CHAPTER 3

BACKGROUND AND PROBLEM ANALYSIS

In this chapter, an electronics appliance company was selected as a case study for this thesis. The company background will be introduced in this chapter. The problems related to quality costs will be identified and analysed.

3.1 Background

3.1.1 Company profile

The selected company is a manufacturing factory of a multi-national company. It was established in 1990 in Chonburi of Thailand. It mainly produces the color PC monitor and all-in-one system (computer and monitor combination, like Internet PC but have additional function such as telephone) for some big OEM customers. It also produces color television chassis for its sister company in England.

The company is manufacturing oriented. It does not have marketing and design function.

The manufacturing pattern is that its headquarters (HQ) design product to OEM customers and find the order then pass to the company for manufacturing. Most of overseas material also supported by HQ, only some metal and packaging materials are supplied locally.

The revenue of the company is from so call manufacturing value added (MVA) charge, plus local material purchasing. The MVA is based on product basis, with 20-40 US dollars per set. This covers all manufacturing cost including facilitation, labor, overheads and possible internal and external failure cost.

Below is the basic company profile.

Established	1990
Capital	675 million Baht
Employee average	2000

Site area	128,000 M^2
Factory area	53,800 M^2
Office area	2,400 M^2
Revenue	3.6 Billion Baht

3.1.2 Product description

1). CDT monitor is the video display terminal of computer. The factory produces the different kinds of monitor by using the different model name to the different target customers. However, they are the same processes.

The display size is 14", 15", 17", and 19". Customers included Compaq, Hewlett-Packard, Packard Bell, Nokia, ViewSonic, etc.

2). All-in-one system is a more complex process than the general monitor. It is the combination of computer and monitor with telephone function. The customer is Intel.

3). Color television chassis. It is PCB assembly for color television. The customer is England company.

As an OEM business, it requires economy of scale and cost leadership. The product is very price sensitive. Quality is the order qualifier, cost and flexible delivery are order winner.

3.1.3 Quality system introduction

The company organization chart can be shown as figure 3.1

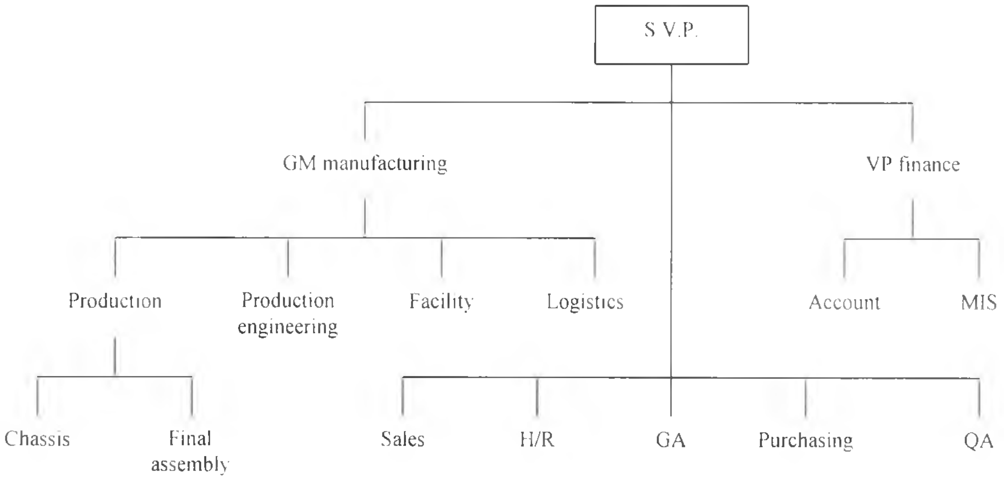


Figure 3.1 Company organization chart

In 1999, the quality assurance organization is shown in figure 3.2

Abbreviations: -
GI: Goods inwards
IQC: Incoming quality control
IPQC: In process quality control
OQA: Outgoing quality assurance
QE: Quality engineering
QD: Quality data
QS & A: Quality system and approval

