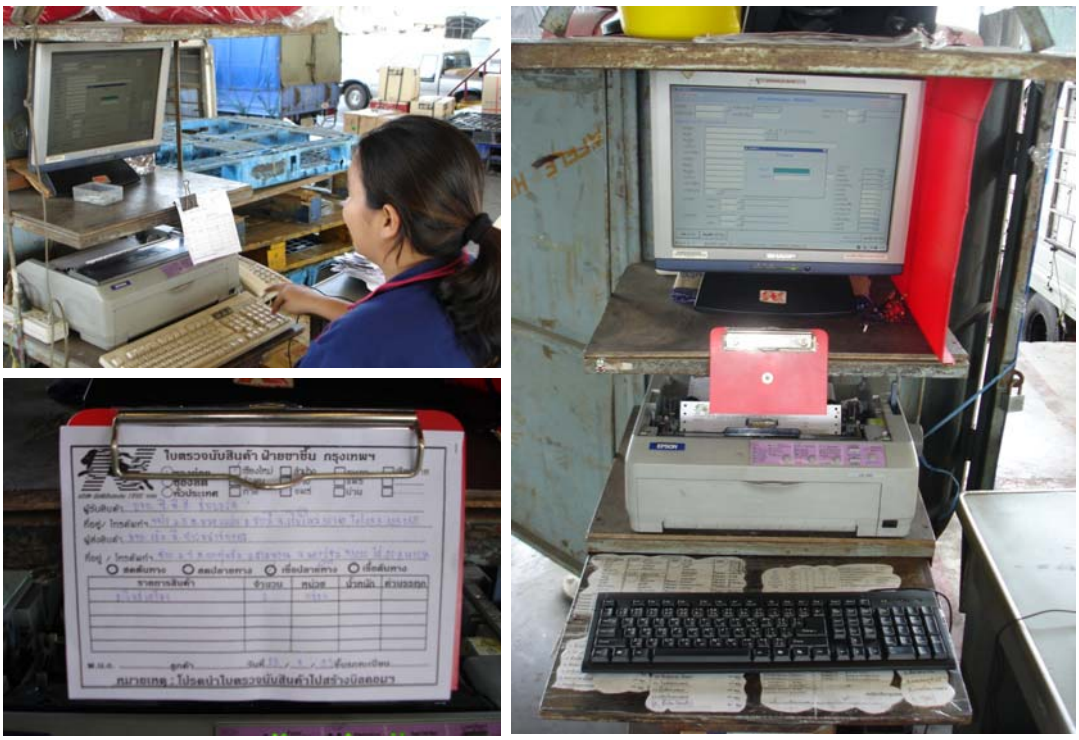


Figure 4.52 Installment of clip on verify count stock bill, before and after

From the Figure, the upper left hand is previous clip the staff has used with verify count stock bill. It is easily sway back and forth under the direction of wind and the officer has to catch it by one hand while another hand is used for typing. This can cause error very easily. The researcher has the idea to improve the plate with the clip

to attach the verify count stock bill to solve that problem. When ask the officer to try on the plate, it is obvious that the plate is effective in terms of reducing the sway from the wind blows. Moreover, a new verify count stock bill which is smaller than the previous one has the same size as the plate which is 100% unmoved. From the assessment of operation in April, the rate of issuing nonconforming bill has gone down to 0.2% from that of 3.0% in March which has rate of nonconforming bill at 2.8%. The assessor feel pleasantly satisfied with the result.

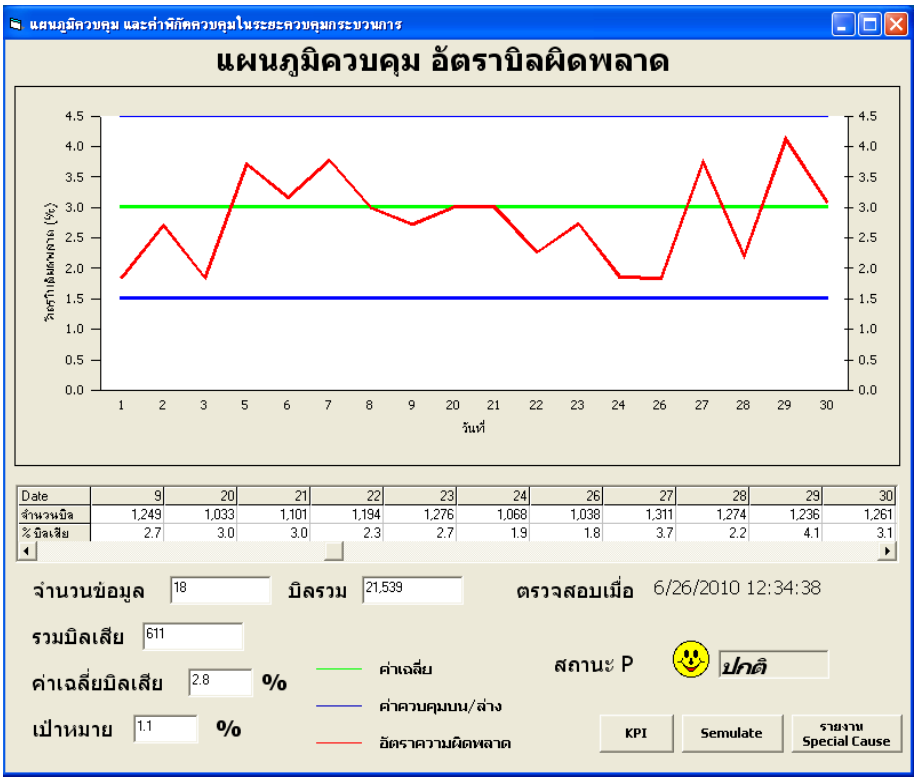


Figure 4.53 Control Chart of nonconforming bill of April 2553

From the Figure

- Axis X is assessment period
- Axis Y is ration of nonconforming bill calculated from nonconforming bill/ total number of bill
- Blue line is Upper Control Limit and Lower Control Limit (UCL, LCL)
- Green line is average of nonconforming bill per day calculated from total number of nonconforming bill/ total number of bill = 0.028 or 2.8%

- Red line is ration of nonconforming bill per day

The Control Chart of April is done by using the control limit occurs after revising the procedure in March which is under control procedure. After that, the control limit is utilized in the process. The finding is the procedure is at normal state while the rate of nonconforming bill has gone down about 0.2% from 3.0% to 2.8%. It is obvious that the rate of nonconforming bill has been reduced down to 0.6% since the improvement process starts. The projection for reduction should exist if the quality of improvement is done continuously and seriously according to the concept of Six Sigma where the purpose of reduction of waste is zero.

4.4.2 Distribution Rate (DR)

Distribution Rate means the ratio of billing that can be distributed within one day starting from the day the goods situated at the platform. The calculation is done by counting the distribution of bill in one day/ total number of bill. Bhuddhamonthon 5 road branch of Nim See Seng 1998 company limited has faced with the problem of meeting up with the firm's target of goods distribution rate at 73% per month. Percentage of distribution rate is calculated by counting percentage of distribution of each day/ total days of the month. This is one among other procedures that the researcher tries to control the quality by applying the On-line Control Chart together with Six Sigma. It is to help distribute goods to meet up with the firm's target. Another problem that arises is there is not enough storage for goods. Hence, there are huge pile of goods at the branch which can cause damage as well as can be difficult to find.

Figure 4.54 Storage area at distribution center of Bhuddhamonthon 5 road branch

Storage area of distribution center is divided into specific destination of the Northern part of Thailand which includes of districts and provinces. It is easy for recipient to pick up goods according to destination area. If the amount of goods arrives at the storage day by day and the number is huge, the center is surely unable to distribute good on time. The distribution center is filling up with goods all over the storage especially on the floor. Moreover, if goods keep coming, this area is unable to handle with extra number of goods. This is part of the problem occurs at the distribution center when it cannot distribute goods to meet up with the target.

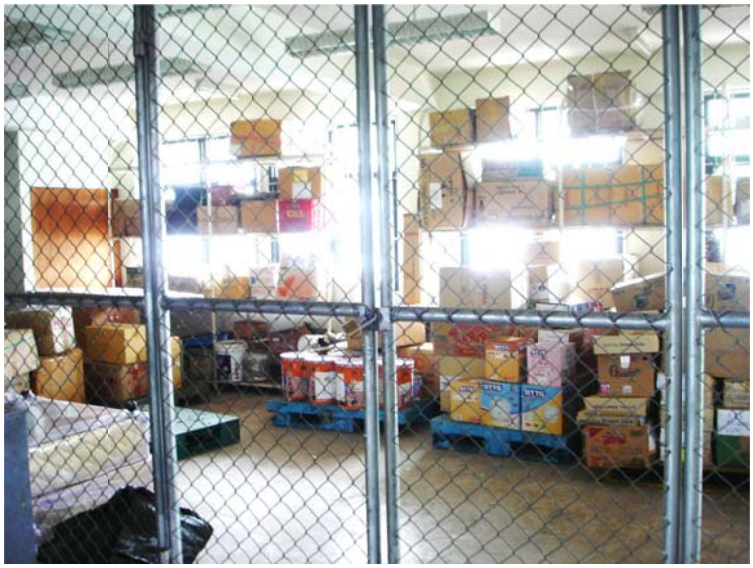


Figure 4.55 Storage area with certain problems at distribution center of Bhuddhamonthon 5 road branch

Storage area with certain problem at distribution center of Bhuddhamonthon 5 road branch is separated from the shelf to identified overstock goods out of other goods. Goods to be stored here are goods with pick up problems. For example, customer leaves out some goods and those goods are separated in order to be in waiting list of customer to come and pick up again. This is to make it easy when searching. If the goods are large in number, they are going to need more storage space and difficult to find.

From the data related to error of distribution rate, it resembles the data related to error of nonconforming bill. The difference is in the process of calculation where total number of bill sent by customer/distribution rate per day. The procedure of good distribution can be seen in Figure 4.56.

