Tutorial letter 201/1/2017

Quality Management and Techniques
MNO2602

Semester 1

Department of Operations Management

IMPORTANT INFORMATION:

This tutorial letter contains important information about your module, as well as feedback on assignments

BAR CODE

CONTENTS

1 Introduction

This tutorial letter contains detailed solutions and feedback for all compulsory assignments for the first semester of 2017, as well as the solution to Assignment 03, which is for self assessment purposes. It also provides useful comments and details about the examination paper which you will be writing during May/June this year.

2 Solutions and feedback to assignments

There were three assignments for the first semester of 2017. Assignment 01 and Assignment 02 were compulsory, while Assignment 03 was for self-assessment purposes. We provide here the detailed solutions and feedback to each assignment. Please let us know if you have any questions or enquiries about these solutions, or perhaps an answer in particular.

References to the prescribed book is also included, and we encourage you to make use of it to revise and sharpen up your knowledge and understanding of that part of the syllabus. We have done our best to explain each answer as clearly and in as much detail as possible, and trust that you will make efficient use of these solutions when preparing for the examination paper later this year.

2.1 Solution to Assignment 01

Assignment 01 consisted of 20 multiple choice questions, which covered topic 1 (study units 1 to 3) and topic 2 (study units 4 to 9). You had to choose the correct option between the five given alternatives. All the questions were of equal value and counted one mark each.

Question 1

Which three of the following statements are correct? (Study unit 1)

a) A user-based definition of quality means that if the customer is satisfied, the product has good quality.
b) Pleasantness and tangibles are not dimensions of service quality.
c) Supply chain management grew out of the value chain. The value chain includes inbound logistics, core processes and outbound logistics.
d) The trend known “relationship management” means that marketing has directed its attention to improving communication between the customer and the supplier.
e) The acronym DMAIC stands for define, measure, analyse, improve and control, and represents the steps in six sigma.

1 a, c, e
2 a, b, c
3 c, d, e
4 b, c, d
5 a, d, e

⇨ ***See study unit 1; p. 27, 30, 31, 32, 37 in the prescribed book***

Alternative 1 is correct because option (a), (c) and (e) are all correct.

Alternative (b) is incorrect because pleasantness and tangibles are dimensions of service quality. Other dimensions of service quality include reliability, responsiveness, assurance, empathy, availability, professionalism, timeliness and completeness. Option (d) is also incorrect because the trend "relationship management" means that attention is directed toward satisfying the customer and delivering value to the customer. More firms are focussing on relationship management because satisfied customers will eventually generate more sales and profit.

Question 2

Which one of the following is a downstream activity in supply chain management? (Study unit 1)

1 supplier qualification
2 supplier development
3 acceptance sampling
4 international sourcing
5 customer support

⇨ ***See study 1; p. 32 in the prescribed book***

Alternative 5 is correct as downstream activities include customer support, shipping and logistics and focuses on delivery reliability.

Question 3

What is the major theoretical contribution of Kaoru Ishikawa? (Study unit 2)

1 The concept of benchmarking.
2 His assertion that the entire organisation should be involved in improving quality.
3 The zero-defects approach to quality improvement.
4 His emphasis on total involvement of the operating employees in improving quality.
5 The quality loss function and the concept of robust design.

⇨ ***Study unit 2; p. 60 in the prescribed book***

Alternative 4 is correct. Kaoru Ishikawa allowed for the complete involvement of the workforce in improving quality and performance. He also believed that the 95% of the company's problems can be solved by the seven tools of quality control and hence options 1, 2, 3, and 5 are unrelated.

Question 4

Which one of the following determinants of service quality is related to trustworthiness, believability, honesty and having the customer's best interests at heart? (Study unit 5)

1 Reliability
2 Responsiveness
3 Competence
4 Credibility
5 Courtesy

⇒ ***See study unit 5; p. 141 in the prescribed book***

Alternative 4 is correct. Reliability involves consistency of performance and dependability. The service is performed right the first time. It involves, amongst others, keeping records correctly. Responsiveness concerns the willingness or readiness of employees to provide service. Competence means possession of the required skills and knowledge to perform the service. Credibility involves trustworthiness, believability, honesty, and having the customer's best interests at heart. Courtesy involves politeness, respect, consideration and friendliness of contact personnel.

Question 5

Which three of the following statements are incorrect? (Study unit 2)

a) There are many variables that build the framework for a quality management theory. Quality management begins with strategic planning and team building.
b) Although Deming is best known for his emphasis on the management of a system for improving quality, his thinking was based on teamwork and leadership for continual improvement.
c) Juran (Foster: 2015) identifies three basic processes that are essential for managing to improve quality. The three aspects of Juran's trilogy are planning, control and evaluation.
d) Ishikawa's (Foster: 2015) quality philosophy were synthesised into 11 points. One of those points is that the ideal state of quality control is when inspection is no longer necessary.
e) Crosby (Foster: 2015) specified a quality improvement programme consisting of 14 steps. One of those steps is to encourage individuals to establish improvement goals for themselves and their groups.

1 a, b, c
2 b, c, d
3 a, b, e
4 c, d, e
5 b, d, e

⇨ ***See study unit 2; p.53, 57, 61, 63, 71 in the prescribed book***

Alternative 1 is correct because option (a), (b) and (c) are all incorrect. Options (d) and (e) are, however, correct. Option (a) is incorrect because there are many variables that build the framework for a quality management theory but quality management begins with leadership. Option (b) is incorrect because although Deming is best known for his emphasis on the management of a system for improving quality, his thinking was based on the use of statistics for continual improvement. Option (c) is also incorrect because the three aspects of Juran's trilogy are planning, control and improvement (not evaluation).

Question 6

Which three of the following terms are part of the eight principles that form the foundation of ISO 9001:2008? (Study unit 3)

a) Customer focus
b) Strategic management
c) The process approach
d) Leadership
e) Six Sigma

1 a, b, c
2 b, d, e
3 c, d, e
4 b, c, d
5 a, c, d

⇨ ***See study unit 3, p. 98 in the prescribed book***

Alternative 5 is correct because option (a), (c) and (d) are correct and form part of the eight principles of ISO 9000:2008. Option (b) and (e) are incorrect because strategic management and six sigma are not part of the eight principles of ISO 9000:2008. The other principles of ISO 9000:2008 include the involvement of people, a systems approach to management, continual improvement, factual approach to decision making and mutually beneficial supplier relationships.

Question 7

Calculate the ratio of prevention to failure costs, based on the information provided below. (Study unit 4)

Failure costs	
Defective products	R 5,500.00
Engineered scrap	R 17,354.00
Nonengineered scrap	R 122,567.00
Consumer adjustments	R 633,000.00
TOTAL	**R 778,421.00**
Prevention costs	
Quality training	R 15,500.00
Product redesign	R 17,000.00
Process engineering: * Corporate * Plant	 R 125,745.00 R 40,000.00
TOTAL	**R 198,245.00**
Appraisal costs	
Receiving inspection	R 35,600.00
Line 1 inspection	R 43,526.00
Line 2 inspection	R 55,679.00
Spot checking	R 62,000.00
TOTAL	**R 196,805.00**

1 0.3689
2 1.6570
3 0.8912
4 0.2547
5 3.8674

⇒ ***See study unit 4, p. 119 in the prescribed book***

Alternative 4 is correct. The ratio of prevention to failure costs is calculated as follows:

Prevention costs / Failure costs

= R 198,245.00 / R 778,421.00

= 0.2547

Question 8

What is the first step in the product development process? (Study unit 7)

1 Project customer needs
2 Generate product ideas
3 Process technology selection
4 Manufacturing system design
5 Marketing plan design

⇨ ***See study unit 7, p. 184 in the prescribed book***

Alternative 2 is correct. Product idea generation is the first step. During this step external and internal resources brainstorm new concepts. Options 1, 3, 4, 5 are subsequent steps of product development design and as such are the incorrect answers.

Question 9

The ten determinants of service quality, as determined by Parasuraman, Zeithamel and Berry include access, which involves approachability and ease of contact. This is demonstrated by: (Study unit 5)

1 Physical safety
2 Convenient hours of operation
3 Providing individualised attention
4 Appearance of personnel
5 Keeping records correctly

⇨ ***See study unit 5, p. 141 in the prescribed book***

Alternative 2 is correct. It includes convenient hours of operation. Options 1, 2, 3, 4 are therefore incorrect.

Question 10

After a year's operation, Champion Cooling Inc. reports a cost of goods sold of R400 000 and a scrap cost of R50 000. What is their scrap efficiency? (Study unit 6)

1 8.0
2 R350 000
3 R8.00
4 12
5 0.125

⇨ ***See study unit 6, p. 164 in the prescribed book***

Alternative 1 is correct. The formula for scrap efficiency is:

= cost of goods sold / scrap

= R400, 000 / R50, 000

= 8.0

Question 11

Which one of the following concepts implies that you must have something to offer the target firm in return for sharing information? (Study unit 6)

1 ***Reciprocity***
2 Baselining
3 Reengineering
4 Interfacing
5 Restructuring

⇒ ***See study unit 6, p. 174 in the prescribed book***

Alternative 1 is correct. Reciprocity is to offer the target firm something in return for sharing information. A small firm may feel it has a little to offer a large firm. However, if the small firm has flexibility, then the large firm may want to learn how they actually achieve this flexibility. Options 2, 3, 4, and 5 are incorrect as they do not fit the description of Reciprocity.

Question 12

What is the world-class production system that Toyota developed known as? (Study unit 6)

1 Business process reengineering
2 Just-in-time
3 Total quality management
4 Benchmarking
5 Statistical process control

⇒ ***See study unit 6, p. 160 in the prescribed book***

Alternative 2 is correct. This production system resulted in previously unseen levels of productivity, minimal cost and a source of competitive advantage. Options 1, 3, 4, and 5 are incorrect.

Question 13

Which one of the following is the first step in supplier development? (Study unit 9)

1 Identify critical suppliers
2 Identify key projects
3 Define details of agreement
4 Identify critical products and services
5 Meet with supplier top management

⇨ ***See study unit 9, p. 250 in the prescribed book***

Alternative 4 is correct. There are seven steps for supplier development. The first step is to identify critical products and services. This involves identifying strategic products and components. Options 1, 2, 3 and 5 are subsequent steps and are incorrect.

Question 14

Complete the following sentence: Manufacturing system design… (Study unit 7)

1 … is the stage in which designers choose the materials and technologies that will provide the best performance for the customer at an acceptable cost
2 … means choosing those processes used to transform the materials picked in the prior step into final products
3 … is the selection of the process technologies that will result in a low-cost, high-quality product.
4 … results in final drawings and specifications for the product with product families by identifying base product and derivative products.
5 … requires definition of the product architecture, the design, production, testing of subassemblies, and testing of the system for production.

⇨ ***See study unit 7, p.186 in the prescribed book***

Alternative 3 is correct. The selection of process technology is a result of projected demand and the finances of the firm. Processes must be stable and capable of producing products that meet specification. Options1, 2, 4 and 5 are incorrect.

Question 15

Which one of the following is a service improvement technique that allows managers to analyse their service processes at a very detailed level? (Study unit 8)

1 Generic service analysis
2 Selective service analysis
3 Service transaction analysis
4 Service data analysis
5 Service quality analysis

⇨ ***Study unit 8, p. 229 in the prescribed book***

Alternative 3 is correct. Service transaction analysis (STA) is a service improvement technique that allows managers to analyze their service processes at a very detailed level. STA is a method for identifying these transactions and evaluating them from the customer's perspective to determine if there is a gap between service design and what the customer perceives as the service. Options1, 2, 4 and 5 are incorrect.

Question 16

In many restaurants, it is common for customers to fill their own drinks. Which one of the following is an example of such an activity? (Study unit 8)

1 Customer compliance
2 Customer interaction
3 Customer coproduction
4 Customer proactivity
5 Customer conformity

⇨ ***See study unit 8, p. 212 in the prescribed book***

Alternative 3 is correct. Customers are actively involved in the production of the service hence they can exert control over the service provider and achieve customization. Options 1, 2, 4 and 5 are incorrect.

Question 17

A university administered the SERVQUAL survey to its customers as a way to assess its current position in the market. On the basis of 80 responses, the following averages were computed for the tangibles construct. (Study unit 8)

Item number	Average perception	Average expectation
1	6.5	6.7
2	6.9	6.5
3	6.2	6.6
4	6.3	6.2

What is the difference for tangibles?

1 -0.2
2 -0.025
3 0.025
4 0.2
5 There is not enough information to answer this question

⇨ ***See study unit 8, p. 223 in the prescribed book***

Alternative 2 is correct.

Item number	Average perception (P)	Average expectation (E)	P – E
1	6.5	6.7	-0.2
2	6.9	6.5	0.4
3	6.2	6.6	-0.4
4	6.3	6.2	0.1

Now -0.2 + 0.4 – 0.4 + 0.1 = -0.1

Therefore the difference for tangibles is -0.1 / 4 = **-0.025**

Question 18

Which one of the following steps for supplier development involves cost, commitments of resources, and metrics for improvement, project charters, accountability and deliverables? (Study unit 9)

1 Identify critical products and services
2 Identify key projects
3 Monitor status and modify strategies
4 Identify critical suppliers
5 Define details of agreement

⇨ ***See study unit 9, p. 250 in the prescribed book***

Alternative 5 is correct. The sixth step defines details of agreement and involves cost, commitments of resources, and metrics for improvement, project charters, accountability, and deliverables. Options 1, 2, 3 and 4 are irrelevant to the sixth step and are therefore incorrect.

Question 19

Which of the following statements are correct? (Study unit 9)

a) Supplier evaluation is a tool used by many firms to differentiate and discriminate between suppliers. Supplier evaluations are often recoded on report cards on which potential supplies are rated based on quality, technical capability, etc.
b) Electronic data interchange (EDI) is a system that aids communication between the distributer and the supplier by linking together supplier and distributer information systems.
c) A supplier relationship management system (SRMS) includes spend analytics, sourcing execution, payment, supplier scorecarding and performance monitoring.
d) The ISO/TS standard applies only to automotive companies.
e) Some of the activities in supplier development include training, consultation and the sharing of data and processes.

1 a
2 ab
3 abc
4 abe
5 acde

⇨ ***See study unit 9, p. 246, 249, 250, 252 in the prescribed book***

Alternative 5 is correct because option (a), (c), (d) and (e) are correct. Option (b) is incorrect because electronic data interchange (EDI) is a system that aids customer and supplier communication by linking together supplier and customer information systems. Customers can now assist suppliers to eliminate bottlenecks in the operation and reduce setup times in an effort to reduce lead times.

Question 20

Which one of the following is the technique used to verify that incoming goods from a supplier adhere to quality standards? (Study unit 9)

1 ***Acceptance sampling***
2 Sole-source filtering
3 Electronic data interchange
4 Resource management
5 Supplier certification

⇒ ***Study unit 9, p. 254 in the prescribed book***

Alternative 1 is correct. Acceptance sampling is the technique used to verify that incoming goods from a supplier adhere to quality standards. Therefore options 2, 3, 4, and 5 do not correspond to the definition and as a result are incorrect.

