Bhimani et al
Chapter twenty: Quality and throughput costing in managing costs

Suggested solutions to some of the questions

20.1 Quality costs (including the opportunity cost of lost sales because of poor quality) can be as much as 10–20% of sales revenues of many organisations. Quality-improvement programmes can result in substantial cost savings and higher revenues and market share from increased customer satisfaction.

20.2 Quality of design measures how closely the characteristics of products or services match the needs and wants of customers. Conformance quality measures whether the product has been made according to design, engineering and manufacturing specifications.

20.3 Exhibit 20.1 in Chapter 20 lists the following seven line items in the prevention costs category: design engineering, process engineering, quality engineering, supplier evaluation, equipment maintenance, manufacturing quality training and new materials.

20.4 An internal failure cost differs from an external failure cost on the basis of when the non-conforming product is detected. An internal failure is detected *before* a product is shipped to a customer whereas an external failure is detected *after* a product is shipped to a customer.

20.5 No, companies should emphasise financial as well as non-financial measures of quality, such as yield and defect rates. Non-financial measures are not directly linked to bottomline performance but they indicate and direct attention to the specific areas that need improvement. Tracking non-financial measures over time directly reveals whether these areas have, in fact, improved over time. Non-financial measures are easy to quantify and easy to understand.

20.6 Customer complaints, on-time delivery rate and delivery delays.

20.7 Process yields, defects per product line and employee turnover.

20.8 Two reasons why lines, queues and delays occur are: (1) uncertainty about when customers will order products or services – uncertainty causes a number of orders to be received at the same time causing delays; and (2) limited capacity and bottlenecks – a bottleneck is an operation where the work required to be performed approaches or exceeds the available capacity.

20.9 No. Adding a product when capacity is constrained and the timing of customer orders is uncertain causes delays in delivering all existing products. If the revenue losses from delays in delivering existing products and the increase in carrying costs of the existing products exceed the positive contribution earned by the product that was added, then it is not worthwhile to make and sell the new product, despite its positive contribution margin.

20.10 The three main measures used in the theory of constraints are:

1 Throughput contribution equal to sales revenues minus direct materials costs.

2 Investments (stock) equal to the sum of materials costs of direct materials stock, work-in-progress stock and finished goods stock, research and development costs, and costs of equipment and buildings.

3 Other operating costs equal to all operating costs (other than direct materials) incurred to earn throughput contribution.

20.11 Cost of quality programme, non-financial quality measures.

1 (i) Prevention cost:

d Labour cost of product designer of Zaccaria.

f Seminar costs for 'Supplier Day', a programme aimed at communicating to suppliers the new quality requirements for purchased components.

(ii) Appraisal cost:

a Cost of inspecting products on the production line by Zaccaria quality inspectors.

(iii) Internal failure cost:

c Costs of reworking defective parts detected by Zaccaria quality assurance group.

g Costs of spoiled parts.

(iv) External failure cost:

b Payment of travel costs for a Zaccaria customer representative to meet with a customer who detected a defective product.

e Cost of automotive parts returned by the customer.

2 Examples of non-financial performance measures Zaccaria could monitor include:

- first-pass calibration yield
- outgoing quality yield for each product
- percentage of returned merchandise
- customer report card
- competitive rank
- on-time delivery.

20.12 Quality improvement, relevant costs and revenues, service.

1 Additional costs of the new scheduling and tracking system are €160,000 per year.

2 Additional annual benefits of the new scheduling and tracking system are as follows:

Additional annual sales from improving on-time performance		
€20,000 (95% − 85%)	€200,000	
Contribution margin from additional annual sales		
45% × €200,000		90,000
Savings in variable costs per year from fewer cartons		
Lost or damaged €60 (3,000 – 1,000)		120,000
Total additional benefits		€210,000

3 Since the expected benefits of €210,000 (requirement 2) exceed the costs of €160,000 (requirement 1), Colombe-Déménagements should invest in the new system. Of course, these calculations assume additional sales and contribution margin from better on-time delivery performance. So long as additional contribution margin of €40,000 (costs of €160,000 – variable cost savings of €120,000) can be realized (corresponding to additional sales of €40,000 ÷ 0.45 = €88,889) investing in the new system is beneficial.

Students might also suggest that only considering the variable cost savings as a result of fewer cartons being lost or damaged, underestimates these benefits.

Reducing the amount of lost or damaged cartons could enhance Colombe-Déménagements' reputation and could lead to higher sales and contribution margin.

Other students might argue that the new system may also reduce the time required to transport goods (service quality measure (a)). This too could lead to additional sales and greater contribution margin.

20.13 Theory of constraints, throughput contributions, relevant costs.

1 Finishing is a bottleneck operation. Hence, producing 1,000 more units will generate additional throughput contribution and operating income.

Increase in throughput contribution	(€72 – €32) x 1,000	€40,000
Incremental costs of the jigs and tools		30,000
Net benefit of investing in jigs and tools		€10,000

Salamanca should invest in the modern jigs and tools because the benefit of a higher throughput contribution of €40,000 exceeds the cost of €30,000.