Distribution procedure

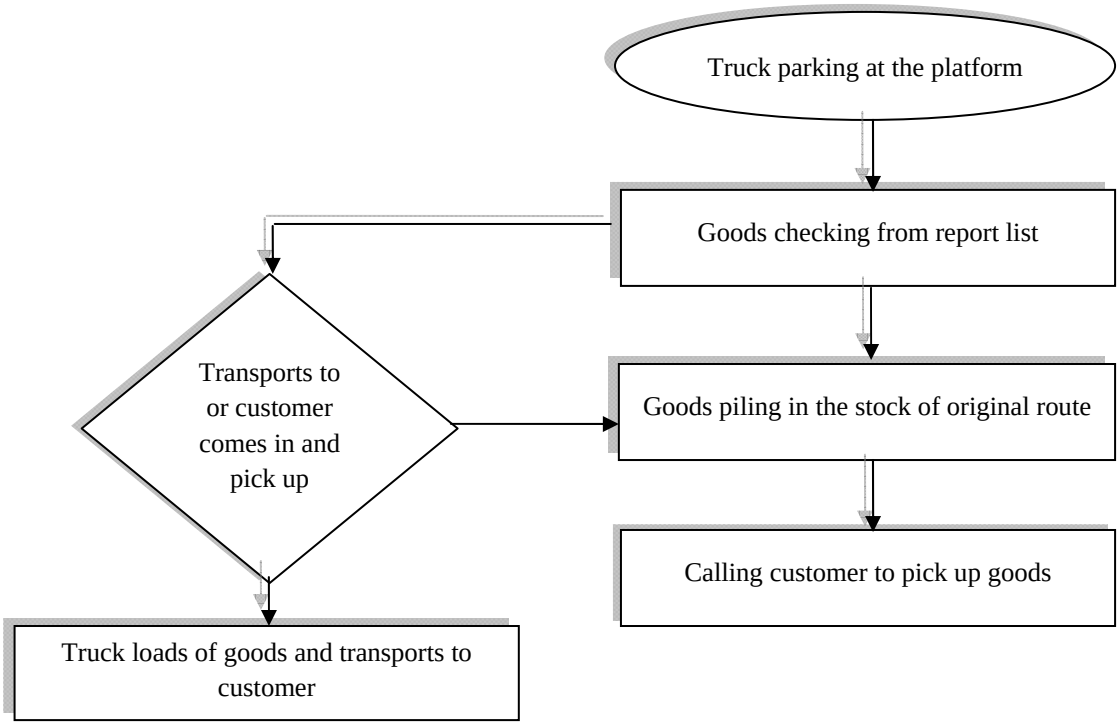


Figure 4.56 The flow chart of distribution procedure

Figure 4.56 the distribution procedure which starts when truck loads of goods from the Northern region arrives at the platform of the delivery center. Then staff is bringing list of goods for checker to check and classifies types of goods. At this station, goods are categorized into two cases. The first case is to deliver goods directly to the customer. The firm will select goods and upload it to a smaller truck and deliver to the customer immediately. Another case is for customer to pick up goods himself. Staff will load goods into the palette and stock it according to its original route such as Chiang Mai-Bangkok or Lampang-Bangkok. After that staff will inform customer to pick up goods.

Figure 4.57 The step of goods distribution procedure

After the truck from the departure route arrives at Bhuddhamonthon 5 road distribution center, staffs will carry goods out of the truck and check number of goods according to the report list. Next, staffs are categorizing goods into two cases the first one is for customers, themselves to come and pick up. These goods are piling in the warehouse waiting for customer to pick up and piling according to its original route or province or district. Another type, by order, is to be further delivered to the destination. The firm has provided many distribution cars to deliver goods.

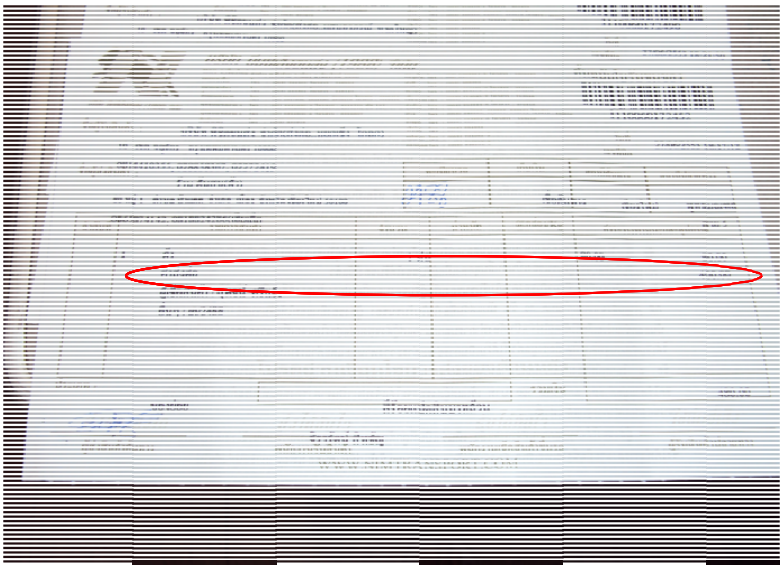


Figure 4.58 Sample of goods list bill to be delivered to the destination

If customers ask the firm to deliver goods to the destination, they must clarify their preference from the departure. In another case, when staff calls customer to pick up goods that arrive at the distribution center and customer is unable to pick up goods. Many customers has asked the firm to deliver goods to the destination and paying extra money to firm for this service.

Figure 4.59 Distribution of goods to customer asking for direct delivery

If customer prefers the direct delivery of goods or connecting delivery, checker will categorized the goods and uploads goods onto distribution car provided by the firm. The goods will be delivered to the appointed destination. This case does not affect the area to store goods waiting for customer to pick up since goods are delivered to customer as soon as they arrived at the distribution center. The Figure of distribution car is shown in Figure 60 and 61.

Figure 4.60 A bigger truck for goods distribution

Figure 4.61 A smaller truck for goods distribution

NIM Transport 1988 Co., LTD. has two types of distribution trucks ride for the service: two smaller trucks and four bigger trucks. The service is to provide delivery for customer which has become more popular. The trucks are used in the distribution service average of six rides per day.

4.4.2.1 Statistics of Distribution Rate

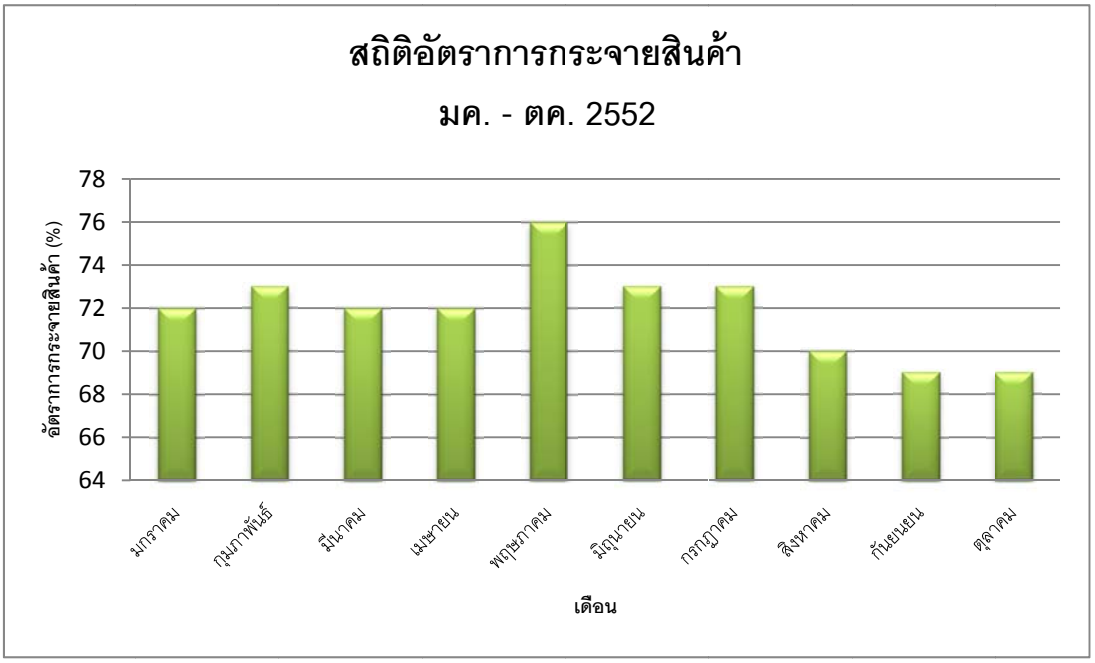


Figure 4.62 The statistic of distribution rate from January to October 2552

Goods distribution rate of the year 2552 from January to July is about 72%. The ratio has reached the firm's target thoroughly. However, starting in August, distribution rate is consequently decreasing. Branch manager has to solve this problem in order to reduce the goods residue. This is one of the causes of little space in the warehouse.

