ANALYSIS OF QUALITY FAILURE COSTS IN THE TECHNICAL DEPARTMENT OF THE LIBYAN ARAB AIRLINES

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ABSTRACT: The cost of maintenance of the aircrafts in the Libyan Arab Airlines is very high, the improper material management plays a big role in this problem. In this study certain steps have been taken to collect and analyze the related Quality Failure Costs, Starting with analysis of quality failure costs in the material Division, using PAF Model. The Study shows that the quality failure costs due to shortage of spare parts, as a result of cancellation of purchase orders (PO), and unserviceable Routable Component which come from repair stations and still under warranty, is very high. The aims of this work are to investigate the actual reason behind the high maintenance costs, and advice the top management of the LAA, to implement proper Quality System to overcome this problem.

Keywords – Failure Costs, Inventory, Purchase Order, Work order

1. INTRODUCTION

Joseph Juran,(2000), one of the world's leading quality theorists, has been advocating the analysis of quality related-costs since 1951, when he published the first edition of his quality control handbook Feigenbaum made it one of the core ideas underlying the total quality management movement, it is a tremendously powerful tool for product quality.

There are three reasons to identify and measure the costs associated with poor quality, these reasons are, to quantify the size of quality problem, to help justify an improvement effort, to guide the development of that effort, to track progress in improvement activities. The quality related costs are much larger than are shown in the accounting reports. For most companies in the manufacturing and service sectors, these costs usually vary from 10 to 30% of sales revenue or between 25 to 40% of operating expenses, (El-Kalhout & El-Harbi, 2004). Some of these costs are visible; some of them are hidden. Such profit leaks to justify an improvement effort, (Campanella, 1999).

Libyan Arab Airlines is the Libyan National Carrier, established on 1965, operating different types of aircrafts, from general aviation aircrafts, to wide Body Ones, with 7000 employees, 1400 of them in the Technical department. During 1970s and early 1980s the company was one of the famous Arab Carriers, on 1983 the company faced the United States of America (USA) embargo, which prevented the company from owning any Aircraft or Spare parts, their contents exceeds 10% originally USA contents, on 1992 the company faced the United Nation (UN) embargo, the result of this embargo, that company not allowed flying out side Libya. The effect of these two major problems forced the company to own spare parts as much as it can, to keep its fleets operative. The handling of this task with the lack of material management, costs the company a lot of money, in this paper the authors investigated the effect of Quality Failure Costs in the Material Division in the TD of the company, by applying the part related to failure costs of the PAF Model.

Ultimately this work aims to analyze quality failure costs in the technical department of the Libyan Arab Airlines, to give an evidence for the company to implement Quality Management System.

2. QUALITY RELATED FAILURE COSTS

Quality cost is one of the total quality management tools, which helps in improving quality performance, as related to product or service, measurable quality improvements have a tangible effect on other business measures, like sales and market share. As a result quality costs must be measured and must reflect cost or lost opportunities to the firm, (Russell & Taylor, 2003). Internal quality failure costs can define as, the costs occur when products or services fail to reach design quality standards, and are detected before transfer to the customer takes place. Also included are avoidable process losses and inefficiencies that occur even when requirements and needs are met. These are costs that would disappear if no deficiencies existed.

External failure costs can be defined as, the costs occur when products or services fail to reach design quality standards but not detected until after transfer to the consumer. Also included are lost opportunities for sales revenue. These costs also would disappear if there were no deficiencies.

As the concept of quality costs is new in Libya, there were very few publications in this field. Ali Elbuzidi and Faraj El-Marimi, (2004), investigated the possibility of implementing cost of quality program in a form of pilot project in a selected manufacturing plant, of assembling personal computer (PC), again Ali Elbuzidi and Lutfi Ahmad (2004), introduced Quality Cost Model for industrial Firms, where they highlighted the basic quality cost concepts, it's important, benefits of quality cost control, and how to use quality cost as a tool to assist the management to take right decisions, to improve quality of the product, by using quality cost reports. Effective material management not only reduce maintenance costs, but also directly related to reducing the airline operating costs, (Ghobbar & Chris, 2004), (Kilpi & Vepsalainen, 2004). The result of the investigation of the failure costs in the TD of the LAA of this work, which is considered as the first of its kind in Libya, can be summarized on the following:-

