



# RESEARCH AND QUANTITATIVE METHODS

## STUDY GUIDE

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MANAGEMENT COLLEGE OF SOUTHERN AFRICA

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## INTRODUCTION

Welcome to the MANCOSA Research Methodology and Quantitative Methods Module.

The MBA Research Methodology and Quantitative Methods Module will serve as an introduction to the research methods and designs relevant to business research. This course will raise awareness of, and enable the student to make methodological choices regarding the completion of not only their MBA research proposal and dissertation, but also, to equip them with the necessary skills for real world contexts and application.

A secondary objective of this course is to get students to reflect upon the research process, and think critically about the choices that are made throughout their research project. The course will provide practical applications for theoretical concepts, with the intention to stimulate the student to think critically and reflect about the decisions that need to be made with reference to every step of their research project.

This Module will cover the following sections through a series of six Chapters:

### CHAPTER 1:

#### **Research steps (QN/QL)**

*Learning Outcomes:*

- To demonstrate an understanding of the steps involved in research, and conceptualise their iterative nature.

#### **Research ideas and Topics**

*Learning Outcomes:*

- To be able to come up with, formulate and assess the viability of research ideas.
- Identify key characteristics of good research questions.

#### **Philosophy and Approach (QN/QL)**

*Learning Outcomes:*

- To understand the context within which projects are situated, so as to ensure that methodologically sound projects are sensitive to the researchers agency.
- To help the student understand which approach and philosophy underpins their intended research, and create an awareness of the implications, methodologically, of all project-related decisions.

## CHAPTER 2:

### Deductive and Inductive research

*Learning Outcomes:*

- The ability to discriminate between the two approaches.
- The ability to relate the need for inductive or deductive research to the research philosophy.
- To relate inductive or deductive approaches to their own intended project.

## Literature Review

*Learning Outcomes:*

- To identify the need for a literature review.
- To determine where the literature review falls in relation to inductive and deductive approaches.
- The ability to demonstrate, through application, the purpose of a literature review.

## CHAPTER 3:

### Research Design (QN/QL)

*Learning Outcomes:*

- To understand the different designs, and their respective suitability to study objectives.
- To apply a research design that is consistent with their research objectives and questions.

## Research Methodology

*Learning Outcomes:*

- Utilise various data collection methods.
- Be aware of, and apply available research methods to their project.
- Determine the relationship between methodology and research design, and objectives.
- Ensure consistency and linearity between research ideas, objectives, questions, design and methods used to answer research questions and achieve objectives.

## CHAPTER 4:

### Data Collection (QN/QL)

*Learning Outcomes:*

- The connection between chosen data collection method, and how this fits with the rest of the project, and achieving the objectives of the study, answering the research questions.

## **CHAPTER 5:**

### **Data Analysis (QN/QL)**

*Learning Outcomes:*

- To distinguish between the available analyses based on project philosophy and objectives.
- To observe the linearity between research ideas, objectives, questions, design, methods, and the type of suitable analysis.
- The application of analysis to intended outcomes.

## **CHAPTER 6:**

### **Research Proposal**

*Learning Outcomes:*

- Application of course content to developing a research proposal.

### **Project Write-Up**

*Learning Outcomes:*

- Grasping how to write-up projects, within their respective approach and philosophy.

The chapter will run parallel with research proposal development. Each section covered in the chapter will be practically applied to the associated sections in the proposal. Learning outcomes will be evaluated and demonstrated through this research proposal which will conclude with lectures.

# CHAPTER 1: INTRODUCTION TO RESEARCH STEPS, RESEARCH IDEAS AND TOPICS



## **Prescribed Reading:**

- Saunders, M.N.K., Lewis, P., & Thornhill, A. (2009). Research Methods for Business Students (5th ed.). Harlow, United Kingdom: FT Prentice Hall.
- Greener, S. (2008). Business Research Methods. Available from:  
<http://bookboon.com/en/textbooks/management-organisation/introduction-to-research-methods>.

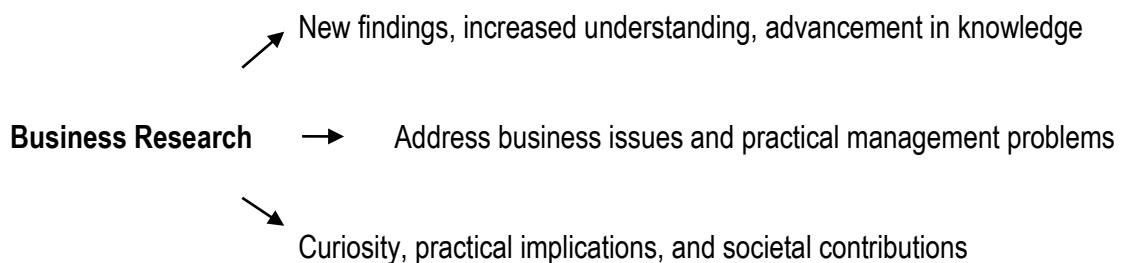
***Let's start from the very beginning***

**Why even do research at all?**

**Firstly, what is research?**

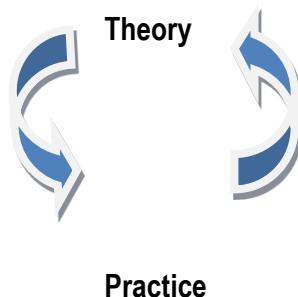
Research is essentially the systematic, rigorous collection and analysis of data, guided by a clear purpose, which is utilised to increase knowledge on a particular topic area.

When we talk about business research, what we are essentially implying is that it is research, to find out, in a logical and systematic succession, matters related to business and management.



Business Research is very important, and is essential in making decisions related to business and managerial activities, and guards against “gut reactions” that most likely lead to erroneous and ill-afforded outcomes. Often managers are under pressure to make decisions, and occupy high positions where answers and decisions need to be taken immediately, leading them to instances where the application of research goes unobserved. Managers often rely on personal experience rather than gathering information systematically to inform decisions. The importance of research in making informed decisions that often lead to personal and commercial success cannot be overstated. But, in order for

research to be successful in the business environment it is imperative that new ideas be developed, and applied practically. The cyclic nature of research should be observed at all times:



Essentially all management and business research projects fall along a continuum:



#### **Basic/Pure Scientific**

- explaining the world around us and trying to understand how the universe operates.
- finding out what is already there without any greater purpose of research than the explanation itself.

#### **Applied**

- look for answers to specific questions that help humanity
- testing theories, often generated by pure science, and applying them to real situations.
- Has direct and applicable findings.

**Ultimately: Research is conducted to find information and/or understand something!**

In Management Studies, we are more interested in APPLIED Research.

**THINK POINT:**

Think of a situation where you have been tasked with making a decision at work:

- Did you have to make a decision in a hurry?
- Was there a lot of pressure on you when you had to make this decision?
- Did you wish you had more information to make a better informed decision?
- Were the results of your decision desirable?
- Would your decision have been better made if you had more information available to you?
- Could your decision have been better?

Alternatively, think of an instance when a poor decision was made at work:

- Could a better decision have been made if there were more information available to the parties making the decision?
- Could a better understanding of the situation at hand have led to better outcomes?
- Were all issues addressed through the decision that was made?

Most people have failed to see the relevance and importance of decision making based on sound statistical evidence, often with the consequence of making decisions based on gut reactions (John and Johnstone, 2002). Often employees perceive research and statistics as playing no part in their daily activities. The grounding for why this misconception persists is inconclusive. Studies have suggested shortfalls in the manner in which business statistics are taught (Easton, Roberts and Tiao, 1986). Others speculate it has something to do with the complicated, mathematical nature of statistics (John and Johnstone, 2002). Regardless, the benefits of incorporating statistics into business-related decision making have been an integral component of any leading market firms' strategy. Without it, uninformed decision making invariably leads to ill-afforded, misguided and unreliable outcomes.

Understanding and applying statistical concepts are needed not only to complete and excel in one's dissertation, but also to make informed decisions in the workplace. Most middle- to upper-line managers are often confronted with work demands beyond the ambit of their academic studies, which hinders them from effectively applying basic statistical concepts. However, gaining research and statistical know-how is imperative to all aspects of both work and academic life. This chapter will highlight the core concepts of performing research, and ensuring successful, well-informed decisions.

So let's review how to actually do research.

**THINK POINT:**

Do you think a company as successful and innovative as Apple make decisions without doing research?

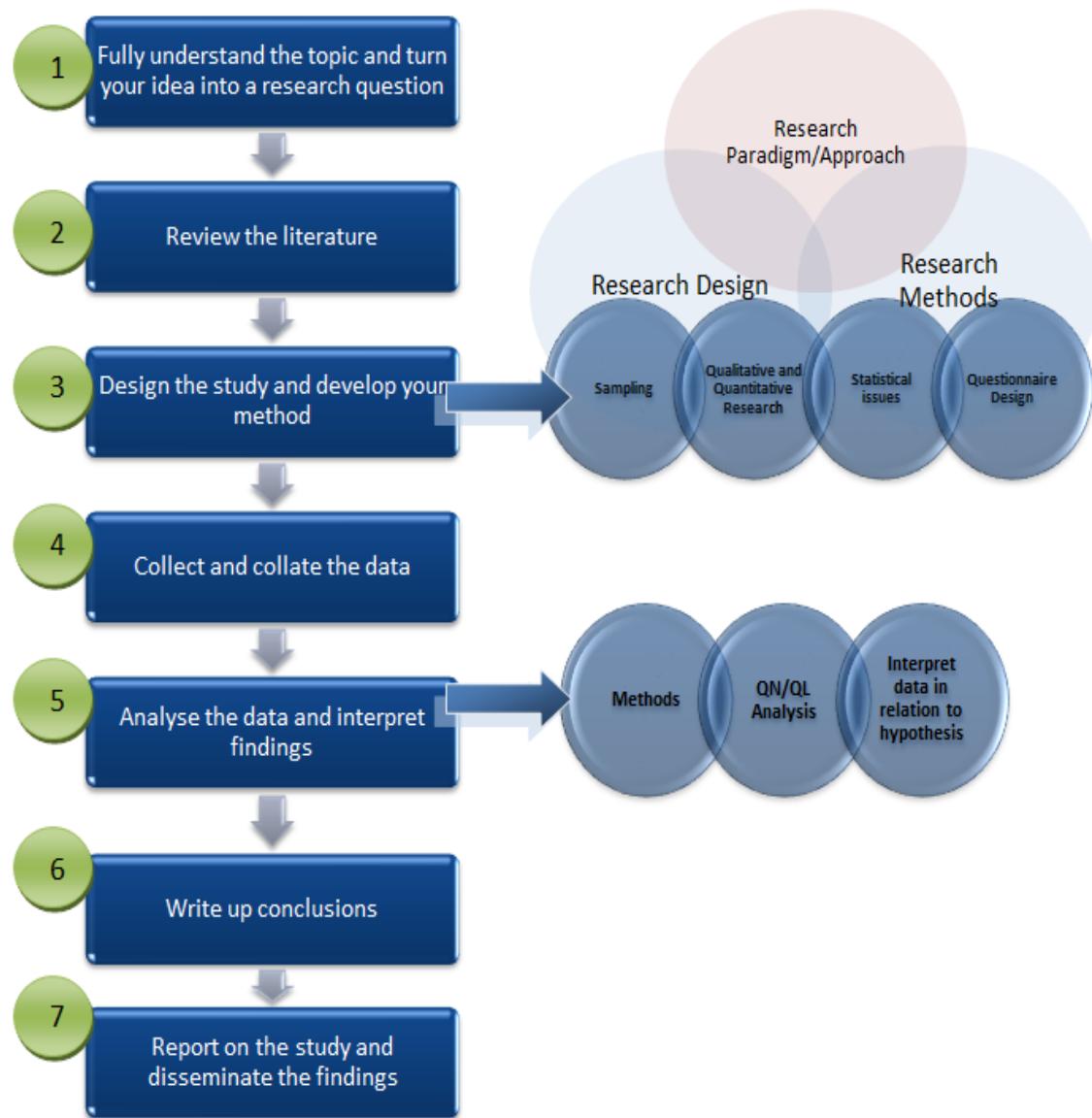
- How do they keep abreast of the competition?
- How do they know which projects to run, and the boundaries thereof?
- How do they know what their market wants?
- How do they identify opportunities in the market?
- How did they come to occupy a niche?
- How do they manage to be so capital efficient?

**How do we actually do it?**

There are numerous steps involved in conducting research. The important thing to remember though is that they are not neatly and rigidly set out and adhered to. The steps are essentially reflective and iterative, and often the researcher will need to visit and revisit each step.

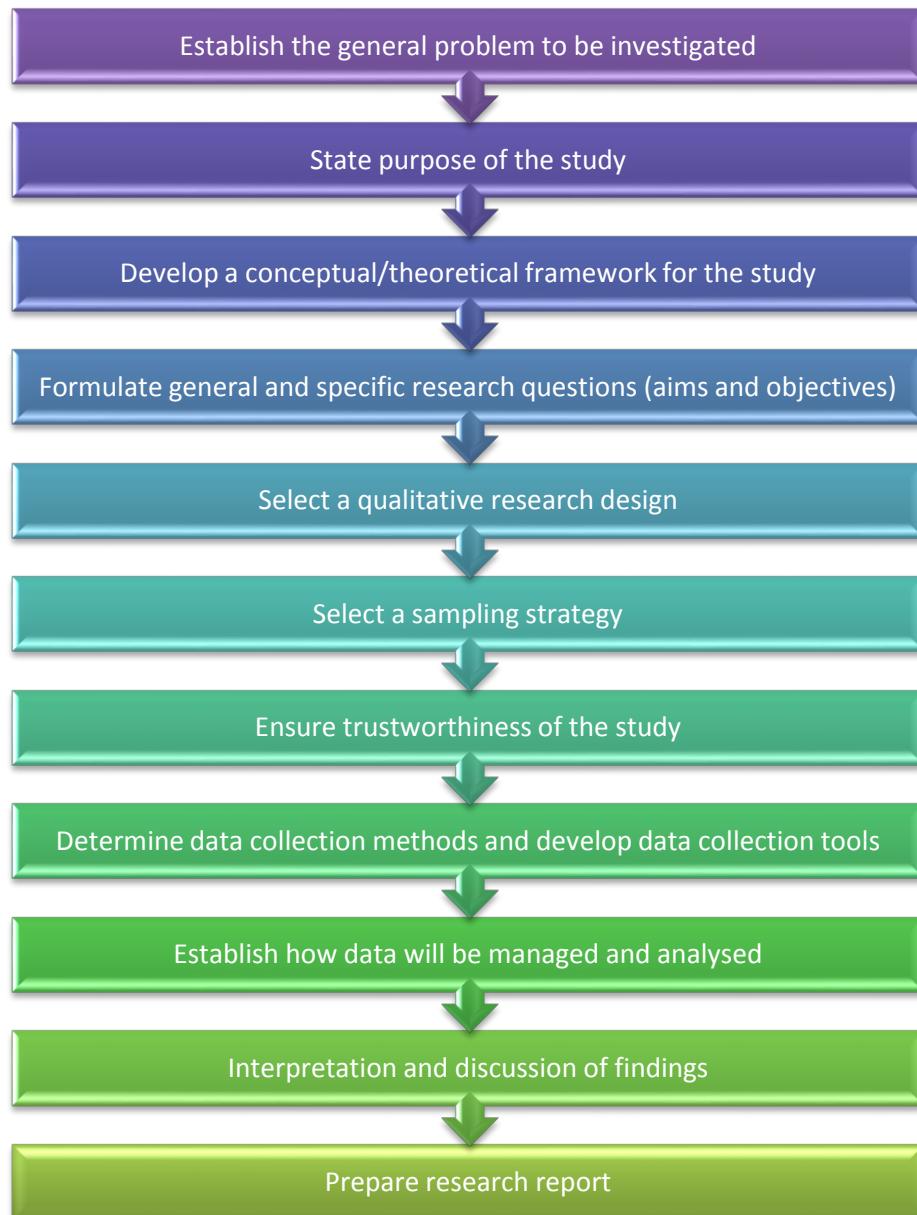
Ideally, there are basic steps to performing both Qualitative and Quantitative Research, They are essentially the same. However, there are subtle differences. For illustrative purposes they have been diagrammatically presented here.

## THE QUANTITATIVE RESEARCH PROCESS



**Figure 1.1 Steps to performing Research**

## THE QUALITATIVE RESEARCH PROCESS



**Figure 1.2 Steps to performing Research**

This Chapter will be structured around these basic steps, and the information relevant to ensuring that you, as a researcher, have thought and reflected logically through each step, to ensure your output clearly, accurately, and reflectively answers your research questions.

## Research Idea and Topic

How do I come up with a research idea?

- By looking at subjects you have already completed.
- Looking at recommendations made by past projects.
- Discussions with others (tutors/lecturers/peers).
- Available literature and preliminary literature searches in areas of personal interest/experience.
- Observations in your workplace.
- The media.

### THINK POINT:

Think of an area in which you will be interested in researching. Possible avenues to think about include:

- Your current employment – are there any shortfalls or gaps in current processes, services provided, employee dissatisfaction, demotivation, “going green”, customer dissatisfaction, programme implementation and change? You could explore people’s perceptions relating to change
- Try to converse with colleagues, friends, lecturers, in order to gain ideas. Most people are likely to be able to give you an idea, or some insight into a business management problem.

Once you have come up with a research idea, you need to ensure that you refine it further. You can brainstorm with peers/lecturers/other colleagues, you can also discuss with others with similar interests in effort to generate and choose a more specific research idea) and trial-running a preliminary study.

### Topic:

You need to ensure that you find the topic personally appealing. However, it needs to be feasible and necessary.

You need to think about whether your topic:

- Meets the criteria for the institution
- Does it excite your imagination?
- Do you have the necessary skills to investigate it?
- What constraints are you operating under?
  - Time constraints?
  - Access
  - Resources
  -

**What makes a good topic?**

- Capability
  - o Is it feasible?
- Appropriateness
  - o Is it worth it?
  - o Is it over-researched?
- Does your topic link to theory?
- Is there enough time to complete the project?
- Will your topic provide fresh insights?
  - o If not, will it test an existing theory for validation?
- Is your topic a management topic?
- Is your topic ethically sound?
- Have you focussed on a time period, geographic location, culture, individual or groups?

Often the title is only finalised at the end of the study project and the study can't always be judged on the title alone; the entire research proposal must be evaluated in order to really make a decision on the viability of the proposed research. There is often a disjuncture between the title and the rest of the study. You need to ensure that by the time you have written the proposal up, and refined your ideas, and the methods to be employed to ensure the aims, objectives and research questions have been adequately answered and met, that the title still reflects what the study is about.

Often the interrogative pronouns assist in topic assessment (5 W's):

<b>Who?</b>	<b>Population/Organisation/Gender?</b>
<b>What?</b>	Behaviour? Attitude? Event? Any point of interest
<b>Where?</b>	Geographic location? Company? Organisation?
<b>Why</b>	Reason for the topic?
<b>When?</b>	Time period for the point of interest

Let's look at some examples.

**Example 1: Analysis of best equity evaluation method for the JSE-AltX**

The topic was disallowed, can you guess why?

Basically, the student was over-ambitious, here's why:

- The submission did not meet the requirements for the institutions level of study requirements.
- Equity evaluation is very broad.
- There is no focus on period, sample.
- Not feasible, and time constraints for such a large, unspecified project will prohibit completion.

**Example 2: The effect of poor management controls in organisations, as evident in cases held at the XYZ Crimes Court**

This topic was also disallowed, here's why:

- Ethically unsound!
- Student wished to look at instances of fraud and corruption – extremely sensitive, and implicating topic, which raised ethical concerns regarding the intended project.
- Issues of access – how was the student going to gain access to this type of information?

**Example 3: The case for improved government resource allocation for road infrastructure in Shellway**

Topic was turned down:

- Not related to business management.
- Suggestions were made to the student requiring a current business management problem be addressed.
- Government level studies are problematic, especially if study purports to make recommendations to change policy as this is rather ambitious.
- Issues of access to government data and resources.
- Sample too large, and if representative sample was collected – the size of the project.

**Example 4: An exploratory study on the importance of extending the product line at ZYX Profit Builder, Western Cape, on its 2013 profitability**

This is an example of a good topic.

- The topic is refined – geographic location, company defined (WHO).
- Variable of interest mentioned (WHAT).
- Ethically sound.

- Type of study mentioned.
- Links to theory, but due to new context could lead to new insights.
- It's small enough to render feasible, and big enough to warrant an MBA dissertation?
- It addresses a current management problem.

**Example 5: An investigation into management of managers and supervisors not putting much effort in the motivation and inspiration of employees in work environment**

This is an example of a bad topic.

- Title is too ambiguous, does not make sense.
- Not academically written.
- Makes an assumption about the employees level of inspiration, and the level of effort of managers and supervisors.
- Objective is not clear.
- Topic too broad – what work environment?
- Too many variables of interest, i.e. managing managers, employee inspiration, effort level of managers – time and resource constraints.
- What type of study is this? Exploratory? Explanatory? Descriptive? Longitudinal? Cross-sectional? Qualitative? Quantitative? Etc.

**Example 6: Succession planning for family-business survival – A case study of Sweet Bee Sugar Estate, Mauritius**

An example of a good topic.

- Specific, focused.
- Answers the 5 W's.
- Area of current interest.
- Practical application, will contribute to furthering understanding, contextually and theoretically.



**ACTIVITY:**

Now that you have developed an idea of study, try to think of the exact topic, and refine it according to the criteria mentioned above.

Subject it to the 5W's test. Is it specific enough? But is it still useful?

Now that you have your research topic, have you refined your research idea by ensuring that you have identified the research area, field, and aspect of interest – you will need to think about your exact research questions.