4.4.2.2 The Application of Control Chart to control Goods Distribution Rate

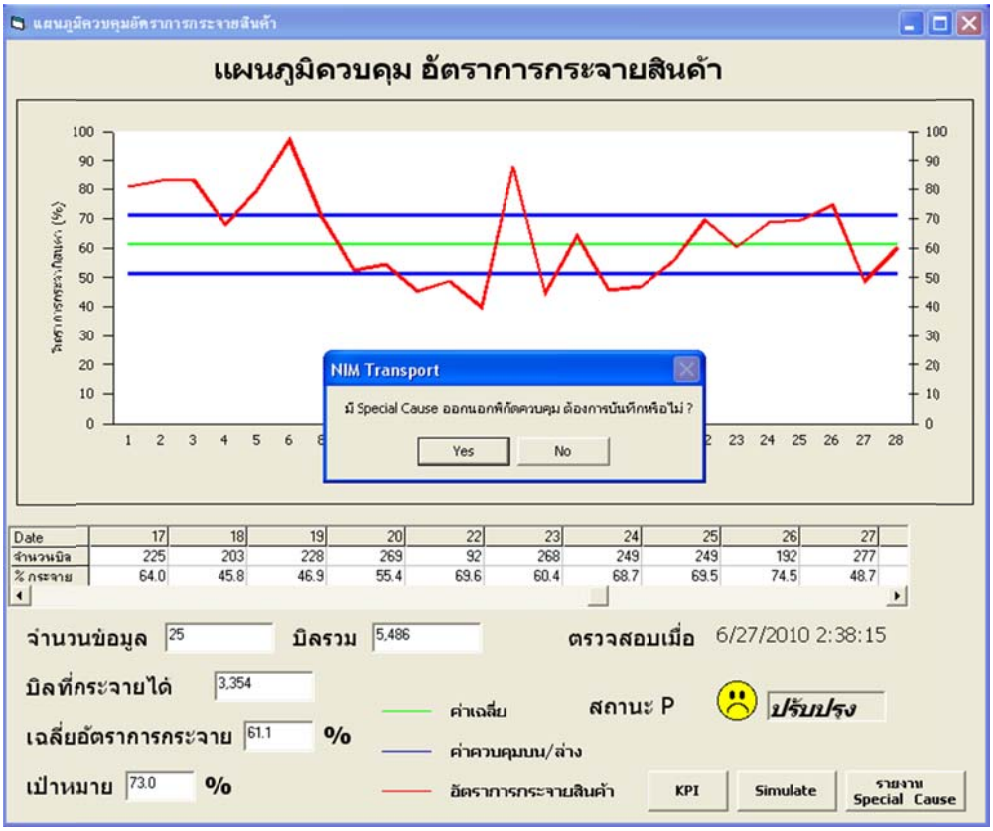


Figure 4.63 Control Chart of distribution rate of February 2553

From the Figure

- Axis X is assessment period
- Axis Y is distribution rate
- Green line is central line calculated from number of distribution bill per day/ total number of bill = 0.611 or 61.1%
- Blue line is Upper Control Limit and Lower Control Limit Red line is distribution rate

The control chart of distribution rate in February 2553 was sway and unstable. There was data spill out of the control limit up to 14 of 25 points. The researcher had separated Sunday from the calculation because Sunday was considered

weekend for most entrepreneurs and stores. Sunday was a day off of other people which is not a good day for goods distribution. Moreover, this February was during the celebration of Chinese New Year which was a long holiday for many entrepreneurs. This was one of the most important causes of unstable distribution rate of the month. We can see from the control chart that between February 9 to 13 which were the holiday to celebrate Chinese New Year: the rate of goods distribution is lower than the standard. The control limit is unable to use for calculation in the second phase because there were more than two special causes. Moreover, there were other types of special cause such as two out of three points are at the level over 2 SD. Hence, this process needed to be observe in the following month on how the control limit would be used to calculate with the procedure again.

However, from the firm's target of distribution rate set around 73%, the researcher has gathered data to find out the cause of unstable variation and the cause of why this branch is unable to reach the firm's target. From the interview with head of the team of the downstream department, the researcher finds out why this branch is unable to reach the firm's target on goods distribution.

1. There are many returned of goods and candies.
2. There are many bills sending late.
3. Distribution center is quite far away from customer.
4. The firm does not have network for goods distribution.

From the problem mentioned above, the researcher has gather data on number of returned of goods and candies and the bills sending lateness to test the hypothesis. The bills sending late are bills that arrive at the distribution center around noon. The details are shown is Table 4.3.

Table 4.3 Detail of returned of goods and candies and bills of sending lateness in February 2553

Date	Total number of bill	Ability to distribute in one day	Percentage of distribution	Number of bill of spoiled candies	Percentage of bill of spoiled candies	Number of bill sending late	Percentage of bill sending late
1/02/53	105	85	81.0	9	8.6	45	42.9
2/02/53	235	195	83.0	3	1.3	48	20.4
3/02/53	231	195	83.1	4	1.7	115	49.8
4/02/53	217	147	67.7	5	2.3	93	42.9
5/02/53	220	167	75.9	16	7.3	53	24.1
6/02/53	177	172	97.2	7	4.0	31	17.5
8/02/53	126	89	70.6	21	16.7	97	77.0
9/02/53	345	181	52.5	24	7.0	108	31.3
10/02/53	333	181	54.4	23	6.9	145	43.5
11/02/53	342	155	45.3	25	7.3	71	20.8
12/02/53	283	138	48.8	10	3.5	83	29.3
13/02/53	244	97	39.8	18	7.4	40	16.4
15/02/53	33	29	87.9	1	3.0	17	51.5
16/02/53	194	87	44.8	11	5.7	63	32.5
17/02/53	225	144	64.0	30	13.3	149	66.2
18/02/53	203	93	45.8	5	2.5	51	25.1
19/02/53	183	21	46.9	18	9.8	58	31.7
20/02/53	269	149	55.4	35	13.0	92	34.2
22/02/53	92	64	69.6	14	15.2	27	29.3
24/02/53	249	171	68.7	47	18.9	113	45.5
25/02/53	249	173	69.5	39	15.7	133	53.4
26/02/53	249	173	69.5	1	0.4	5	2.0
27/02/53	277	135	48.7	23	8.3	114	41.2
28/02/53	148	89	60.1	9	6.1	36	24.3

From the comparison of data related to the number of returned of goods and candies and the bill sending late, the researcher finds out that the cause mentioned previously is not the reason why this branch is not good at goods distribution. For example, the first and second day of the month, the percentage of distribution rate is

close which are 81% and 83 %. However, the number of bill of returned of goods and candies is different that is the first day the percentage of the bill is 8.6% while the second day is only 1.3%. The percentage of bill sending late of the first day is up to 42.9% while on the second day it is only 20.4%. The third of February has distribution rate at 83.1% while on the fourth distribution rate is at 67.7% which is 15.4% in measurement. However, during these two days, the percentage of bill of returned of goods and candies and bill sending late is rather small in number. Another example is on 26th of February where percentage of returned of goods and candies is only0.4% and bill sending late is only 2.0% while distribution rate is at 69.5%.

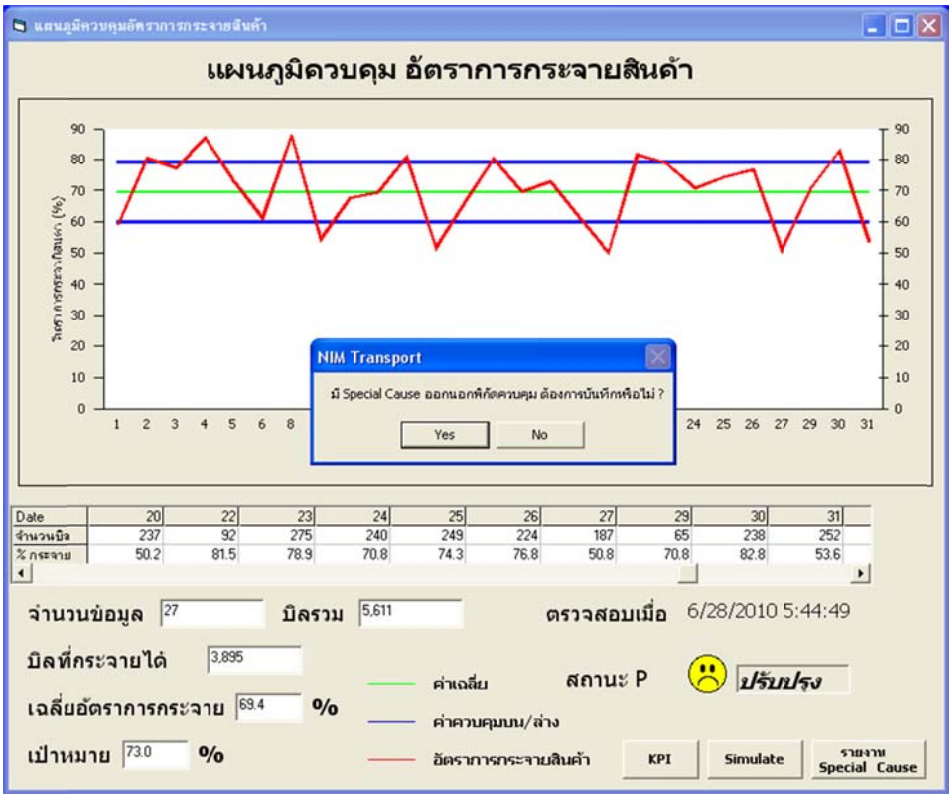


Figure 4.64 Control Chart of distribution rate of March 2553

From the Figure

- Axis X is assessment period
- Axis Y is distribution rate
- Green line is central line calculated from number of distribution bill per day/ total number of bill = 0.69 or 69%
- Blue line is Upper Control Limit and Lower Control Limit

- Red line is distribution rate

The control chart exhibits the unstable variants of distribution rate with special causes at 13 out of 31 points. In March, it is difficult to calculate the control limit to use in the second phase. Therefore, the researcher has gathered data again to find out the cause of variation. The purpose of finding the cause and suggestion for solving of problems are to apply the control chart to use with procedure which will enable customer or entrepreneur to run the service continuously.

4.4.2.3 An Analysis on Distribution Problems

The researcher has collect data to find out the cause why Bhuddhamonthon 5 road distribution center is unable to distribute goods at a perfect level. From the data collected between March 22nd to April 9th 2553, there are total 820 bills which give details about the distribution each day. The distribution consists of classification of goods, how each type is being distributed in number, address of customer of NIM Transport 1988 Co., LTD 5 road distribution center in Bangkok and other provinces.