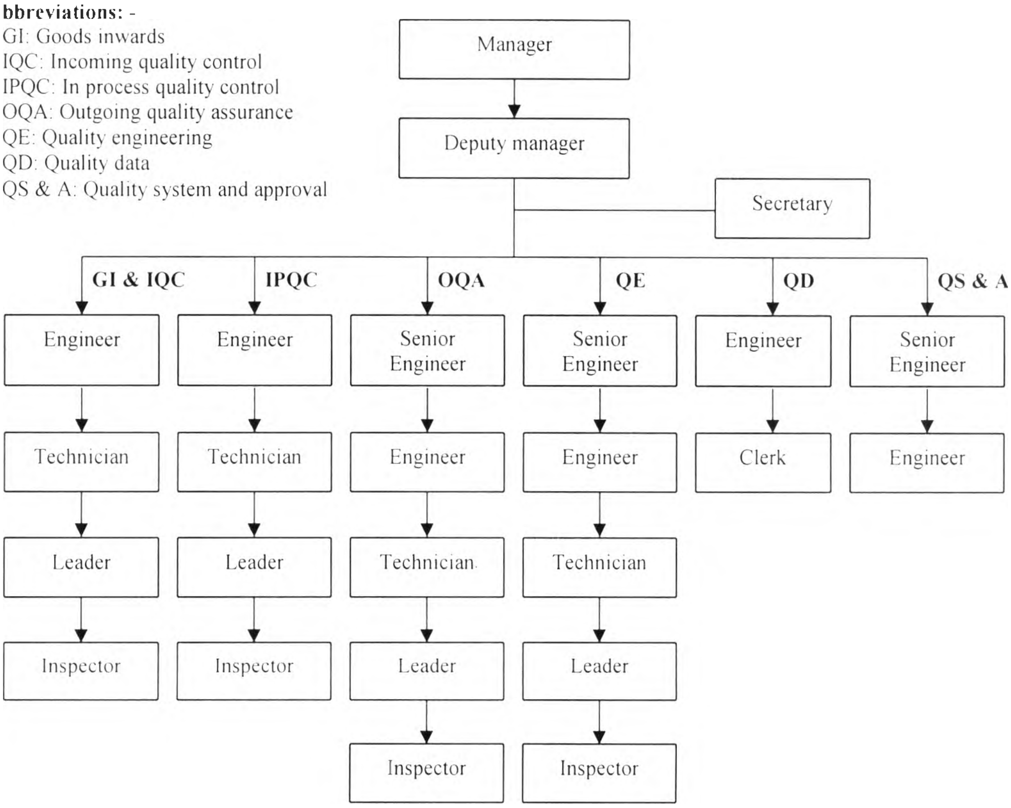


Figure 3.2 QA organization chart

The functions for each section are as below,

1). GI and IQC: Stands for goods incoming & incoming quality control. The function mainly performs incoming material inspection on selected AQL basis.

2). IPQC: It stands for in process quality control. This function performs the inspection in process. For some lay stations, IPQC inspect the product 100%.

3). OQA: It stands for out-going quality audit. It is out-going inspection, takes sampling inspection on the finished goods to assure that the quality of product for the customer.

4). QE is stands for quality engineering. This function ongoing reliability test, environment and life test to ensure the product reliability. This function also perform some precise test to confirm the product compliance of specification.

5). QD: It stands quality data. This function is to collect quality related data, process, and report.

6). QS & A: It stands for quality system and approval. This function performs system set up and certificate approval. Also vender surveillance is part of the job in this function.

Quality system such as ISO9000, ISO14000 approval and audition will be responsible by quality system and approval engineer. Some other safety certificate approval such as TUV, CSA, …etc. also be responsible by the system and approval engineer. Quality performance review and quality improvement plans have to be raised to the customer to ensure their confidence.

Vendor surveillance is also be responsible by quality system engineer. Suppliers quality is very important for the product. A set of monitor consists of around 200 kinds of components. We buy these components from various suppliers. Component quality performance is not always good enough. When we purchase a component from the vendor, the vendor has to be evaluated on their quality performance before the component is approved to buy. Both new vendor evaluation and approval and supplier`s quality audit are performed by the vendor surveillance engineer with the other department such as R&D, purchasing, engineering, etc…