For illustrative purposes, a topic will be selected, and provided as an example running throughout all of the research steps, until completion of the research proposal. All items relating to this topic in relation to:

**Idea:** The NHI fund will only contract health facilities that meet strict quality standards as certified by the Office of Health Standards Compliance (OHSC) to guarantee that standards of hygiene, safety and respect for patients are being met (DoH, 2011c:31). Whilst the government predicts it will take 14 years to complete the NHI project, a 132 bed private hospital in a previously disadvantaged community of the Cape Flats, in the Western Cape, has adopted a long term strategy to be ready for the business changes NHI will bring. The hospital operates at 100% occupancies according to its licensed acuties and specialities already. If the price paid for services is to be reduced then it can be anticipated that revenue will be reduced since sales cannot be increased sufficiently to counterbalance decreased turnover. If the hospital still wants to maximise profits then the hospital has to proportionately reduce expenses. The reduction of expenses cannot sacrifice quality if the hospital wishes to meet OHSC standards to contract with the NHI fund or continue to provide safe services to patients.

Therefore two critical success factors have been identified; one, the ability to meet the quality standards of OHSC and two, the ability to reduce expenses. The significant challenge is reducing the underlying costs in a system where prices are set by the market and not the hospital. Given WHO (2010:79) estimates that 20–40 % of all health spending is waste and suggests that low-income countries could save 12–24 % of their total health spending annually by improving hospital or workforce efficiency, hospital management has identified the tools and philosophies of Lean as a good strategic fit to meet the critical success factors of improving efficiencies whilst eliminating waste.

But Bhasin and Burcher (2006: 56) and Drake, Brennan and Gortz (2008:303) reveal only 10% of Lean change initiatives are successfully implemented. A major contributing factor to the failure is a focus on the technological tools of Lean without an equal focus on the people (Graban 2009:133; Liker 2004:358; Bhasin and Burcher 2006:62). Denison and Spreitzer (1991: 2) advise that organisational development researchers have learnt that core values and assumptions are at the root of organisational systems and structures and in order to change an organisation one must first examine the relationships between underlying values, organisational structures and individual meaning.

To remain profitable when NHI changes the way the hospital conducts its business the Hospital Administrator has chosen to execute a new corporate strategy of Lean management. Unfortunately the first step of the first Lean tool attempted failed to be adopted by the staff. Research into this management problem revealed that organisational culture can impede the successful execution of a Lean strategy. The purpose of this study is to investigate the culture and sub-cultures of the hospital using the Competing Values Framework to establish whether Lean can be implemented within the context of the existing culture or if cultural transformation will be needed ahead of the Lean strategy execution.

**Topic:** Cultural Factors Influencing the Implementation of Lean Management at a Private Hospital in the Cape Flats

A glance at the title tells you:

**How?** examine the hospital's existing cultural typologies, cultural strength and cultural congruence using the Competing Values Framework

**Who?** A private hospital in the Cape flats

**What?** It tells you what variables they wish to measure i.e. cultural typologies, cultural strength and cultural congruence

**Where?** And it tells you the location i.e. the Cape Flats

**Why?** is to investigate the culture and sub-cultures of the hospital to determine whether Lean can be implemented within the context of the existing culture or if cultural transformation will be needed ahead of the Lean strategy implementation

Each section will appear in As follows:

### **Research Objectives**

These are essentially indicative of a clearly defined purpose, and direction. Saunders, Lewis and Thornhill (2009) contend that research objectives allow for more detail and specificity than research questions.

Essentially research objectives should pass the “SMART” Test (Maylor and Blackmon, 2005)

- **Specific** – exactly what is intended to be achieved through the research
- **Measurable** – how will you measure variables to achieve outcomes?
- **Achievable** – are objectives achievable?
- **Realistic** – will you be able to complete your research given time, and personal resource constraints?
- **Timely** – timelines are always very tight when completing your research – will you be able to

**ACTIVITY:**

Now that you have a topic, think of how you are going to investigate that topic – what are you ultimately aiming at achieving through your research? Now subject it to the test!

Can you measure it?

Can you achieve the objectives within a limited time, and with limited resources? Remember – decisions often need to be made quickly!

In essence you need to ensure that you have a firm grasp on the context within which your research falls, such that the validity and viability of your topic can be well understood. This will allow for a quality assessment of the clarity of research questions, and research objectives, which should essentially inform the structure your research should take. Every decision that you will take now that you have defined and clarified your topic will hinge on your research objectives, and invariably, your research aim.

The aim of this study is to analyse the existing culture and sub-cultures of the organisation in order to determine the cultural impact on management's intention to implement a Lean strategy at the hospital. Comparisons will be made from the findings of the primary data obtained, through the administration of the Organisational Culture Assessment Instrument to the staff. It is expected that the results of the research will require that management transform the existing culture before implementing a Lean strategy.

**RESEARCH OBJECTIVES**

- To examine the hospital's cultural typologies using the Competing Values Framework.
- To establish the extent of cultural congruence in the hospital.
- To understand if the existing culture is compatible with the Lean cultural elements required to sustain the strategy.
- To understand to what extent the culture will constrain or facilitate the strategic change initiative.
- To make available recommendations to hospital management for the successful implementation of a Lean strategy.

## Research Questions

It is impossible to answer Research Objectives, as they are statements, rather than questions. So in order for us to conduct research, and find answers that will ultimately achieve the aim of your study, we need to convert our research objectives into research questions.

This is possibly the most important stage of your research project. You need to ensure that you have **clear** and **concise** research questions, as every other aspect of your project will hinge on them. The design you choose, the methods you use, the manner in which you analyse and write your project up will ALL be geared towards answering your research questions. All the data you collect has to answer, with clear conclusions, your research questions.

### How does one ensure that they get their research question just right?

Subject them to the “Goldilocks” (Clough and Nutbrown, 2002) test!

#### Research questions that are:

Too Big – Need substantial funding and resources.

Too Small – of insufficient substance.

Too Hot – Topic is too sensitive, and holds potential to upset people.

Just Right just right for this time, by this researcher, in this research setting.

Be sure that your research questions yield new insights into a subject. Be sure that you have read substantially to avoid replication of others' work.

You can test the viability and applicability of your research question against these criteria. Is it:

- Too easy to answer?
- Too difficult to answer?
- Is your research question easy to understand?
- Does your research question contain jargon?
- Do your research questions clearly spell out the variables under investigation?
- Are they biased in any particular direction?

#### In general, the research questions differ across paradigms:

##### Quantitative research questions

- **Descriptive** – How much, how often, basically – identify relationships between variables
- **Predictive** – Identifying variables that can be used to predict certain outcomes
- **Causal** – different variations of a phenomenon to identify the cause

### Qualitative research questions

- Lived experience
- Insider' perspectives
- Context Meaning oriented rather than measurement oriented
- Use qualitative words e.g. explore, understand, discover
- Begin with words such as “how” or “what”
- Tell the reader what you are attempting to “discover,” “generate,” “explore,” “identify,” or “describe”



#### ACTIVITY:

Now you have your objective clearly thought out, will you be able to answer it?

How will you answer it?

How will you “measure” what you wish to find out?

Are you sure people will be interested in your answers?

*Let's look at some examples of good research objectives and research questions*

Research Objectives	Research Questions
1. To identify the organisations objectives for introducing the new information policy	1. Why has the organisation passed the new information policy?
2. To determine suitable criteria for measuring the impact of the new information policy	2. How will the impact of the new information policy be measured?
3. To describe the extent to which criteria for measuring the impact of the new information policy have been met	3. Has the new information policy been effective?
4. a. To determine what factors are associated with measuring the impact of the information policy b. To determine which factors impact on outputs more than others	4. How can the impact of the new information policy be explained?

Another example:	
1.a. To determine the factors associated with the effectiveness criteria for team motivation sessions. 1.b. To assess if some team motivation activities are more effective than others in increasing motivation	1. How can the effectiveness of team motivating sessions be explained?

Let's look at some examples of poor research objectives and research questions

Research Objectives	Research Questions
1. Measure poorness of FA (knowledge and proficiency) skills within SMEs.	1. Are MIS's an issue in FRK?
2. Measure MIS usage effectiveness in SMEs.	2. Does knowledge and skills of financial administrator MISs and FAs affect the poor quality of FRK?
3. Measure FRK cost effectiveness in SMEs.	3. What impact does a lack of MIS software package have on on SMEs?
4. Determine the effects of FA skills, MIS and FRK on SME growth.	

These are examples of very poor

Research Objectives:

- Use of Jargon
- The objectives are not justified – merely wish to measure
- They are too difficult to answer as measurement is not explicit
- Not easily understandable
- Suggest a biased perspective (Objective 1) with regard to “FA” skills

These are examples of poor Research Questions as

they:

- Use of Jargon
- Not easily understandable
- Do not follow logically from the research objectives – no linearity between the objectives and the questions – yield invalid results, and design direction

Research Objectives	Research Questions
<p>It is necessary to produce sugar at sufficient and sustainable levels in ways, which enhance the economic growth of the country with high returns on shareholders' investments?</p>	<ol style="list-style-type: none"> <li>1. How does the subsidiary's succession plan fit into the overall strategy for Sugar Bee?</li> <li>2. How does localization fit into the overall strategy for the business?</li> <li>3. So many skills were imported from neighboring countries, is the training and development strategy in line with the succession plans, goals and objectives of the organization?</li> <li>4. How best can the succession plan enhance business survival?</li> <li>5. What challenges does the subsidiary face in its succession planning?</li> </ol>

### Continuation of the NHI example

#### The Research Questions:

- What are the hospitals cultural typologies using the Competing Values Framework?
- How congruent is the organisational culture of the hospital?
- Is the existing culture compatible with the Lean cultural elements required to sustain the strategy?
- To what extent will the existing culture constrain or facilitate the strategic change initiative?
- What recommendations can be made to the management of the hospital to procure a successful Lean strategy execution?

## **CHAPTER 2: RESEARCH PHILOSOPHY AND APPROACH - INDUCTIVE AND DEDUCTIVE RESEARCH LITERATURE REVIEW**

### **Learning Outcomes:**

After this Chapter, you will

- be able to situate your proposed study within a particular research philosophy.
- be able to determine the meaning of situating your study within a particular paradigm.
- determine the importance, and value of a literature review.
- determine the role of the literature review in your study.



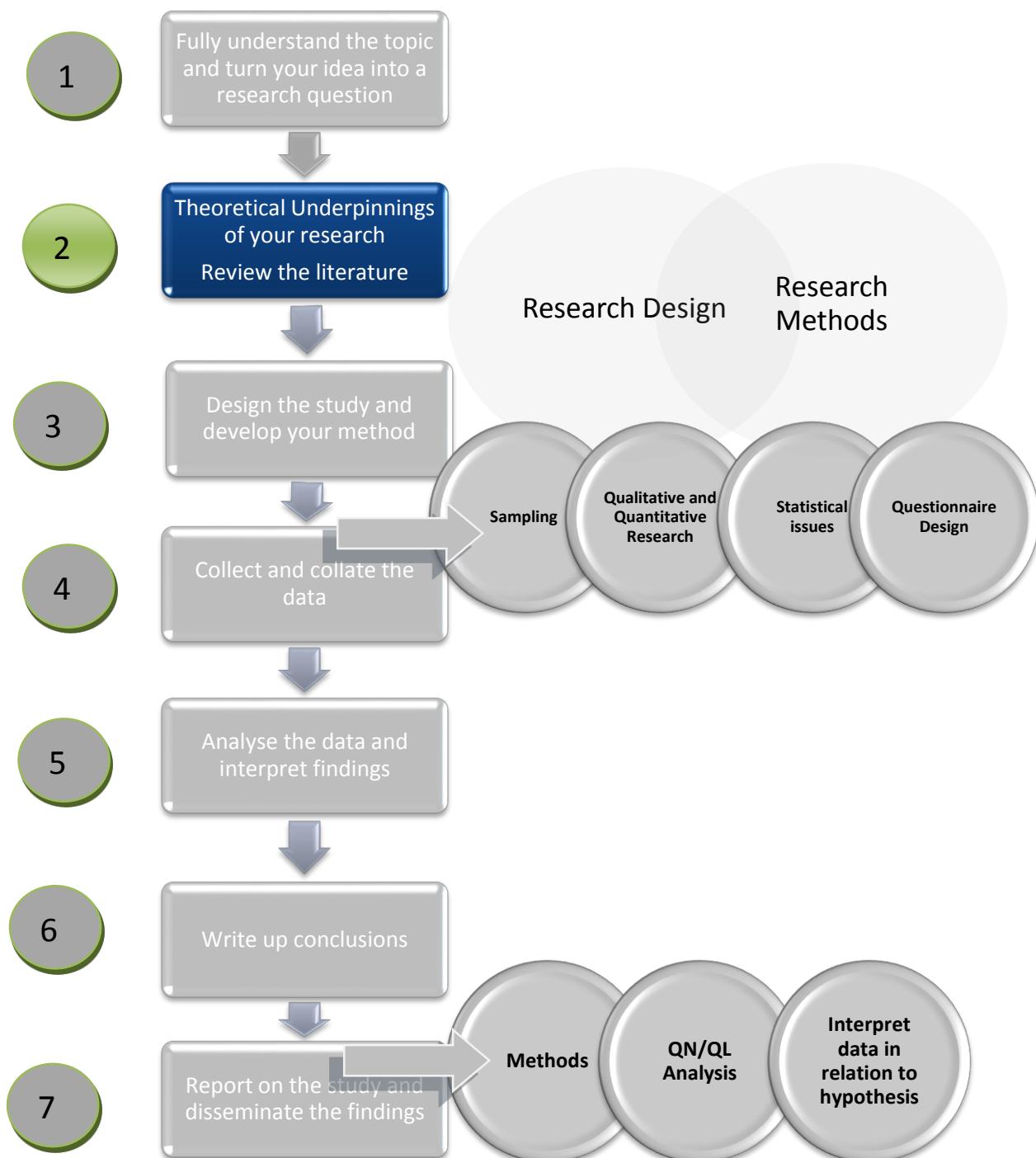
### **Prescribed Reading:**

- Saunders, M.N.K., Lewis, P., & Thornhill, A. (2009). *Research Methods for Business Students* (5th ed.). Harlow, United Kingdom: FT Prentice Hall.
- Saunders, M.N.K., & Rojon, C. (2003). On the attributes of a critical literature review. Accessed 22 January, 2013, from:  
[http://epubs.surrey.ac.uk/7386/2/Lit\\_review\\_paper\\_for\\_Coaching\\_final.pdf](http://epubs.surrey.ac.uk/7386/2/Lit_review_paper_for_Coaching_final.pdf)
- Greener, S. (2008). Business Research Methods. Pages 19-30. Available from:  
<http://bookboon.com/en/textbooks/management-organisation/introduction-to-research-methods>

### **Recommended reading:**

- Creswell, J.W., & Garrett, A.L. (2008). The movement of mixed methods research and the role of educators. *South African Journal of Education*, 28, 321.333.

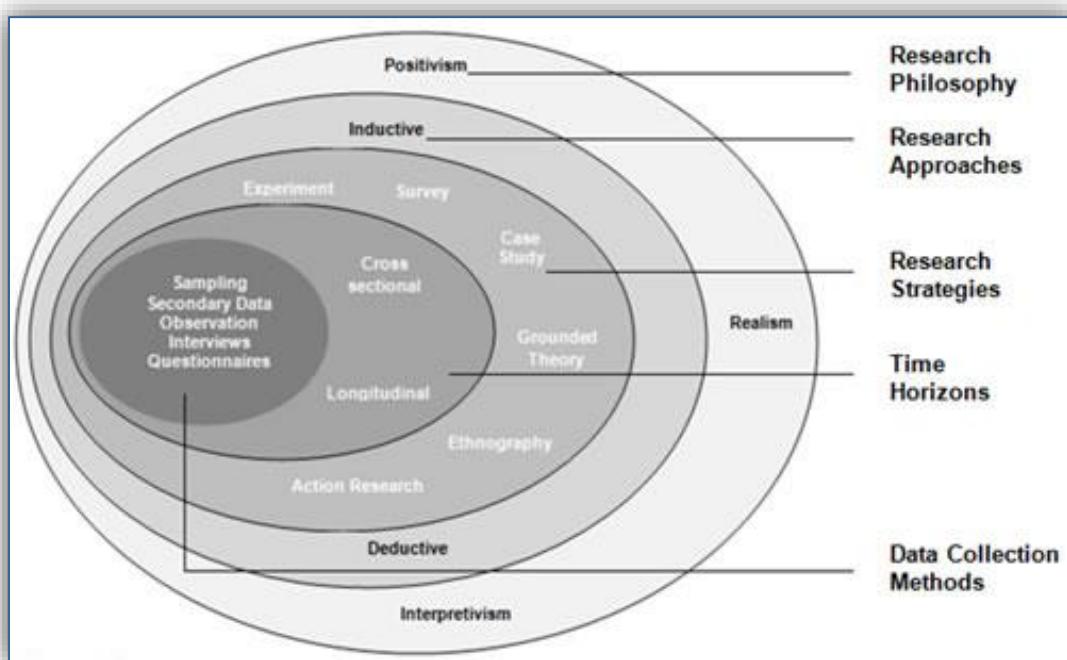
## The Quantitative Research Process



## Research Paradigm, or Approaches to Research

As a researcher, you need to understand how you see the world around you, and how this influences the research process.

Ultimately, the type of data we can collect i.e. the nature and development of knowledge, is determined by the philosophy within which the data is collected. To depict exactly what is meant by this statement, let's refer to the Figure 2.1, known as the research "onion".



**Figure 2.1 The research onion**

Source: Saunders, Lewis and Thornhill (2009: 108)

It is important to be aware of the philosophical underpinnings of your research, however, it is even more important to be aware of how these assumptions have come to inform the type of information you collect about it, and the means you have used to collect it.

Your research question will be framed within a particular **research philosophy**. It is important to embrace the strengths and weaknesses inherent in that philosophy, and the types of answers you can draw from it. In a way, your research question will lean itself towards a particular philosophy that would yield the most suitable answers.

**Epistemology** is intimately bound up in **ontology** and **methodology**. Where ontology examines the philosophy of reality, epistemology entails how we came to know that reality, and methodology entails the processes through which we used to attain it (Krauss, 2005). Some authors go further, and draw a distinction between methods, and methodology, where the former denotes the steps and processes taken to generate data, whereas the latter refers more to the research approach and strategy used to answer research questions.

***Epistemology poses the following questions:***

What is the relationship between the knower and what is known? How do we know what we know?

What counts as knowledge? (Krauss, 2005: 759).

What constitutes valid knowledge and how can we obtain it?

What is the nature of knowledge and the relationship between the knower and the would-be known?

Is there a ‘real’ world ‘out there’ that is independent of our knowledge of it?

***Ontological Questions:***

What constitutes reality and how can we understand existence? What is the nature of reality?

***Methodological Questions:***

How can the knower go about obtaining the desired knowledge?

Essentially there are two types of ontologies, namely foundationalist, objectivist ontology which adopts **positivist** epistemology, and anti-foundationalist, subjectivist ontology with an **interpretivist** epistemology. The latter denotes a reality wherein meaning is contextualised. Unlike the positivist stance, meaning, and therefore reality cannot be inferred independently of the actors within the social realm. What we mean here is that social phenomena that we observe, record, and attempt to “measure” are created by social actors’ perceptions and actions, and cannot be understood outside of those social interactions themselves.

On the other hand, objectivist stances believe that reality exists independently of these social actors, and can therefore be measured and understood independent of the social context.

### Research Paradigm Approaches to Research

**Within the Positivist and post-Positivist paradigms** (Mertens, 2009: 14):

**Ontology** – one reality exists, and it is the task of the research to discover that reality through strengthening theory by eliminating alternative explanations

**Epistemology** – Objectivity is achieved through neutrality on the part of the researcher. This objectivity allows for limited influence of the researcher on outcomes. A good example of researcher neutrality is through blind and double-blind experiments.

**Methodology** – Application of the scientific method = Quantitative.

**Example of underlying positivist paradigmatic assumption.**

*An employee wished to determine the effect of an autocratic style of leadership on employee motivation*

**Ontologically:** Objective reality is assumed, and through systematic and rational investigation the causal laws can be arrived at. In other words, if we were to quantify and measure motivation, when confronted with a behaviour defined as authoritarian, then we will be able to measure the causal relationship underlying the two variables. The causal relationship that will be arrived at, all things constant, is that when presented with a behaviour characteristic of autocratic leadership (e.g. making a decision without consulting employees), employee motivation will decrease.

**Epistemologically:** The researcher is independent from what is being observed. The researcher, by measuring the variables, has no influence on what is being measured, and the measures made on motivation are real measures – independent of the subjectivity and agency of the researcher.

**Methodologically:** Theory is used to operationalise the constructs. In other words, what constitutes autocratic leadership is quantified into measurable constructs, like, does not involve employees on decisions, leader dictates work methods, no trust between leader and employee, and motivation is defined as a general willingness or desire to do something. Hypotheses are set up, **for example**, the more the leader excludes the employee from important decisions, the less willing the employee will want to complete tasks. The constructs are measured, usually through a questionnaire format, that yields numerical data, and this is analysed statistically.

### **Example of underlying interpretivist paradigmatic assumption**

**An employee wished to explore the perceptions, and feelings employees experience when confronted with an autocratic style of leadership in their workplace at ABC Trading Durban**

**Ontologically:** Subjective reality is assumed, meaning can only be derived at through the lived experience of the employee who was subject to autocratic leaders. This lived meaning is socially constructed, and can only be understood from the viewpoint of the employee. There is no objective reality that the researcher can arrive at, and measure.