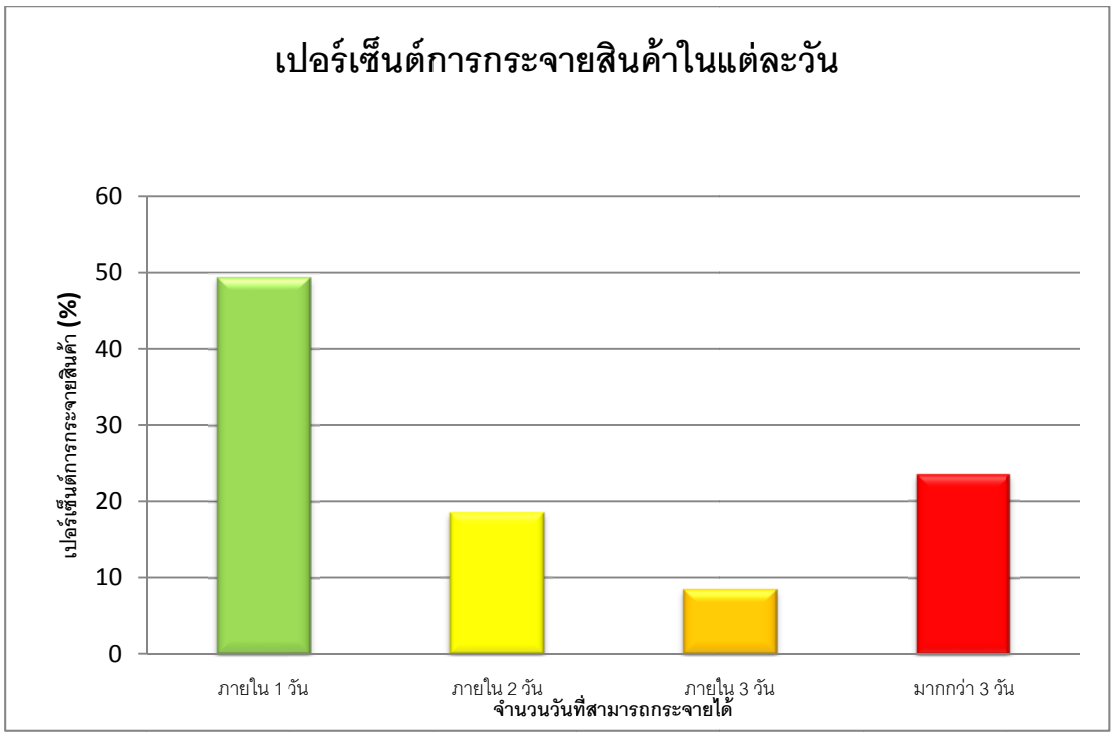


Figure 4.65 The percentage of goods distribution per day

Figure 4.65 the whole data in a graph form. We can see that the distribution per day is only 49.4% while the firm's target is around 73%. It is necessary to find out the cause that makes the distribution fails or rather the distribution is unable to meet up with the firm's target.

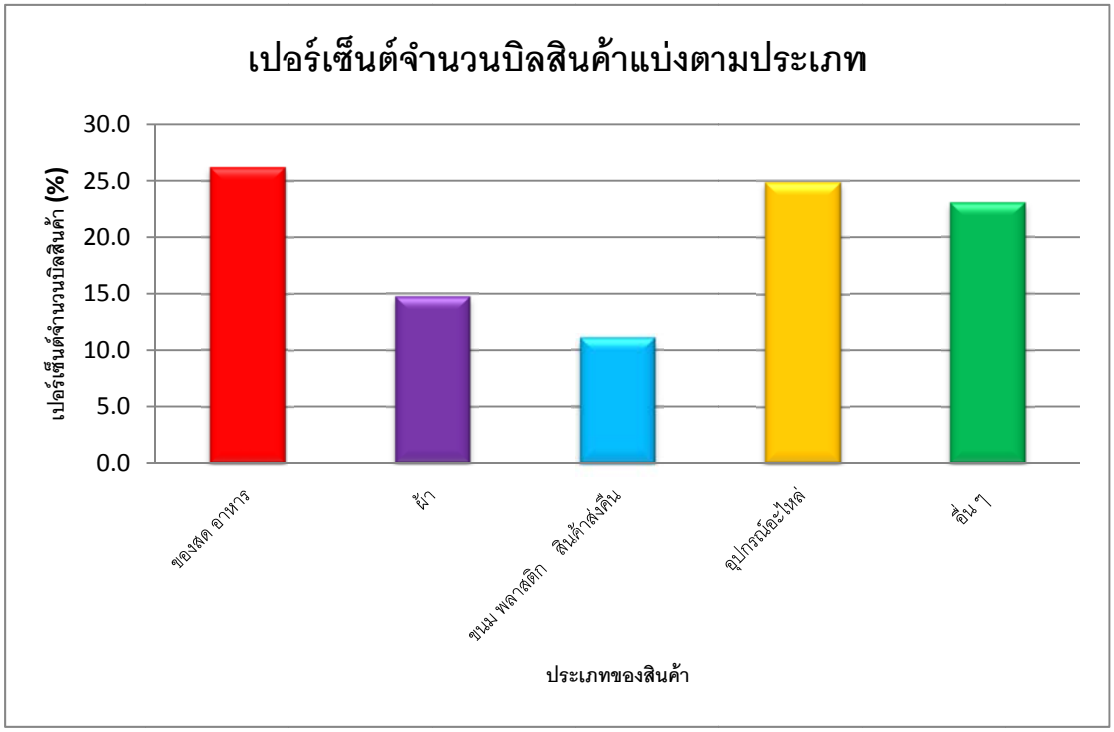


Figure 4.66 Percentage of goods according to their types

Figure 4.66 the number of bills according to the types of goods. Percentage of those goods consist of food and fresh stuff which is 26.22%, textile is 14.76%, candies, plastic and returned goods is 11.10%, tools and equipments is 24.05% and other bills is 23.05%.

Figure 4.67 Percentage of distribution lasts from one day up to more than three days according to types of goods

From the Figure

- Axis X is types of goods
- Red box is percentage of goods to be distributed within one day
- Green box is percentage of goods to be distributed within two days
- Purple box is percentage of goods to be distributed within three days
- Blue box is percentage of goods to be distributed more than three days

From Figure 4.67, goods such as food and fresh stuff are distributed within one day which is considered a good delivery of about 42%. This is because this type of goods is spoiled easily. Customer needs to pick up goods as fast as possible to prevent the spoil. The pace of pick up is decreasing day by day depending on condition of goods such as red onion or garlic which can be picked up after three days of notification. Goods such as candies, plastic or returned goods do not have a good distribution rate of one day. The same case occurs with goods such as tools and equipment with extended period of pick up. Although these types of goods are not spoiled easily and customer does not have to be hurry to pick up, they are increasing in number day after day at the distribution center. Goods such as textile and other goods

are increasing in number if customer does not come to pick up, like the goods mentioned previously. These are problems of distribution rate the branch has faced with each day. Distribution rate of other day tends to face with the same problem.

The researcher has collect data of customer within Bangkok area and other provinces to support the hypothesis of distance. If the distance between customer and distribution center is very far, it is possible that customer finds it inconvenience to pick up goods within one day of notification.

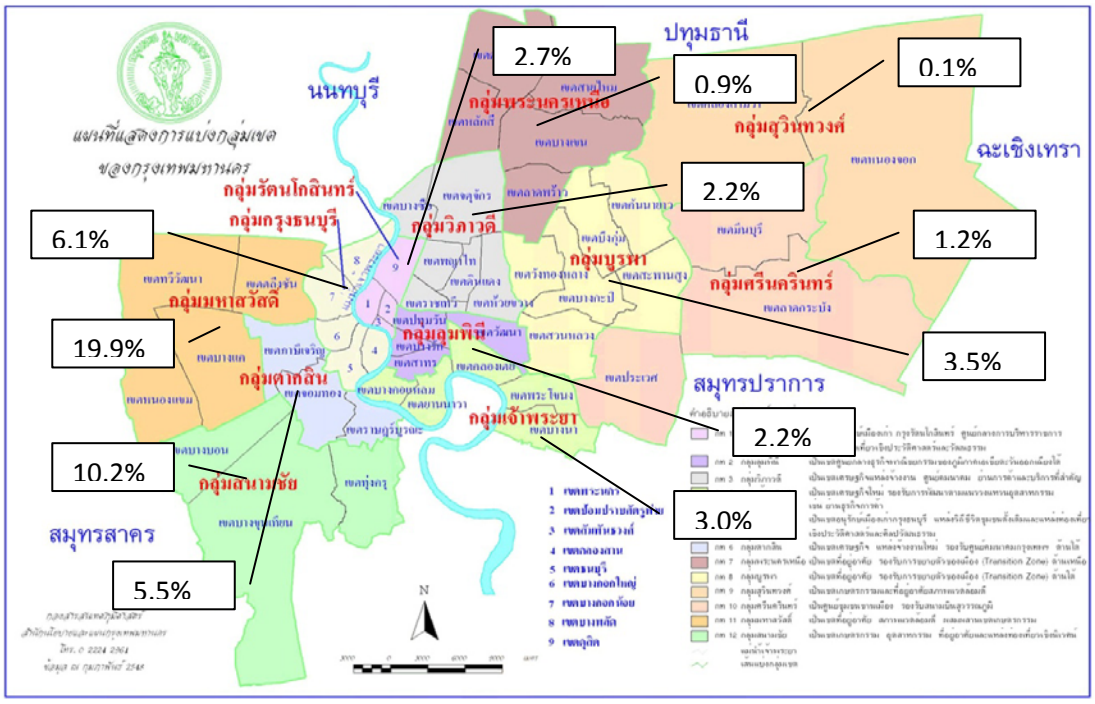


Figure 4.68 Percentage of customer residing in Bangkok area

From Figure 4.68, the bills of customers who reside in Bangkok is about 472 bills which is 57.6% of the total number of bill. We can see that there are group of customers who live not far from the neighborhood of NIM Transport 1988 Co., LTD

5 road distribution center which consists of 41.7% of the rest of customer. This group of people resides in the area of Thonburi group, Mahaswasdi group, Taksin group and Sanam Chai group. On the other hand, there are 15.9% of customer who live quite far from Putthamonthon 5 road distribution center such as the Vibhavadi group, Lumpini group, PhraNakhon Nuea group, Burapha group, ChaoPhaya group, Suwintawongse group and Sri Nakarin group.