3.1.4 General process flow chart

For CDT monitor manufacturing, the brief process flow chart is as figure 3.3

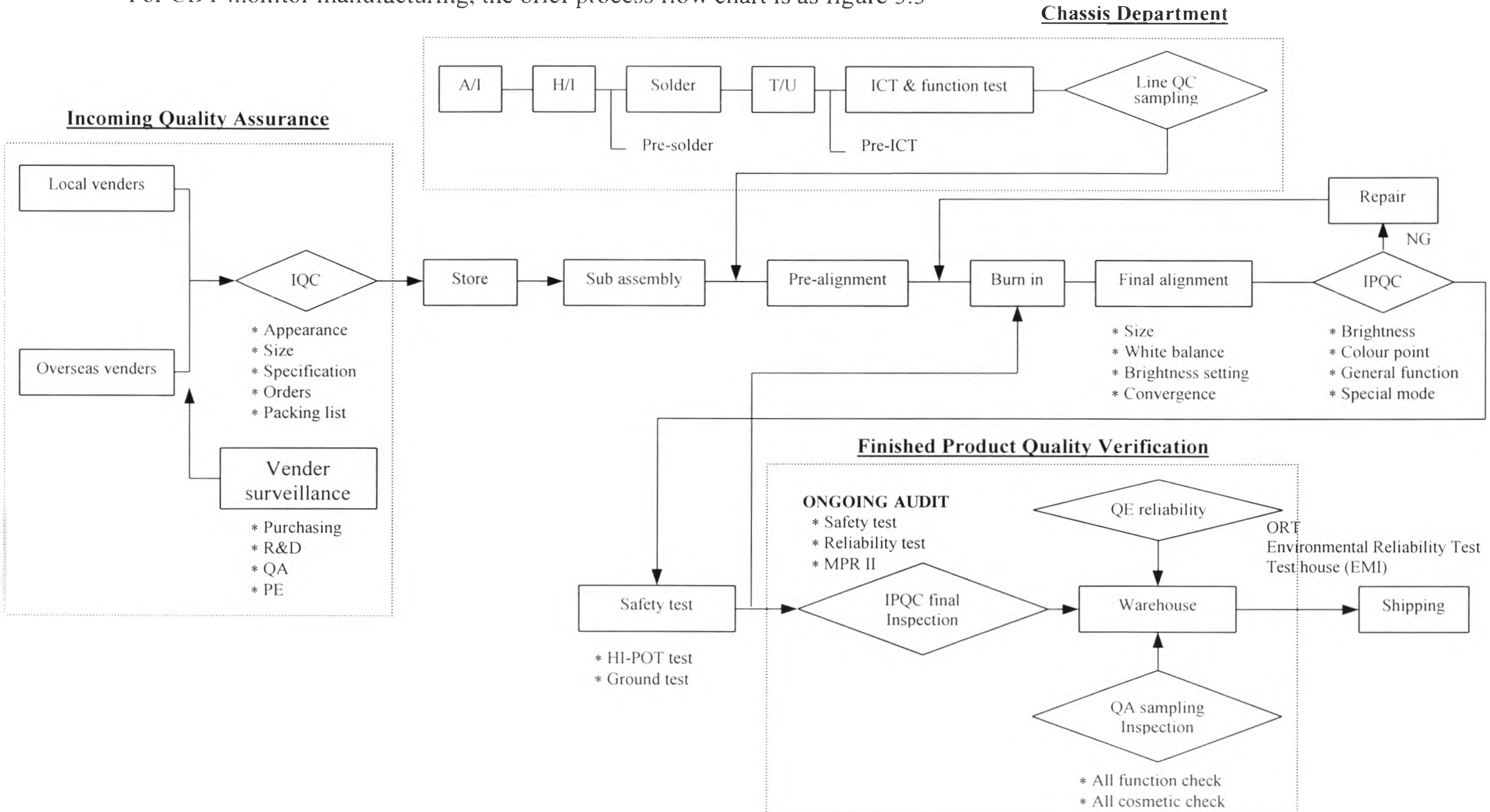


Figure 3.3 General process flow chart

Raw material from both local and overseas will be inspected and confirms by IQC inspectors.

After the confirmation, the material will be transferred to store area.

When planning department issued work order to manufacturing, the chassis department will withdraw material store. Afterwards, they are put through auto-insertion (AI), hand insert (HI), pass through solder and touch up. All boards to be tested by in-circuit-tester (ICT) and function test before go to line QC sampling.

After the chassis is passed, the chassis will be test final assembly together with CDT. In final assembly, their finished goods will be sampling inspected by OQA. Only those "passed" goods can be shipped out.

The goods will also be put in ongoing reliability test, environmental reliability test, and some product will be send to outside test house on EMI (Electrical Magnetic Imitation) test.

3.2 Problem analysis

3.2.1 Problem on quality

The company had a big expansion in year 2000. In the year 2000, its output volume doubled from previous 1.2 Million sets to 2.6 Million sets in 2000. Along the volume up, the quality becomes a very big concerns as there are many field failures and customer complaints.

One of the key customers, who consist of 80% of total company orders, strongly complained product quality problem and claimed big compensation. Even worse, the customer claimed that they might remove the order if the quality can't be improved in a certain time frame. This draws a big concern to management. As the compensation is too high, also the quality really affects the business. All these enforce the management to think how to improve quality. Quality cost program is one of the activities.

3.2.2 Existing company quality control and accounting system

The company, which is an certified by ISO9000 and ISO14000, has a comprehensive quality manual clearly setting out the responsibilities of quality, production, engineering and other personnel for quality-related matters.

Accounting department has some procedures and have codes related to quality cost. Sources of costs identified from accounting are as below,

1. Equipment for test and inspection.
2. Resale for refurbished products.
3. Scrap materials.
4. Warranty cost (include compensation charge).
5. Abnormal time cost (this include many factors such as production change model, material shortage, facility down.
6. Training

It is obvious that so far the accounting system has basic data for quality cost data, but lacks sophistication and the availability of data failed to meet expectations for the quality-related costs. Apart from some data directly referred to quality related cost, most of the costing have to be relied on estimations.

QA department also have some procedure and record related to quality cost but don't have exact figure for the cost itself. However, based on these information, the costs can be calculated.

Items can be source of costs identified from QA are as below,

1. Re-testing / re-inspection
2. Scrap
3. Customer complaints
4. Supplier assurance

Besides Accounting department and QA department, Industrial engineering (IE) also have some data related to quality cost, such as rework / repair, downtime.

3.2.3 Current quality costs detection and measurement.

Before start the quality cost program implementation, we study the BS6143 part2 and current company operating procedure. As the literature survey, it's unwise to try to achieve too much, too fast, because of resource limitation. After internal review meeting, it is decided that some items listed in BS6143 part 2 will not apply in this company as the company dose not have such activities.

3.2.4 Problem analysis

If applying PAF model, we get the following quality cost data for year 2000 (Refer to table 3.1, table 3.2, table 3.3 and table 3.4). In order to have same comparison base in the future, we use the ratio of cost V.S. sales value as reference.

The guidelines for cost calculation and estimation is as below,

1) For those items already have been kept in accounting, just use accounting figure.
2) For those re-test and re-inspection cost, it will be calculated by time multiple the standard cost (128 Baht per hour). Rework need 0.2 hours per set, re-inspection need 0.4 hours per set.
3) Only those equipment or tools used for quality inspector or test are considered into quality cost. Those used for production purpose such as for alignment / test are not consider into quality cost.
4) Equipment depreciation is in five years' frame. Annual cost is one-fifth of the total equipment test.
5) For some items which is difficult to quantify, such as quality planning which involves several persons once but dealing with several products,

we use the portion ratio of staff salary plus overhead (equipment to the salary in this company).