**Epistemologically:** The researcher is not independent from what is being observed. The researcher influences what is being investigated and their own subjectivity and agency influences the process and outcomes of the research. For example, if the researcher was a member of management, then employees are most likely not going to be as honest about their answers as if the researcher was a fellow employee, or independent to the organisation. Furthermore, the researchers own feelings and experiences influence the process, and how they interpret what is being said, and how they respond to it.

**Methodologically:** Most methods for investigating subjectivist topics tend to use interviews, transcripts, focus groups, and other interactive processes to arrive at understandings. A good knowledge of the topic area is required; however, subjectivist research tends to lean itself more to theory generation, than using theory to operationalize constructs. The researcher, a motivational expert, will conduct interviews with the employees, and ask them questions relating to leadership styles, motivation, and probe for answers specific to understanding the effect of autocratic behaviour on employee motivation.

### **Within the Subjectivist Paradigm (Mertens, 2009: 18):**

**Ontology** – Reality is socially constructed. There is no one objective reality, but rather multiple realities, or social constructions of meaning and knowledge.

**Epistemology** – The researcher and the researched influence each other. Objectivity gives way to confirmability as data, interpretation and outcomes are related to the context, and people, separate from the researcher himself.

**Methodology** – because meaning and knowledge is situated within the context, and subjects, and the interaction between the two, methods used are primarily interviews, observations, document reviews and other interactive methods.

You can see how the nature of how we view reality and meaning underpins the manner in which we can come to understand the world around us. This view contains a set of assumptions, and the tools available to generate and capture this understanding. Most of the time, these underlying assumptions are not explicit, but reveal themselves through the chosen methodology and approach. Embedded within the subjective and objective ontologies, we find attached to them research paradigms. There are two broad research paradigms, with their own methodological assumptions, quantitative and qualitative, where the former tends to fall under the ambit of foundationalist ontologies, and the latter, anti-foundationalist.

Ontologies and research paradigms serve the purpose of helping researchers conceptualise how they view reality, and to assist people reading that research in coming to understand and make value judgements on how the researcher came to investigate aspects of reality under the pertinent assumptions, and associated research tools applicable to that world view. The type of paradigm to which the researcher subscribes will influence his/her approach, and methods used to research phenomena. We have two -general approaches to research, the quantitative and the qualitative, where the former most often associates itself with the positivist ontology and the latter the subjectivist.

Reasons why you should ground yourself in a particular approach include:

- It informs your research design
- Define research strategies applicable to answering your research questions
- Allows you to think about the limitations of your research design, and try to overcome them

The approach that is used tends to come with its own set of methods, and methodology. Each method has its own limitations, and the positivist epistemology in particular has been criticised. Positivism purports the possibility of objectivity. Objectivity is only possible when the measuring “reality” is done without obstruction, influence and bias.

However, since research is conducted by humans, it is our own assumptions, and views that make objectivity impossible. No person is without assumptions, emotions, and subjectivity. When we interpret what we are seeing, this is bound up in subjectivity, and therefore clouds pure observation. According to Hollis and Smith (1990: 55), when we test a theory, the theory itself shapes the observation, and therefore no objective observation can exist without theory.

Conversely, interpretivist epistemologies are criticised for its validity and subjectivity (Marsh and Furlong 2002; 27). Due to the lack of claims for objectivity, it is difficult to assess the validity of findings.

Qualitative methodologies, for example, should be chosen when:

- Theory tends to sway away from surveys and experiments.
- Concepts and theory are not developed and sufficiently defined to develop and test hypotheses.
- Very little theory to build questions upon.
- Need to learn about the deeper meaning, intimately bound up with individual realities.

An example using the hypothetical study will be presented following the literature review section.

#### THINK POINT:

You have thought of your topic, the types of questions you want to ask, in terms of the above reviewed philosophies, you need to see which philosophy will best answer your research questions:

- textual/words/written or numerical data
- inductive or deductive research
- Measuring or understanding a phenomenon

#### But what exactly are Qualitative and Quantitative Research Approaches?

Qualitative research attempts to understand human action from the perspective of the social actors themselves in effort to describe, and understand, rather than explain, their actions (Babbie and Mouton, 2005). Methodologically speaking – researchers use qualitative research as a method to study social action. It is characterised by (Babbie and Mouton, 2005: 270 – 273):

- **Naturalism:** Understanding human action, attitudes, behaviours within their natural settings i.e. where the social behaviour occurs and not in laboratories.
- **Process:** Study social changes over time, and as they occur, rather than reconstructing them.
- **Insider Perspective:** Understanding the world through the eyes of the researched. This is known as an insider, or “emic” perspective.
- **Description and Understanding:** Describing actors’ actions in great detail, and thereafter attempting to understand them within the social actors’ own beliefs, history, and context. It is important to note here, that this type of description is VERY different from quantitative description in that it does not emphasise numbers, counting, etc, rather on providing “thick”, lengthy descriptions of actor’s actions in effort to stay true to the meanings of the actors themselves.

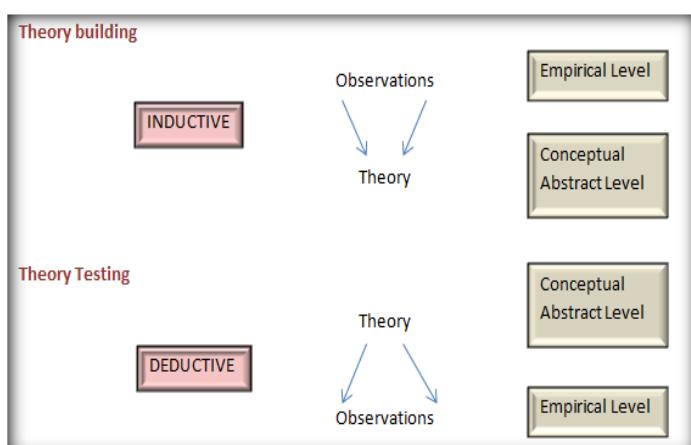
- **Context:** Understanding human action, beliefs, attitudes within the context within which they would otherwise naturally occur.
- **Idiography:** examines, and attempts to understand a phenomenon, or event within the larger context within which it occurs.
- **Intersubjectivity:** the dynamic interaction between the researcher and the researched, as both actors act, and react to each other. The onus is therefore on the researcher to bracket their assumptions, or holding back, or suspending one's own assumptions as a researcher to create a truthful and credible account of observations.

Quantitative approaches to research on the other hand attempt to isolate, and generalise phenomena to a hypothetical population. It is characterised by simulating events in controlled environments, isolate the key variables that a particular phenomenon exists (operationalisation), and generalise or draw inferences regarding observations to the broader population. Generalisability is ensured by studying variables and the relationships between them out of the context (Nomothetic) within which they would naturally occur as the variables will be under stricter control.

## Literature review

### The importance of theory

Just remember that reviewing the literature starts as far back as coming up with your research idea, and clarifying your topic. A literature review, despite its name, needs to be a critical and descriptive analysis of other authors' work.



All decisions are based on **theory**, regardless of whether that theory has been systematically researched and developed, or based on subjective experience. Theory can be developed and dealt with in two ways:

- **Deductively** - developing and applying theory prior to the collection of data; and
- **Inductively** - collecting data, and thereafter developing theory.

The role that theory plays in writing up your dissertation, research report, conducting research and so forth largely depends on your research questions and the literature available on your topic.

Generally, quantitative research involves **deductive theory testing**, (moving from the general to the specific) whereas qualitative research involves inductive (moving from the specific to the general) theory building. In the former, the researcher uses the literature to identify the variables, develop a theory about the causal relationship between them, operationalise how they are going to be measured, and then tests them statistically. Quantification is seen as a major characterisation of a discipline as scientific. In other words, deductive theory testing starts with a theory, and then tests that theory through observation. Due to the objectivity, scientific rigor and controlled nature of the research, the representativeness of the sample, the results should be able to be generalisable.

**Inductive theory building**, on the other hand is most often used in qualitative studies where little is known, or alternative explanations (theories) for particular occurrences are sought. Induction emerged as a criticism against the inability to reduce into measurable data, (reductionism), and isolate social phenomena to a cause-and-effect relationship. Further, it is argued that by reducing phenomena into measurable units, you are ruling out alternative, potential explanations. As mentioned previously, due to the existence of multiple realities as purported by interpretivist researchers, research questions, and theory cannot be established prior to the study, but rather evolve whilst completing the study. In other words, you start with observations, then work your way up to developing or refining a theory. This does not however mean that knowledge on the subject area is exempt.

So you can see how different approaches require you to use literature differently, and how theory plays different roles. Often in qualitative studies researchers delay completing the literature review until after the data has been collected and analysed. Rationale for delaying the literature review: To avoid leading the participants in the direction of what has already been discovered. Why? To show how current findings fit into what is already known.

Let's review this in relation to our hypothetical NHI research example.

### **The Research Philosophy:**

My study is essentially Quantitative in nature. It is informed by theories of:

#### **Appraising TPS, TQM, Six Sigma and Lean**

The term Lean was enriched by Womack and Jones (1996) cited in Radnor and Burgess (2010:3) which defined Lean in terms of five core principles:

- Specify the value desired by the customer;
- Identify the value stream for each product and eliminate waste steps;
- Standardise processes around best practices;
- Introduce pull between all steps of continuous flow; and
- Manage towards perfection to remove non-value adding activity.

These five Lean principles resemble the well-known quality improvement process of Six Sigma developed by Motorola in the mid-1980s and enhanced by General Electric in the 1990s (Bendell, 2006:256; Dahlgaard and Dahlgaard- Park, 2006:268; Nasland, 2008: 272). According to Black and Revere (2006:259) some of the major doctrines of Six Sigma arose from the principles of TQM including the ideology that the whole organisation must embrace the quality effort, the belief that the organisation needs to become a learning organisation and the notion that quality improvement methods must stress root cause analysis.

### **A Case for Lean in Healthcare**

The WHO (2010:xvii) believes all countries could save on health expenditure and attain better healthcare outcomes whilst using the same resources by 1) getting the most out of technologies and health services, 2) motivating health workers, 3) improving hospital efficiency, 4) getting care right the first time by reducing medical errors, 5) eliminating waste and corruption, and 6) critically assessing what services are needed. Hollingsworth (2008:1107) asserts that hospitals could achieve 15% better efficiencies at the same cost or could offer the same level of service but at a cost reduction of 15% following his review of 300 studies investigating the efficiency and productivity of health-care delivery. The growing application of Lean thinking in the healthcare industry is consequently well supported and holds significant business potential for the hospital in this study.

Healthcare services around the world have turned to Lean process improvement methodologies from the manufacturing sector to address issues of quality, cost and inefficiency (Institute for Healthcare Improvement, 2005:17; Graban, 2009: iii; Radnor and Burgess, 2010:11; Radnor, Holweg and Waring,

2011: 364). Lean in healthcare is described by Papadopoulos (2010:209) as a focus on the continual assessment and improvement of clinical processes to identify and eliminate waste from the patient pathways, to enable staff to examine their own workplace, and to increase quality, safety, and efficiency in processes. Such an approach will have a sustainable financial effect on the profit margins of the hospital but more importantly the emphasis on quality and safety will position the hospital favourably with funders and their medical scheme members in the short term and with the OHSC and the NHI in the long-term.

The CVF is presented as an effective means to assess culture type and congruence and by conducting research into the potential influence of the hospital's culture before applying Lean methods; hospital management anticipates circumventing a number of the pitfalls identified in the literature. The research methodology to follow elaborated further on the research conducted.

**Ontologically:** Objective reality is assumed – an objective organisational culture considered “out there, objective, and measureable”. These theories highlight the systematic and rational investigation that can be used to determine causal laws that exist between culture and ability to execute lean principles.

**Epistemologically:** The researcher is independent from what is being observed. The researcher, by measuring the variables, has no influence on what is being measured, and the measure of cultural values – independent of the subjectivity and agency of the researcher.

**Methodologically:** Theory was used to operationalise the constructs. In other words, organisational culture was operationalised, and measured using the Cultural Value Framework.

In South Africa, the Lean Institute Africa reports a substantial increase in requests for information and training in Lean principles from both the private and the public sectors in recent years (Faull, 2009:1). The Institute also reports the successful implementation of Lean projects at Groote Schuur Hospital which have drawn the attention of role-players in South Africa's healthcare industry.

During one of the analyses, it was discovered that up to 44% of highly skilled, trained nurses' time in the Emergency Unit was spent on non-nursing activities such as pushing trolleys, answering phones and giving directions. Lean thinking is helping to achieve the objective of improving quality of care, reducing staff stress and saving on costs.

### **Assessing Organisational Culture using the Competing Values Framework**

The Competing Values Framework (CVF) is considered one of the 40 most important theoretical models in the history of business for assessing organisational culture. It follows the classification of culture represented by the sociological disciplinary foundation (Cameron and Quinn, 2011:2419). One of the most important applications of the CVF according to Cameron, Quinn, DeGraaf and Thakor (2006:12) is as a guide for change wherein hundreds of organisations have used the framework to diagnose and implement culture change, realise strategic objectives, motivate employees, enable organisational development and establish quality processes.

Yu and Wu (2009:37) cite Quinn and Rohrbaugh (1983) as the originators of the CVF whose analysis of organisational effectiveness criteria grouped together in two major dimensions and four main clusters. Scott et al. (2003:68) inform that the effectiveness indicators clustered together in a way that almost exactly replicated Jung's (1923) model of psychological archetypes. These psychological archetypes help to organise the underlying assumptions and understandings that occur among individual organisations and which become labelled cultures. Cameron et al. (2006:7) declare all organised human activity to have a fundamental structure and underlying dimensions; by definition the word organisation connotes patterns and inevitability in relationships. The CVF uncovers these relationships and identifies the patterns and underlying dimensions that exist.

### **Conclusion**

The literature review has demonstrated that Lean philosophy and tools are being used successfully in hospitals where there is acknowledgement from management that organisational culture plays a pivotal role in the implementation strategy. Culture consists of the tacit assumptions, values, norms, and tangible artefacts of the staff which if not congruent throughout the patient.

When you are writing your literature review, it is important to note that you are not merely reviewing literature related to your topic. It is a very critical process that requires a careful scrutinizing of what literature is currently available to determine:

- what arguments have been made through numerous authors' agency, or the reason and intention underlying why the author is writing what they are;
- the current state of affairs as they stand;
- limitations, the wider context within which your project is situated; and
- to provide a rationale for the necessity of your study.

By drawing parallels between existing theory and your research, you will provide the necessary background for your research questions and objectives. Remember, as previously mentioned, you should not reinvent the wheel; research is intended to extend understanding and knowledge on a topic.

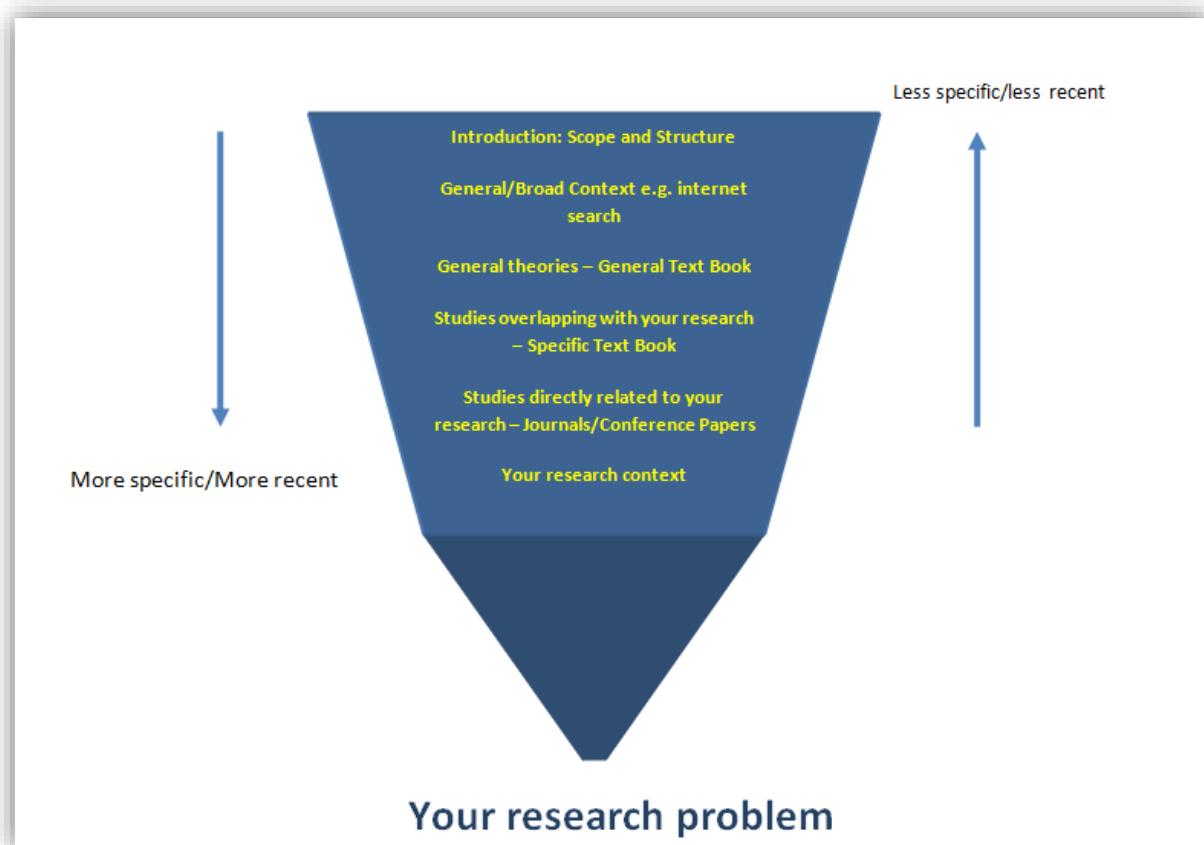
Furthermore, a literature review will allow you to (Kumar, 2005: 30):

- Establish a theoretical background to your study
- Show how your findings have contributed to an existing body of literature
- Contextualise your findings
- Clarify and refine your research problem
- Improve your research methodology

In essence, when following a deductive approach it is necessary and important you review the literature, and identify gaps or limitations in the literature, and ultimately use this knowledge to motivate for your study. Further, you will use the literature to identify and test theories. On the other hand, when there is little literature on the subject, an inductive approach whereby you use primary findings to develop theories, and relate them to literature will ensue. Either approach, however, requires a good, solid knowledge of the subject matter.

**Just remember!** The more you research, the more literature you will come across. Make sure that you keep focused on your research objectives, and ensure you use only the applicable literature. A focussed literature review will allow for new findings to emerge as you move past what is already known to a domain not previously thought of.

A literature review should take on a funnel approach (Hofstee, 2006).



Essentially you start with an overview of the definition, and key theories relating to your study. Thereafter, a more specific discussion of the general theories as they relate to the specific research question, how your research problem relates to previous research, and end your discussion off with the research questions and hypotheses that are unanswered by previous research.

You should be able to link every section and subsection to the former one, allowing for a smooth transition from broad to narrow, such that your reader is led logically through the literature to the point where you conclude with reference to the need for your study. Students tend to forgot that they are writing the literature review for a potential reader. The question will always be whether the reader understands the logic/argument/reasoning. Even if an author has said so, the student/reader must still demonstrate their understanding of the topic at hand, and literature pertaining to it.

In summary, the literature review should be written as a **critical** argument of existing literature, **presenting all views**, and using it to **identify a gap**, or an area, which needs further investigation.

It should **not** be a purposeless listing of all available literature, but instead, a critical, well-chosen, transparent and succinct argument made through comparing and contrasting previous literature,

justifying why your study is being conducted. Let's look at an example of an excerpt of a "bad" literature review.

**Excerpt from a poorly written literature review:**

**Measure FAs's (Knowledge and Proficiency) Skills within SMEs**

**The elements of MIS for Effective FRK**

According to Ferreira, Erasmus and Groenewald (2009:25), in FRK system there will be an input of financial data which will be processed into valuable information resource. Inputs systems include the FAs' skills and knowledge as well as the equipment and application system in place. The input or data gathered has to be calculated, analysed, classified, counted, grouped, sorted, compared, evaluated, summarised or prepared as graphs to be useful information. This runs parallel to the objective of computer information systems, which is to transform data into information.

Grobbelaar, McGee and Prinsloo (2005:193) postulate that there must be joint applications development which is based on the creation of a partnership between the FAs and the information system specialists. The FAs are encouraged to be involved in designing applications for financial statements with the help of information system specialists. Wessels et al. (2005:201) maintain that in respect of financial information systems, control can be considered as a plan that incorporates all methods and procedures to ensure the safeguarding of assets against exposure and to ensure the correctness of accounting data so that managers can be dependent on it.

**Financial Analysts Skills**

Fadhl (2011:18) maintains that recently, with the SME's development and growth, it is important for the managers of SMEs to understand and get involved in the accounting numerals produced. Moreover, relevant accounting information could help users to make wise decisions. Dempsey and Pieters (2008:8) maintain that accounting information is also viewed as relevant and very important to assist managers to reduce uncertainty that influences the economic activities and rely on information with reasonable diligence.

This information can be obtained from general ledgers that are consequently presented to managers with inaccurate financial data to make decisions which affect their understanding (for example; value of the investments in balance sheets and the income received shown in the income statements if it is regarded as income received or receivable).

In his study Hill (2011:145) postulates that financial managers should be able to ask themselves if; their financial decisions fall within the accepted values or standards that are typically applied in the organisational environment; and how they will affect both internal and external stakeholders and White,

Sondhi and Fried (2003:23) state that SMEs require report and describes material uncertainties affecting the financial statement such as; doubt concerns “going concern” assumption that underlies the preparation of financial statements; uncertainty regarding the valuation or realisation of assets or liabilities.