2 The Machining Department has excess capacity and is not a bottleneck operation.
Increasing its capacity further will not increase throughput contribution. There is therefore no benefit from spending €5,000 to increase the Machining Department's capacity by 10,000 units. Salamanca should not implement the change to do set-ups faster.

20.14 Theory of constraints, throughput contribution, relevant costs.

1 Finishing is a bottleneck operation. Hence, getting an outside contractor to produce 12,000 units will increase throughput contribution.

Increase in throughput contribution	(€72 – €32) x 12,000	€480,000
Incremental contracting costs	€10 x 12,000	120,000
Net benefit of contracting 12,000 units of finishing		€360,000

Salamanca should contract with an outside contractor to do 12,000 units of finishing at €10 per unit because the benefit of higher throughput contribution of €480,000 exceeds the cost of €120,000. The fact that the costs of €10 are double of Salamanca's finishing costs of €5 per unit are irrelevant.

2 Operating costs in the Machining Department of €640,000 or €8 per unit are fixed costs. Salamanca will not save any of these costs by subcontracting machining of 4,000 units to Hunt Corporation. Total costs will be greater by €16,000 (€4 per unit × 4,000 units) under the subcontracting alternative. Machining more filing cabinets will not increase throughput contribution, which is constrained by the finishing capacity. Salamanca should not accept Hunt's offer. The fact that Hunt's costs of machining per unit are half of what it costs Salamanca in-house is irrelevant.

20.15 Theory of constraints, throughput contribution, quality.
1 Cost of defective unit at machining operation which is not a bottleneck operation is the loss in direct materials (variable costs) of £32 per unit. Producing 2000 units of defectives does not result in loss of throughput contribution. Despite the defective production, machining can produce and transfer 80000 units to finishing. Therefore cost of 2000 defective units at the machining operation is €32 x 2000 = £64 000.

2 A defective unit produced at the bottleneck finishing operation costs Salamanca materials costs plus the opportunity cost of lost throughput contribution. Bottleneck capacity not wasted in producing defective units could be used to generate additional sales and throughput contribution. Cost of 2000 defective units at the finishing operation is as follows:

Loss of direct materials:	€32 x 2000	€64,000
Forgone throughput contribution:	(€72 - €32) x 2000	80,000
Total cost of 2000 defective units		€144,000

Alternatively, the cost of 2000 defective units at the finishing operation can be calculated as the lost revenue of €72 x 2000 = €144 000. That is, the direct materials costs of €32 x 2000 = €64 000 and all fixed operating costs in the machining and finishing operations are irrelevant since these costs would be incurred anyway whether a defective or good unit is produced. The cost of producing a defective unit is the revenue lost of £144 000.

20.16 Costs of quality analysis, non-financial quality measures.

1 and 2	**2007**		**2006**	
Sales	€12,500,000		€10,000,000	
Costs of quality	**Cost (1)**	**Percentage of sales (2) = (1) ÷ €12,500,000**	**Cost (3)**	**Percentage of sales (4) = (3) ÷ €10,000,000**
Prevention costs				
Design engineering	€240,000		€100,000	
Preventive maintenance	90,000		35,000	
Training	120,000		45,000	
Supplier evaluations	50,000		20,000	
Total prevention costs	500,000	4.0%	200,000	2.0%
Appraisal costs				
Line inspection	85,000		110,000	
Product-testing equipment	50,000		50,000	
Incoming materials inspection	40,000		20,000	
Product-testing labour	75,000		220,000	
Total appraisal costs	250,000	2.0%	400,000	4.0%
Internal failure costs				
Scrap	175,000		250,000	
Rework	135,000		160,000	
Breakdown maintenance	40,000		90,000	
Total internal failure costs	350,000	2.8%	500,000	5.0%
External failure costs				
Returned goods	145,000		60,000	
Customer support	30,000		40,000	
Product liability claims	100,000		200,000	
Warranty repair	200,000		300,000	
Total external failure costs	475,000	3.8%	600,000	6.0%
Total costs of quality	€1,575,000	12.6%	€1,700,000	17.0%

Between 2006 and 2007, Alcazarquivir's costs of quality have declined from 17% of sales to 12.6% . The analysis of individual costs of quality categories indicates that Alcazarquivir began allocating more resources to prevention activities – design engineering, preventive maintenance, training and supplier evaluations in 2007 relative to 2003. As a result, appraisal costs declined from 4% of sales to 2%, costs of internal failure fell from 5% of sales to 2.8% and external failure costs decreased from 6% of sales to 3.8%.

3 Examples of non-financial quality measures that Alcazarquivir could monitor are:

a Number of defective grinders/choppers/dicers/food processor shipped to customers as a percentage of total units of grinders shipped.

b Ratio of good output to total output at each production process.

c Employee turnover.