6) For common expense, will be portioned by sales volume basis. Such as equipment calibration, training, etc...

Table 3.1 Prevention cost for the year 2000

Unit: Million Baht

Cost element		Annual Cost	Source	Sales Value	Source	Ratio: (Cost/Sales value) %
A1	Quality planning	0.6	Estimate	3,594	Accounting	0.02
A2	Design and development of measurement, inspection, etc...	4.74	Estimate			0.13
A3	Quality review and verification of design	0.15	Estimate			-
A4	Calibration, verification	0.84	Accounting			0.02
A5	Supplier assurance	0.3	Estimate			-
A6	Quality training	0.5	Accounting			0.01
A7	Quality auditing	0.48	Estimate			0.01
A8	Quality data	0.24	Estimate			-
A9	Quality improvement program	1	Estimate			-
Total		8.85		3,594		0.24
Projected annual sales turnover (%)		0.25				

Table 3.2 Appraisal costs for the year 2000

Unit: Million Baht

Cost element		Annual Cost	Source	Sales Value	Source	Ratio: (Cost/Sales value) %
B1	PP verification	1	Estimate	3,594	Accounting	0.028
B2	Receiving inspection	0.552	Estimate			0.015
B3	Laboratory acceptance testing	0.5	QA			0.014
B4	Inspection and testing	6.24	Estimate			0.174
B5	Equipment for testing and inspection	5.13	Estimate			0.143
B6	Consumed material during test and inspection	0.13	QA			-
B7	Analysis and reporting of test and inspection results	0.6	Estimate			0.017
B8	Stock evaluation	-	-			-
B9	Approval and acceptance testing	0.9	Estimate			0.025
Total		15.052		3,594		0.42
Projected annual sales turnover (%)		0.42				

Table 3.3 Internal failure costs for the year 2000

Unit: Million Baht

Cost element		Annual Cost	Source	Sales Value	Source	Ratio: (Cost/Sales value) %
C1	Scrap	24.8	QA			0.69
C2	Rework/repair	15.2	IE/Account			0.423
C3	Trouble shooting/repair analysis	1.8	Estimate			0.05
C4	Re-inspection/re-testing	1.1	IE/Account	3,594	Accounting	0.031
C5	Fault of sub-contractor	-	-			-
C6	Modification permit and concession	0.72	QA			0.02
C7	Downgrading	-				-
C8	Downtime	12.5	IE/Account			0.348
Total		56.12		3,594		1.156
Projected annual sales turnover (%)		1.156				

Table 3.4 External failure costs for the year 200

Unit: Million Baht

Cost element		Annual Cost	Source	Sales Value	Source	Ratio: (Cost/Sales value) %
D1	Customer complaints	1	Estimate			0.028
D2	Warranty claims	53	Account			1.475
D3	Product repeated and returned	-	-			-
D4	Concession	-	-	3,594	Accounting	-
D5	Lost of sales	-	-			-
D6	Recall cost	1.5	Account			0.042
D7	Product liability	-	-			-
Total		55.5		3,594		1.545
Projected annual sales turnover (%)		1.545				

Above table can be further summarized to PAF model as shown in table 3.5

Table 3.5 Summarized of quality costs in year 2000

Quality cost categories	Quality cost (Million Baht)	Percent to total quality costs	
Prevention costs	8.85	6.53%	
Appraisal costs	15.05	11.11%	
Internal failure costs	56.12	41.41%	82.36%
External failure cost	55.5	40.95%	
Total quality cost	135.52	100%	
Ratio to sales	3.8%		

From this table, we can know that the failure cost is over 80%. According to Yiming Gong, quality cost optimize analysis model, we are should be I the quality improvement area.

The quality cost for each element can be shown as figure 3.4. The data ranking can be shown on figure 3.5