### **The Integration of Stems and Flow of Financial Information**

According to Ferreira, Erasmus and Groenewald (2009:41) each functional department within the SMEs' is seen as an independent system, although each function is managed individually, they therefore function interdependently as integrated systems where each functional manager is accountable to make productive outputs for the SME to be profitable. In their discovery Wessels et al. (2005:165 and 185) postulate that the network infrastructure operates by linking together different operating units with the common interest of sharing financial transactions across the hierarchical borders. Frequent mistakes made in sending financial data can lead to problems with the new information system which include;

- unrealistic deadlines;
- a change in the users' requirement of the system;
- poor or non-existent planning with no control over the performance of the project team; and
- appointing an information specialist as the financial manager without any knowledge, skills and competency;

### **Financial Administration and Record Keeping System**

According to Groenewald, Mitchell, Nayager, van Zyl, Visser, Train and Emanuel (2006:139) by the first day the SMEs starts trading, records of relevant information must be kept, for it is important to develop an effective and user-friendly record keeping system. Ferreira et al. (2009:42) sustain that financial manager plays an important role in the integration and co-ordination of the different function divisions. Furthermore, the data manager and the information systems manager can assist the financial manager in the processing of financial data into tangible FSs.

In their study Erasmus et al. (2007:224-225) stipulate that FRK, together with filing is one of the most important components of the SMEs. What makes FRK essential is that no one can remember what transactions were made on particular days, not to mention months and years ago. Failure to do so, will lead to general failure of the business.

Some examples and requirements of record keeping systems include the following;

- an effective stock control system;
- a system for keeping information on clients;
- a system for the control of cash inflow and outflow;
- an accounting system that top management understands based on its simplicity and effectiveness;
- a record of turnover and profit for tax purposes and, among others, for levies to local authorities.

### **Collecting and Processing Transaction Data**

According to Eccles, Julyan, Boot and van Belle (2000:558) the challenge on the general ledger system is to prompt and maintain accurate collection, accumulation, classification and recording of transactional data which is not sustained from various accounting applications. The updating of the results to the applicable ledger accounts in the general ledger master file (for example; sales processing and inventory processing), of which the general ledger data based on the nature of transaction data that are used especially for enquiry and auditing purposes.

White et al. (2003) state that lack of electronic data makes the duties and obligations of financial adjustments relatively difficult to cash flow statement. Marshall et al. (2011:24) maintain that highlights of the concepts and statements dealing with the objectives of financial reporting provide financial information that should be useful to investor and creditor concerns about the cash flows of the SMEs. Based on the above requirements of record keeping systems the SMEs must start with a cash book, petty cash book and general ledger.

### **Credit Purchases**

According to Dempsey (2008:177) credit purchases imply that a transaction is concluded between SMEs and the supplier of certain input or resources, of which the payment is due and settled in future date. Ferreira et al. (2009:43) point out that the purchasing manager sets the purchasing policy and standard in the division of information obtained from the administrative or information function. The SME is facing the challenge for linking financial data with suppliers' account for the item purchased on credit. Dempsey et al. (2008:183) maintain that credit purchases imply that a transaction is concluded between two parties, but that payment is not made immediately.

Payment will therefore take place at a future date, and a control system should at least provide for the following:

- If merchandise is required in a certain department, the person responsible must complete and sign a requisition (request form). A precise description of the type of goods required, as well as quantities, should appear on the requisition; therefore the completed form is manually forwarded to the purchasing department, which cost the SME additional funds, on purchase for additional printers, toners and physical storage for safeguarding all necessary financial documents.
- The process of verifying whether the person who made the completion of the requisition is an authorised candidate is time consuming, as compared to the electronically sent documents with identical-electronic signature.
- On the receiver of inventory, an inventory received note is completed, and recorded on the goods received note and compared with the order.
- On the receiving of invoice from the supplier, the invoice is compared to the goods received noted.

### **Automated Cost Management**

According to Marshall *et al.* (2011:496-497) cost management is concerned with the procedure of using cost information from the accounting system to manage the activities of the organisation. Cost accumulation is the easy part; accounting systems always have focused on the collection and recording of transactions, and automated data collection system are available for manufacturing environments today. Cost accumulation is the process of collecting and recording transaction data through the accounting information system.

Van Rensburg, Ambe, Evangelou, Govender, Koortzen and Ziemerink (2005:160) sustain that in an integrated accounting system, there is a single comprehensive accounting system with no division between the financial and cost accounts. In such a system the same bases are used on matters such as inventory valuation and depreciation. Nieman *et al.* (2005:79) maintain that the mess faces declining cost conditions on continual basis cease to be more attractive on growth potential. These systems can be highly automated and provide a real-time view of cost accumulated by the system which is then logically categorised in different ways, such as by the production department. The categorisation of cost emphasises the managerial point of reference and is referred to as a cost pool. Cost obligation is the process of attributing an appropriate amount of cost in the cost pool to each cost object.

### **Input Control for Financial Data**

Wessels et al. (2005:209) point out that input control attempts to ensure that validity, accuracy and completeness of data not entered in the accounting information system, entails financial data observation and recording; data transcription (batching and converting); and transmission data. Heizer and Render (2008:486) point out that good inventory policies are meaningless if management does not know what inventory is on hand and how much it is worth, caused by confusing data edited on a piece of paper.

According to Marshall et al. (2011:150), many transactions are either directly or indirectly affected by the receipts or payment of cash, over a sale of merchandise on account which normally leads to cash receipt when the account receivable is collected. Likewise, a purchase of certain inventory on account results in an increase in creditors' account (suppliers).

That compels the FA to update both the FSs of the firm with the suppliers' accounts. Erasmus et al. (2007:163) maintain that when a contract exists and it is a repurchase situation by the customer, therefore the customer can react easily and quickly on the supply of operations or marketing by the SME. In a new purchasing situation, especially where a contract has to be drawn up, determining the present and future availability of the materials is a vital state by noting price fluctuations.

**An example of a good literature review:**

**Why this is a poor literature review:**

- There's no narrowing of the research topic – doesn't start broad and narrow down
- Merely a presentation of the literature:
  - o There is no application to the study
  - o Literature is not used to identify a gap, or make an argument for why the study needs to be done
  - o Does not use contrasting perspectives to debate the merits of the literature
  - o There is no logical flow of the literature presented here, and you aren't quite sure why this literature is being reviewed. Seems to just be presented, nothing analytical, no application, and no direction.
- Poor grammar – meaning is lost
- Sentences are too long
- Literature is not being used to make a point
- Presentation of bulleted points – but does not discuss which aspects are more applicable and important to this study, and how it will be used – is it to make a point? Identify variables to study? Variables they wish to test? Theory that's going to be tested? Merely presented.
- This was a quantitative, deductive study – could you tell from the literature review? No.
- No linking sentences – you aren't sure why the next sub-heading is reviewed, and why.
- There is no argumentative thread running through the review – no argument building for the gap occupied by the intended study, nor argument made for why the study is necessary.
- Acronyms are used without being introduced in full. Then they are presented in full – no consistency in use.

***These are common mistakes we see in literature reviews. Above all else – please remember that the literature review is a critical debate of available literature intended to create an argument for why you are doing your study. You must NOT regurgitate what other studies have found, nor should you repeat what has already been done. If no reason is made for why you are doing your study – then you are not doing research.***

## INTRODUCTION

Wong, (2012: 1) states: "One of the most notable trends of corporate behaviour in recent decades is the growing sensitivities of businesses toward environmental issues." Wong attributes this to the fact that: "environmental problems are global problems, pollution, global warming, climate change, ozone depletion, greenhouse effect and nuclear meltdown respect no borders." He also suggests that: "People are more aware of the environmental impacts of human activities and are more willing to make behavioural changes for environmental reasons. Consumers and producers have realized that, acting together, they can make a big difference in protecting and preserving our environment."

In this section current information obtained in published work is studied to obtain background knowledge about green manufacturing and green products and how it may be utilized to provide a competitive advantage to manufacturers of switchgear. Firstly, the term green manufacturing is defined to obtain a pathway to green products. The broad term "green manufacturing" is examined to obtain insight into the various aspects of environmental consideration in manufacturing operations. Special attention is given to green compliant products, and consumer sentiment towards such products because of its importance to this study.

Regulations that originated in the developed countries and their influence upon developing countries, such as South Africa, are discussed next. Green manufacturing laws of the European Union and their origin are investigated. This is of interest because of their far-reaching global influence on international trade and on industries situated in developing countries where these laws are not valid and no similar regulations exist.

Thereafter green consciousness of consumers is examined in an attempt to determine how buying decisions may be influenced through green products. Green consciousness may influence consumer preference. Factors such as perceptions of the quality and value of green products are being considered as part of buying decisions.

Finally the term competitive advantage is scrutinized to validate a link with green products. Most firms strive to obtain a competitive advantage in the market. Prior research is explored to determine if this can be achieved with green products. These findings will be compared with the results of this study.

### An example of a good literature review

#### **GREEN MANUFACTURING AND GREEN PRODUCTS**

Green, or sustainable, manufacturing is described by Gutowski and Oye (2004) as: "The concept of producing goods while minimizing the effect on the environments." Wemmerlöv (2004: 1). It relates to manufacturing methods that transforms materials into commercial goods without producing greenhouse gasses, employs renewable resources, excludes toxic substances, and minimizes waste.

According to Noe, Hollenbeck, Gerhart, and Wright (2008: 4-5) communities are important stakeholders in all companies and that it is generally desirable that companies minimize pollution, or waste. Goosey (2007: 47-50) states that: "There is a growing awareness of the need for industry to operate in a more sustainable manner and to minimize its impacts both on people and the environment." He claims that this is particularly applicable to industries in the fields of electrical and electronics manufacturing where growing numbers of products with a short life span are made due to early redundancy caused by continuous technological advances. These products are discarded at their end-of-life at which time they may accumulate dangerous pollutants at dumping sites, or pose a danger to recycling workers.

Heizer, and Render (2009:147-150) believe that planet earth is finite: it's resources should be preserved. They argue that: "The entire product life-cycle, from design, to production, and to final destruction – provides an opportunity to preserve resources. Furthermore: companies should adopt an ethical approach towards their operations: Products should be viewed from a systems perspective inclusive of it's impact upon the entire economy, and not in isolation. Consideration must be given not only to what is more economical for the firm, but to that what is best for the economy, ecology, and society. Six goals are set for ethical and environmentally friendly designs: Developing of safe and environmentally compliant products; Minimizing waste of both raw materials and energy; Reducing environmental liabilities; Increasing the cost-effectiveness of complying with green regulations; Being recognized as a good corporate citizen.

Hu and Hsu, (2010: 593) claim that green manufacturing begins with green design which is described as: "A systematic method for companies to reduce the environmental impact of their products and processes while simultaneously cutting costs and increasing product marketability."

Wong, (2012:19) found that organisational decisions to invest in green innovation have not always been based on economic or compliance reasons alone. In some cases the motivation may be the fulfilment of corporate social responsibility and improvement of a corporate image.

**Example cont.**

A green product may be described as one that does not contain any harmful substances. Both manufacturing personnel and users will not be exposed to any threatening chemicals during any stage of the product's life cycle. The green concept is expanded to include safe and environmentally friendly disassembly and reclamation at the end of the product's service life.

Wong, (2012:8) defines a green product as one that: "takes into account recyclability and disposal issues; the use of material that may be recycled and are less polluting or non-toxic; has consideration for energy use, human toxicity, ecological impact and sustainability throughout it's life cycle."

Malcolm, (2011: 49-51) advocates a holistic approach with consideration for "life-cycle thinking" which involves all stakeholders in minimising environmental impacts across the life cycle of a product. The aim is to achieve greener products with lower environmental impact from conception, throughout it's useful life, to final recycling or disposal. To be effective, this must be achieved without compromising the product's function, performance, quality, or cost.

### **RESTRICTIVE ENVIRONMENTAL LAWS OF DEVELOPED COUNTRIES**

According to Porter and Van der Linde (1995:120-132) regulation is needed for six reasons: To pressurize companies to innovate; Improving environmental quality; Educate companies about resource inefficiencies and areas for technological improvement; Raising the likeliness that new innovations will be environmentally friendly; Creating a demand for environmental improvement; Levelling the playing field during the transitional period to innovation-based environmental solutions. They conclude that: "Proper environmental regulations or standards can trigger green innovations that actually decrease cost, increase productivity, or make companies more competitive."

This work was published more than a decade before the EU introduced their well-known environmental directives: The Restriction of Hazardous Substances directive (RoHS) and the Waste from Electrical and Electronic Equipment directive (WEEE) that were subsequently adopted by most of the developed nations and some developing nations. SPRING (2011: 14) justifies the need for legislation such as RoHS through it's aim to limit the amount of hazardous substances contained in electrical and electronic products.

They state that RoHS-like regulations have already been introduced by the American states of California, New Jersey, and Minnesota as well as by the following developing countries: China, Japan, and South Korea. Regulations are currently being considered by Australia, Norway, and Thailand.

**Example Cont.**

Hanafi, Kara, and Kaebernick (2008:367) states that: "End-of-life (EOL) products, especially Waste of Electrical and Electronic Equipment (WEEE), contain pollutants which are toxic and hazardous to human health. Improper handling of these e-wastes may trigger damage to human health from respiratory problems to cancer. When discarded into a landfill, these hazardous contents are also damaging to the ecosystem."

Hanafi, Kara, and Kaebernick (2008:367) state that: "End-of-life (EOL) products, especially Waste of Electrical and Electronic Equipment (WEEE), contain pollutants which are toxic and hazardous to human health. Improper handling of these e-wastes may trigger damage to human health from respiratory problems, even to cancer. When discarded into a landfill, these hazardous contents are also damaging to the ecosystem". WEEE waste is usually dumped in landfills where hazardous substances contained in this waste, over time, seep into the surrounding land and waterways and eventually into the sea. It can lead to dangerously high levels of toxic substances in the food and water that we consume. It is illustrated by the high mercury contents in certain fish harvests in some parts of the world. These issues were paramount in raising environmental awareness in societies around the globe, and initiated the enactment of various environmental laws. It is an important and growing phenomenon that influences all manufacturing concerns, regardless of size, and cannot be ignored.

According to Johansson and Brodin (2008: 706) the RoHS directive requires new materials and processes to be implemented in the design and manufacturing of electronic and electrical equipment (EEE), whereas the WEEE directive specifically addresses end-of-life management of EEE. According to the WEEE directive, EU Member states should have end-of-life systems operational from 1st July 2006. These systems include the collection, pre-treatment and recycling of EEE. The systems seem to be working and it is reported that in 2005 advanced take-back systems were operating in 11 countries. The RoHS directive proscribes the use of certain heavy metals and flame retardants which are used in many electrical and electronic products. The listed substances are: mercury, lead, cadmium, hexavalent chromium, as well as polybrominated biphenyls (PBBs) and specific polybrominated diphenyl ethers (PBDEs). The substances are clearly defined and the levels above which they must not be present have been specified. The maximum permitted level is stated as a percentage weight of a "homogenous material" that forms part of a product. The precise definition of the latter is still a subject of dispute. Electrical and electronic products covered by the WEEE directive (except medical devices and monitoring and control instruments as well as certain manufacturing and military equipment) and put on the market after 1 July 2006, may not contain any of the materials at concentrations higher than the maximum permitted level.

**Example Cont.**

"Failure to achieve RoHS compliance could result in producers being required to remove offending products from the European market." Goosey, (2007: 47). The first notable example is the forced withdrawal of 1,3 million Sony Play Station consoles from Europe in December 2001 due to the use of non-compliant wiring containing excessive amounts of Cadmium in cable links. Although RoHS was not in effect yet, restrictive laws on the use of Cadmium were already in place in the Netherlands who refused product entry. The loss in revenue due to the recall, is estimated at US\$ 85m. This could be devastating to small and medium-sized enterprises. (SME's). SPRING Singapore (2011: 17).

Due to the popularity of this well-known gaming product and the international fame of the Sony brand, this failed European Christmas Play Station launch gained wide publicity. For these reasons this incident drew the attention of international law-makers, manufacturers, and a concerned public to the issue of environmental compliance of EEE. It is quite probable that this singular event provided momentum to global environmental initiatives and the implementation of EU environmental directives.

Zailani, Eltayeb, Hsu, and Tan (2012: 722) stated that: "Policy makers and governments often institute new environmental regulations, laws, and incentives in response to issues raised by environmental organizations, and to protect the environment and consumers. Similarly, manufacturers typically respond to the same group of organizations to fulfil the demand of the consumers, to comply with legislations, and to take advantage of any financial incentives."

Their study also revealed that multinational companies try to ensure that all products in their supply chain meet all environmental requirements imposed by directives and laws. They do this because of a "concern about their long-term survival, in terms of earning consistent contracts and maintaining good relationships with customers that provide business opportunities."

The environmental laws of the EU have a far-reaching influence on international trade. "The RoHS directive has become a strong incentive to motivate trading companies within the EU to intensify green purchasing. In the electrical and electronic industries, products can only be exported to the European Union when their quality is in accordance with European Union environmental protection regulations such as WEEE, RoHS, Eco-design for Energy Using Products (EuP), and others." In this regard, EU environmental regulations also serve as trade barriers to exporters of non-compliant products. Export-orientated economies outside the EU, such as Taiwan, are not legally bound by EU laws and directives, but must comply in order to continue trade (Huang and Wu, 2010: 1557-1558).

**Example Cont.**

**THE ROLE OF ENVIRONMENTAL CONSCIOUSNESS IN CONSUMER BUYING DECISIONS**

Manaktola, and Jauhari (2007: 386) state that: "Many environmentalists trace the green lifestyles to the moment when the space programme gave us the first view of the Earth from space. Some conclude that it was at this point all were fully aware of the fragility of the planet." They also postulate that: "With the passage of time the knowledge of the individuals enhanced, which made them more aware that life on this planet was special and worthy of it being conserved." This may be constituted as the beginning of greater environmental awareness among the general population which began in the mid 1960's. The presence of environmental awareness becomes quite evident with the emergence of terms such as "Ozone depletion", "Greenhouse effect" and "Acid rain" over the past four decades.

Concern for the environment is a motivator for purchasing green products, whenever a choice between compliant and non-compliant goods is available. Environmental concern is only possible if a consumer has knowledge about the environment, pollution expansion, and the impact it has upon the environment. With an increase in the knowledge about the negative aspects of pollution and the positive aspects of green products, an increased environmental awareness is cultivated. For green products to succeed in the market place, it is crucial that consumers are adequately informed about a product's "greenness."

This may be achieved through environmental support campaigns and symbols, or claims on product labels. Research by D'Souza (2004: 180-185) found that consumers with favourable environmental attitudes are more inclined to buy environmentally friendly products. This view is shared by Akehurst, Afonso, and Gonçalves (2012:982-983) who suggest that: "Consumers with a high level of environmental awareness are more likely to exhibit an environmentally friendly behaviour." Schlegelmilch, Bohlen, and Diamantopoulos (1996: 49) found that: "Consumers' overall environmental consciousness has a positive impact on pro-environmental purchasing behaviour"

Park and Ha (2012:397-399) postulate that: "Public campaigns and educational messages might deliver benefits for acting environmentally, threats for not acting environmentally, personal norm, as well as social pressure in order to make consumers attentive to environmental issues and committed to more pro-environmental behaviour." D'Souza (2004: 180-185) claims that: "A green purchase intention, arguably, depends on a consumer's altruism and the way in which he or she can be motivated." A supplier should therefore provide consumers with information, especially environmental benefits, to assist them in making informed decisions that would ultimately encourage the purchase of environmentally friendly products.

Akehurst et al. (2012: 982-983) found that consumers should be able to perceive a product's effectiveness in protecting the environment in a way that would generate a positive buying decision. This contributes to developing an ecological behavioural orientation, which in turn would lead to a green purchase. The same study also claims that. Green buying decisions constitutes of personal choice and are independent of demographic variables analysed (sex, age, education and income) which are not relevant in explaining ecological conscious consumer behaviour.

### **THINK POINT:**

If you battle to think critically when reading papers and writing up your own work, these steps may help you think critically. Think of your topic. Now think of your research questions. Identify the sources of information that you will review. Think of the particular topics needing review.

Right, now ask yourself this:

- Why are you reading this paper? (Perhaps look at your research questions to keep focus)
- What are the authors trying to say (Does it have relevance to the argument you are trying to make for your study?)
- Do the authors of the paper have a valid point? (Are their findings convincing and credible?)
- How can you use this paper to contribute to your literature?

Now...write a critical summary:

- Introduction (here state the purpose of why you read the paper).
- Report what the paper said (use question 2).
- Evaluate what you wrote (use question 3 and 4 above).
- Draw your conclusion with reference to your study.

By being critical of what you read, you develop a mind-set to not accept things *prima facie*. When it comes to writing up what you have read, your argument for and against has already been developed.

## CHAPTER 3: RESEARCH DESIGN, RESEARCH STRATEGIES AND SAMPLING

### Learning Outcomes:

After this Chapter, you should be able to:

- Identify the research design applicable to your study.
- Identify how the design, and chosen methodology fit hand in hand.
- Identify the chosen methods and tools relevant to the chosen design.
- Determine the appropriate research strategy relevant to your design.
- Determine the most appropriate sampling strategy with an overall understanding of the purpose of your research.