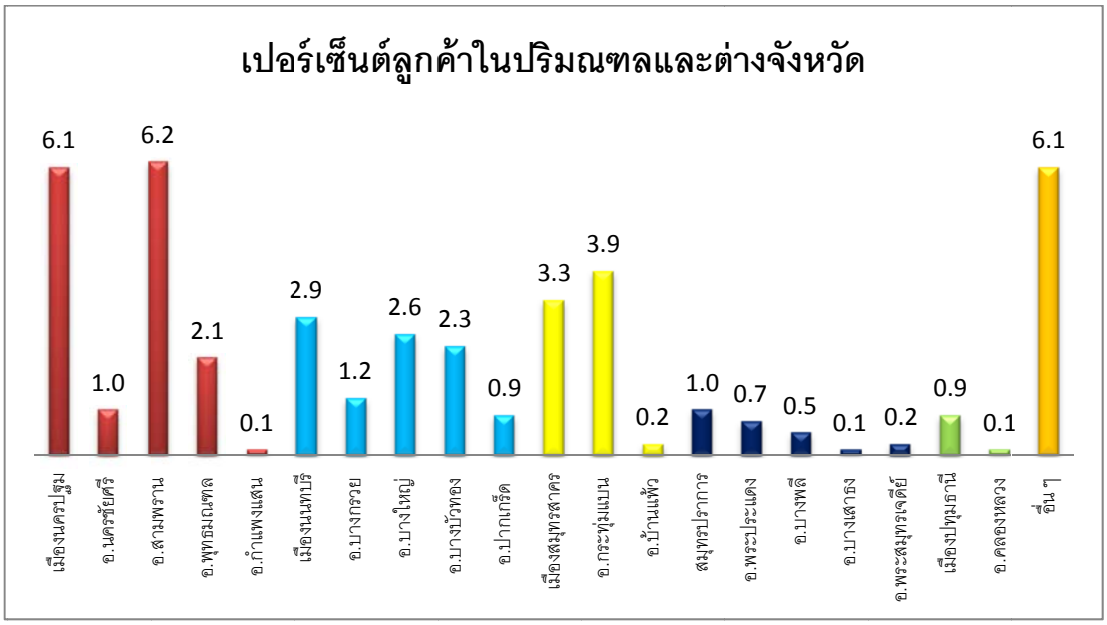


Figure 4..69 Percentage of customer residing in other provinces and districts

From Figure 4.69, the bills of customers who reside in other provinces is about 348 bills which is 42.4% of the total number of bill. The provinces are Nakhon Pathom Province, Nonthaburi Province, Samut Sakhon Province and Pathum Thani Province. Some customers live scatter near the distribution center such as those in Nakhon Pathom Province which is 15.5% of the customer. The rest of the percentage is as followed; Nonthaburi Province is 9.9%, Samut Sakhon Province is 7.4%, Samut Prakarn Province is 2.5% and Pathum Thani Province is 1% respectively. There are other provinces using the delivery service such as Ayutthaya Province, Chacheongsao Province, Ratchaburi Province, Suratthani Province and other all together is 14.6%.

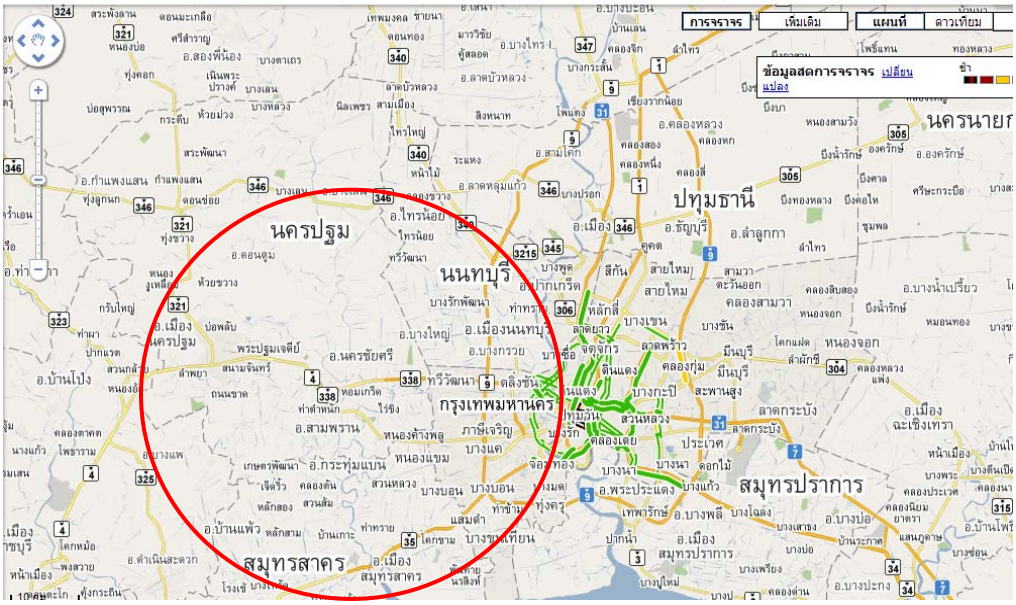


Figure 4.70 75% of customers living within 50 km. of Bhuddhamonthon 5 road distribution center

From the researcher's analysis, most of the customers of more than 75% live not far from the neighborhood of Bhuddhamonthon 5 road distribution center that is around 50 kilometers measuring from Google Map program. The rest of the customers live far apart but distance is not a factor that affects the distribution service of the center. However, the researcher has collect data on the arrival of the trucks of March 1-31 2553 with delivery bill of total 6,361 bills. It is to proof the hypothesis that if goods from the departure that arrives late at the destination, customers are unable to pick up goods within one day. The test is shown in Table 4.4.

Table 4.4 Percentage of arrival bill according to period of delivery and fresh food bill

Date	Total number of bill	Billing between 6.00–12.00 hrs	Billing between 12.01–15.00 hrs	Billing between 15.01–18.00 hrs	Billing of fresh food	Distribution of bill per day
1	81	74(91. 4%)	7(8.6%)	0(0%)	18 (22.2%)	48(59.3%)
2	199	110(55.3%)	72(36.2%)	17(8.5%)	55(27.6%)	160(80.4%)
3	201	112(55.7%)	63(31.3%)	26(12.94%)	56(27.9%)	155(77.1%)
4	192	170(88.5%)	22 (11.46%)	0 (0%)	42 (21.9%)	167(87.0%)
5	209	140(66.9%)	64 (30.6%)	5 (2.4%)	64 (30.6%)	153(73.2%)
6	239	182(76.2%)	51 (21.3%)	6 (2.5%)	78 (32.6%)	146(61.1%)
7	175	116 (66.3%)	56 (32.0%)	3 (1.7%)	42 (24.0%)	102 (58.3%)
8	74	59 (79.7%)	11 (14.9%)	4 (5.4%)	28 (37.8%)	65 (78.8%)
9	271	181(668%)	74 (27.3%)	16 (5.9%)	60 (22.1%)	147 (54.2%)
10	197	157(79.7%)	3 (1.5%)	37 (18.9%)	49 (24.9%)	133 (67.5%)
11	264	175(66.3%)	88 (33.3%)	1 (0.4%)	48 (18.2%)	183 (69.3%)
12	251	186 (74.1%)	55 (21.9%)	10 (4.0%)	64 (25.5%)	203 (80.9%)
13	271	217 (80.1%)	36 (13.3%)	18 (6.6%)	56 (20.7%)	140 (51.7%)
14	184	119 (64.7%)	53 (28.8%)	12 (6.5%)	33 (17.9%)	57 (31.0%)
15	95	62 (65.3%)	33 (34.7%)	0 (0%)	24 (25.3%)	63 (66.3%)
16	271	183 (67.5%)	88 (32.5%)	0 (0%)	69 (25.5%)	218 (80.4%)
17	246	142 (57.7%)	104 (42.3%)	0 (0%)	44 (17.9%)	171 (69.5%)
18	268	196 (73.1%)	55 (20.5%)	17 (6.3%)	69 (25.7%)	195 (72.8%)
9	223	135 (60.5%)	16 (7.12%)	72 (32.3%)	53 (23.8%)	137 (61.4%)
20	237	205 (86.49%)	32 (13.5%)	0 (0%)	51 (21.5%)	119 (50.2%)
21	199	50 (25.12%)	91 (45.7%)	58 (29.2%)	40 (20.1%)	109 (54.8%)
22	92	65 (70.65%)	21 (22.8%)	6 (6.5%)	38 (41.3%)	75 (81.5%)
23	275	239 (86.90%)	27 (9.8%)	9 (3.3%)	61 (22.2%)	217 (78.9%)
24	240	168 (70%)	56 (23.3%)	16 (6.7%)	64 (26.7%)	170 (70.8%)
25	249	173 (69.27%)	48 (19.3%)	28 (11.2%)	71 (28.5%)	185 (74.3%)
26	224	151 (67.41%)	36 (16.1%)	37 (16.5%)	69 (30.8%)	172 (76.8%)
27	187	107 57.21%)	50 (26.7%)	30 (16.0%)	32 (17.1%)	95 (50.8%)
28	192	133 (69.27%)	30 (15.6%)	29 (15.1%)	47 (24.5%)	108 (56.3%)
29	65	39 (60%)	26 (40.0%)	0 (0%)	31 (47.7%)	46 (70.8%)
30	238	160 (67.22%)	71 (29.8%)	7 (2.9%)	46 (19.3%)	197 (82.8%)
31	252	210 (83.33%)	42 (16.7%)	0 (0%)	65 (25.8%)	135 (83.6%)
Total	6,361	4,416(69.4%)	1,481(23.3%)	464 (7.3%)	1,565 (24.6%)	4,271 (67.1%)

From the table above, average of distribution rate per day according to total number of bills is only 67.1%. However, the firm has assessed the performance form percentage of distribution per day and calculated the means of distribution rate of the firm. In March, the means of distribution rate that branch manager has to bring to the executive is 68.1%. Data from Table 4.4 is brought to plot the graph as it is shown in Figure 4.71.