2.2 Solution to Assignment 02

Assignment 02 consisted of 20 multiple choice questions, which covered topic 3 (study units 10 to 13) and topic 4 (study units 14 and 15). You had to choose the correct option between the five given alternatives. All the questions were of equal value and counted one mark each.

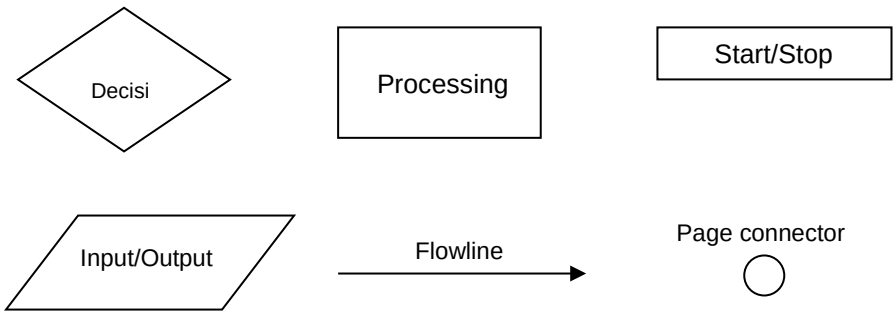
Question 1

With reference to the language of process maps, which one of the following indicates that there is a decision to be made? (Study unit 10)

1 Parallelogram
2 Diamond
3 Rectangle
4 Triangle
5 Circle

⇒ ***See study unit 10, p. 264 in the prescribed book***

The basic symbols used in process maps is given in figure 10-3 on p. 264 of the prescribed book:



As can be seen, a diamond is used in a process map to indicate that a decision is to be made.

Question 2

Calculate the number of classes for a histogram if there are 32 observations in a data set. (Study unit 10)

1 Seven
2 Six
3 Four
4 Three
5 Five

⟹ ***See study unit 10, p. 271 - 272 in the prescribed book***

The formula for calculating the number of classes for a histogram are as follows:

$k \geq \log n / \log 2$; where

n = number of data values

k = the number of classes

Since there are 32 observations in the data set, we have $n = 32$ and so

$$k \geq \log 32 / \log 2$$
$$k \geq 1.5051 / 0.3010$$
$$k \geq 5$$

Hence we choose $k = 5$. Remember that k can only be an integer (for example, the number of classes can't be 5.03 or 5.15, etc). Therefore we choose k as the next integer *larger or equal to* 5. Note that choosing k as the next integer *smaller* than 5, i.e. $k = 4$, will cause some of the larger observations to be disgarded when drawing the histogram.

Question 3

Which one of the following is used to move to lower levels of abstraction in solving problems? (Study unit 10)

1 Pareto chart
2 Cause-and-effect diagram
3 Control chart
4 Histogram
5 Scatter diagram

⟹ ***See study unit 10, p. 274 - 276 in the prescribed book***

The cause-and-effect diagram, also known as the fishbone diagram or Ishikawa diaram, is a handy quality tool to help a team move to lower levels of abstraction when solving a problem. The fishbone diagram is developed during brainstorming sessions, during which the following steps are followed (in this order):

1. State the problem in the head of the fish.
2. Identify major causes of the problem. This forms the backbone and ribs.
3. Continue to fill out the diagram, asking "why?" about each cause.
4. View the diagram, identifying core causes.
5. Set goals to address the core causes.

See figure 10-13 for an example of a simple cause-and-effect diagram.

Question 4

The Shop Brite chain of grocery stores decided to monitor customer complaints. This is an important part of their customer satisfaction improvement programme. They collected data relating to certain types of problems and compiled the following check sheet:

Type of Problem	Frequency
Defective product	13
Product too expensive	9
Shortage of tellers	20
Unhelpful shop assistants	5
Vegetables not fresh	3

When constructing a Pareto chart, how many of these types of problems will account for 80% or more of the complaints received? (Study unit 10)

1 Three
2 One
3 Two
4 Four
5 Five

⇒ ***See study unit 10, p. 276 - 279 in the prescribed book***

First we need to arrange the problems by frequency, from largest to smallest:

Type of Problem	Frequency
1. Shortage of tellers	20
2. Defective product	13
3. Product too expensive	9
4. Unhelpful shop assistants	5
5. Vegetables not fresh	3

Next we calculate the percentage relating to each type of problem:

Type of Problem	Frequency	Percentage
1. Shortage of tellers	20	20/50 x 100 = 40%
2. Defective product	13	13/50 x 100 = 26%
3. Product too expensive	9	9/50 x 100 = 18%
4. Unhelpful shop assistants	5	5/50 x 100 = 10%
5. Vegetables not fresh	3	3/50 x 100 = 6%
Total	***50***	***100%***

Now we calculate the cumulative percentages:

Type of Problem	Frequency	Percentage	Cumulative percentage
1. Shortage of tellers	20	20/50 x 100 = 40%	40%
2. Defective product	13	13/50 x 100 = 26%	40% + 26% = 66%
3. Product too expensive	9	9/50 x 100 = 18%	66% + 18% = 84%
4. Unhelpful shop assistants	5	5/50 x 100 = 10%	84% + 10% = 94%
5. Vegetables not fresh	3	3/50 x 100 = 6%	94% + 6% = **100%**
Total	***50***	***100%***	

From the table above, we can see that shortage of tellers, defective products and products which are too expensive constitute 84% of all the complaints. Therefore, three categories account for 80% or more of the complaints received.

Question 5

Which one of the following statements regarding random variation is true? (Study unit 11)

1 It has a cause that can be identified.
2 It occurs with a somewhat consistent amount of dispersion.
3 It can be controlled easily.
4 It results in a process that is not repeatable.
5 It results from a shift in a process mean or some unexpected occurrence.

See study unit 11, p. 302 - 303 in the prescribed book

There are two types of variation that can occur – random and non-random variation. The statements in this question all refer to nonrandom variation, except statement 3, which refer to random variation.

Random variation is always centered around a mean and occurs with a relatively consistent amount of dispersion. This type of variation cannot be controlled. When the amount of random variation in a process is large, it may not meet specifications on a regular basis.

Question 6

In a variables control chart, which one of the following situations is likely to occur if there are five points in succession, either all above or all below the centre line? (Study unit 11)

1 Erratic behaviour
2 Nonrandom event
3 Process run
4 Process drift
5 Natural variation

⇒ ***See study unit 11; p. 310 - 313 in the prescribed book***

There are various signals of when a non-random event occur. Study figure 11-1 on p.313 of the prescribed book. One of these signals is when five data points occur successively above or below the centre line. When this specific situation occurs, it is refered to as a "process run", which means that the process has shifted. Note that option 2 is also correct, but option 3 is a more accurate description of what would occur in this situation.

Question 7

A quality engineer in charge of a coffee filter pack production line was concerned about the weight of the filter packs being produced. The quality team sampled four packs every hour, throughout the production day. The table below shows the results, where the weight of each filter pack is measured in grams.

Sample number	Weight (g)			
1	20.4	20.9	20.5	20.6
2	19.9	19.8	20.1	19.9
3	20.4	21.0	21.1	20.8
4	21.3	22.0	21.2	21.5
5	21.2	20.9	19.7	20.6
6	20.9	22.1	19.7	20.9
7	21.2	20.7	20.9	20.9

Calculate the control limits for an $\overline{x}$ chart, based on the range. (Study unit 11)

1 UCL = 21.46; LCL = −20.06
2 UCL = 21.46; LCL = 20.06
3 UCL = 20.06; LCL = 21.46
4 More samples are needed to calculate the control limits.
5 UCL = 21.46 ; LCL = 0

⇒ ***See study unit 11; p. 309 - 310 & Example 11-1; p. 314 - 315 in the prescribed book***

The formulas for calculating the upper and lower control limits for an $\overline{x}$ chart are as follows:

Upper control limit: $UCL_{\overline{x}} = \overline{\overline{x}} + A_2\overline{R}$

Lower control limit: $LCL_{\overline{x}} = \overline{\overline{x}} - A_2\overline{R}$

Hence we need the values of $\overline{\overline{x}}$ and $\overline{R}$, as well as A_2. Before we can calculate the values of $\overline{\overline{x}}$ and $\overline{R}$, we need to first determine the average and range of each sample:

Sample number	Weight (g)				Mean	Range
1	20.4	20.9	20.5	20.6	20.60	0.5
2	19.9	19.8	20.1	19.9	19.93	0.3
3	20.4	21.0	21.1	20.8	20.83	0.7
4	21.3	22.0	21.2	21.5	21.50	0.8
5	21.2	20.9	19.7	20.6	20.60	1.5
6	20.9	22.1	19.7	20.9	20.90	2.4
7	21.2	20.7	20.9	20.9	20.93	0.5

Now we can calculate $\overline{\overline{x}}$ and $\overline{R}$ as follows:

$$\overline{\overline{x}} = \frac{\sum \overline{x}}{k} = \frac{20.60 + 19.93 + \ldots + 20.93}{7}$$
$$= \frac{145.29}{7} = 20.76$$

$$\overline{R} = \frac{\sum R}{k} = \frac{0.5 + 0.3 + \ldots + 0.5}{7}$$
$$= \frac{6.7}{7} = 0.96$$

Next we look up the value of A_2 from Table A-1 in the Appendix on p. 446 in the prescribed book. Since there are 4 observations in each subgroup, we find that $A_2 = 0.73$. Now we are ready to calculate the upper and lower control limits for an $\overline{x}$ chart.

$$UCL_{\overline{x}} = \overline{\overline{x}} + A_2\overline{R}$$
$$= 20.76 + 0.73(0.96)$$
$$= 21.46$$

$$LCL_{\overline{x}} = \overline{\overline{x}} - A_2\overline{R}$$
$$= 20.76 - 0.73(0.96)$$
$$= 20.06$$

Question 8

The diameter of a jar is 7.62 cm but can be as large as 7.70 cm and as small as 7.54 cm. Twenty-five samples of these jars are taken and it is discovered that these components have a mean of 7.65 cm and a standard deviation of 0.05 cm. Calculate Cpk. (Study unit 11)

1 0.33
2 0.08
3 0.16
4 0.49
5 0.66

⇒ ***See study unit 11; p. 328 – 329 in the prescribed book***

To determine the process capability, we need to calculate the capability index, Cpk:

$\text{Cpk} = \min\{\text{Cpu},\ \text{Cpl}\}$; where

$\text{Cpu} = (\text{USL} - \mu)/3\hat{\sigma}$ is the upper capability index;

$\text{Cpl} = (\mu - \text{LSL})/3\hat{\sigma}$ is the lower capability index.

From the information given in the question, we have:

$\mu = 7.65$

$\hat{\sigma} = 0.05$

USL = 7.70

LSL = 7.54

So we substitute these values into the correct formulas:

$$\text{Cpu} = \frac{\text{USL} - \mu}{3\hat{\sigma}} = \frac{7.70 - 7.65}{3(0.05)} = \frac{0.05}{0.15} = 0.33$$

$$\text{Cpl} = \frac{\text{USL} - \mu}{3\hat{\sigma}} = \frac{7.65 - 7.54}{3(0.05)} = \frac{0.11}{0.15} = 0.73$$

And hence,

$$\text{Cpk} = \min\{\text{Cpu}, \text{Cpl}\} = \min\{0.33, 0.73\} = 0.33$$

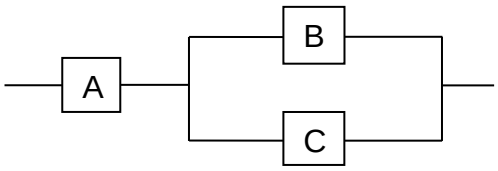
Question 9

Two components of reliability 0.90 are in parallel and this subsystem is connected in series to a component with a reliability of 0.95. What will the overall system reliability be? (Study unit 12)

1 0.93
2 0.94
3 0.95
4 0.96
5 0.97

⟹ ***See study unit 12; p. 349 – 351 in the prescribed book***

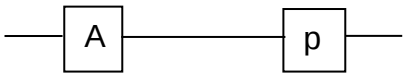
The system can be represented by a diagram as follows:



It is given that $R_A = 0.95$, $R_B = 0.90$ and $R_C = 0.90$. We first calculate the reliability of the two components in parallel:

$$\begin{aligned} R_p &= 1-(1-R_B)(1-R_C) \\ &= 1-(1-0.90)(1-0.90) \\ &= 1-(0.10)(0.10) \\ &= 1-0.01 \\ &= 0.99 \end{aligned}$$

We now have the following equivalent system, consisting of only two components in serie:



The reliability of this series system is as follows:

$$\begin{aligned} R &= (R_A)(R_p) \\ &= (0.95)(0.99) \\ &= 0.9405 \end{aligned}$$

Therefore, the overall system reliability is 0.94 (rounded off to two decimal places).

Question 10

Consider the following scenarios and rearrange them according to the following types of attributes (in this order): Sensory, Structural, Temporal, Performance, Ethical. (Study unit 12)

a) Whether or not a satellite dish provides a signal
b) The atmosphere in a restaurant
c) Meeting the due date for assignment submission
d) An empathetic insurance claims administrator
e) A sport suspension package on a new Audi RS4

1 d, b, c, e, a
2 b, e, c, a, d
3 a, e, c, d, b
4 a, d, e, b, c
5 c, e, d, a, b

⟹ ***See study unit 12; p. 338 – 339 in the prescribed book***

There are five types of attributes, namely:

- ***Structural*** attributes, which is the physical characteristics of a product or service.
- ***Sensory*** attributes, which relate to your senses, i.e. touch, smell, vision and sound. What do you smell? See? Hear? Touch?
- ***Performance*** attributes, which relate to whether or not a product/service does what it is supposed to do.
- ***Temporal*** attributes, which relate to time, often involves the reliability of delivery.
- ***Ethical*** attributes, which are important to firms. This has to do with honesty, integrity and transparency.

So we can see that *scenario a* refers to a ***performance*** attribute, because it has to do with whether or not a satellite dish performs as it is supposed to, and that is to provide a signal to watch a channel on your television.

Scenario b refers to a ***sensory*** attribute, since it involves your senses. The atmosphere in a restaurant involves smell, sound and vision.

Scenario c refers to a ***temporal*** attribute. You need to submit your assignment before a given date, hence it relates to time.

Scenario d refers to an ***ethical*** attribute, because the insurance claims administrator must adhere to certain ethical behaviour; it forms part of his/her responsibilities.

Lastly, *scenario e* refers to a ***structural*** attribute. A sports suspension package is part of the physical characteristics of a car, the same as dark tinted windows would be.

Question 11

A manufacturer of prescription contact lenses regularly takes samples of 100 lenses and inspects them for scratches. If a lens has a single scratch, it cannot be sold. The results of 10 samples are shown below:

Sample	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Number of scratched lenses	3	2	0	1	2	2	1	0	1	2

Which sample is out of control? (Study unit 12)

1 ***None of the samples are out of control.***
2 Sample B
3 Sample D
4 Sample F
5 Sample H

⟹ ***See study unit 12; p. 338 – 339 in the prescribed book***

To determine which sample is out of control, we need to make use of a control chart. Note that we are dealing with ***defectives*** here, NOT ***defects***.