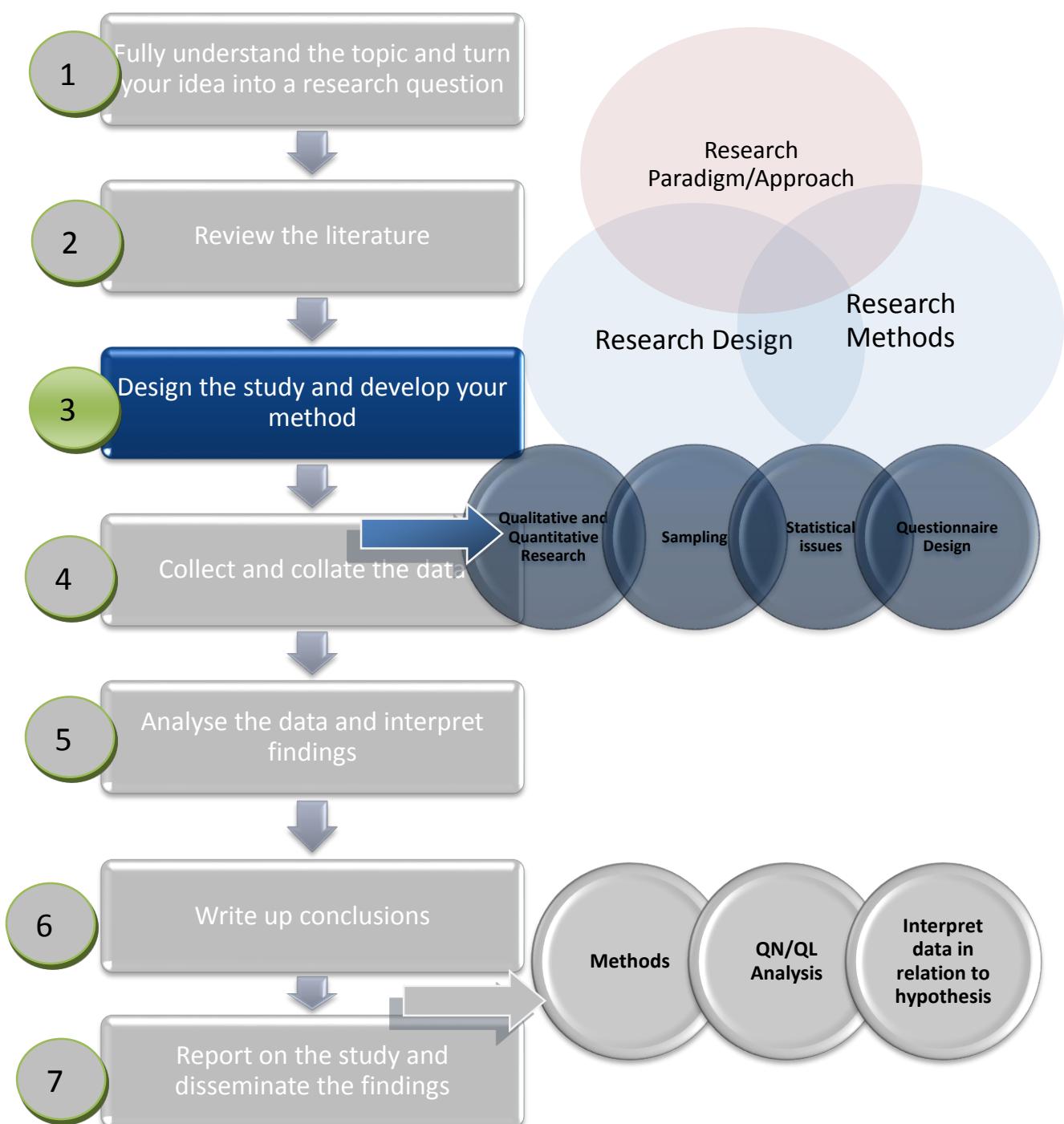
### Prescribed Reading:

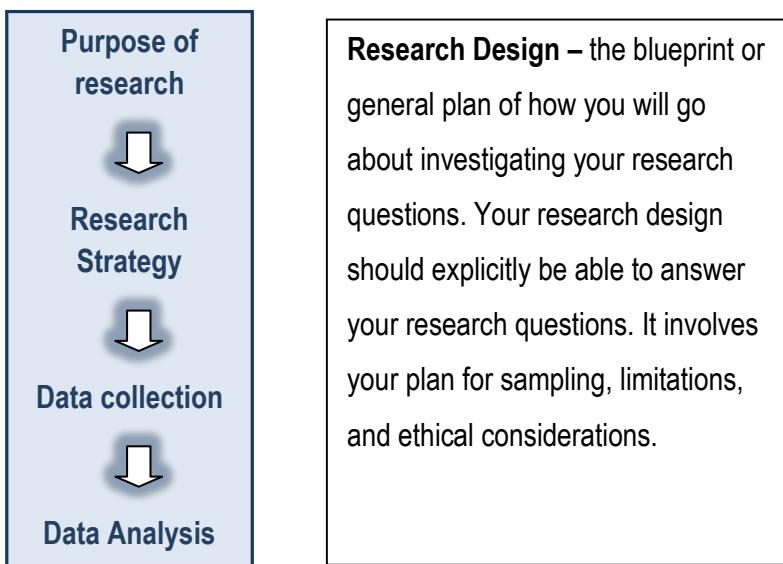
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- Srivastava, T.N., and Rego, S. (2011). *Business Research Methodology*. New Dehli: Tata McGraw-Hill Education private Limited. Chapter 4.
- Babbie and Mouton. (2005). *Qualitative studies: Types of Research Design*.
- Terreblanche, M & Durrheim, K. (1999). *Research in Practice*. Cape Town: UCT Press.

### Recommended reading:

- Kumar, R. (2005). *Research Methodology: A step by step guide for beginners*. (2<sup>nd</sup> ed.). Sage Publications: California.
- Turner, D. W. (2010). Qualitative interview design: A practical guide for novice investigators. *The Qualitative Report*, 15(3), 754-760. Accessed from <http://www.nova.edu/ssss/QR/QR15-3/qid.pdf>
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## THE QUANTITATIVE RESEARCH PROCESS





Chapter 3 is going to focus on the research design, processes and methods for conducting your research. It will start with a brief description of research design, a quick reminder of the context and framework within which research falls, the types of designs available to researchers within each paradigm, sampling considerations, and questionnaire design.

### **Research Design**

The first two Chapters discussed research philosophies and approaches to research. These are important when deciding the finer details of your project, namely your research design, data collection methods, and analysis, as they put the researcher on a particular footing, and give him/her the necessary tools to conduct their research. It is important to remember the philosophical approach you are using to ensure that your project is aligned from beginning to the end. It is no use subscribing to an interpretivist ideology, where the importance of context in understanding phenomena is pivotal, and then using a questionnaire and statistical analysis to conduct the research. This not only undermines the cornerstones upon which the contextualised, socially-constructed nature of interpretivist reality are constructed, but it will most likely be unfit to answer your research questions and objectives that require interpretivist strategy, as it was your research question itself that informed your choice of strategy.

In other words, research design is a plan that outlines the elements (variables, respondents) their inter-relationship, and methods involved in your research, whilst producing valid conclusions and conduct practical research.

A quick recap of the two approaches of research underpinned by positivist and interpretivist ideologies:

**Quick Recap of:****Qualitative and Quantitative Research*****Quantitative:***

## Descriptive statistics

- numbers used to describe a group of items

## Inferential statistics

- inferences from sample to a larger population.
- make generalizations.
- accuracy of inferences critically affected by the sampling procedures used.
- quantifies the problem.
- involves analysis of numerical data.
- surveys (online, phone, paper), audits, points of purchase (purchase transactions), and click-streams.

***Qualitative:***

- Exploratory.
- When we don't know what to expect, or how to define the problem or develop an approach to the problem.
- Get deeper into issues of interest.
- Explore nuances related to the problem at hand.
- Focus groups, in-depth interviews, uninterrupted observation, ethnographic participation or observation.
- Involves analysis of data such as words (e.g., from interviews), pictures (e.g., video), or objects (e.g., an artefact).
- Qualitative research is collecting, analysing, and interpreting data by observing what people do and say
- Qualitative research refers to the meanings, concepts, definitions, characteristics, metaphors, symbols, and descriptions of things.
- Adjectives like rich, deep, thick often used in talking about qualitative data.
- Deliberate focus on 'subjectivities'.
- the participant is the expert.

Based on this quick recap, you can see that the different approaches require different information, and different methods of investigation. It would not be appropriate to collect verbal information via an interview if you wish to measure the correlation between stress and performance? By the same token, you will be unable to gain rich, in-depth understanding from respondents if you merely give them a closed-ended questionnaire.

Your choices regarding design should flow naturally from your research questions, objectives, and philosophy. As such, the ***purpose of your research*** will have direct implications for the type of results you wish to yield, and therefore the type of research you will conduct:

## Purpose

- This entails the purpose for which the research is being conducted

## Paradigm

- Theoretical paradigm informing the research

## Context

- The context or environment within which the research is being conducted

## Technique

- The methods and techniques used to collect and analyse data

*Adapted from: Terreblanche*

*and Durrheim (2005: 33)*

The process needs to be such that they link the research questions to the implementation, such that it yields output that will most adequately address the research questions and objectives. You need to ensure, at all times, that there is both design validity and design coherence (Terreblanche and Durrheim, 1999: 34-36):

- **Design Validity:** Be cognisant of the confounding, “third” variables (these are variables that affect the relationship between two variables e.g. a factor other than smoking that causes lung cancer), and identify possible rival hypotheses which will be dropped where the confounding variables are controlled for or measured.
- Design Coherence: Ensuring that the chosen purpose, and techniques mentioned above fit within the paradigmatic framework within which the research falls.

With regards to the purpose of the study, different conclusions will be drawn using different types of research.

## **Types of Research**

There are different types, or strategies that can be employed for the purposes of research:

### **Exploratory**

This type of research investigates an area or issue on which little previous work has been carried out, or where rival explanations not previously thought of are needed. The aim is to look for patterns, ideas or hypotheses, rather than testing or confirming a hypothesis. They tend to be more open, flexible and inductive.

### **Relational Research**

When you investigate relationships between things. It describes how a change in one variable brings about changes in another. The task is non-manipulative, and observational, and requires a coordinated observation of at least two variables.

### **Speculative**

Implemented strategically, where researchers take account of current situations and speculate as to their future implications.

### **Descriptive**

Gather information that illuminates relationships, patterns and links between variables. Basically, to describe phenomena as they exist.

### **Explanatory**

Goes beyond merely describing characteristics, and aims to show why relationships, patterns and links occur i.e. causality.

### **Predictive**

Develop a model that predicts the likely course of events given particular intervening variables or circumstances.

### **Evaluative**

To evaluate the impact of something.

## **It depends on your goals, aims and purpose of your research!**

Sometimes you will combine types of research – it all depends on the purpose of your study! Perhaps you will describe a phenomenon (descriptive research), but in order to make the project more viable, you may want to also explain the relationship between variables, so what you will end up with is a descripto-explanatory study.

### **Examples of different types of research.**

#### ***Exploratory: To explore the impact of CSR on long term profits***

Little is known on the impact of CSR on long term profits. As such no hypotheses can be developed or tested in the face of a lack of information. As a result, a quantitative analysis testing this theory is not possible. Rather, through a temporal analysis extending over five years, the researcher engaged with companies to determine their CSR initiatives, how they engaged with them, and their financial performance over time to gain better insight into the topic at hand. From this, the researcher was able to explore a relatively new topic, and identify patterns, generate ideas, and start building knowledge on the topic.

#### ***Descriptive: A descriptive study of the possible impact of NHI on private healthcare practices and practitioners, and long-term feasibility in the South African context***

The current healthcare situation is assessed, and speculations are made about the future implications of the NHI on private healthcare practices, and practitioners.

#### ***Explanatory: An explanatory study to assess the impact of stress and burnout on employee performance at ABC Hospital, Mpumalanga***

The researcher was not merely aiming to describe the relationship between stress, burnout and performance, but rather wished to look for causal explanations of why performance was at an all-time low. To do this, and in review of the literature he identified stress and burnout, and decided to isolate all other rival explanations and determine whether there are aspects of stress and burnout that cause poor work performance, and why.

#### ***An explanatory study to assess the influence of customer satisfaction on sales at ABC Hardware***

Once again, the researcher wished to explore reasons underlying poor sales performance at ABC Hardware. He reviews the literature, and uses his own observations to develop a hypothesis that poor customer satisfaction causes poor sales. He sets out to determine the current level of customer satisfaction, and variables of customer satisfaction that could serve as an explanation of poor sales.

#### ***Predictive: A predictive study to develop a model to understand, and predict consumer behaviour when faced with branded vs. non-branded ocean gear***

The researcher is a marketing manager of a very well-known ocean branding company Quicksurf. He wishes to develop a model that can be used to explain and predict how customers behave when faced with branded vs. non-branded ocean gear that encapsulates the things they consider and look for when presented with this information.

He aims to develop this model so that it can be used to understand why customers make the choices they do, and predict outcomes when presented with certain information. This model will not only help the researcher understand what factors consumers consider when buying ocean goods, but also helps to boost their sales, and predict outcomes were changes to be made in their branding and marketing strategy. Further, it can be used, and refined by other marketing researchers to try to promote their products more profitably and successfully, by trying to predict the outcomes of customer decision making.

**Evaluative:** *To evaluate the impact of the introduction of participatory management at ABC textiles on employee motivation:*

The researcher works at ABC Textiles as their PR officer. Upon observation, and in consultation with the literature, the researcher proposed to management to implement a more participatory management style in attempt to increase employee motivation as employees were frequently absent, came late to work, took extended lunch breaks, and generally under-performed. The researcher, in attempt to determine the impact of this shift in management measures employee motivation prior to change implementation. This information he uses as his baseline. The participatory management intervention is rolled out, and after successful implementation and practice, the researcher again measures employee motivation six months after implementation. He compares the level of motivation before the implementation of the new management style (baseline data) to the level six months post implementation to see if motivation has increased at all. Any change witnessed could be considered attributable to the impact of the intervention.

#### THINK POINT:

Think about your study. What do you aim to achieve – are you trying to merely explain? Are you looking for reasons attributable to certain outcomes? Are you looking to develop a model, or merely measure the impact of some intervention or change?

Now that you have thought about it, try to think of how you will achieve it.

In your title and write-up of your study, the research design needs to be explicit, as it automatically communicates to the audience of your research what you intend to achieve.

Think of how you will include the research design explanation in the title of your research – have you? If not, insert it now!

## Research Designs

Under the aforementioned research strategies, we have congruent research designs. In general there are different types of research designs specific to the approach chosen to perform your research.

### ***Quantitative Research Designs***

In general, quantitative research designs can be classified into four major designs:

1. Cross-sectional
2. Longitudinal
3. Observational
4. Experimental

#### **Cross-sectional (one-shot, status studies)**

- Most commonly used
- Helps to determine prevalence by taking a cross-section of the population
- Useful to create a snapshot of the present status of a problem at that present time
- Indicate change at one point in time
- Cheaper and faster to conduct than its longitudinal counterpart

Steps in doing a cross-sectional study:

**Step 1:** Determine what you wish to study

**Step 2:** Identify the study population

**Step 3:** Select a sample

#### **Example**

An example of such research includes conducting an opinion poll of services offered by Organisation PTY on a particular day.

Another example could include a percentage increase in net profits of a group of public owned businesses for the financial year 2012-2013.

Study of the highest marks obtained for the research proposal by Business Research Methodology students in areas of specialisation (marketing, management, finance).

## Longitudinal Studies

These are studies that are conducted over a long period of time. As such, they are useful in determining changes in phenomena over time.

### Advantages:

Elucidates trends and temporal changes in variables allows the researcher to pin-point when changes occurred, and therefore what factors contributed to that change.

### Disadvantages:

Cost High drop-out rates (death, change in attitude or beliefs, changes, or shut-down in the company under investigation)

#### Examples of longitudinal studies include:

Patterns of expenditure of a group of individuals, or a company over a period of 20 years prior to, and post 1994. NPA's (Non-performing Assets) of PPLSBank.

Different types of communication changes occurring between the USA and SA over the past 20 years.

A study of the changes in worker performance prior to, and post changes and adjustments to salaries

## Descriptive or observational

- Case:  
Reports data on only one subject
- Case series:  
Descriptive studies of a few cases
- Case-control or retrospective:  
Compare cases (subjects with a particular attribute, such as an injury or ability) with controls (subjects without the attribute); comparison is made of the exposure to something suspected of causing the cases

### **Example of case study**

Card, D., and Krueger, A.B.(1992). Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania. *The American Economic Review*, 84 (4): 772 - 793.  
Available from: <http://davidcard.berkeley.edu/papers/njmin-aer.pdf>

On April 1, 1992, New Jersey's minimum wage rose from \$4.25 to \$5.05 per hour. To evaluate the impact of the law we surveyed 410 fast-food restaurants in New Jersey and eastern Pennsylvania before and after the rise. Comparisons of employment growth at stores in New Jersey and Pennsylvania (where the minimum wage was constant) provide simple estimates of the effect of the higher minimum wage. We also compare employment changes at stores in New Jersey that were initially paying high wages (above \$5) to the changes at lower-wage stores. We find no indication that the rise in the minimum wage reduced employment.

**Case-control studies are also called retrospective, because they focus on conditions in the past that might have caused people who didn't have the condition, to develop the condition.**

### **An example of a case control/retrospective study**

An excerpt taken from: Silverman, D.T. et al. (2012). The Diesel Exhaust in Miners Study: A Nested Case-Control Study of Lung Cancer and Diesel Exhaust.

Most studies of the association between diesel exhaust exposure and lung cancer suggest a modest, but consistent, increased risk. However, to our knowledge, no study to date has had quantitative data on historical diesel exposure coupled with adequate sample size to evaluate the exposure-response relationship between diesel exhaust and lung cancer. Our purpose was to evaluate the relationship between quantitative estimates of exposure to diesel exhaust and lung cancer mortality after adjustment for smoking and other potential confounders.

Methods: We conducted a nested case-control study in a cohort of 12 315 workers in eight non-metal mining facilities, which included 198 lung cancer deaths and 562 incidence density-sampled control subjects. For each case subject, we selected up to four control subjects, individually matched on mining facility, sex, race/ethnicity, and birth year (within 5 years), from all workers who were alive before the day the case subject died. We estimated diesel exhaust exposure, represented by respirable elemental carbon (REC), by job and year, for each subject, based on an extensive retrospective exposure assessment at each mining facility.

We conducted both categorical and continuous regression analyses adjusted for cigarette smoking and other potential confounding variables (e.g., history of employment in high-risk occupations for lung cancer and a history of respiratory disease) to estimate odds ratios (ORs) and 95% confidence intervals (CIs). Analyses were both unlagged and lagged to exclude recent exposure such as that occurring in the 15 years directly before the date of death (case subjects)/reference date (control subjects). All statistical tests were two-sided.

## **Experimental Designs**

Experimental designs deal largely with experimental type studies where you (Srivastava and Rego, 2011):

- Generate data through experimentation
- Experiment to make a discovery
- Test hypotheses
- Demonstrate a belief

### **Example**

An example of an experimental design study would be where the researcher wishes to ascertain which the best marketing strategy would be between advertising a product by saying, "buy one and get one free", or perhaps "50% off marked price".

Another hypothesis that a researcher could test would be, "MBA students ability to conduct research within their workplace settings significantly improved after completing the MBA Research Methodology course".

In terms of demonstrating a belief – perhaps the researcher believes that males would be superior to females in conducting quantitative research.

There are various types of experimental designs available to researchers – it will, however just briefly present them here (Srivastava and Rego, 2011):

- One-factor experiment.
- Two-factor experiment.
- Two-factor experiments with interaction.
- Latin-square design.
- Factorial designs.
- Quasi-experimental designs.
- Ex post facto design.

The following table is taken from University of Southampton eResearch Methods  
[\(\[http://www erm ecs soton ac uk/theme7/study\\\_design.html\]\(http://www erm ecs soton ac uk/theme7/study\_design.html\)\)](http://www erm ecs soton ac uk/theme7/study_design.html)

<b>Research Study Designs</b>				
Name	Class	Type	Protocol	Examples and uses
Experiment	Experimental	Longitudinal	Select a sample; Measure baseline for parameter, apply intervention, measure outcome. Or divide sample into intervention and control groups. Apply intervention to one group, measure outcome for both and compare.	Before and after measurements such as in a clinical trial for a new therapy, laboratory experiments, field trials e.g. of pesticides or fertilisers.
Cohort	Observational	Longitudinal	Define a cohort and assess current status and influential factors. Observe outcomes.	How a disease progresses,
				Whether family income affects educational achievement.
Case-control	Observational	Longitudinal	Define a cohort and divide into those exhibiting and those not exhibiting parameter of interest. Investigate history to assess risk factors.	Whether most lung cancer patients have previously smoked.
				Whether parental divorce affects future employment choice.
Cross-sectional	Observational	Cross-sectional	Define a sample and collect information about parameter of interest.	Prevalence estimates, such as how many people have a given disease, or how many people watch a particular television programme.

Repeated cross-sectional	Observational	Cross-sectional	Define a sample and collect information about parameter of interest. Repeat at defined intervals, but not necessarily with the same sample.	Trends, such as how many people are giving up smoking, the effect of publicity on the number of people who cycle regularly, or the popularity of a political party over time.
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### ***Qualitative Research Designs***

There are generally three types of qualitative research designs (Babbie and Mouton, 2005: 278-287):

1. Ethnographic Designs
2. Case Studies
3. Life Histories

All of these designs require contact with the researched, study only a small number of cases, and have a degree of flexibility that allows the research to adapt to the sequence of events accordingly.

#### **1. Ethnographic Research Design**

Essentially, this is the study of cultures through observation and detailed note-taking, reporting and evaluation. This design usually employs the use of interviews and observation to gather data.

#### **2. Case Studies**

This is an intense investigation of a single unit, whether it is a person, a company, or a culture.