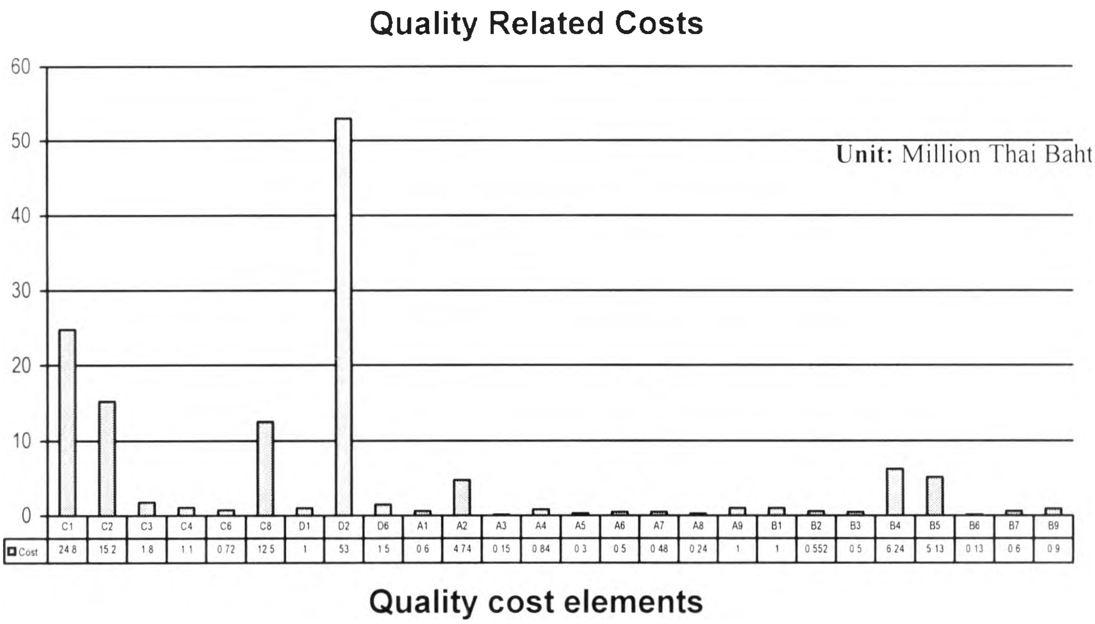


Figure 3.4 Quality costs statistic status chart for year 2000

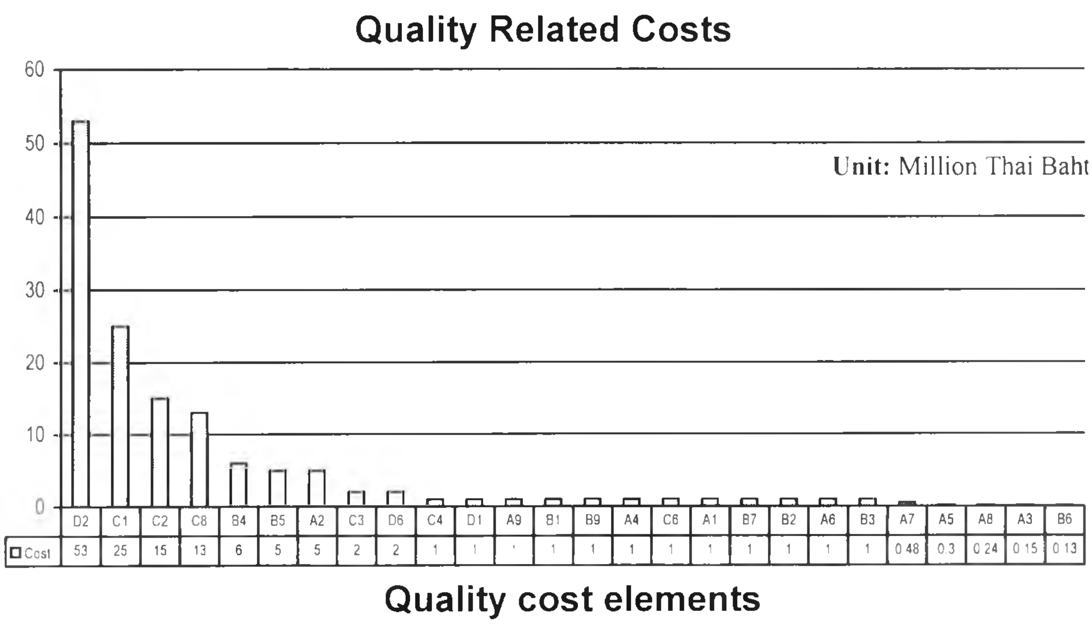
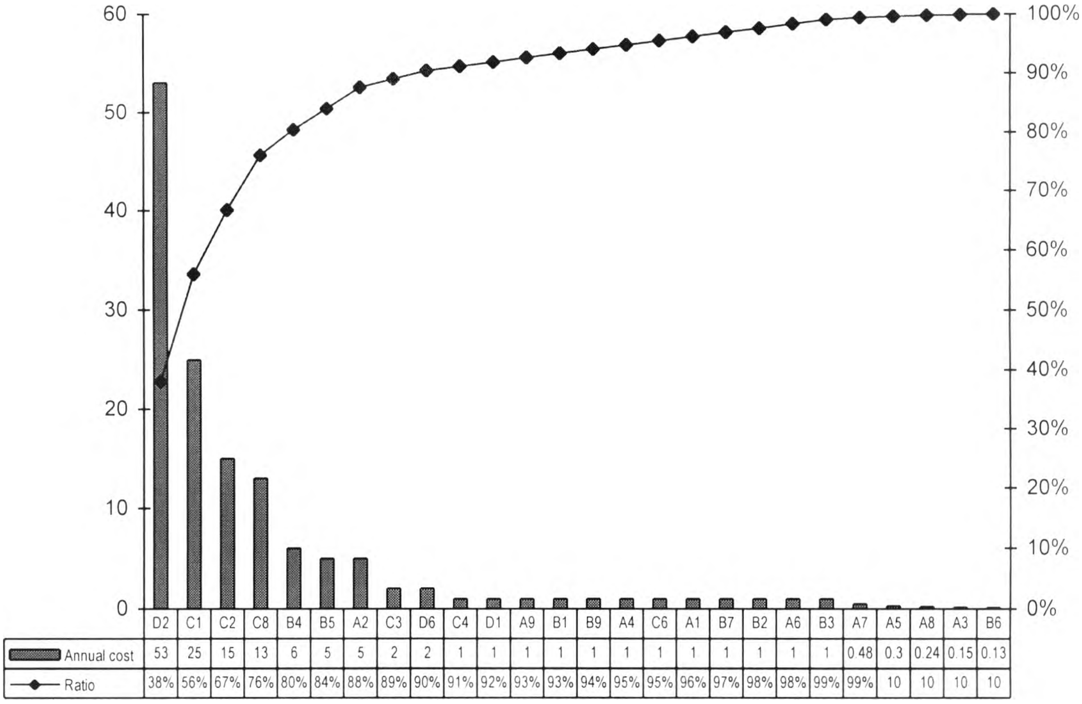