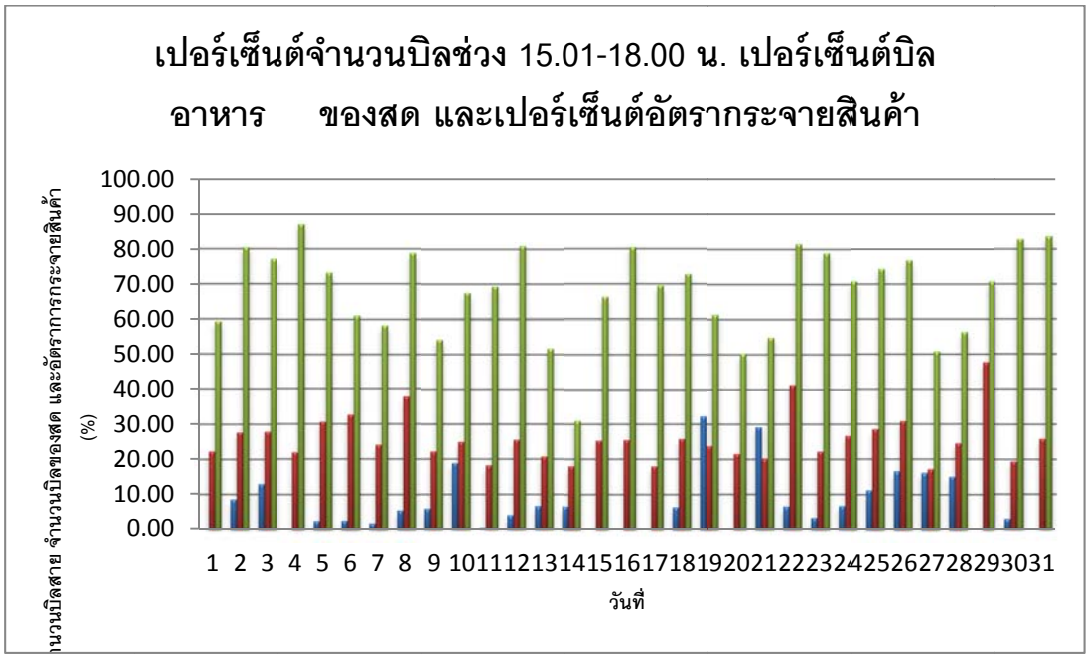


Figure 4.71 The graph of percentage of bill of the 15.01-18.00 hrs and percentage of bill of food and fresh food together with distribution rate of March 2553

From the Figure

- Axis X is survey date
- Axis Y is percentage of bill
- Blue line is bill of the 15.01-18.00 hrs
- Red line is food and fresh food bill
- Green line is distribution rate

When bringing the data from Table 4.3 to plot the graph, if the days in the table are Saturday and Sunday, many companies are closed since they are weekend for most people. Distribution rate of Saturday and Sunday is not at a satisfied level. For example, on the 6th of the month, distribution rate is at 61.1% while on the 7th of the month, distribution rate is at 58.3%. On the 13th of the month distribution rate is at 51.5%. On the 14th of the month distribution rate is at 31.0%. On the 20th of the month distribution rate is at 50.2%. On the 21st of the month distribution rate is at 54.8%. On the 27th of the month distribution rate is at 50.8%. On the 28th of the month distribution rate is at 56.3%. It is obvious that during the weekend distribution rate is not a good statistics and it affects means of distribution rate of the month. It is unable to meet up with the firm's target.

From the above analysis, the researcher has separated assessment date into three groups of period that are Monday, Saturday and Sunday, and Tuesday to Friday. The differentiation is meant to observe variation of data happens on Monday, Saturday and Sunday, and Tuesday to Friday. The data is shown from Table 4.5 to 4.7.

Table 4.5 Percentage of bill divided according to the arrival period and food billing of Monday

Date	Total number of bill	Billing between 6.00–12.00 fhrs	Billing between 12.01–15.00 hrs	Billing between 15.01–18.00 hrs	Billing of fresh food	Distribution of bill per day
1	81	74 (91.4%)	7 (8.6%)	0 (0%)	18 (22.2%)	48 (59.3%)
8	74	59 (79.7%)	11 (14.9%)	4 (5.4%)	28 (37.8%)	65 (78.8%)
15	95	62 (65.3%)	33 (34.7%)	0 (0%)	24 (25.3%)	63 (66.3%)
22	92	65 (70.65%)	21 (22.8%)	6 (6.5%)	38 (41.3%)	75 (81.5%)
29	65	39 (60%)	26 (40.0%)	0 (0%)	31 (47.7%)	46 (70.8%)
Total	407	299 (73.5%)	98 (24.0%)	10 (2.5%)	139 (34.2%)	297 (73.0%)

If we separated the activities on Monday from other days, it is obvious that total number of bill per day is up to 73.0% and the means of distribution rate is around 71.3%.

Table 4.6 Percentage of bill divided according to the arrival periodand food billing of Saturday and Sunday

Date	Total number of bill	Billing between 6.00–12.00 hrs	Billing between 12.01–15.00 hrs	Billing between 15.01–18.00 hrs	Billing of fresh food	Distribution of bill per day
6	239	182 (76.2%)	51 (21.3%)	6 (2.5%)	78 (32.6%)	146 (61.1%)
7	175	116 (66.3%)	56 (32.0%)	3 (1.7%)	42 (24.0%)	102 (58.3%)
13	271	217 (80.1%)	36 (13.3%)	18 (6.6%)	56 (20.7%)	140 (51.7%)
14	184	119 (64.7%)	53 (28.8%)	12 (6.5%)	33 (17.9%)	57 (31.0%)
20	237	205 (86.49%)	32 (13.5%)	0 (0%)	51 (21.5%)	119 (50.2%)
21	199	50 (26.12%)	91 (45.7%)	58 (29.2%)	40 (20.1%)	109 (54.8%)
27	187	107 (67.21%)	50 (26.7%)	30 (16.0%)	32 (17.1%)	96 (50.8%)
28	192	133 (69.27%)	30 (15.6%)	29 (15.1%)	47 (24.5%)	108 (56.3%)
Total	1,684	1,129 (67.0%)	399 (23.7%)	156 (7.3%)	1,565 (9.3%)	876 (52.0%)

If we separated activities on Saturday and Sunday from other days, it is obvious that total number distribution rate of this month is only 73.0% and the means

of distribution rate per day is around 51.78% which is relatively small when compares with the firm's target of 73%. The reason behind this little percentage is Saturday and Sunday are weekends and many companies close on those days. They are also days off for other people. These problems affect the distribution rate of the branch.

After separated Monday, and Saturday and Sunday from other working days, the data to be assessed is relatively small. The researcher decided to choose the range of activities on Tuesday to Friday to create the control chart to observe the variation of distribution rate.

Table 4.7 Percentage of bill divided according to the arrival period and food billing from Tuesday to Friday

Date	Total number of bill	Billing between 6.00–12.00 hrs	Billing between 12.01–15.00 hrs	Billing between 15.01–18.00 hrs	Billing of fresh food	Distribution of bill per day
2	199	110 (55.3%)	72 (36.2%)	17 (8.5%)	55 (27.6%)	160 (80.4%)
3	201	112 (55.7%)	63 (31.3%)	26 (12.94%)	56 (27.9%)	155 (77.1%)
4	192	170 (88.5%)	22 (11.46%)	0 (0%)	42 (21.9%)	167 (87.0%)
5	209	140 (66.9%)	64 (30.6%)	5 (2.4%)	64 (30.6%)	153 (73.2%)
9	271	181 (66.8%)	74 (27.3%)	16 (5.9%)	60 (22.1%)	147 (54.2%)
10	197	157 (79.7%)	3 (1.5%)	37 (18.9%)	49 (24.9%)	133 (67.5%)
11	264	175 (66.3%)	88 (33.3%)	1 (0.4%)	48 (18.2%)	183 (69.3%)
12	251	186 (74.1%)	55 (21.9%)	10 (4.0%)	64 (25.5%)	203 (80.9%)
16	271	183 (67.5%)	88 (32.5%)	0 (0%)	69 (25.5%)	218 (80.4%)
17	246	142 (67.7%)	104 (42.3%)	0 (0%)	44 (17.9%)	171 (69.5%)
18	268	196 (73.1%)	55 (20.5%)	17 (6.3%)	69 (25.7%)	195 (72.8%)
19	223	135 (60.5%)	16 (7.12%)	72 (32.3%)	53 (23.8%)	137 (61.4%)
23	275	239 (86.90%)	27 (9.8%)	9 (3.3%)	61 (22.2%)	217 (78.9%)
24	240	168 (70%)	56 (23.3%)	16 (6.7%)	64 (26.7%)	170 (70.8%)
25	249	173 (69.40%)	48 (19.3%)	28 (11.2%)	71 (28.5%)	185 (74.3%)
26	224	151 (67.41%)	36 (16.1%)	37 (16.5%)	69 (30.8%)	172 (76.8%)
30	238	160 (67.22%)	71 (29.8%)	7 (2.9%)	46 (19.3%)	197 (82.8%)
31	252	210 (83.33%)	42 (16.7%)	0 (0%)	65 (25.8%)	135 (63.6%)
Total	4,270	2,988 (70.0%)	984 (23.0%)	298 (6.9%)	1,565 (7.0%)	3,098 (72.6%)

Between Tuesday to Friday, total number of distribution rate is high in figure of up to 72.6%. After that the researcher brings the percentage of distribution rate per day to find the means which gives the result at 72.6%. Moreover, after separating the days into three periods of time, only Saturday and Sunday shows the

worst sign of distribution rate. On the other hand, Monday and Tuesday to Friday shows the sign of good distribution rate which almost reaches the firm's target.

Then the data of distribution rate on Tuesday to Friday from Table 4.4 is brought to create the control chart as shown in Figure 4.72.