Case studies examine:

- Multiple variables
- Interaction of the unit under investigation and its context
- Thick descriptions of multiple perspectives
- Understanding the impact of multi-level social systems on the acting agent

There can be various types of case studies:

- **Individual:** Descriptions detailing one person
- **Community:** Describing one or more communities, analysing patterns, and relationships between communities

**Social Group:** Study of small or large groups

- **Organisations and Institutions:** Business and Management studies – where focus is on firms, companies, corporations, trade unions and so forth, looking mainly at best practices, policy implementation and evaluation, Human Resource practices, management issues, organisational culture, change processes, re-engineering etc.
- **Events, roles and relationships**
- **Countries and nations:** International politics, foreign policies, often comparative.

Here emphasis falls on:

- **Role of Conceptualisation** – Need to state purpose of the study, guiding principles (hypotheses and research questions), and well-defined concepts. This is achieved through a careful review of the literature, and researcher experience.
- **Contextual Details and in-depth Descriptions** – To understand, and make interpretations regarding the social actor under study (case), it is necessary to explain in great detail the context within which observations are made. This allows the researcher to better understand the influence of contextual variables on the unit of analysis. It also allows for the requirement of repeatability.
- **Using Multiple sources of data** – Use of more than one method, and more than one interview or observation, and more than one informant, on more than one occasion. This all allows for a thick description, therefore allowing for replication, and convergence.
- **Analytical Strategies** – Involves a description of the organisation of findings, generalizability, and deals with theory development

### 3. Life Histories

A history gathered and documented over an extended period of time, using the actors own words. This approach can be used not only to develop new theories, or used to test existing ones. Here there is a focus on (Babbie and Mouton, 2005: 283-284):

- The individual's subjective reality – phenomenology of everyday experience
- Process, ambiguity and change – life is not ordered, nor routine – this methods helps to uncover the confusion, ambiguities and contradictions characteristic of everyday life
- Understand phenomena in totality. In other words, the researcher views the inside and outside world of the social actor in totality, or as a whole.

- Its use as an historical tool – shifts between the ever-changing individual biography and social history.

## Research Strategies

There are several different research strategies that can be used to conduct the above mentioned research designs. Different strategies clearly lend themselves more towards different types of research – once again – you need to ensure that the purpose of your study, which has guided the type of study, needs to also inform the strategy employed to carry out your study.

Research Strategies include (Saunders, Lewis and Thornhill, 2009: 141):

### Experiment

Inherently positivist in structure as stems from natural sciences. Its purpose is to establish causal links by asking, measure the strength of the change, and determine the relative importance of two or more Independent Variables. A typical experiment here would entail a control and experimental group. The assumption is that, through randomised assignment, both groups will be equal except for the Independent Variable, which should cause the only difference, and this difference will be measured to determine causality.

#### Example

An example hereof is the efficacy of Panado. Persons aged between 19 and 49 were randomly assigned to two arms – the control arm, where the cohort received a placebo pill, and an experimental arm, where they received the Panado. Due to randomised assignment, the only difference between the groups was assumed to be the active vs. the placebo pill. The Independent variable was the pill (placebo or active) and the DV was the occurrence of headaches. The outcomes (frequency of reported headaches) were then measured to determine if there was any difference between the two groups, where the difference was ascribed to be Panado use.

### Survey

Usually involves the use of questionnaire administration. Due to the standardised format of the questionnaire – the assumption is that data is standardised, and therefore comparable. Produces and is analysed quantitatively, and gives the researcher more control over the research process, and sampling considerations, especially for generalisation purposes. Surveys as a data collection technique will be discussed further under the data collection section.

### **Example of the survey method**

If you wished to determine the level of satisfaction with the quality of service of XYZ Trading company as a result of numerous customer complaints brought forward. You want information, fast, easily, and that which provides cross-sectional understanding of the current situation.

You administer a questionnaire to a sample of 100 XYZ customers. You ask them questions regarding service quality, and due to the standardised questions asked, fast, reliable, and easy to interpret results are gathered. If it turns out that the overall service satisfaction rating is low – you could take corrective action, and reassess the situation following intervention to see if improvements have been made.

### **Case Study**

This examines a particular phenomenon within its real life context. Often you utilise a variety of techniques, and triangulate, or compare the findings from different methods to validate findings. The case study focusses on an individual case, rather than being a method of enquiry. It can be both qualitative and quantitative. A case can be either a single child, for example, or a class of children.

#### **Types:**

- **Intrinsic:**
  - Case itself is of interest
- **Instrumental:**
  - Case provides insight into an issue or refines a theory
- **Collective:**
  - Number of cases are studied jointly to provide insight or refine a theory

Case Study Examples	Uniqueness/Point of Interest
Shifting Attitudes of Youth-Serving Service Providers	Your program was able to change service providers' attitudes towards dealing with Adolescent Sexual and Reproductive Health (ASRH) needs in an environment where provider's attitudes have been a barrier to young people accessing SRH services.

## Action Research

Can be used to solve an immediate problem, or initiate a reflective process to solve problems. This requires active participation, as members form part of the change process, and the solution. It requires collaboration amongst all actors, who embark on an interactive inquiry in which thought and action are integrated.

### Example of a case study

Firm ABC wishes to assess the efficacy of its training and development programmes. ABC wishes to determine the extent to which these programmes ensure that the necessary skills and competencies needed to conduct business effectively are instilled in their employees. In order to assess this, the researcher conducts both interviews and assessments. The interviews reveal the lived meaning and experience that workers attribute to training and competency, and assess measureable outcomes of training. Based on these methods, new insights, and modifications are made to existing training programmes.

### Example of action research

If a researcher wishes to investigate the resources most important to a community without imposing their ideas or tools upon them, and also to uncover meaning and importance without any political, or empowerment issues impacting on outcomes, then the researcher, as the tool for data collection, will go into the community, and ask that key informants (perhaps the chief, community representatives and so forth) to use items within their surroundings to construct a community map (one of the tools used by Participatory Action Research). The community members will use sticks, stones, and any other items in their environment. An example of this study was performed in Bergville in 2010, and the community map revealed that the community gardens were disproportionately big when compared to other resources represented in the map. Without the members of the community realising it, and independent of political or other influences, meaning and importance to community members was uncovered.

## Grounded theory

Is used in exploratory/descriptive studies to develop and build theory. Data is collected, and interpreted at a conceptual level which allows for conclusions, and previously unthought-of insights. Starts with a basic knowledge on theory, focusses on the lived experiences of actors, and uses this to create new insights into a phenomenon. It is useful in areas where little is known or when a new perspective is needed, and used for exploratory, descriptive studies. Theory must be faithful to the evidence, as it attempts to explain a process, an action, or interaction about a substantive topic.

### Example

Company ARB wish to evaluate the time-management skills of their employees. They employ the action research approach by documenting her work with the employees themselves. The researcher not only wants to understand how they manage their time, but also, helps employees innovate with time management. The research will spend time with the employees, documenting, and coming to understand the phenomenon “time management” as they see it. She will, together with employees new solutions will be sought, implemented (action taken), and results will be assessed. Further the results, further action can be taken.

### Argument:

***Theory generated from observations of the empirical world may be more valid and useful than theories generated from deductive inquiries***

## **Leadership under Severe Stress: A Grounded Theory Study**

### Example

If a researcher aimed to investigate the similarities and differences, and challenges in the experience of organisational transformation in three different mining companies in Johannesburg, and if the theories of organisational transformation in developed economies are applicable to developing economies. Here, grounded theory is applicable, as you are looking at the lived experiences of miners; also, you are building upon existing theories to develop a new theory or model that best deals with the challenges in an emerging economy.

### Ethnography

**Ethno**= people; **Graphy**= describing something

Therefore, describes and explains the social world within which research subjects are embedded, and describes it in the way that they would describe and explain it. The researcher is expected to immerse themselves in the subject's world, adopting a naturalistic stance. The aim is to understand behaviour from the subject's perspective, not the researchers. In other words, it is characterised by immersion.



Cartoon by Maurice Henry, published in La Quinzaine Littéraire, 1 July 1967.

### Student Contribution: 'An ethnographic study of gender influences on social behaviour of members at a private golf club'

#### Example of Ethnographic Study

Intel uses corporate ethnographers to understand consumer requirements and needs. What they aim to do is "develop a deep understanding of how people live and work." This knowledge is used by Intel to inform and guide the company's direction for product development (Anderson, 2001). Anderson, who joined Intel in 2001, argues that "you need an ethnographer to cover both sides – the outside populations and the company itself. If you do a really excellent study but present the results in a way that doesn't match the company's culture, it's not going anywhere. A lot of innovation dies because people can't articulate it in a way that makes sense. [...] Our job is as much about understanding translation as understanding people." To do this the team Intel People and Practices Team started off their ethnographic research from smaller rural communities within Europe, to more populated cities, and thereafter metropolis. External consultants were used who had already developed rapport with the members in those communities, so as to decrease the sheer amount of time that ethnographic studies usually require. These consultants also assisted with issues of access, and identification of key social groups.

#### Archival Research

The primary source of data is drawn from either current or historical records and documents.

#### Example of Archival Research

A researcher wished to study the temporal changes in psychological diagnosis trends over the history of a Child and Family Centre, they could access all of the process notes, and look at diagnoses made.

### **Phenomenology**

The central question to Phenomenology is “What is the meaning, structure, and essence of the lived experience of this phenomenon for this person/group of people?”. In other words, it is concerned with describing the essences of lived experience. Here essence denotes to the elements related to the true meaning of something that gives common understanding to the phenomenon under study. This essence is believed to be conveyed with descriptive language, and therefore it analyses the language used.

The phenomenological, or interpretivist realm focusses on the life world, and the experiences of subjects, with an emphasis on providing accurate descriptions, bracketing foreknowledge, and arriving at the essential meaning of these descriptions (Kvale, 1992).

### **Argument:**

*Objectivity is virtually impossible to ascertain, so to compensate, one must view all research from the perspective of the researched*

## **Phenomenological Research and Adolescent Female Sexuality: Discoveries and Applications**

### **Participatory Research**

This research strategy emphasises the political aspects of knowledge production, as it concerns itself with power and powerlessness. It aims to empower through conscientisation (building self-awareness and constructing knowledge), with the aim to develop effective action, improve practice, and implement change

### **Time horizons**

One feature that becomes evident when reviewing the above research is the “time” element. Does your study collect information about the here and now, or, does it look at more temporal trends in phenomena?

There are two different types of timelines:

### **Cross-sectional**

These include studies that examine phenomena at a particular time. The most likely strategy used for this type of study is the survey method.

## Longitudinal

This is when observations are made over an extended period of time to determine if there has been change.

### Example of cross sectional

For example, the researcher wished to assess, using a questionnaire, customer satisfaction with service at XYZ Trading. He collects responses from customers at that particular time. Essentially he is assessing the incidence of that phenomenon (service satisfaction) at that point in time.

### Example of longitudinal

Similarly, longitudinal studies in the business world can follow temporal changes in an organisation. For example, Poon and Swatman (1997) conducted a study between 1995 and 1997 to assess the change in expectation amongst a group of small Australian businesses in the Small Business Internet Commerce (SBIC). They found that internet was perceived as being important in terms of competitiveness, which with time, shifted more towards information gathering, time efficiency, while advertising and sales became less important.

### Example of longitudinal

One of the longest ever longitudinal studies started in 1921 by Lewis Terman. The study is aimed at examining the development and characteristics of gifted children into adulthood. The reason for his study is that he aimed to demonstrate that gifted children are not sickly, socially inept, and are equally as well-rounded as less gifted children. As of 2003, a sample of 200 was still being followed-up. The study will discontinue until the final participant withdraws, or passes away.

### **Example of participatory research**

Moving out of the nursing home and into the community: The Department of Disability and Rehabilitation at the University of Illinois ran a project designed to document the experiences and concerns of disabled people who attempted to move out of nursing homes, and to develop, implement, and evaluate an individual and a community empowerment and policy change intervention known as the Social Action Group (SAG) Program.

Initial focus groups with 30 disabled people transitioning out of nursing homes informed the development of the primary project intervention—a five-week SAG Program, which then was field tested through a controlled intervention trial. By the end of the project, a significant difference was observed between the AG intervention group and the control group in terms of the proportion who had successfully transitioned out of nursing homes (37 percent of SAG members vs. 20 percent of controls). By mid-October 2004, more than 200 disabled people had participated in the project through social action working groups, and many had developed skills as advocates for policy-level changes that could help address the bias toward institutionalization in long-term care funding and availability. Focus group data also helped uncover key community concerns that then became the basis for subsequent policy-focused efforts.

### **Example of phenomenological study**

Servant Leadership is a leadership model offering the prospects of illustrating how to meet the complex demands of guiding knowledge-based organizations in the 21st century while addressing existing and emergent problems related to social responsibility. This qualitative phenomenological study used a modified van Kaam method by Moustakas with semi-structured, recorded, and transcribed interviews to focus on selected attributes of the phenomenon of Servant Leadership. The study explored the lived experiences of a purposive sample of 20 business and government leaders in knowledge-based organizations located in the western Pennsylvania region. Seven themes emerged from the research.

The key findings reveal that servant leaders develop mutual respect in the leader-follower relationship by building trust through delegation and using active listening to promote understanding. Leading by example based upon consideration, empathy, and participation may establish ethical credibility. Servant leaders increased participation by providing resources and unselfish support to group members and inspired engagement to accomplish organizational goals by demonstrating commitment to leaders at every level of responsibility. Servant Leadership may offer the potential to convert normative values into concrete actions to drive performance and achieve personal fulfillment while promoting organizational sustainability based upon ethical practices.

## Sampling

When sampling, you need to ask:

- Who will be surveyed? (The Sample)
- How many people will be surveyed? (Sample Size)
- How should the sample be chosen? (Sampling)
  - Sample members may be chosen at random from the entire population (probability sample)
  - The researcher might select people who are easier to obtain information from (non probability sample)

**Census survey** – when every unit in the population is captured

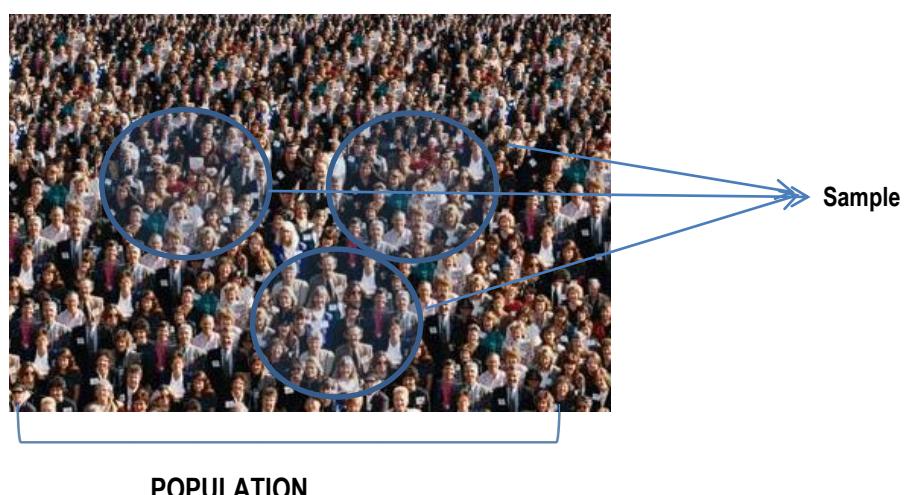
**Sample survey** – when a few units of the population are selected

You need to consider bias and error, which could be created through:

### Purposive or non-probability sampling

- deliberate selection of particular units of the population for constituting a sample which represents that population.

Simple random (probability) sampling every item in the population has an equal chance of inclusion in the sample.



## Sampling Design

Drawing samples from populations are done given the limited nature of resources and time available to researchers. Sampling is the process of drawing a portion of the population for your study in such a manner that it represents the population as a whole. The intention of drawing a representative sample is to make inferences about the characteristics back to the population.

The choice between qualitative and quantitative sampling techniques should be determined by the research questions, NOT the researcher's preference.

A good quantitative sample is one which:

- Random sample selection
- Generalisable
- Representative of the population from which it was drawn
- Minimal bias
- Sample size determined by desired power of the study
- Larger the sample size, the more accurate the representivity. Note however, key to representivity is random selection. If it has been drawn randomly, a fairly small sample can be valid; likewise a larger sample (not drawn randomly) would still not be accurate or representative.

Ultimately, the sample should be able to yield results that answer more “what” questions, and test established hypotheses, with the intention to generalise findings.

Good qualitative samples are ones in which:

- Sample size is adequate to yield insight into a phenomenon, and answers the research question (the aim is not to generalise, and therefore does not necessarily need to be representative).
- Data saturation and sampling redundancy usually determines sample size. What this refers to is when the researcher reaches that point where the same themes emerge over and over again – and nothing new is learned. This can happen from as early as 10 people.

You need to create pre-determined criteria for sample selection in order to elicit responses from people who are most likely to relinquish the most information on your topic area. The end result of this will ensure your chosen sample is smaller, focused, and will allow for pragmatic decisions.

Qualitative sampling is intended to provide in-depth understanding into complex, more social issues answering the more “how” and “why” questions. In other words, instead of asking shoppers how many times they buy certain items, you ask them “why” they are buying those items.

Generally there are two broad categories under which sampling methodology falls:

Probability	Non-probability
Simple Random	Accidental
Systematic	Convenience
Stratified	Judgement
Cluster	Purposive
	Quota
	Theoretical
	Self-Selection
	Snowball

### **Probability Sampling**

#### **Simple Random Sampling**

Each member of the population is chosen randomly, and without any systematic underlying method, which means that each unit within that population has an equal, known chance of being selected. The assumption, therefore, is that the selected sample is representative of the population from which it is drawn as there are no factors biasing it in one or other direction.

#### **Example of simple random sampling**

If you were to choose a sample from an organisation that has nine branches, and you wish to administer your questionnaire to 50 people from each branch. Your sampling needs to be random, and every person within the population needs to have an equal, and known chance of being selected. One way in which this can be done is to gather a register of every employee, and then use a random number generator to select participants. Alternatively, you could use the lottery method whereby you assign a number to each unit of the population, mix the numbers up thoroughly in a bowl or jar, and randomly select numbers without looking. Microsoft Excel has an option for randomisation:

On the Insert tab, the galleries include items that are designed to coordinate with the overall look of your document. You can use these galleries to insert tables, headers, footers, lists, cover pages, and other document building blocks. When you create pictures, charts, or diagrams, they also coordinate with your current document look.

You can easily change the formatting of selected text in the document text by choosing a look for the selected text from the Quick Styles gallery on the Home tab. You can also format text directly by using the other controls on the Home tab. Most controls offer a choice of using the look from the current theme or using a format that you specify directly.

To change the overall look of your document, choose new Theme elements on the Page Layout tab. To change the looks available in the Quick Style gallery, use the Change Current Quick Style Set command. Both the Themes gallery and the Quick Styles gallery provide reset commands so that you can always restore the look of your document to the original contained in your current template.

There is also the option of a random number table – or as previously mentioned, a random number generator which can be found at: <http://www.psychicscience.org/random.aspx>

[http://download.cnet.com/Random-Number-Generator/3000-2066\\_4-10499948.html](http://download.cnet.com/Random-Number-Generator/3000-2066_4-10499948.html)

### **Advantages:**

- Unbiased or least biased of all techniques
- Representivity
- Ease of sampling as sampling frame previously established
- Can be used with large sample populations

### **Disadvantages:**

- Sample could be collected in clusters – poor representation of overall parent population
- Does not ensure that all key sub-groups are present within the final sample
- Not useful in trying to measure relationships between sub-groups within the population
- Sampling errors through chance (decreases though sample increases)
- Time consuming to complete entire sampling frame

### **Systematic**

This is when you select your sample systematically from an ordered sampling frame, or basically when data is chosen in a systematic/regular way. In other words, the units making up the population of interest are placed into a list, and every  $k$ -the element is chosen. Here “ $k$ ”, or your sampling interval, stands for the number with which each element will be chosen, for example, every 9<sup>th</sup> person, and is calculated by dividing the population size by the sampling size.

#### **Example of systematic sampling**

If for the purposes of your research you needed to conduct a survey across all the ABSA branches across the country, and there were approximately 10000 employees, of which you only wished to draw a sample of 1000.

You would gain a list of all the members of that population, assign a number to each person, and automatically select every 10<sup>th</sup> person (10000 / 1000) from the list as your sample, starting from a randomly selected number, 5. So you will select as your sample, persons numbered 5, 15, 25, 35 etc.

### **Advantages:**

- Simple
- Adds systematic element to a random sample
- Good coverage of study area

### **Disadvantages:**

- The selection process can contain a hidden periodic trait, or some pattern or bias that may be specific to choosing every kth element which may result in an over and under representation of a particular pattern
- Results may be more biased

## **Stratified**

This sampling technique involves the division of the entire population into sub-groups or strata, based on a particular attribute, then randomly samples within each stratum. They can be divided into strata systematically, or randomly.

### **Example of stratified sampling**

You want a representative sample of records over the Business Management School's past 30 year history. You want to choose a representative sample within each year. You divide your sample up by year (strata), extending from 1983 – 2013, and then randomly selects a sample within each year. By dividing your sample up into years – you ensure that each subject does not overlap with other strata and therefore increase its chance of being selected.

### **Advantages**

- Highlights a particular sub-group within a population, and ensures that key sub-groups are present (especially rare extreme cases within a population), and therefore allows for particular niches within the population to be better dealt with, and it has better coverage of the population
- Useful when observing relationships between two or more sub-groups in the population
- Require small sample sizes as cases are chosen with more scientific precision
- If proportions of sub-sets are known, the entire population can be represented

## Disadvantages

- Difficult to identify appropriate strata for the study
- Complexity in organising and analysing results
- Proportions of sub-sets may not necessarily be known

## Cluster

This type of sampling exists when there are “natural” and homogenous sub-groups within a population. The sample is divided into groups, known as clusters, and simple random sampling within groups ensues. The difference between cluster sampling and stratified sampling is that in cluster sampling the cluster itself is the sampling unit and analysis is done on a population of clusters, whereas in stratified, the sampling is done on elements within the strata.