2.1 Internal Failure Costs

The internal failure costs in the TD of the LAA, come from, *design failure costs*, during the design of any modification, by Engineering and Planning Division, *re-work costs* due to any design change, *Purchasing Failure Costs*, (Purchased material Reject Disposition Costs, Purchased Material Replacement Costs, and Maintained Material Replacement Costs), in the material division, *Re-inspection/Retest Costs*, in the work shops section, *shelf Life Time Expiry costs*, for the inventory, *short on inventory costs*, *improper troubleshooting costs*, during rectification of snags, in the line maintenance division, or production division, (Barrie Dale & Jim Plunket, 1999).

2.2 External Failure Costs

The External failure costs in the TD of the LAA, comes from, costs of *customers complaint investigations*, due to maintenance of the aircrafts or routable components to the customers at the LAA facilities, or the rejection of the A/Cs from the company pilots, *costs incurred due to warranty claims*, as a result of problems with aircraft, or routable components maintained at LAA facilities, *costs of penalties*, due to technical mistakes from the TD staff, *lost of sales*, due to no quality in the work of the TD, which lead to loss of customer goodwill, *the delay on payment to the suppliers*, have a big contribution on the quality failure costs, *and the cancellation of purchase orders*, leads to short of spare parts, which effect the work in the TD(Campanella, 1999).

3. DATA COLLECTION

One of the major tasks of the material Division, the focus of this study is to provide spare parts, tolls, equipments, and all necessary materials to the TD, at the same time this Division, is taking care of the maintenance, repair, and test of the routable parts. The second researcher spent three months in the TD of the LAA collecting data related to quality failure costs, in the material division, for the years 2002 & 2003, started by reviewing the issued POs, and the issued work orders (WOs), specially the Pos contained the routable parts received unserviceable from the suppliers, or become unserviceable during the warranty period. During the years 2002, and 2003 the material division issued 1063 purchase orders, 734 of them issued during 2002, 85 of them are cancelled, and 329 purchase orders issued during the 2003, 48 POs of them are cancelled, due to different reasons. During the year 2002, the material division issued 1322 work orders, 11 of them found their contents unserviceable, and during the year 2003, 1454 work orders were issued 11 of them found their contents unserviceable.

Two factors found that have strong contribution on the quality failure costs in this division, and make it very high. These factors are the cancellation of purchase orders as shown in Table1, and the maintenance of the routable components abroad on different repair station, sent direct or through third parties.

Table.1 shows that, there are Two major factors in cancellation of the purchase orders, cancellation due to no payment effected to the suppliers by the company, and cancellation due to no delivery made by the suppliers in the right time, three POs from each factor for each year to be analyzed, to find their effect in the quality costs, in the TD.

4. ANALYSIS OF THE RESULTS

The calculations made by the researchers for finding the failure costs are based on the detailed analysis of salaries, facilities usage, process mapping which has resulted to the following:-

1- The cost of man hour for the employees in the TD of the LAA is, USD 3.11 in the Material Division, USD 5.05 in the Engineering and Planning Division, and USD 12.61 in the Maintenance Divisions (Line Maintenance, Production, Work Shops, and General Aviation Divisions).
2- The cost of preparing one purchase order is USD 51.94 .

3- The cost of canceling one purchase order is USD 10.11 .
4- The cost of preparing one work order, is USD 210.61, on table 5, the cost of shipping for each item is added to the process cost, the shipping costs depends on the weight of the part, and the repair station location.
5- The lost of profit in table 5, based on the expected, profit/hr, for each type of aircrafts, owned by the company (500 USD/hr for B727, 300 USD/hr for F28, 250 USD/hr for F27, 150 USD/hr for DHC-6).