Figure 3.5 Quality costs statistic analysis chart for year 2000

Cumulative data and Pareto analysis graph can be shown on table 3.6 and figure 3.6

Table 3.6 Quality costs cumulative data for year 2000

Item	Annual cost	Cumulative	Ratio (%)
1	53	53	38.05%
2	25	78	56%
3	15	93	66.76%
4	13	106	76.09%
5	6	112	80.40%
6	5	117	84%
7	5	122	87.58%
8	2	124	89.01%
9	2	126	90.45%
10	1	127	91.17%
11	1	128	91.88%
12	1	129	92.61%
13	1	130	93.32%
14	1	131	94.04%
15	1	132	94.76%
16	1	133	95.48%
17	1	134	96.2%
18	1	135	96.91%
19	1	136	97.63%
20	1	137	98.35%
21	1	138	99.07%
22	0.48	138.48	99.41%
23	0.3	138.78	99.63%
24	0.24	139.02	99.8%
25	0.15	139.17	99.9%
26	0.13	139.3	100%
Total	139.3		



	D2	C1	C2	C8	B4	B5	A2	C3	D6	C4	D1	A9	B1	B9	A4	C6	A1	B7	B2	A6	B3	A7	A5	A8	A3	B6
Annual cost	53	25	15	13	6	5	5	2	2	1	1	1	1	1	1	1	1	1	1	1	1	0.48	0.3	0.24	0.15	0.13
Ratio	38%	56%	67%	76%	80%	84%	88%	89%	90%	91%	92%	93%	93%	94%	95%	95%	96%	97%	98%	98%	99%	99%	10	10	10	10

Figure 3.6 Pareto analysis on quality costs of year 2000

From the data we can know top 9 items consist more than 90% of total quality cost. If following the value, there are,

1. Warranty claims
2. Scrap
3. Rework/repairs
4. Downtime
5. Inspection and testing
6. Equipment for testing & inspection
7. Design & development of measurement & inspection
8. Trouble shooting & analysis
9. Recall cost

The top 3 are failure cost should be tried to improve first. Therefore, after review, we consider warranty claims, scrap, rework/repairs, recall cost and re-test/re-inspection are key areas for improvement.

Inspection and testing, equipment for testing and inspection and trouble shooting & analysis are appraisal cost, design & development of measurement & inspection is the prevention cost. They are considered to further improve.

If we review the business operation process and possible causes for above cost, we can get below,

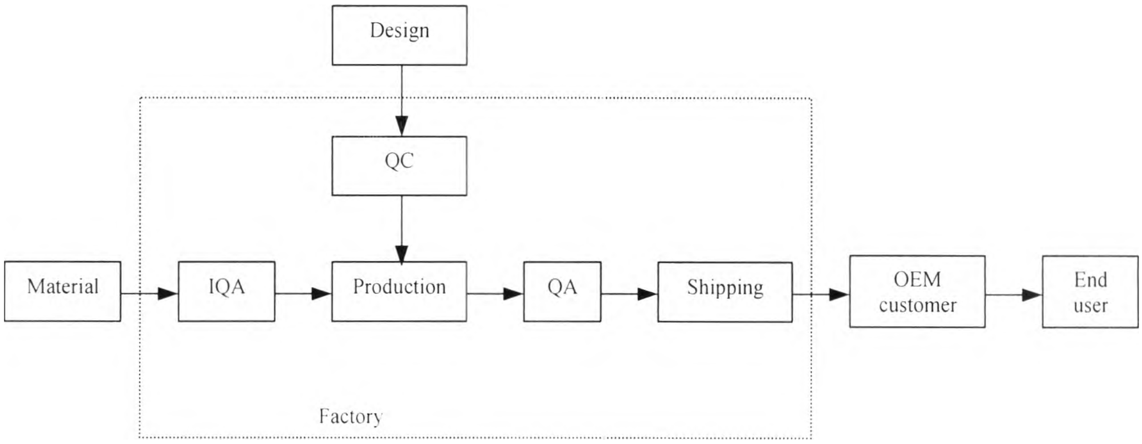


Figure 3.7 Operating process

If we use 5M method, the cost will occur as figure 3.8.

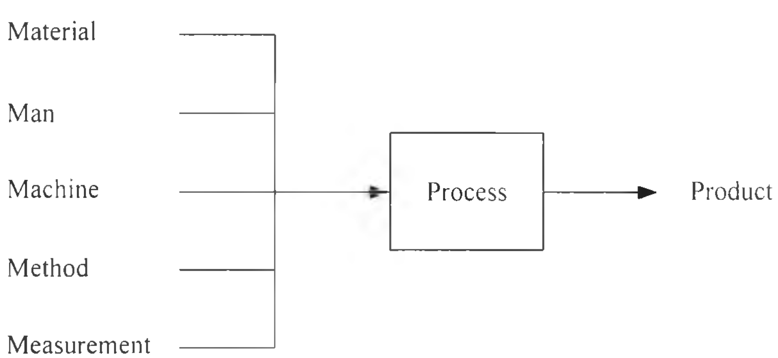


Figure 3.8 Factors affecting product quality

Applying the 5M method, the quality costs program team consists of production, production engineer and QA held several meetings to review the high failure costs. The table 3.7 list out possible causes after brainstorming in the meetings.