### Example of cluster sampling

A food company wishes to determine what the most popular item on their menu is. The researcher would create a cluster for each store, and pick clusters and obtain a sample from all the people within that cluster. They keep track of each customer's order, and decide which menu item is most popular. The company only tracked people within chosen clusters, trying to get all people within those clusters.

## Advantages

- Generating sample frames for clusters are economical, and it is often easily obtainable
- Cost-efficient

## Disadvantages

- May not reflect diversity
- Sampling error

## *Non-Probability Sampling*

### Convenience

This is when the researcher merely uses people who are available to participate in the study. It is the least rigorous sampling technique.

### **Example of convenience sampling**

Say for example the researcher wished to determine peoples “everyday” views on the 2013 budget speech. So he chooses a convenient sampling technique by asking people on the street. So he will walk around, and merely ask people if they are willing to participate, and asks them what, if they are knowledgeable about it, their views on the 2013 Budget speech is.

### **Advantages**

- Useful for obtaining the opinions of certain groups of people at a specific point in time

### **Disadvantages**

- Representivity is often not achieved or ascertainable as researcher has no control over subject characteristics
- Limited generalizability
- Poor quality data
- Lacks intellectual credibility – needs more thoughtful selection

### **Judgement/Purposeful**

This sampling technique is most common in qualitative studies, and involves the use of knowledge for selection, as the researcher or field workers select the sample based on their knowledge of that population, and the characteristic of interest. The aim is to gather a sample that would yield the most insight into the phenomenon at hand, and therefore, those who would best answer the research question.

### **Example of Judgement/Purposeful**

If the researcher in an HR position was interested in studying intelligence and communication skills to determine if managers with higher than “normal” intelligence are able to communicate effectively with employees, judgement or purposive sampling is the best choice of technique. With permission, using academic records, the researcher is able to identify “high end achievers” in management position. He then interviews these managers and his /her sub-ordinates and is able to ascertain their communication efficacy. In this manner he has tapped into a deviant portion of the population (high IQ) by purposively selecting them.

If a researcher wished to obtain a sample of previously disadvantaged populations' perceptions on workplace acceptance in the 21<sup>st</sup> century, it would make sense that only those who are previously disadvantaged were selected for the sample. To do so, the researcher sets out clearly defined characteristics of what constitutes previous marginalisation, perhaps along ethnic or cultural lines, and employment status, where only those participants whom meet these requirements will be included in the sample. Only those people who meet these characteristics and inclusion criteria will then be interviewed.

### **Advantages**

- To study deviant or extreme cases – gain better understanding of “normal”
- patterns of behaviour
- Access a particular portion of the population quickly

### **Disadvantages**

- Bias

### **Quota**

A quota sampling technique is one in which the researcher chooses their sample based on a fixed quota, i.e. one divides the population into **mutually exclusive** sub-groups. Here units of the population are selected into a sample based on pre-determined characteristics such that the sample is made up of the same proportion of representivity as it would appear in the total population. The purpose of quota sampling is to represent the major population characteristics by sampling proportionally of each. The main difference between stratified and quota sampling is that in quota sampling judgment is used instead of randomness to select within each stratum. The number of sampling units chosen within each sample depends on the proportion.

### **Example**

A researcher wished to study female representivity in management positions in KwaZulu-Natal, first you would need to know the total female proportion of the gender demographic in KwaZulu-Natal, and sample accordingly to be able to determine what the proportion of the female population are in these positions. So if in KwaZulu-Natal, women made forty-seven percent of the total population, then you need to draw a quota sample of 47% female, and 53% male. If your sample size is 1000, 470 would be female, and 530 male.

## Advantages

- Cost savings due to its independence from sampling frames

## Disadvantages

- The quota frame, i.e. the proportions, need to be accurate
- Selection could introduce bias, when highly specified characteristics are met, this may be to the exclusion of others

## Theoretical

This is when pre-decided categories indicate those aspects that are more and less important. In other words, you collect data to generate a particular theory, and as the data is collected, the researcher makes decisions on what data next to collect, and where to collect it from. It is useful for obtaining more information about the topic under study.

**An example of a Phenomenological, Qualitative Study: A Phenomenological Study of the Lived Experiences of Elementary Principals Involved in Dual-Career Relationships with Children (Zeek, 2012):**

This qualitative study examines the experiences of eight elementary principals from the Midwest who were involved in dual-career relationships with children under the age of 18. The primary data collection method was in-depth interviews. The data were coded and analysed according to the research questions. The research resulted in three major themes which emerged out of the experiences shared by the elementary principals: 1) there exists a gap between actual and perceived values; 2) stress develops from a high number of work tasks; 3) coping strategies are utilized to manage daily stressors. I analysed these themes from the principals' experiences through the theoretical lenses of theory-in-use and espoused theory, symbolic interactionism, cultural hegemony, and authentic leadership. The experiences associated with the elementary principals in this study serve as a framework for discussion about the gap that exists between principals' actual and perceived values.

**In general probability sampling techniques are associated with the quantitative paradigm, and non-probability to the qualitative.**

**Given thus, and as a crude rule of thumb:**

**Simple Random Sampling** should be used when the entire population is available.

**Systematically sample** when a stream of representative people are available

**Stratify** when there are sub-groups to investigate

**Quota** sample when you have access to a wide population, including sub-groups

**Purposive/Judgement sample** when you, the researcher, are the expert, and you are studying particular groups

**Snowball** sample when you are looking for groups with similar subjects

**Convenience** sample when you are unable to proactively seek out subjects

**Cluster Sample** when access to all members of the population is a problem

**THINK POINT:**

***Think about your study:***

Do you want to generalise your findings to the broader population?

Do you want to tap into a unique portion of the population?

Do strata naturally exist in your population?

What are the chances of your sample clumping together and being unrepresentative?

What limitations does your sample hold for your study?

If quantitative – will there be enough cases to draw valid conclusions?

Once chosen – will your sample be biased in any way?

Are you interested in a unique sector of the population?

These are examples of the types of questions you should be asking yourself when considering what sampling method to use. Please however remember...AT ALL TIMES your sampling method should be aimed at yielding data that will best answer your research questions, given the practical reality of time and resource constraints, the paradigm within which your research is situated, access, ethics and so forth.

## CHAPTER 4: DATA COLLECTION

### **Learning Outcomes:**

After this Chapter, you should be able to:

- Identify what data collection methods are available to you as a researcher
- Discern which data collection methods are particular to each research paradigm
- Identify which data collection methods are most applicable to your study
- Be able to discern the relative advantages, and disadvantages of each method of data collection
- Ensure that the data collection strategy is suitable to collect the type of data you need to answer your research questions

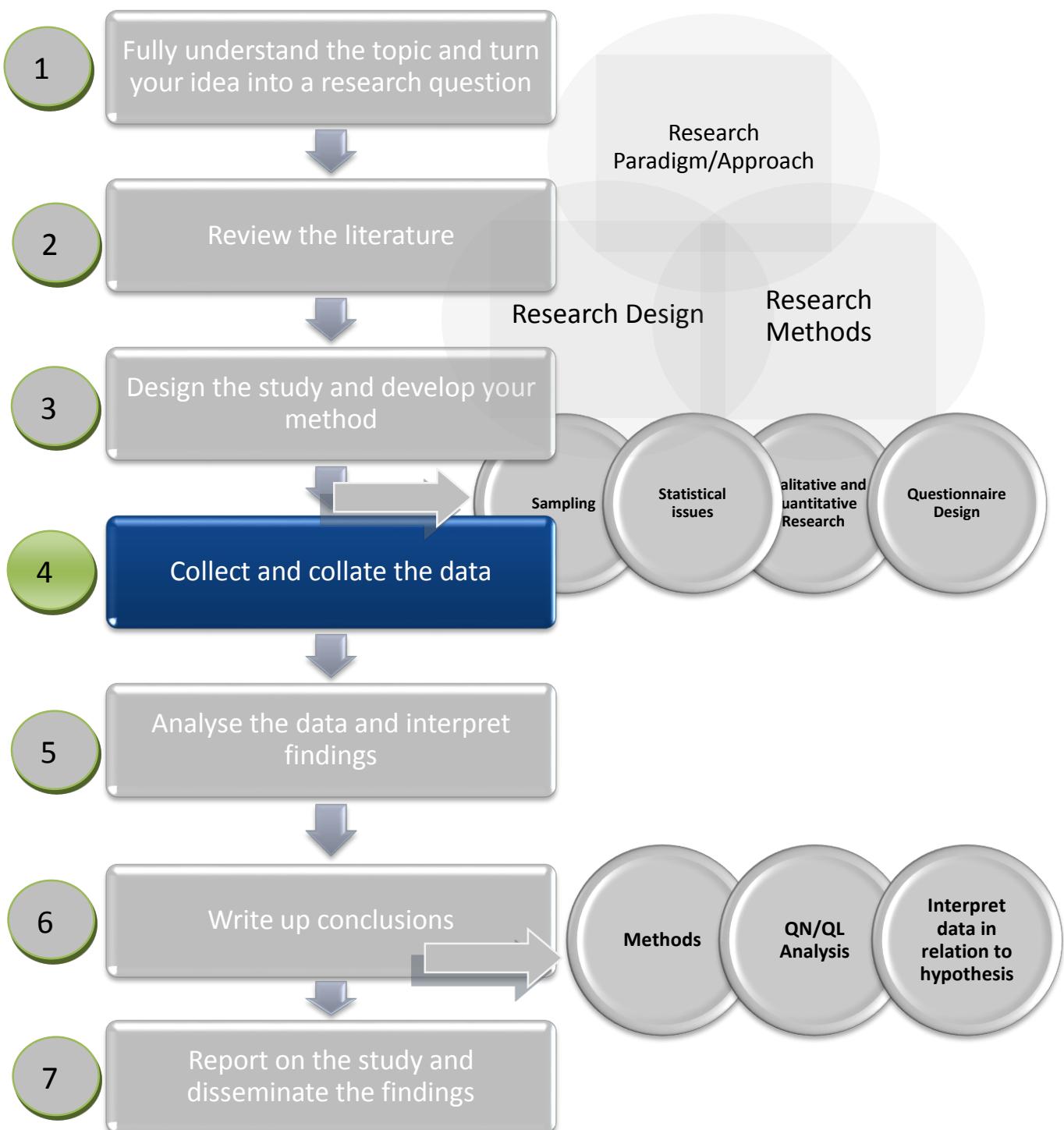


### **Prescribed Reading:**

- Saunders, M.N.K., Lewis, P., & Thornhill, A. (2009). *Research Methods for Business Students* (5th ed.). Harlow, United Kingdom: FT Prentice Hall.
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- American Journal of Pharmaceutical Education, 69 (5), 1-11
- Kerlinger , F.N. & Lee, H.B. (2000) *Foundations of Behavioural Research*. 4th Edition. Thousand Oaks, California: Sage Publications.

### **Recommended reading:**

- Marshall, C., and Rossman, G.B. (2006). *Designing Qualitative Research*. (5<sup>th</sup>ed.). Sage Publications: California. Pages 97 – 140. Available at: [http://www.sagepub.com/upm-data/10985\\_Chapter\\_4.pdf](http://www.sagepub.com/upm-data/10985_Chapter_4.pdf)
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## Data Collection

**Before we start to review this chapter, just remember:**

**The process of the research will be determined by the purpose of your research!**

Your method chosen for data collection has to align to your research questions, and has to be able to produce primary findings that directly answer or address your research objectives, aims, and questions. Both methodological approaches to research (Quantitative and Qualitative) have their benefits in relation to the types of questions you are trying to answer. Similarly, the type of method used to collect data will yield specific type of data that will lean itself more to the qualitative or quantitative tradition.

### **Quantitative Data Collection Methods**

In general, the following data collection methods are associated with the **quantitative tradition**:

#### **Structured surveys employing the use of a questionnaire**

Surveys or questionnaires are most suited for gathering descriptive information. A questionnaire consists of a set of questions presented to a respondent for answers. The respondents read the questions, interpret what is expected and then write down the answers themselves. There are two different types of surveys:

- **Structured Surveys:** use formal lists of questions asked of all respondents in the same way
- **Unstructured Surveys:** let the interviewer probe respondents and guide the interview according to their answers

There are three basic types of questions:

- **Close-ended** –all possible answers/prewritten response categories, and respondents are asked to choose among them
- **Open-ended** -allow respondents to answer in their own words.
- **Combination of both**

The benefits of using questionnaires are that they are economical, convenient, standardized, and anonymous. The disadvantage is that you only gain insight into what you are asking the participant (questions), and no further information can be relinquished. You are unable to clarify terms in the event that respondents are confused, and you cannot probe for further information regarding responses.

**Questionnaires should be developed and tested carefully before being used on a large scale!**

### **Questionnaire Design**

Designing questionnaires can be quite a lengthy and tenuous process, whereby you need to make sure at all times that it will yield the type and level of data you require to answer your research questions. To do this you will need to make sure all the steps discussed prior to this chapter are followed:

- Decide on a topic
- Decide on aims of, and rationale for, your research (Defining your objectives, and research questions)
- Formulate hypotheses (based on literature review and objectives)
- Know the subject (Literature review)
- Define information needed to test hypothesis, or explore the subject at hand

This once again points to ensuring that your project flows logically from one step to the next, in order to ensure that by the time you have collected your data, you have made the correct choices in sampling, and the data collected fits within your research paradigm, and is therefore adequate and suitable in answering your research questions, achieving your objectives, and ultimately reaching the aim of the study. This highlights the importance of ensuring that you have a good idea of the objectives of your study, and the questions you are asking. Your research questions will dictate exactly what the suitable research design and methodology will be, and ultimately the type and level of data needed to be collected.

A critical aspect of survey design is the development of **indicators** for concepts. What this means is that you need to delineate phenomena into measureable units. To do this, you need to:

- **Clarify concepts:** obtain a range of definitions for that concept, decide which definition you are going to adopt, and delineate the dimensions of that definition
- The definition should allude to the various dimensions of the concept that can be measured.
- **Evaluate them:** test reliability, validity (same results as existing measure and previous definitions); and dovetail with literature. Please refer to page 184 for a formal discussion of the concepts of validity and reliability

As pointed out previously, the most common method of quantitative data collection is through questionnaire administration. The assumptions underlying this method are implicit to the positivist ideology as they require testable hypotheses, and variable formulation and operationalization.

Questionnaire or survey research is possibly the most popular type of data collection method, and therefore warrants further explanation.

The benefits of survey research are that they tend to have high response rates, and facilitate an easy data summarisation and analysis due to their standardised format. They do however have underlying assumptions that the respondent will accurately recall and present information, without much regard for the bias of information presented. The fact that respondents even answer the survey already creates a bias as they are different from respondents who refused to.

Questionnaires are best suited to answer questions like proportion of competitors customers interested in your service being offered, or product being sold; how markets are segmented geographically; market demographic make-up and how it is different to your competitors and market shares available to market your product.

Let's run through a quick example of questionnaire development.

**1. Once you have identified your topic:**

An explanatory study on the effect of the introduction of TQM on the quality of outputs at XYZ Manufacturers, Durban

**2. Refined your research objectives:**

To determine the effect of the introduction of TQM on the quality of product at XYZ Manufacturers

**3. Defined your research questions:**

Is there a significant improvement in the quality of outputs at XYZ Manufacturers

Have practices been standardised since the introduction of TQM

Has the frequency of deficiencies in quality decreased since the introduction of TQM?

**4. Using your literature review, your research questions should be developed.**

Let's say the literature review identified the following benefits of TQM.

- According to Fasset (2004:7) an organisation will derive many benefits from implementing TQM systems. Of these benefits include:
- Defines and conveys the provider quality objectives, policies and practices;
- Facilitates uniformity in practice;
- Reduces, eliminates and prevents quality deficiencies;
- Facilitates training of new employees;
- Provides a basis for audits to be conducted;
- Provides assurance to the client; and
- Assists the provider towards achieving accreditation.

**5. Using secondary findings identified in your Literature Review, construct the items that should be included in your questionnaire that would best answer your Research Questions:**

Likert scales are most often between 5 and 7 points – with a neutral measure in the middle, and extremes on the end

	Strongly Agree	Agree	Neither Agree Nor Disagree	Strongly Disagree	Disagree
1. TQM systems reduces quality deficiencies?					
2. TQM systems prevent quality deficiencies?					
3. TQM systems eliminate quality deficiencies?					

**A few comments on the Likert scale:**

1. Much has been written on this type of scaling and on whether it must be called a Likert scale or a Likert-type scale. Some authors will argue that the researcher must refer to a Likert scale but to Likert-type items. Whereas other writers argue that what Rensis Likert really had in mind was to construct a summative scale to measure attitudes, perceptions and similar notions
2. Rensis preferred to call the scale he developed a Likert-type scale and, yes, he was also in favour of summative rating scales and viewed such scales as interval scales.
3. Some researchers these days use the term “Likert scale” loosely to refer to any questionnaire that uses a five-point response scale.
4. Most writers, however, recommend that the term Likert-type scale and Likert-type item be used instead of “Likert scale”.
5. There has been (and still is) a controversy about whether Likert-type scale values must be treated as values on an ordinal scale or whether the researcher can treat the values as interval data.
6. There are two schools of thought on the Likert-type scales. The more conservative school plays it safe and classify Likert-type responses as ordinal scale values, with the statistical restrictions that go with it. (It is often recommended that only non-parametric statistics (like the Chi-square) be used to analyse the ordinal data obtained with a Likert-type scale).

7. The second school of thought treats well-constructed Likert-type scales as providers of interval scale data, which then opens up the use of parametric statistical techniques ( means, standard deviations, test, correlations analysis and so on). This second school argues strongly for treating the Likert-type scale as a summative rating scale. Supporters of the second school of thought went further and strongly recommend to use a number of Likert-type items per construct and to then sum the scales to get a single measurement for the construct in question. Alternatively they propose to average the set of Likert-type items to get to a single score for the construct).
8. The most useful property of the Likert-type scale is that it can be used as a summated rating scale. Without tapping into this property the use of the scale is to a great extent meaningless. By the same token is it an almost futile exercise analysing all the items separately (as many students did in the past)
9. Students should be encouraged to construct their Likert-type scales with care but at the same time be encouraged to use it as a summative type scale which can be subjected to parametric statistics.
10. If a Likert-type scale is subjected to an item-analysis and the subsequent coefficient of internal stability (Cronbach's Alpha) is adequate there is no reason whatsoever that prevents data obtained by using a Likert-type summative rating scale being treated as data on an interval scale.

You can see how the literature, which relates directly to the theory surrounding your topic, research objectives and questions, help you, the researcher, to identify and structure questions that would directly answer your research questions. In the above example, the third research question was answered using the literature on quality deficiencies.

#### **THINK POINT:**

Have you asked yourself these when assessing your questionnaire?

#### **Have your questions:**

Been kept short and simple?

Been checked for double barrelled questions?

Been checked for eliciting prestige bias, or the tendency to want to lie in response to a sensitive question e.g. "my boss is an idiot"

#### **Have you avoided using:-**

Close-ended questions...? As they constrain answers

Leading Questions...? Lead respondent to answer in a certain way

Double negative questions

#### **Have you:**

Used indirect questions for sensitive issues?

### An example of a poor questionnaire

This is an excerpt taken from a student's questionnaire. There were 7 pages in total, with over 46 questions of similar length and format.

#### 4.3 Emotional intelligence leadership style.

- 4.3.1 How do you rate management positive reinforcement of an emotionally intelligent environment that enables the development of a service oriented climate which is authentic in nature and more effective?
- 4.3.2 How to assess management promotion of deep acting to find ways to enhance teachers' emotional intelligence level via cultivating a service oriented organizational climate, training and socialization of teachers?
- 4.3.3 How do you rate management emotional learning system that is a systematic, sequential, step-by-step process to learn, develop, and apply emotional skills that requires an active and intentional approach to learning?
- 4.3.4 How do you assess management ability to cultivate strong and trusting relationships with teachers that points to the importance of emotional intelligence in the workplace?
- 4.3.5 How do you rate management emotional intelligence that support management in more accurately perceiving reality through understanding and relating to teachers' emotions which is vital to teachers leadership?

#### Why is this an example of a poor questionnaire?

- Questions are too long
- Questions are unclear – confuses the reader
- Questions contain too much jargon – must be pitched a lower level
- Trying to assess too many variables in one sentence – if the respondents rates “poorly” to question 4.3.3. – To what do you think they are referring: Poor systems? Poor learning processes? Poor emotional skills? Poor requirements for active and intentional approaches to learning? Too many variables – with the result that the response answer is not clear, and cannot be analysed properly
- Poor grammar
- Poor punctuation – with the effect of seeming unprofessional
- Take too long to read through – respondent fatigue

**An example of a good questionnaire**

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1.	Dominant Characteristics					
A.	The hospital is a personal place.					
B.	The hospital is a dynamic innovative place.					
C.	The hospital is results driven.					
D.	The hospital is a structured place					
2.	Hospital Leadership					
A.	The leadership in the hospital generally shows nurturing					
B.	The leadership in the hospital generally shows risk taking					
C.	The leadership in the hospital generally shows a results focused approach					
D.	The leadership in the hospital generally shows coordination					
3.	Management of Employees					
A.	The management style of the hospital is characterised by teamwork					
B.	The management style of the hospital is characterised by individual risk-taking					
C.	The management style of the hospital is characterised by hard-driving competitiveness					
D.	The management style of the hospital is characterised by security of employment					

### What makes this a good questionnaire

- Questions are short
- Questions do not use jargon
- Questions focus on only one dimension – not multi-faceted
- Questions are not leading
- No double negatives
- No double negative questions
- Simple, and straight forward
- Quick to answer

### Practical exercise:

- Indicate which of the below are a good or bad question in a questionnaire
1. I am not satisfied with the lack of resources made available to us at ABD Productions
  2. I am aware of the policies and procedures of ABD and believe that there is a good work ethos
  3. I look daily for a new job in both newspapers and online
  4. I am satisfied with my current position at ABD Productions
  5. I will never miss out on the opportunity not to apply for a promotion when an opportunity is made available
  6. Both the managers and the shareholders are fair and effective when disciplinary action is required
  7. In my current position I am dissatisfied with (select one which applies):

Management	Staff	Work	Resources	Perks
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8. I strongly dislike my manager
9. I find that at times I am lazy
10. The RAU based within the CBD is largely a socially constructed, phenomenological entity
11. Do you agree that the hospital staff were close to exhaustion?
12. Do you feel firms today are concerned about their employees and customers?