Table 1. purchase orders cancelled on 2002 and 2003

No.	Cancellation Reason	2002	2003
1	Cancelled due to delay in payment	**9**	**24**
2	Cancelled due to price increased by supplier	10	0
3	Cancelled due to supplier request	9	1
4	Cancelled due to no delivery made	**47**	**20**
5	Cancelled due to condition changed by supplier	1	1
6	Cancelled due to no enough quantity ordered	2	0
7	Cancelled due to supplier unable to supply	2	0
8	Cancelled due to mistake in currency	1	0
9	Cancelled due to non destructive testing (N.D.T)	1	0
10	Cancelled due to Ordering mistakes	1	0
11	Cancelled due to or management decision	1	1
12	Cancelled due to parts sold	1	1
	Total	85	48

4.1 Purchase Orders

Three purchase orders, from each factor, for each year, as shown in tables 2&3 were selected, during the selection, the authors put in to consideration, the different types of Aircrafts owned by the company, and at the same time, the parts to be purchased for the use of the workshops, Aircrafts, or Inventory, and the deferent suppliers dealing with.

The cancellation of purchase orders, or the delay of payments to the suppliers, cost the company a lot of money as shown on tables 2&3, for all the POs, re-ordered, the new prices became more than the previous ones, at the same time the short of spare parts some times forced the company to seek for different solutions to solve the operation problems, and one of these examples, the company leased one Auxiliary power unit (APU) for one of their F28, for 18 months, costs the company an amount of USD 149145.00, which became more than the cost of purchasing one APU, as in the PO No. 02-06B005.

Table 2. Failure cost in USD of PO's cancelled due to no payments made

No	PO. No	Price	New Price	Difference	Process Cost	Initial Cost	Total Failure costs	% of failure costs
1	02-10TL003	2660.00	NRO*	-	62.05	2772.05	62.05	2.28
2	02-03A043	514.80	688.50	173.70	62.05	576.85	235.75	40.87
3	02-12IN011	2509.65	NRO	-	62.05	2571.70	62.05	2.41
4	03-12WB004	11718.00	19627.20	7909.20	113.99	11831.99	8023.19	67.81
5	03-03A034	1275.00	2683.75	1408.75	62.05	1337.05	1470.80	110.00
6	03-03A038	5775.00	12300.00	6525.00	62.05	5837.05	6587.05	112.85

Table 3. Failure cost in USD of PO's cancelled due to no delivery made

No	PO. No	Price	New Price	Difference	Process Cost	Original Cost	Total Failure costs	% failure costs
1	02-06B005	140000	NRO	-	62.05	140062.05	149207.05	106.53
2	02-03A124	250.00	425.00	165.00	62.05	312.05	227.05	72.76
3	02-04B009	11200.00	17921.25	6721.25	62.05	11262.05	6783.30	60.23
4	03-01A004	142.50	916.50	730.56	62.05	204.55	836..05	408.73
5	03-03A028	49.00	82.10	33.10	62.05	111.05	95.15	85.68
6	03-05A014	3162.00	6012.50	1850.50	62.05	3224.05	3160.75	98.04

***** NRO, no reordering

The total failure costs of the item No. 1, in the table 2, contain an amount of USD 149,145.00, came from the lease of one auxiliary power unit (APU), to the cover a short of APU, due cancellation of the PO, and no spare one available.

Fig 1; shows the form used to gather and calculate all the data related to quality failure costs, for each purchase order, shown in table's 2&3.

The form divided in to four parts, first part contain the purchase order necessary information and data, part two contain the purchase order details, part three contain the new purchase order details if the part reordered, and part four, which is the important part for our study, contain the failure costs incurred details.

4.2 Work Orders

Three samples from each year, to be analyzed, to find their effect as a Quality failure cost, as shown in table 4; the work carried as follows:

The failure costs are generated from, installation and removal of the parts, work orders processes, aircrafts ground time due to no spare parts, and the lost of profit due to no spare parts. By compared the total failure costs, with the original work orders costs, found that the failure costs range between, 2.41 to 408.73%, from the original costs. This can be avoided or at least reduced, by implementing quality cost system in the TD of the LAA.