Remember, a ***defective*** is a unit which, as a whole, is not acceptable or doesn't meet the stated requirements (nonconforming to specification). For example, a bicycle whose gears don't shift smoothly is defective. A letter with the wrong address is defective.

On the other hand, a ***defect*** is an irregularity or problem with a larger unit. For example, a piece of glass may contain several bubbles or scratches. A metal sheet of some length may have a few small dents.

In this case, each scratched contact lens is a ***defective***. Therefore, since we are working with ***defectives***, we need to make use of either a p chart or an np chart. Since the sample size of each subgroup is the same, we can use any one of the two. Let's use a *p* chart. We need to calculate the upper and lower control limits in order to see which sample falls outside and therefore is out of control.

Lower control limit: $LCL = \overline{p} - 3\sqrt{\overline{p}(1-\overline{p})/n}$

Upper control limit: $UCL = \overline{p} + 3\sqrt{\overline{p}(1-\overline{p})/n}$

The sample size for each subgroup is $n = 100$. To calculate $\overline{p}$, we first have to determine the relevant proportions of scratched (defective) contact lenses:

Sample	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
No defective contact lenses	3	2	0	1	2	2	1	0	1	2
Proportion	0.03	0.02	0.00	0.01	0.02	0.02	0.01	0.00	0.01	0.02

Now we can calculate the average proportion as follows:

$$\overline{p} = \frac{\sum p_i}{k}$$

$$= \frac{0.03 + 0.02 + \ldots + 0.02}{10} = \frac{0.14}{10} = 0.014$$

Now we substitute the value above for the average proportion into the formulas for the upper and lower control limits:

$$\begin{aligned} UCL &= \bar{p} + 3\sqrt{\bar{p}(1-\bar{p})/n} \\ &= 0.014 + 3\sqrt{0.014(1-0.014)/100} \\ &= 0.014 + 3\sqrt{0.00013804} \\ &= 0.049 \end{aligned}$$

$$\begin{aligned} LCL &= \bar{p} - 3\sqrt{\bar{p}(1-\bar{p})/n} \\ &= 0.014 - 3\sqrt{0.014(1-0.014)/100} \\ &= 0.014 - 3\sqrt{0.00013804} \\ &= -0.021 \end{aligned}$$

(LCL = 0, since a *p* chart cannot have a negative lower control limit.)

Going back to our data table above, we see that all of the sample proportions are between 0 and 0.03, hence falling within the control limits. Therefore none of the samples are out of control.

Question 12

Suppose a product has a failure rate of 0.02 per operating hour and a useful life of 80 hours. Calculate the reliability of this product. (Study unit 12)

1 1.600
2 0.202
3 0.798
4 0.153
5 The product's failure rate is too low to calculate its reliablity.

⇒ ***See study unit 12; p. 351 – 352 in the prescribed book***

To calculate the reliability of a product, we make use of the following formula:

$R(t) = e^{-\lambda t}$; where

$\lambda =$ failure rate of the product
$t =$ the useful life of the product

The product has a failure rate of 0.02 failures per hour and a useful life of 80 hours, therefore:

$\lambda =$ 0.02 and $t =$ 80

The reliability can be calculated by substituting the above values for λ and t into the formula for the reliability of a product:

$$R(80) = e^{-0.02(80)}$$
$$= e^{-1.6}$$
$$= 0.201897 \approx 0.202$$

Question 13

In which one of the following phases of DMAIC are tools used in process FMEA, process capability assessments, basic statistics and decision-making? (Study unit 13)

1 Measure
2 Define
3 Analyse
4 Improve
5 Control

⟹ ***See study unit 13; p. 365 – 367 in the prescribed book***

Six Sigma management is implemented by following the steps outlined in the DMAIC process. DMAIC is short for *define, measure, analyse, improve* and *control* (see table 13-2 on p 366 of the prescribed book). The DMAIC process is similar to the PDCA cycle proposed by Shewhart and Deming. Figure 13-5 in the prescribed book provides an overview of the tools used at each stage of the DMAIC process. The key tools used during the "measure" stage are as follows:

- XY Matrix
- Process FMEA
- Basic Statistics
- Decision making
- Graphical data analysis (non-normal data)
- Measurement System Analysis (MSA)
- Process capability assessment

Question 14

Which step in the analyse phase of the DMAIC process requires you to determine what characteristics of the process need to be changed to achieve improvement? (Study unit 13)

1 Analyse sources of variability
2 Improvement projection
3 Performance objectives definition
4 Independent variable identification
5 Return to control

⟹ ***See study unit 13, p. 379 in the prescribed book***

During the third stage of the DMAIC process, namely the "analyse" stage, there are three steps that need to be followed:

a) Define performance objectives
b) Identify independent variables (X's)
c) Analyse sources of variability

It is during the first step of the "analyse" phase during which you need to determine what characteristics of the process need to be changed to achieve improvement. Firstly, you need to review the capability analysis to determine where the processes are incapable (figure 13-16). The capability analysis shows whether or not certain parameters or discrete events are meeting specifications. If these parameters are not centered on the desired mean, the process mean needs to be adjusted, and if there are too much variability, then the variability is reduced.

Question 15

In the context of quality teams, which one of the following is the need for mutual support and encouragement between line management and project managers as well as personal loyalty of project managers to their teams and organisations? (Study unit 14)

1 Recognition for personal achievement
2 Mutuality
3 Belonging
4 Bounded power
5 Creative autonomy

⟹ ***See study unit 14, p. 397 in the prescribed book***

As emphasised by Joseph Juran, and supported by Philip Crosby, teams and projects play a vital role in the improvement of quality. Teams with a good team leader often lead to improved employee morale. Employees like teams for many reasons, some of them include:

- ***Mutuality***
- Recognition for personal achievement
- Belonging
- Bounded power
- Creative autonomy

The first of these reasons, namely ***mutuality***, is the need for mutual support and encouragement between line management and project managers, as well as personal loyalty of project managers to their teams and organisations.

Question 16

Which one of the following statements relates to the preconditions that are necessary for empowerment, when employees should be involved in planning related to their jobs?
(Study unit 14)

1 Participation in planning at all levels
2 Clear authority and accountability
3 Organisational learning
4 Responsibility with authority
5 Adequate communication and information for decision-making

⇒ ***See study unit 14; p. 397 – 398 in the prescribed book***

The following preconditions are necessary for empowerment:

- *Clear authority and accountability.* Management must inform employees exactly what is expected from them and give them authority over their own work.

- ***Participation in planning at all levels.*** It shouldn't be only management who does the planning. *Employees should also be involved in planning related to their jobs* and they should be provided with planning tools.

- *Adequate communication and information for decision making.* The correct managerial information is necessary for employees to make important decisions regarding their jobs.

- *Responsibility with authority.* A definition of power should be given to employees. This definition should focus on getting things done rather than exerting influence over people.

Question 17

Which one of the following types of teams is assigned to work on a specific problem for a limited amount of time? (Study unit 14)

1 Temporary teams
2 Tiger teams
3 Cross-functional teams
4 Time management teams
5 Self-directed work teams

⇒ ***Study unit 14, p. 402 – 404 in the prescribed book***

There are various types of teams used in improving quality. Continuous process improvement often requires small teams that are segmented by work areas. The most important types of teams include the following:

- Process improvement teams
- Cross-functional teams
- Tiger teams
- Natural work groups
- Self-directed work teams
- Virtual teams

Tiger teams are a type of team who is assigned to work on a specific problem for a limited time period. They are often used in reengineering or in certain projects where a problem needs solving in a short period of time. The work done by tiger teams is intense and therefore has a limited duration.

Question 18

Consider the following building blocks for the system of quality improvement. Which one of these building blocks represents the core of a company's capabilities? (Study unit 15)

1 Processes
2 People
3 Information and finance
4 Closeness to customers
5 All of the above

⇒ ***See study unit 15; p. 426 – 427 in the prescribed book***

A quality system depends on the interactions of many variables. See figure 15-1 on p. 426 of the prescribed book. These variables can be seen as the building blocks in a system for quality improvement. The Quality System Model shows that the following variables are included in such a system:

- ***People***
- Organisational learning and knowledge
- Culture
- Closeness to customers
- Information and finance
- Processes

The model is built on a base of people because people are the core of a company's capabilities. They have the intellect, empathy and ability that is required to provide excellent customer service.

Question 19

Which one of the following can be used to observe the practices of other firms and achieve even higher levels of performance? (Study unit 6)

1 Benchmarking
2 The integrative approach
3 Information systems
4 Statistical process control
5 Generic self-assessment

⇒ ***See study unit 6, p. 160-161 in the prescribed book***

A *benchmark* is an organisation recognised for its exemplary operational performance. There are many benchmarks in the world, including Toyota for processes, Intel for design, Motorola for training, Scandinavian Airlines for service, and Honda for rapid product development.

Benchmarking is the process of finding a company that is very good at a particular activity, studying what it does, and gathering ideas for improving your own operation in this area.

Question 20

Which one of the following is not a step in the basic quality audit? (Study unit 15)

1 Preparation
2 Client interaction
3 Audit team selection
4 Develop checklists
5 The opening meeting

⇒ ***See study unit 15; p. 436 - 437 in the prescribed book***

A quality audit is an internal assessment tool to identify areas for improvement, i.e. to determine ways to improve customer service and to investigate if current customer service processes are being performed. The basic quality audit consists of the following steps:

- Preparation
- Audit team selection
- Develop checklists
- The opening meeting
- Implementing the audit
- Analysis
- The exit meeting
- Reporting and corrective action
- Follow-up
- Closure

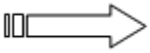
2.3 Assignment 03 (self assessment)

Assignment 03 consisted of various essay-type questions and covered all topics at random. This is a very important assignment in view of your preparation for the examination. Make sure you understand each question and answer. Especially pay attention to the questions regarding statistical tools and techniques (questions 13 to 20); these questions are often the biggest hurdle for students in the examination.

Question 1

You have been appointed as the director of quality in an organisation that manufactures executive office furniture. The chairman of the board has requested a presentation on the following areas of quality:

a) Identify and define the various product quality dimensions and indicate its application to the product of the company. [16]



See study unit 1; p.28 – 29

1. ***Performance*** *– refers to the efficiency with which a product meets its intended purpose, e.g. is the filing cabinets designed for the right size files?*

2. ***Features*** *– These are the bells and whistles that supplement the product's basic performance, e.g. high gloss vanish, glass top on desks, velvet padded chairs.*

3. ***Reliability*** *– the requirement for the product to perform consistently over its useful life, e.g., appropriate tests carried out on the products to last for at least 10 years. Metal handles, stainless steel hinges, steel legs for chairs.*

4. ***Conformance*** *– Meeting the design specifications. There has to be adequate quality control to ensure that products are manufactured to specification. For example, length, width and colour of desks.*

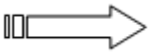
5. ***Durability*** *– is the degree to which a product can tolerate stress and trauma before failing. For example, chair covers can be plastic coated, thick glass tops for desks.*

6. ***Serviceability*** *– this shows how easy it is to repair and maintain a product. For example, can the chair seats be easily and cheaply replaced if they tear?*

7. ***Aesthetics*** *– these are features that appeal to sensors of taste, feel, sound, look and smell. For example the colour of the desk, does one feel like an executive manager, a supervisor, or a student.*

8. ***Perceived quality*** *– this is based on the customer's or user's opinion. Terms such as excellent, good, satisfactory, okay, useless, rubbish and no value are some terms that can be used to express perceived quality.* [8 × 2 = 16 marks]

b) Explain the difference between ISO 14000 and ISO 9000:2008. [10]

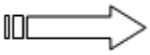
 ***See study unit 3; p. 96 – 101***

ISO 9000:2008 is a set of standards that provides companies a format for documenting their quality systems in a series of manuals for the purpose of facilitating trade through supplier conformance. The standards originated in Europe. The ISO standard was developed so that an international standard for documentation of quality systems could be applied in many different cultures.

Given the success of ISO 9000:2008, ISO embarked on developing an international standard for environmental compliance named ISO 14000. ISO 14000 is a series of standards that provide guidelines and a compliance standard in the environmental area. ISO 14000 uses the same basic approach as ISO 9000:2008 with documentation control, management system auditing, operational control, and so on.

In addition to these controls, ISO 14000 includes quantified targets, established objectives, emergency and disaster preparedness, and disclosure of environmental policy. Such a system may provide the basis for a comprehensive environmental management system. Table 3.11 on p.101 of the prescribed book presents the ISO 14000 elements.

c) An explanation of quality assurance and quality control functions, and how they can be implemented. [8]

 ***See study unit 1; p. 41 – 42***

<u>Quality assurance:</u>

Quality assurance refers to activities associated with the guaranteeing of the quality of a product or service. These activities are usually design related thus the best way to ensure quality is in the design of products, services and processes.

Activities include:

- *FMEA*
- *Concurrent engineering*
- *Experimental design*
- *Process improvement*
- *Design team formation and management*
- *Off-line experimentation*
- *Reliability / durability product testing*

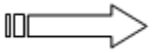
Quality control:

The first sphere is quality control which is embedded within a process to consistently meet standards. The control process is based on the scientific method, which includes the phases of analysis, relation and generalisation. The control process involves observing or measuring actual performance, comparing it with some standard and then taking appropriate remedial action if there are deviations.

Activities include:

- *Monitoring process capability and stability*
- *Measuring process performance*
- *Reducing process variability*
- *Optimising processes to nominal measures*
- *Performing acceptance sampling*
- *Developing and maintain control charts*

d) The components of a customer relationship management process for customer turnaround. [12]

 ***Study unit 5, p.138 – 140***

1. ***Complaint resolution***

Within this context, there are three types of complaints - regulatory complaints, employee complaints and customer complaints. However all complaints must be seen as opportunities for improvement. The resolution process includes, compensating for losses, and contrition. There should be a complaint recovery process including the documentation of complaints, resolving the complaint, documenting recovery, and feedback for system improvement.

2. ***Feedback***

Data is necessary to understand the behaviour, wants and needs of the customer and one of the methodologies of collecting data is customer feedback. There are two main types of feedback: feedback to the customer and feedback to the firm as a basis for process improvement. Customer feedback includes the reporting of the resolution of the complaint to the customer. This can be done telephonically, electronically and/or by post. Feedback to the firm should occur on a constant basis and should result in process improvement.

3. ***Guarantees***

A guarantee takes into account customer rights. The guarantee promotes the confidence about the purchase of the product. There are various conditions to a guarantee:

- *Unconditional: No small print or red tape.*
- *Meaningful: Customer grievances to be fully addressed and any financial loss recovered.*
- *Understandable: The customer must understand the scope of the guarantee and understand the procedure for quick resolution.*
- *Communicable: The phrasing of the guarantee should resonate with the customer.*
- *Painless to invoke: The customer should not be inconvenienced in any way.*

4. ***Corrective action***

Failures should be addressed in a way that it never happens again. Management should ensure that there are adequate resources and teams who will ensure that the necessary action is taken to prevent reoccurrence. They should analyse complaints and recommend improvements to the customer service delivery system. This is referred to as closed-loop corrective action.