Table 3.7 Possible causes of failure costs

Cost items	Insufficient inspection capability unreliable quality
Warranty claims	Material – Unreliable suppliers, unsuitable material used, design Man – Poor workmanship, lack of training, lack of quality concept Method - Design failure, increase process, incorrect procedure
Scrap	Man – Poor workmanship, incorrect design, test standard not clear, wrong test specification used Method – Method-design ECN, design modification, poor quality, alternative material, different procedure
Rework/repair Retest/re-inspection	Man – Poor workmanship, lack of training, unskilled operator, do the skill required job Method - ECN, modification because of poor design Machine - Equipment error, measure-spec adjustment
Recall cost	Material – Unreliable suppliers, second source have mismatch problem Man – Poor workmanship, lack of training Method - Design deficiency

For above each items, they can be appraised and prevented, therefore, we may achieve overall cost reduction via reducing failure cost and increasing appraisal and prevention costs.

In details, analyse to these possible causes, the meeting presenters. Summarized the major factors and mirror factors by estimating the affect degree and frequency. It's is found that design issue, poor workmanship, material quality are major factors. We can improve design, workmanship material quality to reduce failures. If the failure is reduced, we can further reduce appraised cost.

Table 3.8 Factors affecting quality

Possible causes	Workmanship problem	Design problem	Component problem	Wrong measurement	Machine error	Environment problem
Affect degree (1-5)	5	4	5	1	1	∅
Occur frequency (1-5)	4	4	5	1	1	2
Overall rate	20	16	25	1	1	∅

1) For the workmanship issue, we can find out there are two major problems existing in the organization.

A. Quality organization review

For some reason, IPQC was removed from QA department to production department in year 2000. The after change quality department organization chart is as figure 3.9

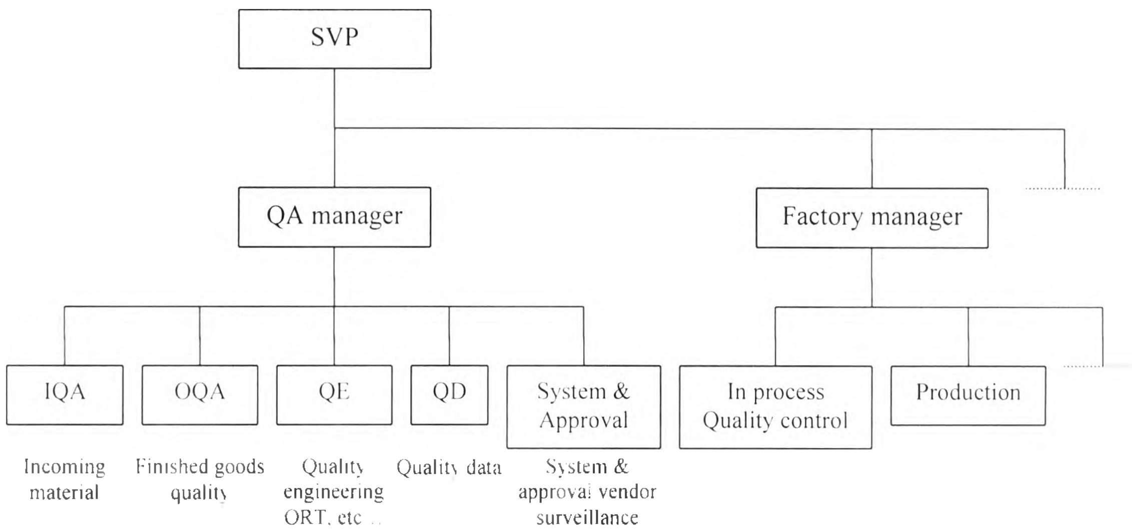


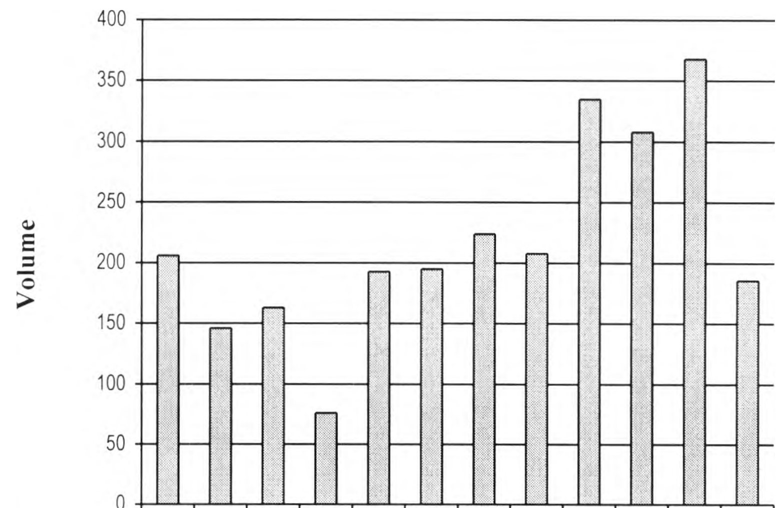
Figure 3.9 Quality department organization chart in year 2000

In theory, the QA is separated from manufacturing and directly report to top manager, it is good system. IPQC originally belonged to QA but because IPQC only performed inspection, not assisting on alignment, then the function was moved to manufacturing function in order to increase output.