Table 4. WO's failure cost in USD

Part No.	Description	Installation test, and Removal cost	Process and shipment cost	Ground time & lost of profit cost	Total failure costs	Original Cost	% of failure cost
TT8D-15	Engine	2644.12	7620.61	292000	302246.73	901008.08	33.55
2588423	Instrument	9.45	212.05	500	721.51	6002.05	12.02
731753	Constant speed driver	69.39	334.36	1500.00	1903.72	39489.36	4.82
19911-1C	Vertical gyro	15.77	227.90	750.00	993.67	8593.67	11.56
9599-606	Radio altimeter.	6.30	216.25	166.67	389.22	3317.91	11.73
G2379A	Very high frequency coupler	18.92	275.47	875.00	1169.39	4848.08	24.12

PO. No. 02-04B009 Supplier: FP
PO Date 26.06.2002 Amount: 11,200.00 USD
Delivery Time: 6 weeks
- PO cancellation date 06.08.2002

- PO contents

No.	Description	Part No.	Quantity	U. price	T. price
1-	Booster Pump	65c38378-1	1	11,200.00	11,200.00
	Wire Bundle				
	Sleeve				

- Ordered for

Inventory	Workshops	Aircraft
(X)	( )	( )

The operation effected for (-) days

-The next order details:-

No.	PO No.	PO. Date.	Quantity	U. price	T. price
1-	02-04B014	11.08.2002	1	17,921.25	17,921.25

- Failure Costs incurred

- Cost of Process
  - Cost of ordering 51.94
  - Cost of cancellation 10.11
- Deference between new and original price 6721.25
- Total Failure costs 6768.44
- Original price 11243.44

% of additional costs (6783.30/11262.05)*100= 60.23%

Fig. 1. Sample of purchase orders form

Fig 2; shows the form used to gather and calculate all the data related to quality failure costs, for each work order, shown in table 4.

The form divided in to three parts, first part contain the work order necessary information and data, part two contain the part movement from the inventory to the aircraft, and all the operation happened, and part three, contain the details of the failure costs incurred.

W/O No. 99-03-0135 Company ATC
W/O Date 16.03.1999
Description: Engine
Part No. JT8D-15 Serial No. 696459
GRN No. 01BD658 GRN Date 31.10.2001

Fitted to A/C 5A-DIB Fitting Date
Remove Date 31.01.2002 R. Reason High EGT

Build up Time	Removal Time	Ins. time
120 hr	24 hr	158 hr

Warranty W/o No. 02-03W0005 W. W/O Date: 09.02.2002
GRN No. 02-B0094 GRN Date:- 11.04.2002
A/G Ground Time: 2 days

Failure Costs Incurred

- Cost of Build up the Engine 120*12.61 = 1523.20
- Cost of removing the Engine 24*12.61 = 302.64
- Cost of Installation the Engine
  - installation cost 38*12.61 = 1992.38
  - Fuel & Oil cost = 143.60
  - Maintenance reserve cost 750,000/4000 = 187.50
- Cost of A/C ground time 2*8*500 = 8000.00
- Cost of shipment the engine 2*1.24*3000 = 7,410.00
- Cost of process = 210.61
- Lost of profit due to A/C grounded (71 days) 71*8*500 = 284,000.00

- **Total Failure costs = 302,264.73**

- **Original Maintenance Cost = 901008.08**

- **% of failure costs = (302264.73/901008.08) = 33.55**

Fig. 2. sample for collecting quality failure costs of work order

5. CONCLUSIONS

The results of investigation of failure costs in the TD of the LAA has revealed that, the company was losing a remarkable amount of money which is never been recorded in their accountants, the material division play an important role in providing the spare parts for the TD, and also deal with the work orders. The fact that a lack of proper set of procedures to follow has resulted in the cancellation of many POs and WOs. As a result of that extra cost has to be paid for reordering. The percentage in the increase of cost could reach up to 174% of the original cost for POs and 47% for WOs . The increase of these costs are mainly due to the following:

1. Increase on prices, during the re-ordering of the same item.
2. Shortage of spare parts as a result of the cancellation the POs. fig 1 show the failure costs incurred due to the cancellation of one purchase order, to purchase one APU for one of the

company F-28 aircrafts, and there is nil spare, the company forced to lease one APU from another operator for more than 18 months, which cost the company 149000 $.

3. Incurred amounts, due to ordering and then canceling the purchase orders.

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