[4 × 3 = 12 marks]

e) Problems that prevented the success of benchmarking, and how you will overcome it. [8]

⇨ ***Study unit 6, p.174 – 175***

1. ***Difficulty in getting cooperation with the benchmarking partner****.*
   To overcome this there must be an exchange system, in the sense you need to offer something in exchange to get what you want from the partner.

2. ***You might engage with a non-appropriate partner.***
   The predominance of functional benchmarking with firms in non-competing industries makes it difficult to benchmark these firms. You have to conduct research and study business literature before the selection of a benchmarking partner.

3. ***You do not understand your own processes****.*
   This becomes a wasted effort, if you do not understand your own processes. Use tools such as business process maps and business process reengineering, before embarking on a benchmarking exercise. This makes it possible to identify the exact performance measures needed from the target firm.

4. ***Benchmarking is costly and time consuming***
   Benchmarking incorporates double barrel costs. Costs and time costs are actually doubled, because it incorporates costs for the beneficiary and partner. Costs include time for planning, travel and implementation. To keep costs to a minimum, the plans for benchmarking and implementation need to well-structured and managed.

[4 × 2 = 8 marks]

Question 2

Apply Deming's 14 points to a manufacturing company or service provider of your choice by explaining how each point will further benefit the organisation. [14]

See study unit 2; p. 54 – 57

1. ***Create constancy of purpose toward improvement of product and service with the aim to become competitive, stay in business and provide jobs.***

   This means that organizations are in existence not just to make money or generate profits. They are in existence to serve their customers and employees. Management of these organizations needs to ensure that there are strategic plans, with clear visions and missions and to invest in innovation, training and research.

2. ***Adopt a new philosophy. We are in a new economic age.***

   Traditional methods of management create mistrust, fear and anxiety. The new philosophy focuses on a customer-centred approach based on mutual cooperation between the management and the workforce who are always engaged in continual improvement.

3. ***Cease dependence on mass inspection to improve quality***

   Routine inspection activities acknowledge defects but do not add value to the product. Instead, it encourages defects as an inspector is viewed as the person who will detect and filter out defects. This methodology leads to an increase in cost and a decrease in productivity. Eliminate the need for inspection on a mass basis by building quality in the first place.

   Deming suggests instilling quality at the source. This means that all workers are responsible for their own work and perform needed inspections at each stage of the process to maintain process control, and quality is not only the responsibility of the quality department.

4. ***End the practice of awarding business on the basis of price tag alone.***

   The purchasing department is responsible for the procurement of raw materials and components for the manufacture of products and services. Traditionally purchasing decisions were based on the price and not on quality. This will result in defective products if the raw materials are inferior in quality.

   Deming suggests that costs be minimised and move toward a single supplier for an item and build loyalty and trust in a long term relationship. There is a misconception that the approach of having many suppliers would result in competition that would improve quality and decrease cost. In reality, having many suppliers causes an over emphasis on cost and an increase in variability.

5. ***Improve constantly and forever the system of production and service, to improve quality and productivity, and thus constantly reduce cost.***

   Continual improvements should be encouraged in small increments rather than in leaps and bounds. The big step approach normally will lead to expensive innovations and technology which may eventually demodulate improvements. This focuses on the management of the systems of production. The system of production includes product design, process design, training, tools, machines, process flows, and a host of other variables that affect the system of production and service.

   In the final analyses, management is responsible for most of the system design elements as it is management who has the authority and the budget to implement systems. This means that workers can only be held responsible for their inputs into the system. The poor performance of the system is often due to the poor performance of management.

6. *I**nstitute training on the job***

   It is essential for people to have the necessary training and knowledge to perform their work. Training will also improve the productivity and morale of the work force by showing them that the company is interested in helping them to invest in their future. Deming stresses that training, although a necessary condition for improvement is not sufficient to guarantee successful implementation of quality management.

7. ***Improve leadership***

   The aim of supervision should be to help people, machines, and gadgets to do a better job. All quality experts agree that leadership is key to improving quality. For wide ranging quality improvements to occur, upper management must be involved. It is upper management that has the money and authority to oversee the improvement of quality.

8. ***Drive out fear, so that everyone may work effectively for the company***

   Deming was referring to those employees who were fearful to change or admit that problems exist. At times, employees who surface problems and request changes were considered as troublemakers. Some employees fear making or suggesting improvements, because they are not acknowledged and end up ignored. Employees also fear asking for improvements for fear that these improvements might end up in them losing their jobs. Many Japanese firms overcome these fears by offering lifetime employment.

9. ***Break down barriers between departments***

   Deming suggests that people in research, design, sales and production must work as a team to see problems of production. The focus should be that the organisation works collectively to meet the needs of customers by improving processes. Teamwork is an important means of attaining the organization's goals and objectives.

10. ***Eliminate slogans, exhortations, and targets for the workforce that asks for zero defects and new levels of productivity***

Deming believed that such exhortations only create adversarial relationships, as most of the causes of bad quality and low productivity belong to the system and lies beyond the power of the workforce. His view was that such exhortations "to get it right the first time" and "zero defects forever" can have the opposite of the intended effect.

By pressuring employees to higher levels of quality and productivity, management place the onus for improvement on the employees, and if the structures and resources are not in place to assist employees, they can become frustrated and discouraged and lowering their performance even further.

11. ***Eliminate work standards on the factory floor***

Deming did not like the promotion of work standards and work measurements. His view was that management should instil better leadership instead of standards, and once standards are achieved continuous improvement stops. In other words there is a focus on results and not on processes and this does not promote long term behaviour. Managers need to understand the system and the variations within the system and seek to reduce it in the long term.

12. ***Remove barriers that rob workers of their right to pride in the quality of their work***

The responsibility of supervisors must be changed from managing numbers to quality. Many casual workers are hired on an hour to hour basis just to perform physical tasks. These workers suffer from low morale and low commitment to the organisation. Unskilled managers also add to this problem by reinforcing the fact that employees cannot be trusted with decisions and self-determination.

Deming was of the view that performance appraisals were destructive to pride of workmanship. Performance appraisals do not promote teamwork, but competition between workers for the sharing of limited resources. Objectives are driven by numbers which normally focuses on short term results that does not focus on the customers.

13. ***Institute a vigorous program of education and self-improvement***

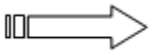
Deming believed in a learning organisation. Such an organisation requires a structure that reinforces and rewards learning. The organisation must create the environment in which employees strive to achieve their best by attaining better skills and better education. This in turn will motivate the worker.

14. ***Put everybody in the company to work to accomplish transformation***

The transformation process is everyone's job. Hence a quality management system must include all the workers in an organisation.

Question 3

What is the relationship between quality and ethics? [5]

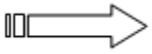
 ***See study unit 4; p.116***

Quality is not only good business, it is also good ethics. It is unethical to ship defective products knowingly to a customer. Reliable products and low defect rates reflect an ethical approach of management's care for its customers.

Companies focusing on their customers often develop a set of ethics that includes valuing employees. This is reflected in education, training, health, wellness, and compensation programs that show empathy for the employees. Increasingly, environmental friendliness is seen as an ethical concern.

Question 4

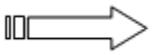
By globalising, organisations considerably change the physical environment, the task environment and the social environment. Distinguish between the task environment and the social environment of a firm. [6]

 ***See study unit 3; p.77***

The task environment of the firm has to do with the operating structure that the firm encounters when globalizing. In contrast, the social environment facing globalizing corporations refers to cultural factors such as language, business customs, customer preferences, and patterns of communication.

Question 5

The head of the purchasing department at Gauteng Electronics asked you to assist them with "supplier development". He heard this term recently at a conference he attended but is not sure what it means. Write a short report on the meaning of the term "supplier development" as well as on the steps to follow in this process. [20]

 ***Study unit 9, p.250 (maximum of 20 marks)***

Supplier development has to do with activities that the buyer undertakes to improve the performance of suppliers. The seven steps of supplier development:

1. ***Identify critical products and services*** *– this involves strategic products and components (those that are difficult to obtain, high cost or high volume).*

2. ***Identify critical suppliers*** *– these may be suppliers who provide strategic components but do not meet quality objectives or schedules.*

3. ***Form cross functional teams*** *– the buyer forms a cross-functional team to work with the supplier.*
4. ***Meet with supplier top management*** *– this is to discuss strategic alignment, performance measures and expectations.*

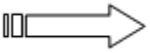
5. ***Identify key projects*** *– projects are selected using criteria such as ROI, feasibility and impact.*

6. ***Define details of agreement*** *– this involves cost, commitments of resources, accountability, deliverables etc.*

7. ***Monitor status and modify strategies*** *– monitor progress and advise strategies as needed.*

Question 6

What are FMEA and FMECA and what is the primary difference between the two? [10]

 ***See study unit 7; p.201, 204***

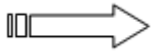
Failure modes and effects analysis (FMEA) systematically considers each component of a system; identifying, analysing, and documenting the possible failure modes within the system and the effects of each failure on the system.

Failure modes, effect, and criticality analysis (FMECA) is an extensive but simple method for identifying ways in which an engineered system could fail. As in FMEA, failures, effects and causes are identified in this analysis also.

The difference between the two is that FMECA rates failure modes by ranking each possible mode according to both the probability of its occurrence and the severity of its effects. The primary goal of FMECA is to develop priorities for corrective action based on estimated risk.

Question 7

The Dean of Students at your university wants to do a survey regarding service quality experiences of UNISA students worldwide. Since you are almost graduating with a BCom degree, she asked you to assist with this research project. You suggested that the SERVQUAL instrument should be used. Write a short report on what the SERVQUAL instrument entails, how it is used, and what it reveals. [10]

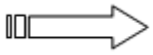
 ***See study unit 8; p.217 – 224***

The SERVQUAL instrument is a customer survey that is used for assessing service quality. It consists of two 22 survey questions measured on a Likert scale that address each of the five dimensions of service quality (tangibles, reliability, responsiveness, assurance, empathy). Customers are given the surveys and instructed to answer all 22 questions. The survey administrator then determines average responses for the survey items and averages those averages for each of the five dimensions of service quality.

The two parts of the survey, an expectations section and a perceptions section, are to be compared. These two sections, and the differences between the two, are used to assess gaps that might exist in the company's service delivery system. If a large gap is revealed on one or more of the five service quality constructs, then the company knows it should target efforts in closing this gap.

Question 8

A customer is the receiver of goods or services. Differentiate between internal and external customers. [4]

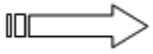
 ***See study unit 5; p.136***

Internal customers are employees receiving goods or services from within the same firm. For example, management information systems (MIS) technicians and programmers view the users within their company as internal customers.

In contrast, external customers or end users are the bill-paying receivers of a company's work. A person that enters a restaurant and purchases a meal is an external customer.

Question 9

Many scholars believe that business process benchmarking is the most important type of benchmarking. Do you agree with this particular belief? Give reasons to justify your answer. [5]

 ***See study unit 6; p.168 – 169***

Most students will agree with this statement. The example that is provided in the chapter to support this position is as follows: Suppose that you do a comparison of your customer service with that of the competitor. You find out that your competitor is using a standard survey instrument to gauge customer satisfaction. You then administer the survey yourself to your customers and find out that on a five-point scale, your company rates a 4.3 and your chief competitor rates a 4.7.

Now what do you do with this information? The fact that your score differs from your competitor tells you nothing about how the competitor is achieving these higher scores. To understand how your competitor has achieved these scores, business process benchmarking is necessary. Business process benchmarking is based on the concept of ***5w2h*** *developed by Alan Robinson. A business process benchmarking project should result in the answers to 7 questions.*

*The **"5W"**: who, what, when, where and why and the "**2h"**: how and how much. The 5w2h concept is a good starting point because it focuses the participants in the benchmarking process on the "nuts and bolts" of what is being done. If the initiator organization can answer the 5w2h questions at the end of a benchmarking process, then information will be in place that could, for instance, help a company improve its customer satisfaction.*

Question 10

North West Appliance Manufacturing and Distribution Pty (Ltd) manufactures a range of household appliances and has a national presence, with manufacturing plants in all nine (9) provinces in South Africa. The head of the purchasing department asked you to assist them with quality function deployment (QFD). He heard about this term at a conference he attended recently, but is not sure what it means. Compile a short report on the definition of QFD and the steps used to perform a QFD. [15]

⇨ ***See study unit 7; p.187 – 190 (maximum of 15 marks)***

***Quality function deployment (QFD)** translates customer requirements into technical requirements for each stage of product development. Under QFD all operations of a company are driven by the voice of the customer, rather than top management. Sometimes this is referred to as "the voice of the customer."*

QFD has a structure called the House of Quality. It is made up of eight (8) steps:

1. ***Develop a list of customer requirements** – this includes the major customer needs as they relate to a particular aspect of a process.*

2. ***Develop a list of technical design elements along the roof of the house** – these are the design elements that relate to customer needs.*

3. ***Demonstrate the relationship between the customer requirements and technical design elements** – a diagram can be used to demonstrate these relationships.*

4. ***Identify correlations between design elements** – indicate whether different design elements are positively or negatively correlated.*

5. ***Perform a competitive assessment of the customer requirements** – perform an assessment of how your product compares with those of your key competitors.*

6. ***Prioritize customer requirements** – these priorities include importance to the customer, target value, sales point, and absolute weight.*

7. ***Prioritize technical requirements** – technical requirements are prioritized by determining degree of difficulty, target value, absolute weight and relative weight.*

8. ***Final evaluation** – The success of QFD depends on effective communication and cooperation among all major functions that contribute to getting a product to market*

Question 11

Differentiate between voluntary and involuntary services with examples. [4]

⇨ ***See study unit 8; p.213***

Voluntary services are services that we actively seek out and employ of our own accord. Generally, we research a voluntary service, such as a gas station, a restaurant, or a hotel, and have certain expectations when we engage its services.

A typical example of an involuntary service is a prison. Other involuntary services include hospitals, the IRS, the police department, the fire department, and other services that you do not choose. If you have the chance to engage this type of service at some point, you likely will have vague expectations about the experience.

Question 12

The value chain is a tool that disaggregates an organisation into its core activities to help reduce costs and to identify sources of competitiveness. From a quality perspective, explain the concept of the "chain of customers". [4]

⇨ ***See study unit 9; p.244***

From a quality perspective, an interesting variation of the value chain is the concept of the "chain of customers." Looking at the activities along the value chain sequentially, we see that the links in the value chain are really people performing different functions.

The chain of customers is revealed when you view the step in the chain after you as your own customer. This means that if you work at workstation 4 in a process at the core of the value chain, you will make sure that the work you do is absolutely impeccable before you release it to your "customer" in workstation 5.

This chain extends from raw materials through supplier firms to the producing firm, with the final link in the chain being the ultimate consumer of the product. The notion is that if each of us along a chain works to satisfy our own customer, the final customer will be very satisfied, and our products and services will be free of defects and mistakes.