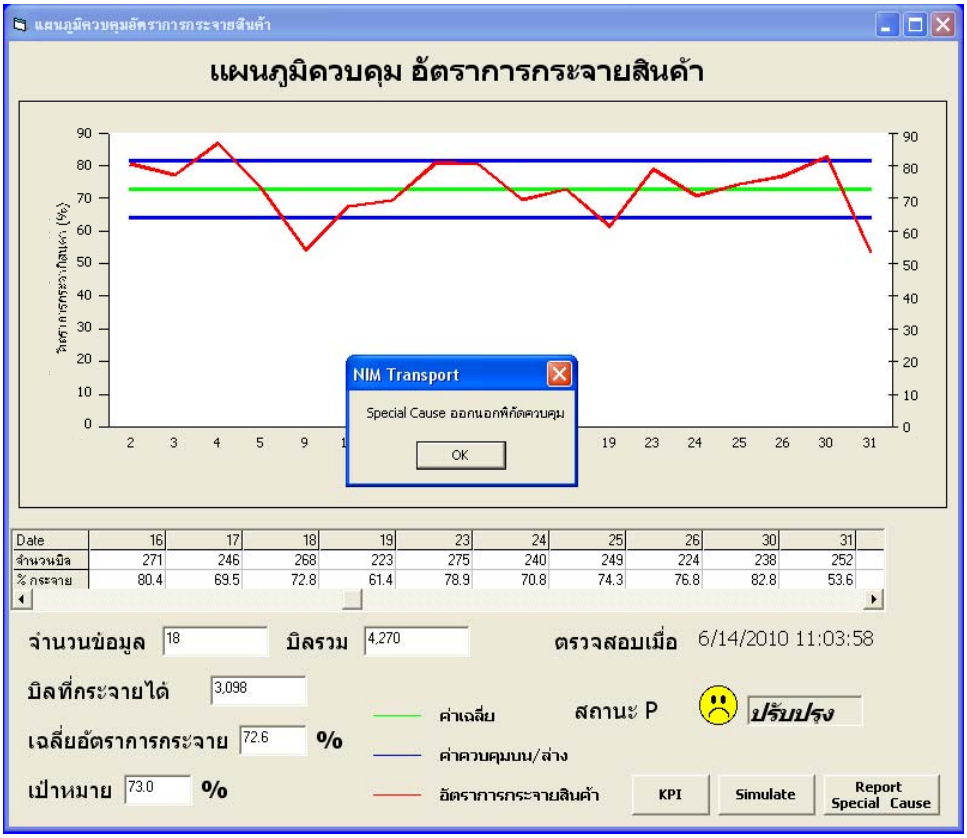


Figure 4.72 Control chart of distribution rate for March 2553 (assessed from Tuesday to Friday)

From the Figure

- Axis X is assessment period
- Axis Y is distribution rate
- Green line is central line calculated from number of distribution bill per day/ total number of bill = 0.726 or 72.6%
- Blue line is Upper Control Limit and Lower Control Limit (UCL, LCL)
- Red line is distribution rate

After separating assessment period into three period that are Monday, Saturday and Sunday and Tuesday to Friday, we will get the control chart with little variation. From Figure 4.72, we can see that special cause has been reduced to only 5 values. The value is distributed from three out of five and has fallen into the Lower Control Limit which is not a good distribution. After observing from the timetable of bill sending late, there are two out of three days that are the 9th of the month withhold the bill sending late at percentage of 33.2 from 12.01 hours. On the 19th of the month, the bill sending late is up to 39.4% of distribution rate which is not a good result. On the 31st of the month, the period of bill sending late at 12.01 hours is relatively small. However, before 12.00 hours of that day the distribution rate of bill sending late is up to 83.33% which is extremely high. The researcher has examined this cause and finds out that during the 09.01-12.00 hours percentage of bill sending late is quite high at 53.3%. It can be assumed that at that period, the branch is unable to distribute goods to meet up with the target. On the observation of good distribution rate, the distribution is being managed over the control limit of two or rather stays at the line of the Upper Control Limit. From table 4.4, during the 15.01-18.00 hours of the 4th, 16th, and 17th, no bill to be distributed. Moreover, during 15.01-18.00 hours of the 30th of the month, only 2.9% of bill to be distributed. From the average of distribution rate of Tuesday to Friday, the distribution is pretty high at 72.6% of the firm's target of distribution at 73%.

From the observation, if goods or products arrive during weekend, the operation of Bhuddhamonthon 5 road has faced with problems of distribution. The branch is unable to meet up with the firm's target. Moreover, fresh food is one of the factors to resist the distribution when compare day by day. To make the data more reliable, the researcher has collect data by interviewing 60 customers using the service during April 1-10 2553 to find out the reason of unable to pick up goods within one day. The data is use to improve distribution procedure.

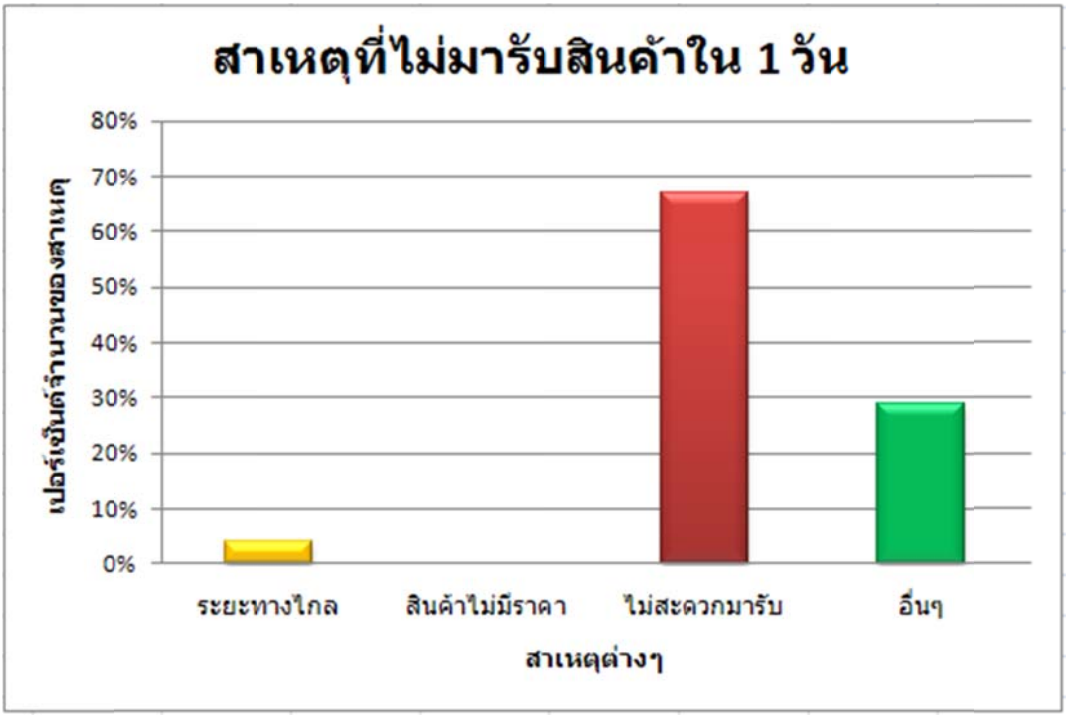


Figure 4.73 The cause why customer is unable to pick up goods within one day

Figure 4.73 the cause why customer is unable to pick up goods within one day. Inconvenience is the most important reason for customer to pick up goods which is 67%. The rest of the problems consist of others which is 29%, distance which is 4% and goods is priceless. The previous problems mentioned above are still not the cause of unable to pick up goods within one day. From the interview, there are many other reasons why customer is unable to pick up goods such as the firm's procedure and customer's inconvenience.

Procedure operation of the customer's firm

- many procedures after being informed
- wait until there are lots of goods to pick up at the same time
- if customer is supposed to pick up goods from different places, the farthest place is the first destination
- closed on Saturday and Sunday
- not many cars to pick up goods

Inconvenience of customer

- the centre is not a regular route of customer

- wait for goods of another round or wait until everything is being sent
- rely on customer's preference
- if goods to be picked up is candies and is easily spoiled, no need to hurry for a pick up

From the data collected, the most important factors related to worst distribution of goods of Bhuddhamonthon 5 road delivery center are lateness of goods arrival, goods arrive on weekends, inconvenience of customer to come and pick up and procedure of operation of the firm using of the service. The way to solve this problem is to change the firm's target of distribution of goods within one day. Previously, the firm aims to start distributing goods from the moment the goods arrive to the closing hour of the firm. This procedure is advised to change to the distribution of goods within 24 hours of arrival. If the goods arrive very late in the afternoon, most of the companies or stores are already closed. It is difficult to distribute arrival goods on time. Another suggestion to solve the problem is to produce leaflet to inform customer of nearby branch which makes it more convenience for customer to pick up. Moreover, there should be an advice on the advantageous of picking up goods within one day. For example, it is better to pick up goods within one day because the risk of damage of goods is relatively small and it is easy to find goods day by day. Many customers give opinion on how to encourage customer to pick up goods within one day. Further, the use of control chart to control distribution rate is to separate the group of working day into Tuesday to Friday, Saturday and Sunday and Monday. The purpose is to get the closest data to monitor, control and assess with the procedure by using the control chart.

From the above reasons, the researcher has tested the hypothesis on distribution of bill on the 9^{th}, 19^{th}, and 31^{st}. The experiment is done by setting the rate of bill sending late at little in number together with the good rate of goods distribution. the result of the control chart of the procedure is the answer. Hence, the control chart is shown in Figure 4.74.

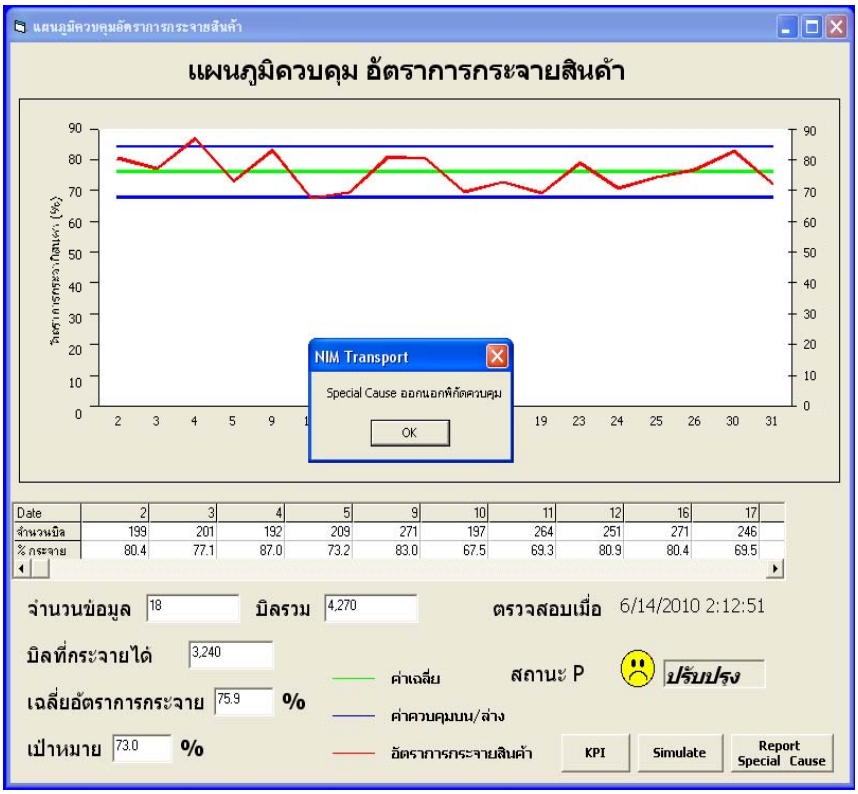


Figure 4.74 The control chart of distribution rate gaining from the hypothesis figure of bill sending late for three days to encourage a good distribution

From the Figure

- Axis X is assessment period
- Axis Y is distribution rate
- Green line is central line calculated from number of distribution bill per day/ total number of bill = 0.759 or 75.9%
- Blue line is Upper Control Limit and Lower Control Limit (UCL, LCL)
- Red line is distribution rate

The hypothesis figure of bill sending late of three days to encourage a good distribution yields the result that can be observed from Figure 4.74 with only one point of special cause. The point has a very good distribution rate of over the upper

control limit. If special cause occurs only for one point, the control limit is calculated within the control period.