If IPQC moved to production, QA lose a "leg" as many data should be collected/analyses by IPQC then report to QA manager, QA manager can take necessary action. The organization exist deficiency. This may make the responsibility is not clear. Sometimes communication became difficult as information path is changed. The control action is slow. Workmanship is lack control scrap cost, rework/repair cost increased.

B. Incentive scheme and operator training and qualification

The business is U shape business, with quarter 1 and 2 are low season, quarter 3 grow up and Q4 become peak season. This can shown as figure 3.10



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Output (K)	206	146	163	76	193	195	224	208	335	308	368	186

Figure 3.10 Seasonal business pattern

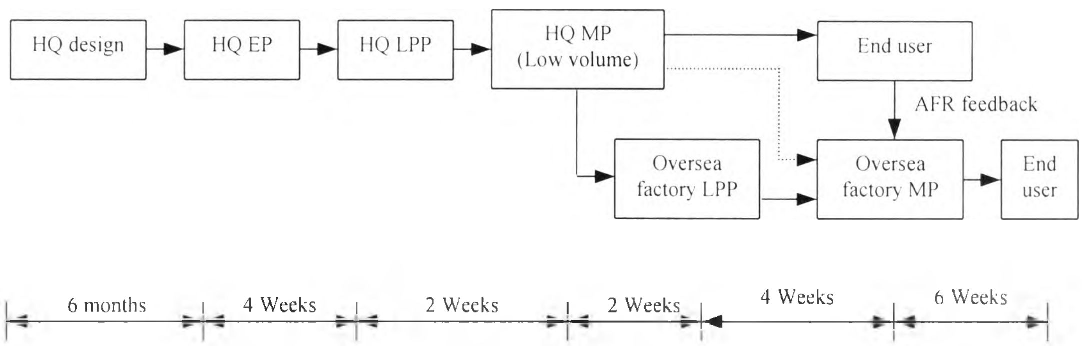
To overcome this, the company keep skilled employee on routine operation, recruit temporary operators on peak season. Also ask the production work overtime to catch up the big order during the peak season. The problem is that some temporary operator can not fully performing the job due to short time training and need learning curve to achieve the skill.

In order to encourage the operator work overtime, the company launched incentive scheme. The scheme is considered quantity achievement as 70% and quality achievement as 30%. As a result, production put more concentration on production volume, and relatively ignored quality. The supervisors push the operator to quickly perform their jobs and the IPQC also inspect product not strictly in order to achieve the quantity target to share the incentive allowance. Re-test/re-inspection rate increased. Some potential problems which QA couldn't find out flow to the customer and this caused the increasing of compensation.

2) Design issue

Design is the start point for product. When a new product is introduced, there have many procedure to verify the design. However, some potential design issue may not be detected until it go to mass production, even after go to the field.

Original new product introduction flow is as figure 3.11



EP: Engineering production
LP: Line pre production
MP: Mass production

Figure 3.11 Original new product introduction flow and time base

For cost consideration, HQ decided to move LPP from HQ to oversea factory, and delete mass production to HQ. The revised new product introduction flow is as figure 3.12

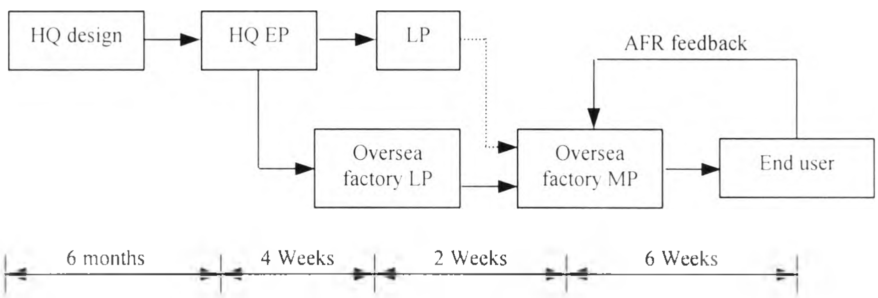


Figure 3.12 Current new product introduction flow and time base

Such a process can compress the time and reduce manufacturing cost, however, the disadvantage is that some potential problems was still not screened out but put in high volume production. It has a great risk that product with potential problem go to the field before solution cut in. then increasing the possibility of warranty claims costs.

Typically, the AFR information can be get after 6 weeks MP. On original model, the AFR information can be get just oversea factory MP start. Design can cut in solution immediately.

On revised model, the AFR information can be only get after oversea factory MP 6 weeks. If there exist design issue and need cut in solution 6 weeks, product already shipped out and have big risk. High AFR is very possible.

3) Component

For inspection capability reason, some components have to follow "ship to stock" procedure. These components are mainly semi-conductor. If they have potential problem, they may not be detected via MP or small quantities of "ongoing reliability test (ORT)". Current ORT process is 5 sets per model per day. However, some products may be produced on several lines at the same time, and per line per day can get average 1,000 sets. If 3 lines produce same product, and we only do sampling 5 sets, the ratio is only 0.17%.

If the company failure ratio is not as much as 0.17%, then they may not be detected and passed to customer.

As a summary, the major problem for existing system are,

1) Poor workmanship
2) Design problem
3) Component problem