Question 13

The following dataset contains the number of defective products, produced by a sample of 18 machines at Ntini factory:

14	21	44	26	29	32
55	19	48	46	45	22
25	14	21	30	45	27

Develop a histogram to graphically summarise the data. [9]

⇒ ***See study unit 10; p. 271 – 272 in the prescribed book***

First we need to determine the number of classes. We make use of the formula

$$k \geq \log n / \log 2$$

Since there are 18 observations, we have $n = 18$ and so

$$k \geq \log(18)/\log 2$$
$$k \geq 1.2553/0.3010$$
$$k \geq 4.17$$

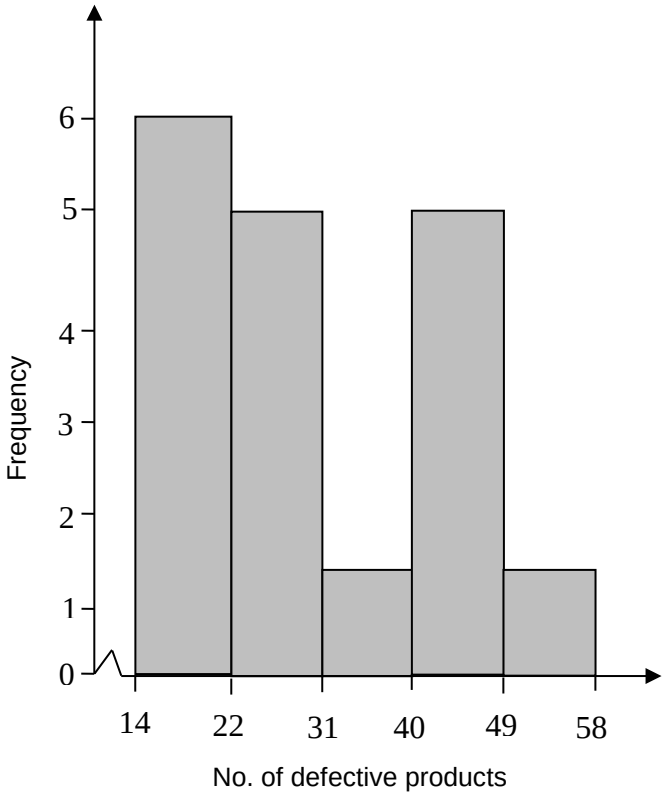
Therefore we take $k = 5$, which is the next integer *larger* than 4.17. Now, with 5 classes, the class width is:

$$\frac{Range}{k} = \frac{55-14}{5} = \frac{41}{5} = 8.2$$

Since the dataset consists of only whole numbers, we choose the class width as 9, which is the next integer *larger* than 8.2. The frequency distribution is then as follows:

Class	Frequency
14 – 22	6
23 – 31	5
32 – 40	1
41 – 49	5
50 – 58	1

From the frequency table above we can now draw the histogram:



Question 14

Consider the following problem faced by a particular bank. After several brainstorming sessions held by the Financial Quality Management Committee, the problem was defined as being incomplete ATM transactions. Data concerning the causes of these incomplete ATM transactions were collected, and the results are shown in the table below:

Cause	Frequency
ATM malfunctions	32
ATM out of cash	28
Invalid amount requested	23
Lack of funds in account	19
Magnetic strips unreadable	234
Warped card jammed	365
Wrong pin	23

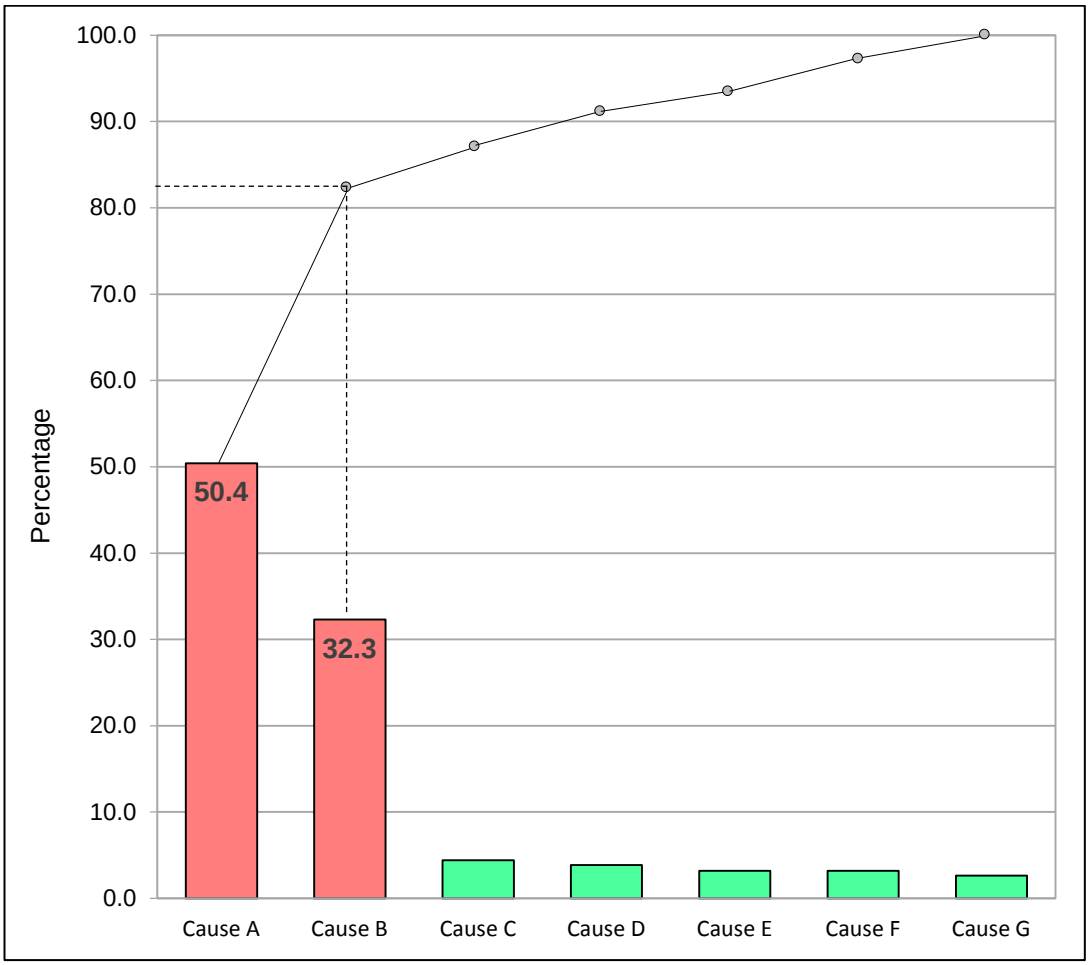
Perform a Pareto analysis in order to assist the Financial Quality Management Committee with solving this problem. [7]

See study unit 10; p. 276 – 279 in the prescribed book

First we need to order the causes according to their frequency, from largest to smallest and construct a frequency table containing the frequencies, percentages and cumulative percentages.

Cause	Description	Frequency	Percentage	Cumulative percentage
A	Warped card jammed	365	365/724 × 100 = 50.4 %	50.4 %
B	Magnetic strips unreadable	234	32.3 %	50.4 + 32.3 = 82.7 %
C	ATM malfunctions	32	4.4 %	87.1 %
D	ATM out of cash	28	3.9 %	91.0 %
E	Wrong pin	23	3.2 %	94.2 %
F	Invalid amount requested	23	3.2 %	97.4 %
G	Lack of funds in account	19	2.6 %	100.0 %
Total		724	100 %	

Now we are ready to draw a pareto diagram. Here is the completed diagram:



Note that we start with the cause with the highest frequency, i.e. “warped card jammed”. This will be the leftmost bar of the graph. Then we draw the bar representing the cause with the second highest frequency, namely “magnetic strips unreadable”. We continue until all of the above causes have been “converted” to bars, and this will complete the pareto diagram.

So we can see from the pareto diagram that about 83% of the problems are created by only two (roughly 29%) of the causes. This is exactly what the pareto principle (80/20 rule) is all about – more often than not it is found that, if 20% of the major causes of a quality problem can be eliminated, then 80% of the problem will be solved.

Question 15 (Study unit 10)

a) Name the seven phases of the quality circle process. [7]

⇨ ***See study unit 10; pp. 97-98 of the study guide***

1. *Identification of problem areas*
2. *Selection of problem area*
3. *Registration of problem*
4. *Analysis of the problem*
5. *Information gathering during problem-solving/cause elimination*
6. *Presentation to top management*
7. *Implementation and evaluation of the solution*

b) Name the steps to follow when implementing the fourth phase of the quality circle process.

⇨ ***See study unit 10; p. 97 of the study guide***

1. *Definition of the problem*
2. *Identification of causes*
3. *Place causes on an Ishikawa diagram*
4. *Assign values to the causes on the Ishikawa diagram*
5. *Draw up a table of values based on the vote counts*
6. *Draw the Pareto diagram*

[6]

c) By making use of your own practical quality-related example, discuss the first four phases of the quality circle process. Illustrate each step, where applicable. [16]

⇨ ***See section 10.3; p. 95 – 101 in the study guide***

I have chosen to use the DSTV call centre as an example to apply the quality circle process. I had to phone this call centre numerous times in the past and it is such a pivotal part of customer service at the Multichoice company, so I thought it would be appropriate.

The Chief Executive Officer (CEO) of Multichoice SA has asked the head of the service quality department to launch an investigation into the recent poor feedback received from their customers. A team consisting of eight people have been chosen to perform this task.

Phase 1: Identification problem areas

During the first phase of the quality circle process, the team members participate in a brainstorming session to write down ideas as to what the problem may be. There must be a clear distinction between grievances and quality problems.

Development of ideas

Poor customer service at service centres

Conflict at accounts department

DSTV call centre struggles to handle increasing call frequency

Incapable cashiers at service centres

Decision by management to increase subscription fee

Evaluation of ideas

Poor customer service at service centres

Incapable cashiers at service centres (combine)

~~*Conflict at accounts department*~~ (scrap)

DSTV call centre struggles to handle increasing call frequency

Decision by management to increase subscription fee

\+ *Poor television coverage in rural areas* (add)

Phase 2: Selection of problem area

After the problem areas has been identified during the brainstorming session, a problem is selected by means of the weighted vote system. Each idea is prioritised as follows: Each member has to cast three votes, namely three points are given for the most important problem, two points for the second most important and one point for the third most important.

Voting process:

Problem area	*Votes*	*Total vote points*
1. Shortcomings at service centres	2 3 1 3 2 1	12
2. DSTV call centre struggles to handle increasing call frequency	3 3 2 3 2 2 3 2	20
3. Decision by management to increase subscription fee	1 1 2 3 1	9
4. Poor television coverage in rural areas	1 2 1 1 3	8

Result: Problem 2 is selected.

Phase 3: Registration of the problem

During the third phase, the problem is registered after the facilitator, together with management, have evaluated the problem according to the relevant policy and procedure. It is important that proactive control is practised at this stage to ensure an efficient quality circle process.

Phase 4: Analysis of the problem

This is the most important phase of the quality circle process during which various quality tools are applied. There are six steps to follow in this phase:

4.a – Definition of the problem

The problem which was selected in phase 2 must now be defined. It is important that the problem is defined in a brief and clear manner, otherwise irrelevant data could be gathered if the problem is vaguely defined.

2. DSTV call centre struggles to handle increasing call frequency = "Inefficient DSTV call centre"

The problem is defined as: "Inefficient DSTV call centre".

4.b – Identification of causes

During this stage of phase 4 the brainstorming technique is used again, this time to write down ideas regarding possible causes of the defined problem. It is important that solutions are not yet considered.

Development of ideas

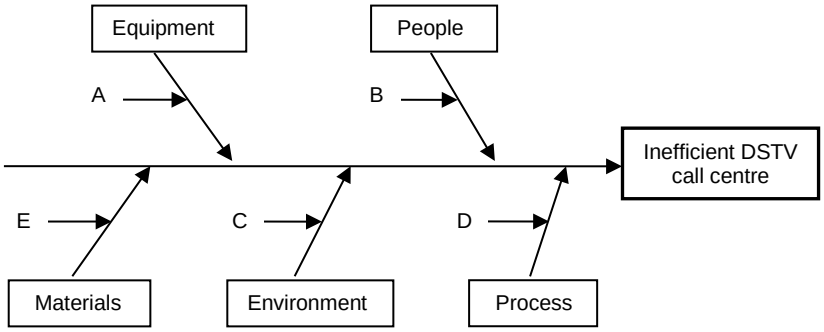
Lack of self-service facilities
Shortage of personnel
Not enough office space to accommodate more personnel
Calls are not funnelled correctly
Out-dated computer software

Evaluation of ideas (unaltered)

A Lack of self-service facilities
B Shortage of personnel
C Not enough office space to accommodate more personnel
D Calls are not funnelled correctly
E Out-dated computer software

4.c – Place causes on an Ishikawa diagram

This step involves drawing an Ishikawa diagram and then lining up the identified causes on the diagram. This will serve as a visual aid to the team leader and also provides a clear picture of the problem and its causes and possible sub-causes.



4.d – Assign values to causes on Ishikawa diagram

This step requires data collection and capturing in order to set up a frequency table and draw a pareto chart. The head of the service quality department has requested a statistician to collect and capture data concerning the five causes in step 4b. The statistician is then invited to come and present a short summary of the results.

Summary of results after data collection:

Cause	*Freq*
A Lack of self-service facilities	*27*
B Shortage of personnel	*108*
C Not enough office space to accommodate more personnel	*3*
D Calls are not funnelled correctly	*9*
E Out-dated computer software	*3*

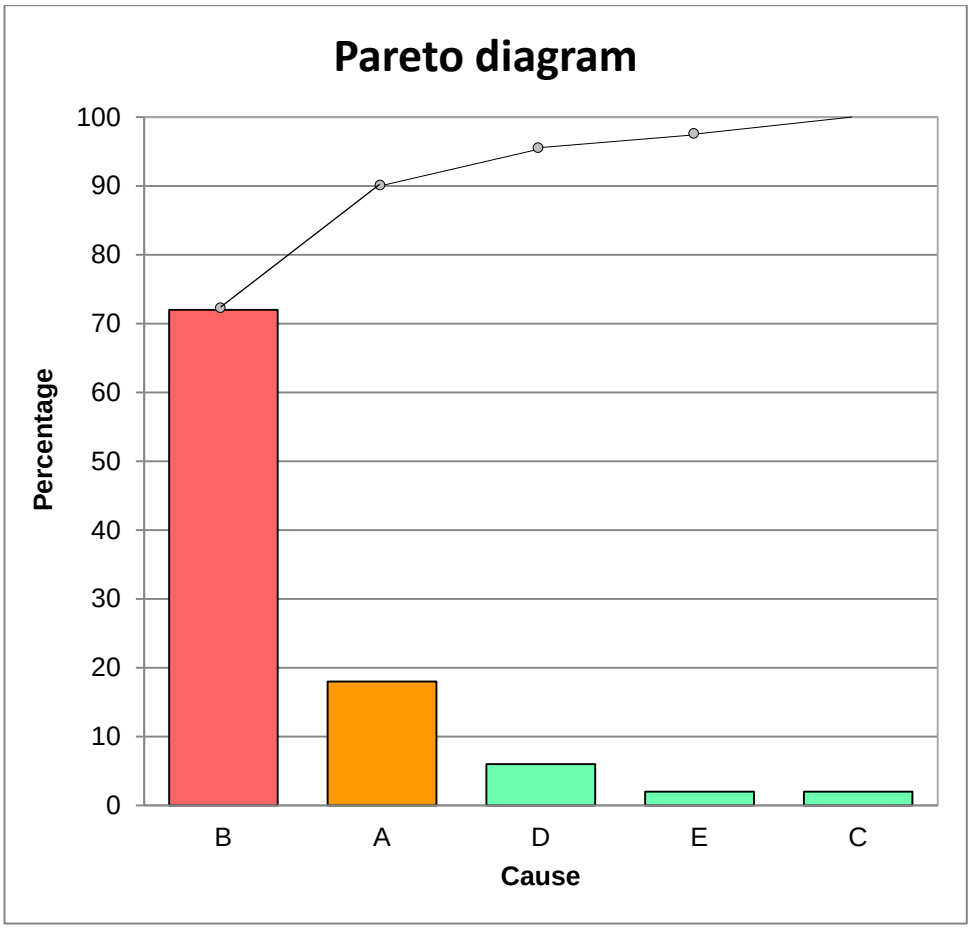
4.e – Construct a frequency table

The results from the previous step is now used to draw up a frequency table. The causes are arranged according to their frequency, from largest to smallest. The cumulative percentages need to be calculated in order to determine the 80/20 point.