The problems related to KPI of nonconforming bill and distribution rate that Bhuddhamonthon 5 road delivery center of NIM Transport 1988 Co., LTD has faced with is to find the way to improve its operation to meet up with the firm's target of the two KPIs. The researcher has applied the Statistics Process Control package to use with the operation of the branch by developing control chart prototype which is able to work On-line. The program is used to control, monitor, and assess the operation of both KPIs. They are to help find the cause as well as to reduce the problems occur during the operation of both KPIs. Apart from that, the application of Six Sigma in improving the operation procedure to meet up with the firm's target has been started from February 1, 2553 to April 30, 2553. The researcher finds out that the application of control chart to both KPIs is acceptable save that user has to pay attention to data input. This is because most of business data is unstable. For example, unstable of data that occurs with distribution rate comes from problems related to weekends or long holiday. These problems affect distribution rate. It is advised to separate the data of those days to be assessed separately while finding the closest group of data to be assessed together. On the other hand, there are not many problems on nonconforming bill rate since the factors that have impact on error are controllable. For example, error ness of staffs or customers which is a consist error that occurs.

After the assessment and finding of the cause why the branch is unable to meet up with the firm's target, there are two factors that affect distribution of goods within one day. The first factor is weekends and long extended holiday which are days off of companies and stores as well as the resting day of many people. The distribution rate during that period is not good. Another factor is number of bill from departure port that arrives late at the distribution center especially during the 15.01-18.00 hours. The timing of the bill causes delay in picking up of customer within the day. Therefore, the distribution of goods is relatively low. The solution of this problem is to set a new distribution rate. Previously, the distribution of the branch starts from the time that goods arrive until the closing hour. The suggestion is to open the distribution period up to 24 hours since goods from departure port arrive at the distribution center.

The purpose of applying of Six Sigma to the procedure is to improve problem of nonconforming bill and the other two problems. The first problem is the about customer's negligence of verify stock count bill as well as unable to fill in verify stock count since customer is always filling the form wrongly. The researcher has improved the information section to inform the procedure of sending goods. Moreover, there is sample of correct verify stock count. After the improvement, it is obvious that this can help to reduce error ness to 0.4% from 3.4% in February to 3.0% in March. The second problem is the clip uses to attach verify stock count. Previously, verify stock count is often swayed due to the wind blows. This often causes error of data filling. The solution for this problem is to change the clip that helps to reduce the frequency of swaying. After the improvement, ration of error ness in April has been reduced at 0.2% from 3.0% to only 2.8%. The details of improvement will be elaborated in Chapter V.

CHAPTER V
CONCLUSION

The concept of control chart is meant for user to assess, monitor and control of the production operation. After 65 years of implementing the concept of Statistical Process Control, control chart is being used continuously and has been developed consistently. The development is made to be related to the changing of the world. From the research related to Statistical Process Control using the control chart as a main concept to apply to operation other than production operation, there is no research trying on this kind of application. The concept of On-line SPC control chart is developed from the monitor of heartbeat in the emergency room which resembles to the application of service operation of logistics.

The researcher has a chance to conduct the research at one of the largest service delivery entrepreneurs of Thailand. Therefore, the researcher has developed the On-line SPC program and applies the program to control level of service of two KPIs that the company is facing at the moment. The two KPIs are nonconforming bill rate and distribution rate.

5.1 On-line SPC Program

From the test and development of the program, the researcher finds out that the program is able to calculate necessary values such as Upper Control Limit, Central Line and Lower Control Limit (UCL, CL, LCL) fast and correct. For the part that connect the program with the database, the program is able do it correctly and effective. The test of the On-line program by connecting two computers together is done by setting the first computer as Application Server to collect database of both procedures. The other computer is set to shows Real-time data as soon as it is used under operation. Somehow, the occurrence of data with the two procedures happens only once a day. The data does not occur too frequent or the amount of data is high.

Hence, the test of monitoring the heartbeat in the emergency room does not provide second plan. However, the firm has advised the researcher to test on the On-line SPC program and the quality control. There are two KPIs under the quality service that the firm is facing with: nonconforming bill and distribution rate. The assessment is done in order to observe, monitor and control the performance of the operation. It also helps to reduce problems with the two KPIs. Apart from that, there is application of Six Sigma concept to improve the operation procedure.

5.2 Control, Monitor and Assessment of rate of Nonconforming Bill

The application of control chart concept to use with rate of nonconforming bill from February to March 2553 shows that if the period of issuing is at the weekend or long extended holiday or even Chinese New Year holiday, there are unusual causes occur. For example, some day the number of sender is relatively small or there are not enough distribution cars which causes over left goods in the storage. When plotting control chart from rate of nonconforming bill, the data is swaying and instable with occurrence of many special cause. The researcher is unable to plot the control chart of the control period. On the other hand, during a normal month where there is no extra holiday or extended holiday like March, the data on nonconforming bill used to plot the control chart is stable in the procedure. It can be used to build the control limit and starts the control chart of the second phase or the control period. However, when applying the control chart to the following month, April, it is advised to separate unusual day out of normal day. April also has long extended holiday like Songkran Day or Thai New Year. It is obvious that even after the Songkran holiday the amount of sender is relatively small. If we include data during this period, the control chart is swaying and instable. Therefore, after we exclude those holidays off the chart, the procedure is running as usual. The control chart is being applied to the procedure effectively. However, from the assessment of the procedure, the rate of nonconforming bill is higher than what the firm has expected. The researcher then has applied the concept of Six Sigma to improve the procedure. There are five steps of improvement applying with the procedure. After the improvement, it is obvious that rate of nonconforming bill is down at 0.6%. If the improvement is done with cooperation

from everyone continuously and seriously, the rate of nonconforming bill is supposed to reduce until it reaches the firm's target.

5.3 Control, Monitor and Assessment of Distribution Rate

The researcher has brought data about distribution rate of Putthamonthon Sai 5 distribution center to create the control chart of both February and March 2553. When plotting control chart from distribution rate that occurs everyday, the data is swaying and instable with occurrence of many special cause every week. The researcher is unable to plot the control chart of the control period. The researcher then searches for the cause and finds out that during the weekend or long extended holiday, distribution rate is far lower than the firm's target. This is because many companies or stores close for the weekend the distribution rate is very bad. Moreover, there is small number of bill on Monday due to the fact that there are a few people delivery goods at the departure port on Sunday. Therefore, the number of goods that arrives on Monday is very small in number. This is another reason to exclude Monday from the control period if the firm wants to apply the control chart with distribution rate. Another factor related to problem of distribution rate is if the truck uploads goods from departure ports arrives very late or after 12.01 hours, customer is unable to pick up goods within one day. If the branch wants to solve this problem, it is necessary to change the target of distribution rate. Previously, the distribution of the branch starts from the time that goods arrive until the closing hour. The suggestion is to open the distribution period up to 24 hours since goods from departure port arrive at the distribution center.

Control chart is being applied to the logistics service which is acceptable and effective, if we starts by reviewing the input data or types of data to be assessed. For example, the purpose of using it with distribution rate, it is necessary to exclude days of assessment or control date which has an influence on the stability of the control chart.

CHAPTER VI
SUGGESTIONS

6.1 Types of data

The test of the On-line SPC program with the KPIs of both data can be done only one type per day. The researcher has developed On-line SPC program that can be used handful and effectively. Moreover, the program should be use with KPI of data with frequent occurrence. The quality control is transferred from data to data and user is able to acknowledge of special cause immediately. It leads to correction and improvement of service quality according to customer's standard preference.

Another important factor related to the application of On-line SPC program is instability and high risk of data from the operation procedure of delivery service and logistics. It is advised to review the data cautiously. For example, distribution rate during weekend or long extended holiday is different from that of other weekday. This is because those days are days off of companies and stores as well as the resting day of many people. The distribution rate during that period is not good. User should separate those days to assess separately because the inclusion of weekend and long extended holiday into the calculation of distribution rate would yield unstable result and unable to be applied with the control chart.

6.2 The Implementation

The idea of implementing Statistical Process Control program with operation of goods transportation business and logistics is actually not so easy. User is unable to implement the program immediately because the control chart derived from the program is relatively high variant and is unable to control. The occurrence of variant is inconsistent. Moreover, the operation procedure of logistics business is totally different from that of the production procedure. The implementation of Statistical Process Control rather is in need of revision of data. For example, the

operation data gaining during the weekend which are the companies or most people's days off is different from operation data gaining during weekdays. It is advised to exclude data of weekend from weekdays in order to get the closest of data to be implemented with the SPC concept.

6.3 On-line SPC and Quality Improvement

The problem that Putthamonthon Sai 5 delivery center branch of Nim See Seng Transport 1988 Company Limited is facing is the operation procedure which is unable to meet up with the firm's target. The researcher has analyzed, searched the problem thoroughly, and experimented on every concept in order to improve and solve the problem related to the operation procedure. The implementation of Six Sigma concept to the procedure shows sign of quality improvement for rather a short time. The most important thing is to believe that the improvement is for accomplishment of the company. Moreover, good attitude will alleviate the status of the company with serious intention of quality improving. The improvement should be done continuously, understandably and with cooperation of all parties in the company, from executives to staffs. These related factors mentioned above will enhance the quality control and improvement to be more efficient.

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