Cause	Description	Frequency	Percentage	Cumulative percentage
B	Shortage of personnel	108	72 %	72 %
A	Lack of self-service facilities	27	18 %	90 %
D	Calls are not funnelled correctly	9	6 %	96 %
E	Out-dated computer software	3	2 %	98 %
C	Not enough office space to accommodate more personnel	3	2 %	100 %
	Total	***150***	***100 %***	

4.f – Pareto analysis

The frequency table from step 4.e is now used to construct a pareto diagram, from which a pareto analysis can be done. This is the final and defining step during the fourth phase of the quality circle process.



According to the pareto diagram, causes A and B are responsible for 90% of the problem. Therefore, in order to solve the problem efficiently, the focus should be on cause A and (part of) cause B.

The quality circle process can be applied to almost any quality-related situation. This over-simplified example was used only to illustrate the practical use of the quality circle process. Study it carefully and make sure that you understand each phase. You can use this example as a guideline, but it is important to be able to apply the quality circle process to your own example, especially in your workplace.

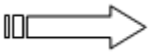
Question 16

The branch manager of a bank wants to reduce the customer waiting time for teller service during weekdays from 12:00 to 13:00. A subgroup of four customers is selected (one at each 15 minute interval during the one-hour time period) and the time (in minutes) is measured from when each customer enters the line to when he/she is served by the teller assistant. The results are as follows:

Day	Time (min)			
1	7.2	8.4	7.9	4.9
2	5.6	8.7	3.3	4.2
3	5.5	7.3	3.2	6.0
4	4.4	8.0	5.4	7.4
5	9.7	4.6	4.8	5.8
6	8.3	8.9	9.1	6.2
7	4.7	6.6	5.3	5.8
8	8.8	5.5	8.4	6.9
9	5.7	4.7	4.1	4.6
10	3.7	4.0	3.0	5.2
11	2.6	3.9	5.2	4.8
12	4.6	2.7	6.3	3.4

The branch manager has asked you to analyse the waiting time. After consulting the head of the quality control department, you decide to make use of Statistical Process Control. In order to assist the branch manager, you need to answer the following questions, based on the data above:

(a) Develop an $\bar{x}$ chart based on the range. [12]
(b) Construct an $\bar{x}$ chart based on the standard deviation. [12]
(c) For each of your charts in (a) and (b), state whether or not the process is in control. Motivate your answer. [4]
(d) Comment on the similarity/difference between your findings in (c). [2]



See study unit 11; p. 309 – 316, 320 – 322 in the prescribed book

(a) In order to develop an $\bar{x}$ chart based on the range, we first need to calculate the average (mean), as well as the range for each subgroup. See the table below.

Next we compute the overall average (grand mean) and average range:

$$\bar{\bar{x}} = \frac{\sum \bar{x}}{k} = \frac{68.825}{12} = 5.735$$

$$\bar{R} = \frac{\sum R_i}{k} = \frac{39.8}{12} = 3.317$$

Day	Time (min)				R	$\bar{x}$
1	7.2	8.4	7.9	4.9	3.5	7.100
2	5.6	8.7	3.3	4.2	5.4	5.450
3	5.5	7.3	3.2	6.0	4.1	5.500
4	4.4	8.0	5.4	7.4	3.6	6.300
5	9.7	4.6	4.8	5.8	5.1	6.225
6	8.3	8.9	9.1	6.2	2.9	8.125
7	4.7	6.6	5.3	5.8	1.9	5.600
8	8.8	5.5	8.4	6.9	3.3	7.400
9	5.7	4.7	4.1	4.6	1.6	4.775
10	3.7	4.0	3.0	5.2	2.2	3.975
11	2.6	3.9	5.2	4.8	2.6	4.125
12	4.6	2.7	6.3	3.4	3.6	4.250
				Total	***39.8***	***68.825***

Before we can calculate the control limits, we need to look up the value of A_2, the factor associated with an $\bar{x}$ chart when it is based on the range. From Table A-1 in the Appendix on p. 446 of your prescribed book, we find that $A_2 = 0.73$ for a subgroup of size $n = 4$.

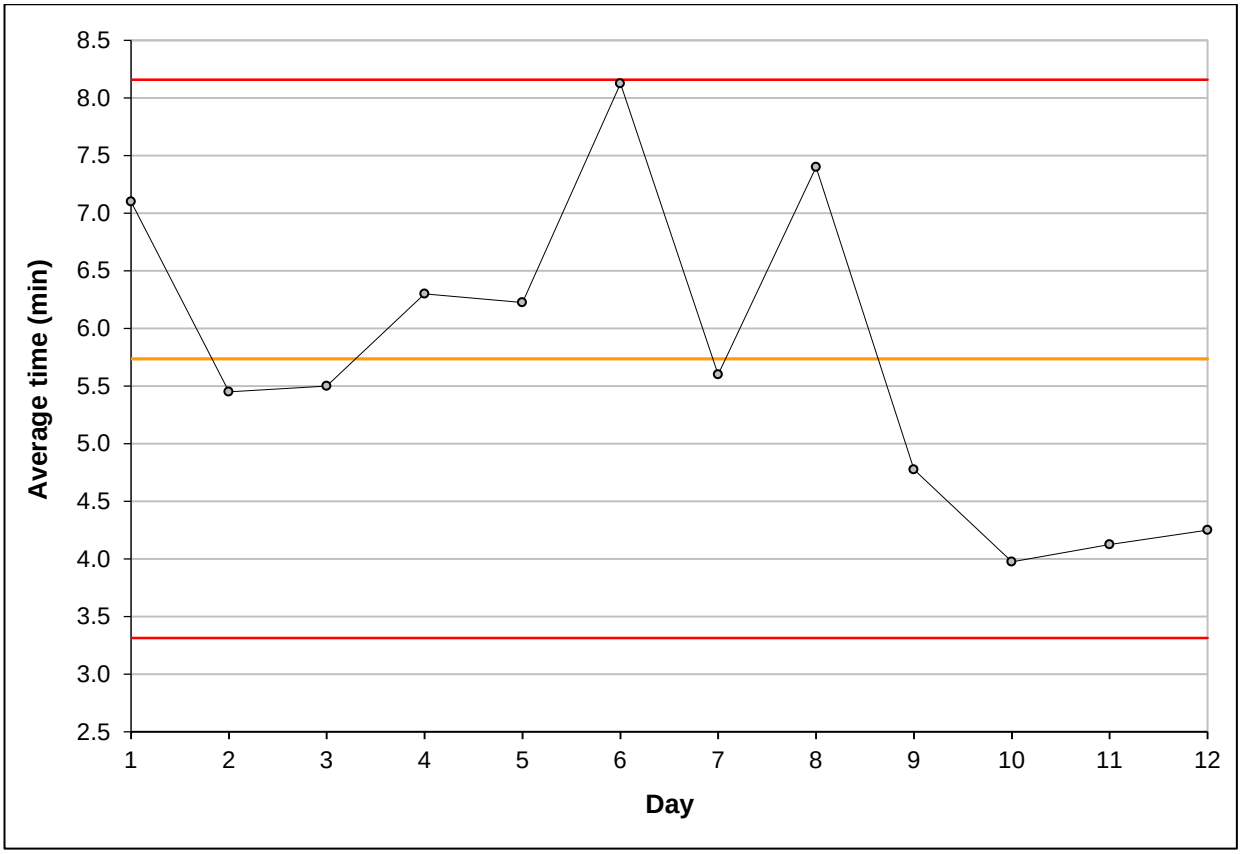
The control limits are then calculated as follows:

$$CL_{\bar{x}} = \bar{\bar{x}} = 5.735$$

$$\begin{aligned} UCL_{\bar{x}} &= \bar{\bar{x}} + A_2\bar{R} \\ &= 5.735 + 0.73(3.317) \\ &= 5.735 + 2.421 \\ &= 8.156 \end{aligned}$$

$$\begin{aligned} LCL_{\bar{x}} &= \bar{\bar{x}} - A_2\bar{R} \\ &= 5.735 - 0.73(3.317) \\ &= 5.735 - 2.421 \\ &= 3.314 \end{aligned}$$

Finally, we are ready to draw the $\bar{x}$ chart, based on the range.



(b) In order to develop an $\overline{x}$ chart based on the standard deviation, we first need to calculate the average (mean), as well as the standard deviation for each subgroup:

Day	Time (min)				s	$\overline{x}$
1	7.2	8.4	7.9	4.9	1.547	7.100
2	5.6	8.7	3.3	4.2	2.364	5.450
3	5.5	7.3	3.2	6.0	1.711	5.500
4	4.4	8.0	5.4	7.4	1.685	6.300
5	9.7	4.6	4.8	5.8	2.375	6.225
6	8.3	8.9	9.1	6.2	1.328	8.125
7	4.7	6.6	5.3	5.8	0.804	5.600
8	8.8	5.5	8.4	6.9	1.508	7.400
9	5.7	4.7	4.1	4.6	0.670	4.775
10	3.7	4.0	3.0	5.2	0.918	3.975
11	2.6	3.9	5.2	4.8	1.153	4.125
12	4.6	2.7	6.3	3.4	1.576	4.250
				Total	***17.639***	***68.825***

Next we compute the overall average (grand mean) and average standard deviation:

$$\overline{\overline{x}} = \frac{\sum \overline{x}}{k} = \frac{68.825}{12} = 5.735$$

$$\overline{s} = \frac{\sum s_i}{k} = \frac{17.639}{12} = 1.4699$$

Before we can calculate the control limits, we need to look up the value of A_3, the factor associated with an $\overline{x}$ chart when it is based on the standard deviation.

From Table A-3 in the Appendix on p. 448 of your prescribed book, we find that $A_3 = 1.628$ for a subgroup size $n = 4$.

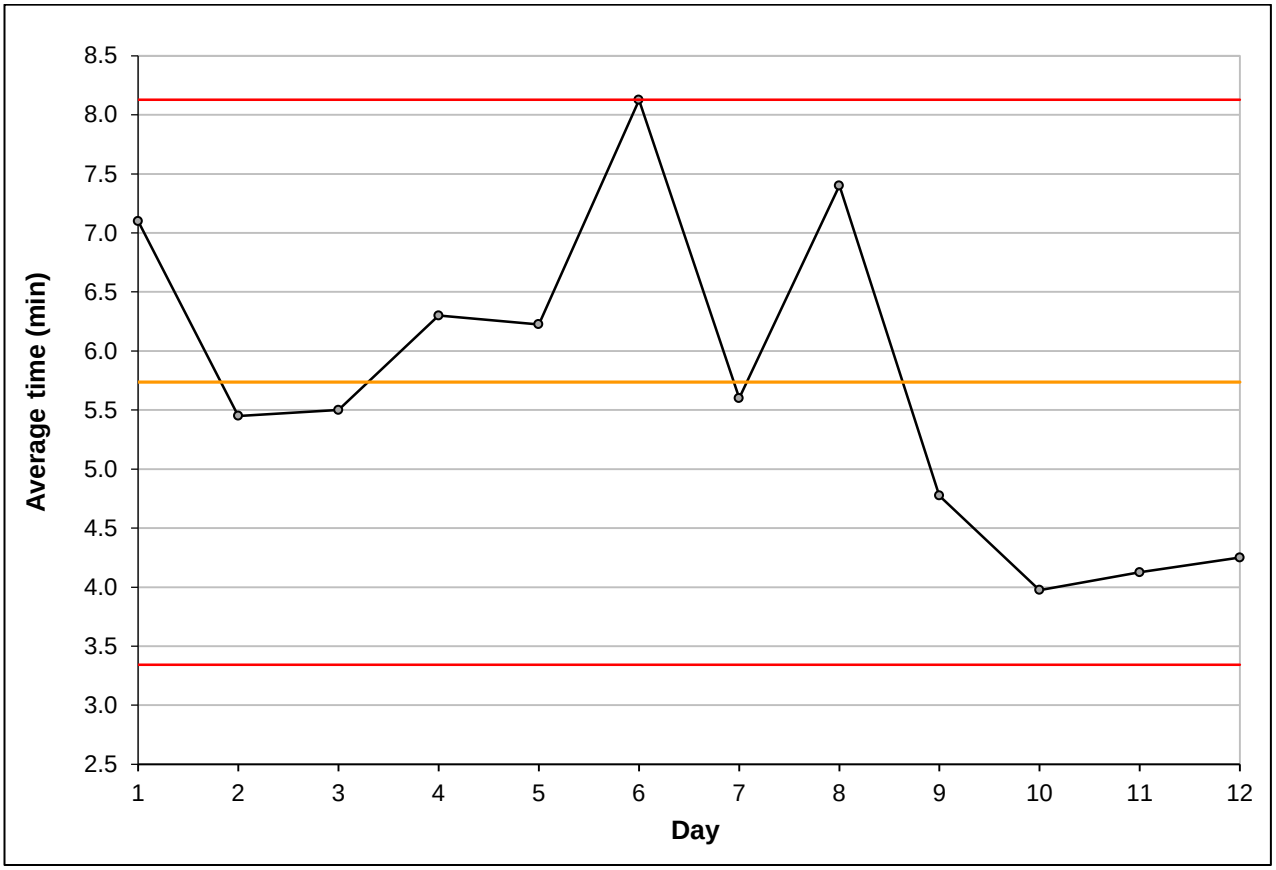
The control limits are then calculated as follows:

$$CL_{\overline{x}} = \overline{\overline{x}} = 5.735$$

$$\begin{aligned} UCL_{\overline{x}} &= \overline{\overline{x}} + A_3\overline{s} \\ &= 5.735 + 1.628(1.4699) \\ &= 5.735 + 2.393 \\ &= 8.128 \end{aligned}$$

$$\begin{aligned} LCL_{\overline{x}} &= \overline{\overline{x}} - A_3\overline{s} \\ &= 5.735 - 1.628(1.4699) \\ &= 5.735 - 2.393 \\ &= 3.342 \end{aligned}$$

Finally, we are ready to draw the $\overline{x}$ chart, based on the standard deviation.



(c) In both charts there are evidence of a possible non-random situation. There is a sudden change in level of more than three standard deviations, occurring between day 6 and 7 and again between day 8 and 9.

(d) The findings are similar, because both the range and standard deviation are measures of dispersion. Note, however, that the s chart is used in conjunction with the $\bar{x}$ chart where variation in a process is small.

Question 17

Specifications for a bicycle derailleur are 6 cm ± 0,01 cm. The current process produces derailleurs with a mean of 6.002 cm and a standard deviation of 0.004 cm.

(a) Is the process capable? Motivate your answer. [8]
(b) Assuming a normal distribution, what percentage of these derailleurs will not meet the specifications? [7]

⇨ ***See study unit 11; p. 329 in the prescribed book***

In order to determine whether or not a process is capable, we need to calculate the capability index.

The upper capability index is:

$$\text{Cpu} = \frac{\text{USL} - \mu}{3\hat{\sigma}} = \frac{6.01 - 6.002}{3(0.004)} = 0.67$$

The lower capability index is:

$$\text{Cpl} = \frac{\mu - \text{LSL}}{3\hat{\sigma}} = \frac{6.002 - 5.99}{3(0.004)} = 1.00$$

The capability index is then the smaller of the upper and lower capability indexes:

$$\text{Cpk} = \min\{\text{Cpu},\ \text{Cpl}\} = \min\{0.67, 1.00\} = 0.67$$

We see that the capability index is 0.67, which is much less than 1.25, and therefore we conclude that the process is not capable of producing bicycle derailleurs which meet the specifications limits.

(a) Please note that this question is not for examination purposes, but rather to enrich your understanding of process capability by illustrating how it is linked to the normal distribution (see figure 11-23 on p.329 of the prescribed book). It is assumed that you have the basic knowledge about the standard normal distribution.

To answer this question, you need to determine the probability that a bicycle derailleur will fall outside the specification limits. We first convert the LSL and USL to standard normal z-values by making use of the formula

$$z = \frac{x - \mu}{\hat{\sigma}} \ .$$

Therefore we have

$$z_{LSL} = \frac{5.99 - 6.002}{0.004} = -3.00$$

$$z_{USL} = \frac{6.01 - 6.002}{0.004} = 2.00$$

Using the Z table on p.447 of the prescribed book, we obtain that:

$$P(0 \le Z \le 2.00) = 0.47725;$$

i.e. the probability of obtaining a z-value between 0 and 2 is 0.47725.

Similarly, we have $P(-3.00 \le Z \le 0) = 0..49865$;

i.e. the probability of obtaining a z-value between -3 and 0 is 0.47725.

Note that $P(0 \le Z \le 3.00) = P(-3.00 \le Z \le 0)$ due to the symmetry of the standard normal distribution. Therefore we have

$P(Z \ge 2.00) = 0.50 - 0.47725 = 0.02275$;

i.e. the probability of obtaining a z-value larger than 2 is 0.02275.

Similarly, $P(Z \le -3.00) = 0.5 - 0.49865 = 0.00135$;

i.e. the probability of obtaining a z-value smaller than -3.00 is 0.00135

Hence the total probability of obtaining a z-value outside the specification limits is 0.02275 + 0.00135 = 0.0241.

Therefore, it is expected that 2.41% of these bicycle derailleurs will not meet the specifications

Question 18

A manufacturer of ceramic tiles subjects their tiles to several quality checks. Tiles found to have surface deformities or failing to meet size specifications are considered as defectives. The table below presents the number of defective tiles in 12 samples of 50 tiles each:

Sample number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Number of defective tiles	7	5	4	3	3	6	2	5	8	4	6	1

(a) Construct a p chart for this manufacturing process. [11]
(b) Using the same data, construct an np chart for this process. [10]
(c) For each of your charts in (a) and (b), state whether or not the process is in control. Motivate your answer. [4]
(d) Comment on the similarity/difference between your findings in (c). [2]

See study unit 11; p. 339 – 344 in the prescribed book

(a) In order to construct a *p* chart, we first need to calculate the proportion of defectives for each subgroup:

Sample	Defectives	Proportion
1	7	0.14
2	5	0.10
3	4	0.08
4	3	0.06
5	3	0.06
6	6	0.12
7	2	0.04
8	5	0.10
9	8	0.16
10	4	0.08
11	6	0.12
12	1	0.02
Total:	54	1.08

Next we compute the overall average proportion of defectives:

$$\overline{p} = \frac{\sum p_i}{k} = \frac{1.08}{12} = 0.09$$

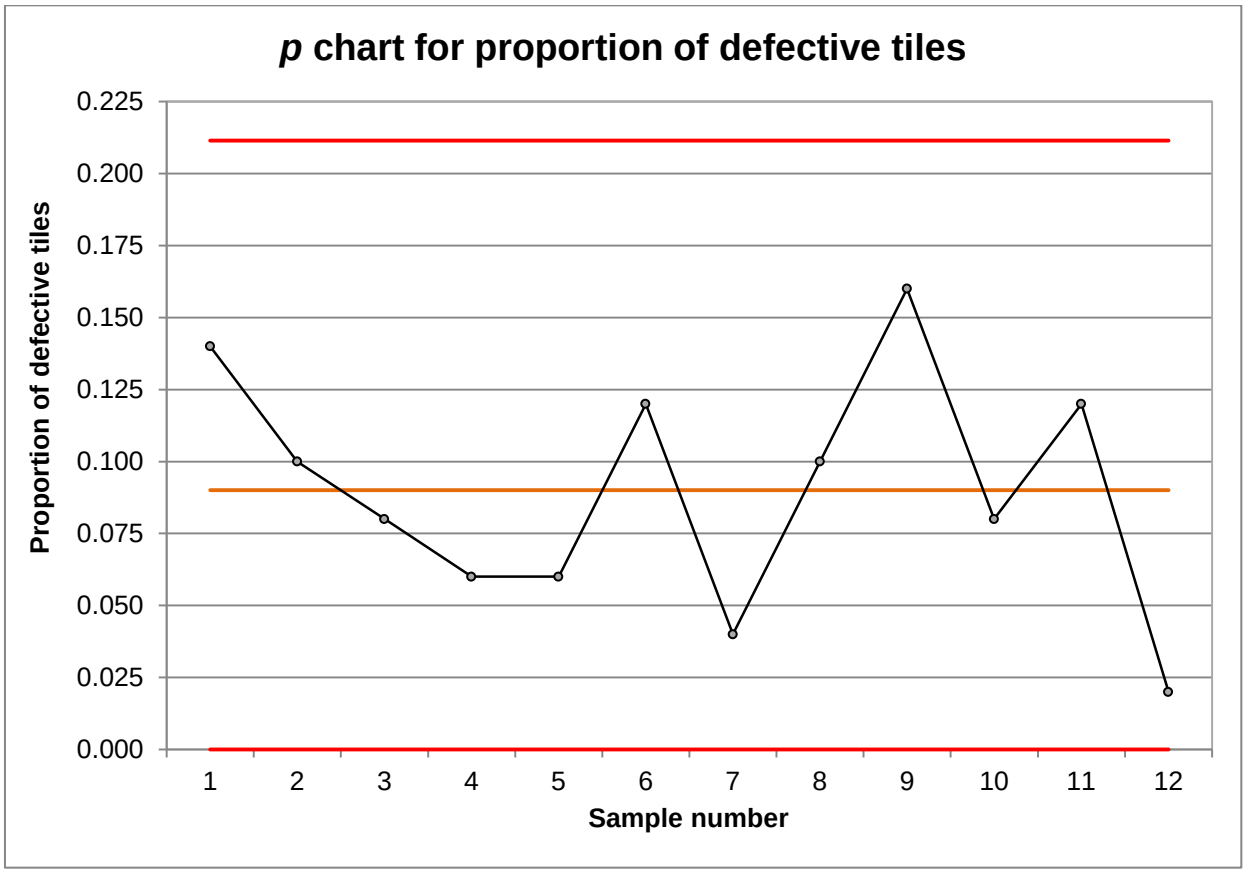
Note that this is also the centre line of the *p* chart. The upper and lower control limits for a *p* chart is then determined as follows:

$$\begin{aligned} UCL_p &= \overline{p} + 3\sqrt{\overline{p}(1-\overline{p})/n} \\ &= 0.09 + 3\sqrt{0.09(1-0.09)/50} \\ &= 0.09 + 3\sqrt{0.001638} \\ &= 0.211 \end{aligned}$$

$$\begin{aligned} LCL_p &= \overline{p} - 3\sqrt{\overline{p}(1-\overline{p})/n} \\ &= 0.09 - 3\sqrt{0.09(1-0.09)/50} \\ &= 0.09 - 3\sqrt{0.001638} \\ &= -0.031 \end{aligned}$$

(LCL = 0, since the lower control limit of a *p* chart can never be smaller than zero.)

The completed *p* chart are now as follows:



(b) In order to construct a *np* chart, we first need to calculate the proportion of defectives for each subgroup. See the table in 18 (a) above.Then we compute the overall average proportion of defectives:

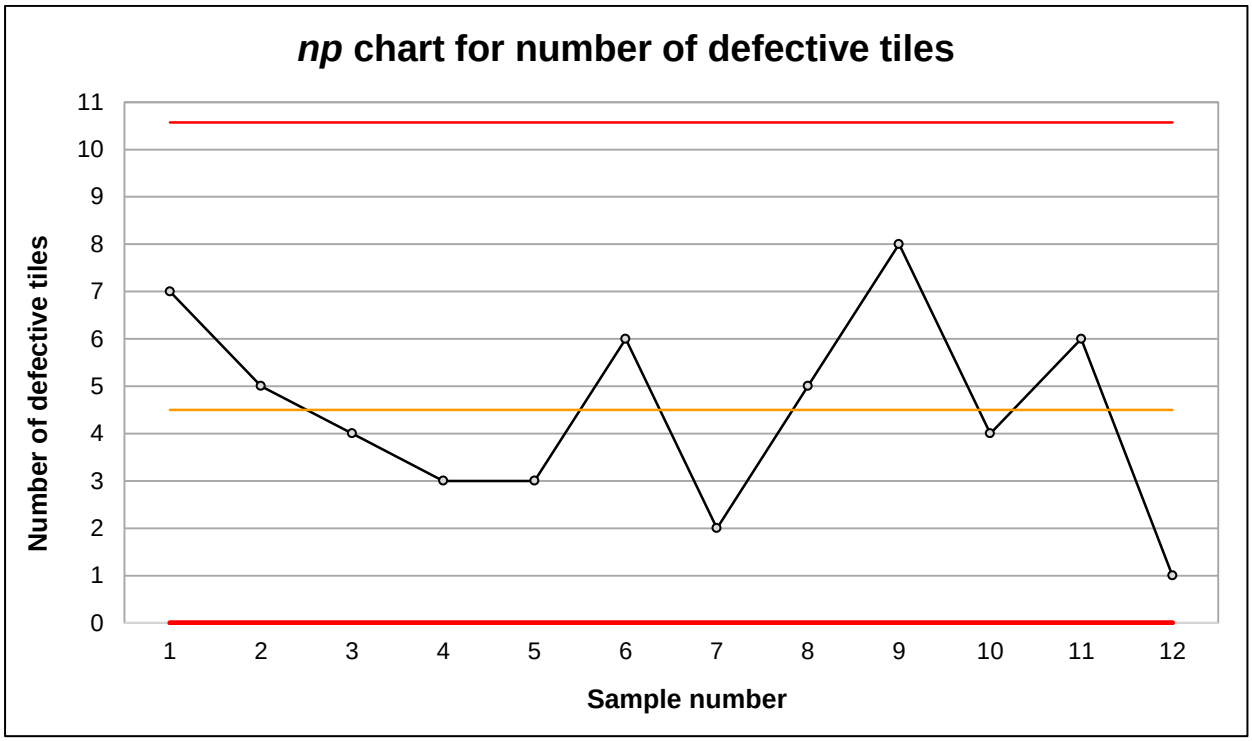
$$\bar{p} = \frac{\sum p_i}{k} = \frac{1.08}{12} = 0.09$$

Note that this is also the centre line of the *p* chart. The upper and lower control limits for a *np* chart is then determined as follows:

$$\begin{aligned} LCL &= n\bar{p} - 3\sqrt{n\bar{p}(1-\bar{p})} \\ &= 50(0.09) - 3\sqrt{50(0.09)(1-0.09)} \\ &= 4.5 - 3\sqrt{4.095} \\ &= 4.5 - 6.0708 \\ &= -1.5708 \end{aligned}$$

(LCL = 0, since the lower control limit of a *np* chart can never be smaller than zero.)

$$UCL = n\bar{p} + 3\sqrt{n\bar{p}(1-\bar{p})}$$
$$= 50(0.09) + 3\sqrt{50(0.09)(1-0.09)}$$
$$= 4.5 + 3\sqrt{4.095}$$
$$= 4.5 + 6.0708$$
$$= 10.5708$$

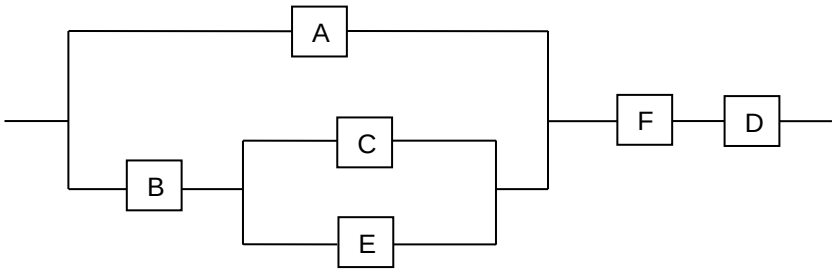


(c) In both cases, there are no clear evidence of a non-random event, therefore we can conclude that the process is in control.

(d) Note that the subgroup sizes are the same, therefore either the *p* chart or *np* chart can be used. They are in this case essentially the same chart. Hence the findings are similar.

Question 19

A system consists of six components, connected as in the figure below:



The reliability of each component in the system is shown below:

Component A: $R_A = 0.87$ Component B: $R_B = 0.95$;
Component C: $R_c = 0.85$ Component D: $R_D = 0.92$;
Component E: $R_E = 0.83$ Component F: $R_F = 0.90$.

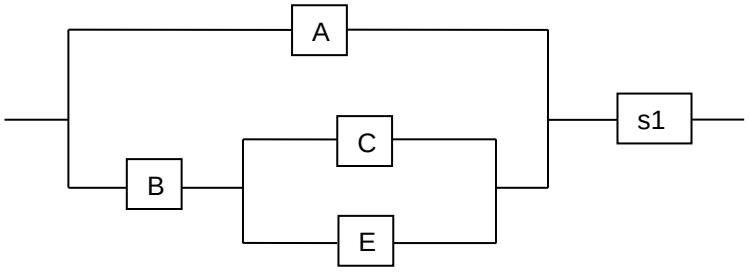
Determine the reliability of the system. [8]

See study unit 12; p. 349 – 351 in the prescribed book

First, notice that components F and D are connected in serie:

$$R_{s1} = (R_F)(R_D) = (0.90)(0.92) = 0.828$$

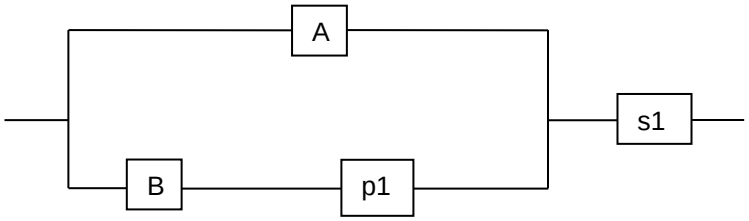
Now we have the following equivalent system:



Next, we see that components C and E are connected in parallel:

$$R_{p1} = 1-(1-R_C)(1-R_E) = 1-(1-0.85)(1-0.83) = 0.9745$$

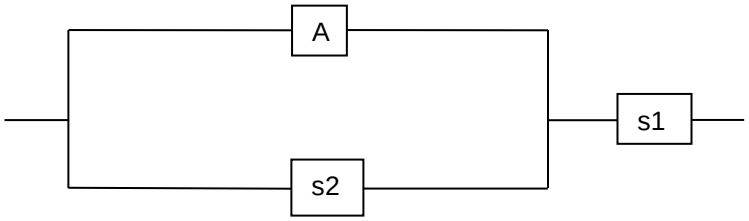
The system can now be further simplified as follows:



From the figure above, notice that components B and p1 are connected in serie, i.e.

$$R_{s2} = (R_B)(R_{p1}) = (0.95)(0.9745) = 0.925775$$

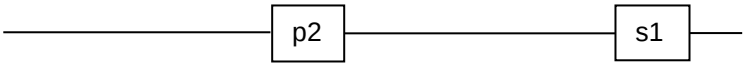
Now we have an equivalent system as follows:



Components A and s2 are now connected in parallel, i.e.

$$R_{p2} = 1-(1-R_A)(1-R_{s2}) = 1-(1-0.87)(1-0.925775) = 0.99035075$$

Lastly, the system is simplified to only two components connected in serie:



Hence the reliability of the system is:

$$R = (R_{p2})(R_{s1}) = (0.99035075)(0.828) = 0.82$$

Question 20

(a) Determine the reliability of a product with a failure rate of 0.002 and a useful operating life of 150 hours. [3]

(b) Suppose a product is designed to operate for 210 hours with a 0.02 probability of failure.
i) How many failures per hour is incurred by this product? [4]
ii) What is the MTTF for this product? [2]

⇒ ***See study unit 12; p. 351 – 352 in the prescribed book***

(a) The reliability is calculated by making use of the formula $R(t) = e^{-\lambda t}$.
The failure rate of the product is $\lambda = 0.002$, and the product's useful life is $t = 150$.

Therefore, the reliability of the product is:

$$R(150) = e^{-0.002\times150} = e^{-0.3} = 0.74$$

Hence the reliability of the product is 0.74 failures per hour, or 74 failures every 100 hours.

(b) The product's useful life is $t = 210$, with a reliability of $R(210) = 0.02$.

i) In this case, we need to calculate the failure rate, λ. We again make use of the reliability function, namely $R(t) = e^{-\lambda t}$. Therefore, we have:

$$0.02 = e^{-210\lambda}$$

$$\ln(0.02) = -210\lambda$$

$$\lambda = \frac{\ln(0.02)}{-210} = 0.019$$

So this product incurs 0.019 failures per hour, or approximately 19 failures every 1000 hours.

ii) The mean time to failure is:

$$\frac{1}{\lambda} = \frac{1}{0.019} = 52.63 \text{ hours.}$$

Question 21

a) Briefly explain the Six Sigma concept. [3]

⇨ ***See study unit 13; pp. 361 – 363 in the prescribed book.***

Six Sigma is a very popular and effective approach to improving quality. Several distinctions of Six Sigma differentiate it from traditional continuous improvement:

- *Six Sigma is a well thought out packaging of quality tools and philosophies in an effort to provide rigour and repeatability to quality improvement efforts.*
- *Six Sigma is much more cost reduction oriented than traditional continuous improvement.*
- *The third fundamental nuance of Six Sigma is the way it is organised around creating champions, black belts, green belts, and yellow belts.*
- *Six Sigma and lean production have been combined into an approach termed Lean Six Sigma. It is Six Sigma, with an increased emphasis on reducing waste.*

Six Sigma represents a well-thought out packaging of quality tools and philosophies in an honest effort to provide rigor and repeatability to quality improvement efforts. Six Sigma is also much more cost-reduction-oriented than traditional continuous improvement.

The "sigma" refers to the greek symbol σ, which in statistics is the notation for the standard deviation. The "six" refers to the number of standard deviations from a certain specification limit to the mean of a highly capable process.

There are two key versions of Six Sigma. From one perspective, it is a programme initiated at Motorola in 1982. They needed to improve their product designs and analytical techniques in order to cut their costs. From the other perspective, Six Sigma is an advanced quality improvement approach designed to help tackle the most difficult quality problems.

At the core of Six Sigma is the following equation: $Y = f(X)$.

This simply means that Y (the dependent variable) is a function of X (the independent variable). In Six Sigma language, we say that Y (the output) is a function of X (the inputs and processes).

b) Briefly explain the concept of Lean Six Sigma. [3]

⇨ ***See study unit 13; p. 363 – 365 in the prescribed book***

When firms undertook implementing Six Sigma, many saw that it had a lot in common with lean manufacturing. So, rather than having two competing models for improvement, many organisations have combined Six Sigma with lean. This is often referred to as Lean Six Sigma.

In this context, the focus is more on reducing wastefulness in organisations. It recognises the fact that all processes are inherently wasteful and include the possibility of improvement. Shingo's seven wastes are targeted as opportunities for improvement.

c) List the key players involved in Six Sigma and discuss the role of each player. [12]

⇨ ***See study unit 13; p. 363 – 365 in the prescribed book***

The key players involved in the implementation of Six Sixma are as follows:

Champion. *The primary function of a champion is to work with black belts and potential black belts to identify possible projects. Also, the champion plays an important role in providing continuing support for the project and validating the results after the project is completed.*

Master black belt. *These are the experienced black belts in some companies. Master black belts serve as mentors and trainers for newly appointed black belts. At the same time, they play a role in reducing costs, since in-house training is less expensive.*

Black belt. *The black belt is the key to lean-Six Sigma. They are specially trained individuals who commit themselves full-time to completing cost-reduction projects. Black belts usually move into management positions afterwards where they are able to apply their valuable experience to decision-making.*

Green belt. *The green belts are trained in basic quality tools and work in teams to improve quality. They are assigned part-time to work on process and design improvement.*

d) List the five phases in the implementation of Six Sigma. [4]

⇨ ***See study unit 13; p. 365 in the prescribed book***

Six Sigma management is implemented by following the steps outlined in the DMAIC process. Also see table 13-2 on p 366 of the prescribed book. DMAIC is short for:

1. ***D****efine*
2. ***M****easure*
3. ***A****nalyse*
4. ***I****mprove*
5. ***C****ontrol*

e) Name the steps involved in the first phase of the DMAIC process. [4]

⇨ ***See study unit 13; p. 363 – 365 in the prescribed book***

1. *Developing the business case*
2. *Project evaluation*
3. *Pareto analysis*
4. *Project definition*

f) Briefly discuss the third phase of the DMAIC process. [9]

⇨ ***See study unit 13; p. 379 – 380 in the prescribed book***

*The **analyse** phase of the DMAIC process involves gathering and analysing data relative to a particular black-belt project. The steps in this phase are as follows:*

Define your performance objectives
In this step of the analyse phase you need to determine what characteristics of the process need to be changed to achieve improvement.

Identify independent variables
If data is to be gathered, you need to determine which variables will contribute significantly to process or product variation. The primary tools used for this purpose are process maps, XY matrices, brainstorming and FMEA.

➲ ***Analyse sources of variability***
Use of statistical tools to better understand the relationships between independent and dependent variables for future experimentation. A number of tools and techniques are used, including histograms, box plots, scatter plots, regression analysis and hypothesis tests.

Question 22 (Study unit 14)

a) What are the primary sources of conflict in work teams? What are some of the methods for resolving team conflict? [15]

⇨ ***See study unit 14; p. 406 – 407 in the prescribed book***

There are two types of conflicts occurring in work teams, namely internal and external conflicts. The primary sources of these conflicts are as follows:

Internal conflicts:

- *Personality conflicts*
- *Rivalries*

External conflicts:

- *Disagreements over rewards systems*
- *Scarce resources*
- *Lines of authority*
- Functional differentiation

The following methods can be used (usually by the team leader) to resolve team conflict:

- ***Passive conflict resolution:*** *Some managers and leaders ignore conflict. They may prefer that subordinates resolve matters among themselves or the conflict may be minor and will take care of itself over time. Leaders may feel that some issues are small enough not to merit micromanagement.*

- ***Win-win:*** *This approach seek solutions to problems that satisfy both parties. One form of such an approach is called balancing demands for the participants. This is when the manager determines what each person in the conflict wants as an outcome and then looks for solutions that can satisfy the needs of both parties.*

- ***Structured problem-solving:*** *Fact-based approach during which data regarding the problem is analysed by a disinterested observer to support the claims of one of the conflicting parties.*

- ***Confronting conflict:*** *Sometimes it is best to confront the conflict and use active listening techniques.*

- ***Choosing a winner:*** *When differences between the conflicting parties are great, the leader may choose a winner of the conflict and develop a plan of action to resolve conflict between the parties.*

- ***Selecting a better alternative:*** *Sometimes there is an alternative which neither of the parties involved has considered. The leader then asks them to pursue this alternative plan of action.*

- ***Preventing conflict:*** *Skilled leaders use different techniques to create an environment that is relatively free of conflict. These approaches are more strategic and involve organisational design fundamentals.*

b) Briefly describe the stages of a team's development. [5]

⇨ ***See study unit 14; p. 401 – 402 in the prescribed book***

1. ***Forming:*** *The team is composed and the objective for the team is set.*
2. ***Storming:*** *Team members begin getting to know each other and agreements haven't yet been made that facilitate smooth interaction.*
3. ***Norming:*** *Team becomes a cohesive unit and interdependence, trust and cooperation develop.*
4. ***Performing:*** *A mutually supportive, steady state is achieved.*
5. ***Mourning:*** *Team members regret the end of the project, breaking up as a team.*

Question 23

a) Name and briefly discuss the main ingredients to an audit. [5]

⇨ ***See study unit 15; p. 436 – 437 in the prescribed book***

There are three main ingredients to an audit, namely:

- ***Auditing principles:*** *Basic truths and doctrines that indicate the objective of auditing; the basis for the application of audit procedures in a logical manner*
- ***Auditing standards:*** *A measurement of performance or a criterion establishing professional authority and consent*
- ***Auditing procedures:*** *The courses of action available to the auditor to judge adherence to the standards and the validity of the application of principles*

b) The first step in the quality audit process is preparation. State briefly the tasks which need to be performed when preparing for a quality audit. [5]

⇨ ***See study unit 15; p. 437 in the prescribed book***

1. *Develop lists of questions.*
2. *Gather materials.*
3. *Form a list of candidates for the audit team.*
4. *Establish schedules.*
5. *Perform the activities required for the beginning of the audit.*

Question 24

There are regions in which the three spheres of quality overlap. Briefly discuss some of the overlaps between quality management, quality assurance, and quality control and why they are important. [15]

⇨ ***See study unit 1; p. 41-42, study unit 15; p. 429 – 430 in the prescribed book***

None of these three spheres are independent. Chapter 1 presents a simpler view of the three spheres of quality (see figure 1-8 on page 41 of the prescribed book):

FIGURE 1-8 Three Spheres of Quality

Quality Management can be conceptualised by means of the three spheres of quality, namely quality control, quality assurance and quality management.

*The first sphere is **quality control**. The control process is based on the scientific method and this includes the three phases of analysis, relation and generalisation. Activities relating to quality control are, amongst others, as follows:*

- *Monitoring process capability and stability*
- *Measuring process performance*
- *Reducing process variability*
- *Optimising processes to nominal measures*
- *Performing acceptance sampling*
- *Developing and maintaining control charts*

***Quality assurance** is associated with guaranteeing the quality of a service or product. This view of quality states that quality control is reactive rather than proactive – quality problems are detected after they occur. Quality assurance activities include tasks such as*

- *Failure mode and effects analysis*
- *Concurrent engineering*
- *Process improvements*
- *Design team formation and management*
- *Off-line experimentation*
- *Reliability/durability product testing*

Quality management *is the management process that oversee and tie together the control and assurance activities. This integrative view of quality supports the idea that quality is not only the responsibility of quality managers, it is the responsibility of the whole management team. A number of supervisors, managers and employees are involved in activities such as the following:*

- *Planning for quality improvement*
- *Creating a quality organisational culture*
- *Providing leadership and support*
- *Providing training and retraining*
- *Designing an organisational system that reinforces quality ideals*
- *Providing employee recognition*
- *Facilitating organisational communication*

It is important to note that many quality-related activities can occur simultaneously within the "three spheres of quality" framework. Since these activities and tasks overlap, there need to be good communication between the key role players performing the different activities.

3 Examination paper

We do not provide a scope for the examination, because the paper will cover the whole syllabus. However, we did mention at the start of the feedback for Assignment 03 that you need to work through Assignment 03 when preparing for the exam.

If you did well in Assignment 01 and 02 and worked through Assignment 03, as well as the activities and examples in the study guide, you really should not have any problems when writing the exam paper. The paper is straight forward - nothing strange - we don't try to trick you or catch you out. We simply want to see if you understand the topics and are able to carry out the necessary calculations and apply some of the most important statistical techniques. So, to summarise:

- Revise and work through your assignments again (Assignment 01 and 02)
- Work through Assignment 03 (especially the statistical techniques)
- Do the activities in the study guide
- Work through the examples in the study guide
- Practise writing a "demo" exam against the clock (say about 2 hours or so)
- CONTACT YOUR LECTURER FOR ASSISTANCE

The examination paper will cover the whole syllabus (all topics and study units). We therefore urge you not to leave out or ignore any part of the study material while doing your final examination preparation. The format of the examination paper is as follows:

The examination paper counts a total of 70 marks consisting of two sections. Section A contains ten multiple-choice questions, worth one mark each. Section B consists of three essay-type questions and each question has a number of sub-questions. You need to select only two questions from Section B, each counting 30 marks. Therefore, the total for Section A is 10 marks and the total for Section B is 60 marks.

The duration of the examination will be two hours. The final mark for this module will consist of your examination mark (80%) and your assignment marks (20%). Please check carefully the exact date, time and venue of your examination session and make sure that you are on time.

4 Conclusion

We trust that you have enjoyed studying this module in Quality Management and Techniques. Hopefully this valuable new-found knowledge will enable you to apply most of the concepts, principles and techniques in your everyday work environment with great success. Good luck for the examinations!

Kind regards
R Dirkse van Schalkwyk & FJ Hammann

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University of South Africa