**Answers to questions above:**

1. Poor – double negative – causes confusion
2. Poor – double barreled
3. Poor – double barreled
4. Good
5. Poor – Double negative – confusing
6. Poor – Double barreled
7. Good
8. Poor – loaded question – respondent will lie in order to protect themselves from any potential negative consequences
9. Poor – loaded question, will most likely lie as don't want to incur any negative consequences
10. Poor – too much jargon – people will not know what the question is actually asking
11. Poor – leading question
12. Double barreled – what if they are concerned about employees, but not customers? You would not be able to separate them out.

**Qualitative Data Collection**

When making decisions regarding how to collect qualitative data, respondent selection should rely on (Babbie and Mouton, 2005: 288):

- **Thorough knowledge of the cultural norms characteristics of a particular culture or group:** as a person who already has experience of a particular setting/event etc.
- **Current Involvement:** Need to find respondents who are currently immersed in and knowledgeable of the subject of our investigation.
- **Adequate Time:** Your respondents have sufficient time to meet with you.

In general, the following methods are associated more with answering more **qualitative questions**:

**Interviews**

Interviews involve the Investigator following a rigid procedure and seek answers to a set of pre-conceived questions through personal interviews. The purpose of interviews, are to:

- Elicit feelings
- Thoughts
- Opinions
- Previous experiences
- Meaning people give to certain events

Basically, an interview is an interaction between the interviewer, and interviewee, where the interviewer has a general sense of what they want to ask respondents. The respondent needs to do most of the talking. Kvale (1996: 3-5) refers to two metaphors for interviewers:

1. Miner: Where the interviewer is involved in “digging out” the information that the interviewee posses
2. Traveller: where the interviewer travels with the interviewee along the spectrum of dialogue

There are several different types of interviews

- **Informal conversational interview** – takes the form of a normal conversation as the questions are not pre-determined but rather emerge from the moment, and the interview is guided by the interaction itself
- **General Interview Guide Approach** - Set up a general interview guide (McNamara, 2009) – develop a general set of questions – but these may be adapted accordingly depending on the setting and interviewee
- **Standardised open-ended interview** – Wording of sentences are structured, participants are asked similar questions, but the responses thereto are open-ended. The open-ended nature thereof allows the interviewee to delve into as much details as deemed necessary, and the interviewer can ask follow-up or probing questions. Produces rich and thick qualitative data, but can difficult for the researcher to fully reflect an overall perspective of all interview responses through the coding process. Gall, Gall, and Borg (2003), however say this reduces researcher biases within the study, particularly when the interviewing process involves many participants.  
Say for instance I wished to conduct an interview for my study, how do I go about doing it?

In general, Kvale (1996: 88) mentions seven steps to completing an interview:

1. **Thematising:** Identifying the goal of the interview, and what needs to be covered
2. **Designing:** Thinking of all pragmatic concerns relating to the conducting of the interview
3. **Interviewing:** Conducting the interview
4. **Transcribing:** Converting verbal to written statements
5. **Analysing:** Turning data into meaningful information
6. **Verifying:** Taking findings back to respondents for verification of truth and wholeness
7. **Reporting:** Sharing and disseminating the findings of your research

### The Advantages of interviews include:

- Puts participant at ease by avoiding difficulty with poor vision or low literacy, may be more enjoyable, clarification, richness, completeness
- Verbatim quotes capture the language and meaning expressed by participants
- Accurate data can be obtained immediately,
- Probe for reasons and observing non-verbal responses.

### Disadvantages:

- Time consumingExpensive if trained interviewers are required

## Example of different types of questions

### Types of questions

#### Open- and Close-ended

- *Open-Ended: What sites do you expect to see on your vacation?*
- *Close-Ended: May I use the bathroom?*

#### Experience and behaviour questions

- *Experience: In what ways have your college experiences prepared you for a career?*
- *Behaviour: Give an example of an occasion when you used logic to solve a problem.*

#### Opinion and value questions

- *Fact: Name the chores Cinderella was given to do*
- *Opinion: Why do you think Cinderella's stepmother was so cruel to her?*

#### Feeling questions

- *How do you feel when you watch Alice fall down the hole?*

#### Knowledge questions

- *What is the biggest city in Japan?*

#### Background/demographic questions

- *What is your age?*

#### Descriptive questions

- *Ask participants to describe their experiences (e.g., their ideas, circumstances, viewpoints, dilemmas, etc)*

### Structural questions

- Ask participants how they organize their world (e.g., activities)

### Contrast questions

- Ask participants what is meant by specific terminology

## Steps to setting up an interview

### Step 1. Prepare for the interview

McNamara (2009) advises that you should:

- Choose a setting with little distraction.
- Explain the purpose of the interview.
- Discuss issues of confidentiality.
- Explain how the interview is going to ensue.
- Mention the length of time the interview is anticipated to be.
- Give them your contact information in the event they wish to contact you.
- Ask them if they have any questions for you before the interview gets underway

*Just remember that your memory is not sufficient to capture all responses, cues, and innuendo's – so ensure that you have a recording device, or materials to capture this information i.e. tape-recorder, video-recorder, paper, etc.*

### Step 2: Participant Selection

As mentioned previously – your selection of subjects depends on the sampling strategy that will best yield the most credible persons who can relinquish the most detailed, and informed responses to answer your research questions.

### Step 3: Piloting

As you would do with a questionnaire – you will need to pilot your interview to ensure that there are no weaknesses, flaws or barriers to successful implementation of your research interview design. To perform a pilot – you will use a group of people with similar interests to those of your final target population.

### Step 4: Constructing Research Questions

You, as the researcher, will need to ensure that the types of questions you ask allow you to delve DEEP into people's experiences, thoughts, knowledge etc to yield rich data suitable for qualitative designs.

McNamara (2009):

- Questions should be open-ended allowing respondents to use their own words to respond.
- Avoid questions that are leading, or loaded – try to keep them as neutral as possible.
- Questions should be asked one at a time.
- Questions should use words that are indigenous to the respondent, i.e. culturally sensitive and appropriate, and should not be complicated – they should be easily understood.
- Try to avoid asking “why” questions

### **Examples of good and bad questions**

#### **“Good”**

How have your experiences of being the CEO of Company XYZ influenced, or not influenced the manner in which you approach business?

#### **“Bad”**

How has your experience of being the CEO of Company XYZ affected you as a manager?

Can you tell why?

The first is an example of a good question as it is open-ended and allows the interviewee to respond in their own terms, by drawing on their own experiences without the assumption that being the CEO actually has had any bearing on other business related decisions.

The second is an example of a bad question as you are making the assumption that being the CEO has affected them as a manager - we should not make any assumptions – and should not hold any hypotheses about people's experiences and knowledge.

### **Step 5: Conducting the interview**

McNamara (2009) suggests that:

- You should check intermittently if the recorder (audio or video) is working properly
- Try not to show any emotional reaction to responses – this will bias responses, and your interviewee will tend to withhold similar type of information
- Encourage responses by nodding, and “uh-huh-ing”
- Be aware of the signals you are sending when taking notes – the respondent can see through the speed and enthusiasm of recording responses your emotional reaction to what they are saying
- Provide direction to your participant when switching between topics – i.e. “we have previously been talking about the prevailing style of management at Company XYZ, I would now like to ask you a few questions about your experience of the current morale at your company.”
- Make sure you keep on topic – ensure that your respondent doesn't stray off track

## EXAMPLE OF AN INTERVIEW

Human Resources Outsourcing: A Study of KwaZulu-Natal Companies Use of Outsourced Human Resources Services, Reasons and Benefits.

### RESPONDENT PROFILE

**Participant:** Sipho Mathembu

**Name of organisation:** XYZ Industries

**Number of employees:** 28

**Designation / Job description:** Financial Manager / HR Manager / IT / Company Secretary

**Years in position:** 10

**Highest educational qualification:** CA (SA)

**Date of interview:** 21 November 2012

**Time interview started:** 11.35am

**Time interview finished:** 12.17pm

**Name of interviewer:** Mary Foster

**Location of interview:** Westville, coffee shop

I: Hi Sipho, thank you so much for meeting me – I really appreciate you taking the time.

R: No Problem...Thank you Mary for inviting me

I: This interview won't take long, I uhm .merely wish to explore some of the reasons why your company has decided to outsource its HR erm unit to our company so that we can make recommendations going forward.

R: ah..yeah..err.

I: Do you have any questions for me before we get started?

R: Erm..no, thanks

I: alright, shall we get started then...

R:ok-

I: Could you please kindly provide a description of the industry in which you work and identify the erm..current HR challenges experienced by an organisation in that particular industry.

R: Sure..err....(5secs) XYZ markets and distributes speciality chemicals, water-based paints, products for the personal care market and the textile industry. The main line of chemicals is preservatives. The erm

I: ok..<nodding>

R:..HR challenges start with the fact that we do not have a dedicated HR department <takes sip of coffee> err.. The organisation is small and we are not unionised..like erm..ahhh..

Keeping up to date with legislation and practices in the industry is our main challenge though. In the industry we need to try and stay competitive by offering competitive packages. That is why we are looking at cost to company as our new remuneration policy.

I: So do you view HR to be a erm...function that supports the organisations overarching strategy or do you consider it to be an administrative function?

R: I think in the past we have seen it as an admin function, but in recent times we have seen it as a strategic function. We are starting to invest more in staff but this is a long-term project.

I: aha-

R: Ideally we would like to see it as a strategic function...it's just that time is an issue.

I: I understand, particularly in a company this size. We experience the same pressures at Outsourcing Ltd.

R: You see-

I: ok, so, erm... If you consider HR to be of strategic significance, what alternatives did your organisation look at to reduce the pressure on this department, enabling them to better support the functioning of the organisation?

R: well..yes..erm.. Purely from an HR side we have never looked at it like this...errr-

I: OK-

R: We have looked at mainly outsourcing. This function has been transferred from the MD to me and I am now trying to give it more time, but as you can see I have numerous portfolios to look after and finding time is difficult-

I: -That seems to be a common theme..err (3 secs) Did the organisation consider HR outsourcing as one of the preferred solutions to ease this pressure?

R: Well yes, Definitely<bangs table> We just do not have the capacity or skills to deal with all these issues (hands waving). When I get time...[laughs] my aim is to try and look at the bigger picture.

I: The bigger picture, ok, uhm, if other options had been considered first, why do you say they not successful in achieving their goals?

R: well, err.. I think that this was before my time (stops) (5secs) we outsource things like IT and HR because we are not experts or have the resources.

I: ok..

R: Ja, whilst people work in their various departments we are trying to cross-train people.

I: OK, I see-

R: We have started in the Admin section by encouraging people to learn other people's functions (higher tone). We have identified this as a weakness from a continuity point of view...but again ..erm..time is an issue. We have a flat structure so we do not have people floating around who we can use in other areas. Whilst we are trying to work on the cross training issue we are not pushing it that hard.

I: Ok, I see, the cross training point that you raised is quite refreshing. Is this common amongst the clients that I deal with?

R: Yes indeed (3 secs) ..erm.. in an organisation of our ..erm..size it is a step in the right direction.

#### THINK POINT:

When you are selecting data collection strategy you need to be able to justify why you chose that strategy, and how it falls in with your selected design. Basically, every decision taken needs to be justified, and explainable. Below is an excerpt from a paper compiled by Groeneweld in 2004, titled: "*Phenomenological Research Design*"

#### When documenting your interview, and the reason for it, please see excerpt below on how this type of decision is reached

The specific 'phenomena' (from the Greek word phenomenon, meaning appearance) that I focused on is co-operative education, and more particularly the joint ventures (completed and/or under way) between educational institutions and enterprises in order to educate people and grow talent. My central research question was: what is the contribution that co-operative education can make in the growing of talent of the South African people? However, Bentz and Shapiro (1998) and Kensit (2000) caution that the researcher must allow the data to emerge: "Doing phenomenology" means capturing "rich descriptions of phenomena and their settings" (p. 104). For this reason, the actual research questions that were put to participants (both academics and enterprise representatives involved) were:

- How did/do you experience the joint educational venture?
- What value, if any, has been derived from the collaborative effort?

Kvale (1996) draws a similar distinction between the research question and the interview question. Further, it was important to keep in mind that the findings may, or may not, illustrate that the practice of co-operative education contributes to the growing of talent. In this regard Jon Kabat-Zinn state that "inquiry doesn't mean looking for answers" (cited in Bentz and Shapiro, 1998, p. 39).

I conducted unstructured in-depth phenomenological interviews with both the educational institution-based programme managers and with the enterprise-based representatives. The remainder of this paragraph explains how these interviews were conducted. My questions were “directed to the participant’s experiences, feelings, beliefs and convictions about the theme in question” (Welman & Kruger, 1999, p. 196).

According to Bentz and Shapiro (1998), Husserl called it bracketing when the inquiry is performed from the perspective of the researcher. Bracketing (Caelli, 2001; Davidson, 2000; King, 1994; Kruger, 1988; Kvale, 1996) in this study entailed asking the participants/informants to set aside their experiences about the collaborative educational programme and to share their reflection on its value. Data were obtained about how the participants “think and feel in the most direct ways” (Bentz & Shapiro, 1998, p. 96). I focused on “what goes on within” the participants and got the participants to “describe the lived experience in a language as free from the constructs of the intellect and society as possible”.

This is one form of bracketing. There is also a second form of bracketing, which, according Crabtree (1992, p. 24) is about the researcher that “must ‘bracket’ her/his own preconceptions and enter into the individual’s life-world and use the self as an experiencing interpreter”. Moustakas (1994, p. 85) points out that “Husserl called the freedom from suppositions the epoché, a Greek word meaning to stay away from or abstain”. According to Bailey (1996, p. 72) the “informal interview is a conscious attempt by the researcher to find out more information about the setting of the person”.

The interview is reciprocal: both researcher and research subject are engaged in the dialogue. I experienced that the duration of interviews and the number of questions varied from one participant to the other. Kvale (1996) remarks with regard to data capturing during the qualitative interview that it “is literally an interview, an interchange of views between two persons conversing about a theme of mutual interest,” where researcher attempts to “understand the world from the subjects’ point of view, to unfold meaning of peoples’ experiences” (pp.1-2). At the root of phenomenology, “the intent is to understand the phenomena in their own terms — to provide a description of human experience as it is experienced by the person herself” (Bentz & Shapiro, 1998, p. 96) and allowing the essence to emerge (Cameron, Schaffer & Hyeon-Ae, 2001).

The maxim of Edmund Husserl was “back to things themselves!” (Kruger, 1988, p. 28). ‘Memoing’ (Miles & Huberman, 1984, p. 69) is another important data source in qualitative research that I used in this study. It is the researcher’s field notes recording what the researcher hears, sees, experiences and thinks in the course of collecting and reflecting on the process.

Researchers are easily absorbed in the data-collection process and may fail to reflect on what is happening. However, it is important that the researcher maintain a balance between descriptive notes and reflective notes, such as hunches, impressions, feelings, and so on. Miles and Huberman (1984) emphasize that memos (or field notes) must be dated so that the researcher can later correlate them with the data. In addition to the ten interviews conducted in this study, the educational institution-based programme managers in two instances arranged access to programme participants. Depending on the circumstances, I either talked directly to the programme participants to ask them to write essays, or worked through the programme manager and presented the following request: Write down your viewpoint, perspectives or feelings of the programme you are undergoing, or have completed. You need not give your name. You need not concern yourself with grammar or spelling. If possible, compare this programme with others you may have done, which are not offered through collaboration between an employer and an educational institution (or compare this programme with pure academic programmes, known to you from talking to other students). Having explained the three data-gathering methods – unstructured in-depth phenomenological interviews, memoing and essays – the data storage will be explained next.

**Can you see how the researcher has used the literature to argue for decisions made here? Can you see how he has explained his sampling technique with reference to the research design?**

### ***Observation***

- Collection of information by way of investigator's own observation, without interviewing the respondents.
- Intensive, usually long term, examination of a social group, an organization, etc.
- Describe the setting, exterior physical signs, expressions, language behaviour, time to complete a task.
- Technique that involves systematically selecting, watching and recording behaviour and characteristics of living beings, objects or phenomena
- Measurement procedure, assigning numerals to human behavioural acts
- First-hand experience – assists with analysis
- See what is normally taken for granted or not easily spoken about
- Observes their behaviour and learns meaning systems (which are tied to language)  
Confirm perceptions of respondents
  - Structured – for descriptive research
  - Unstructured - for exploratory research

- Participant Observation
- Non-participant observation
- Disguised observation

### Example

A researcher wishes to investigate whether workers at CVT Productions (a company which produces parts for cars along a production line) have altered their work practices after receiving extensive training on Occupation Health and Safety Practices for Car Manufacturers following a series of adverse incidents at the factory.

The researcher operationalizes or defines what sets of behaviour, or sequence of events, they are interested in observing. This sequence of performance is then observed using a video camera. The employee does not know when their turn will be for observation, but have consented to observations being made.

The sequence of steps is observed prior to the training, and again following the training. Notes are kept, and observations made. The researcher looks to see if there have been any significant changes, or improvements in the employee's sequence of steps followed when performing the task subsequent to the training to determine training implication and efficacy.

### Advantages

- Observations can give additional, more accurate information on behaviour of people than interviews or questionnaires.
- They can also check on the information collected through interviews especially on sensitive topics

### Disadvantages

- the effect of the observer on the observed
- observer inference

## Direct observation

### Advantages

- Respondent is generally not aware of being observed and therefore behaves in a natural way
- Reduces the likelihood of gathering biased data

### Disadvantages

- Passive form of data collection, and there is little opportunity to probe for reasons or investigate behaviour further

An excerpt from another paper following an observational approach to data collection:

**What Do Successful Managers Really Do? An Observation Study of Managerial Activities**

Fred Luthans<sup>1</sup>,  
Stuart A. Rosenkrantz<sup>2</sup> and  
Harry W. Hennessey<sup>3</sup>

Author Affiliations

**Abstract**

Rather than evaluate managers on the basis of activities traditionally prescribed for success, an observation study was conducted to determine empirically which activities successful managers actually perform. Trained participant observers recorded the behaviors of 52 managers in three diverse organizations—a state department of revenue, a medium-sized manufacturing plant, and a campus police department—over a two-week period. In analyzing the data collected, the authors measured success by using a promotion index of level over tenure and by considering the top managers of each organization to be successful. Regression analysis found that two activities were significantly related to managerial success: interaction with outsiders and socializing/politicking. Further comparative analysis of managers ranked in the top and bottom thirds indicated that successful managers exhibited more behaviors related to conflict management, and comparisons of top-level managers with those in the middle and first levels indicated that successful managers exhibited more behaviors related to decision making and planning/coordination. The study found that some of the activities of the successful managers apparently depended upon the type of organization in which they worked.

Despite observation being a potential data collection technique – it is often not used in business.

### **Focus Groups**

Focus groups are used in attempt to understand people's thoughts and feelings, by eliciting their opinions, values, feelings. They are usually set-up as follows:

- Homogenous demographics, but heterogeneous views
- Strangers
- 8-12 people
- 1-2 hours
- Moderator and note taker
- Prepare discussion guide

In other words, focus groups bring together small numbers of people to discuss a topic. Topics can include things such as reactions to a new product or service, opinions regarding competitors, brand choice and so forth, and are best situated to determine how people make decisions, if there are unmet needs in the market, barriers, and reactions to changes made to products or services.

Due to poor participation, it has been advised to solicit 10 times more than need, e.g. 200 for two groups of 10. Further, you could offer incentives to get participation.

Perhaps the trickiest aspect of conducting focus groups is moderating and facilitating the session. The moderator needs to be objective, knowledge of the subject and industry, and some understanding of group dynamics.

### **Advantages**

- Cost-effective
- Allows participants to create meaning amongst themselves – not individually
- Get a variety of perspectives/reactions to a certain issue in a short time
- Quality of data enhanced by group participants
- Can quickly assess the extent to which there is agreement or diversity
- Enjoyable for participants

### **Disadvantages**

- Restricts number of questions
- Responses by each participant may be constrained
- Requires group process skills
- Silences the minority view
- Confidentiality
- Explores major themes, not subtle differences. Outside of natural setting

### **Example**

A researcher is interested in branding. Focus Groups are often used in marketing to understand how consumers make decisions about, and understand the factors that influence, consumer choice in product use. Furthermore, marketing researchers use focus groups to explore new product or service ideas, understand brand imaging, testing the efficacy of advertising campaigns, identifying strengths and weaknesses of competitors, product testing amongst others.

Given thus, Organisation XYZ have recently made changes to their packaging. They have changed both colour, and shape of packaging to be more environmentally friendly, and reduce its carbon footprint. They want to find out, before rolling the new product packaging out if consumers would still buy it, or are more likely to buy it. As such, they provide a cash incentive to a random group of shoppers at the local mall, and hold a focus group of eight people in a designated, quiet room. The researcher facilitates the process, and a video recording is made.

### **Exercise:**

For each of the examples below please state:

***Research Approach (QL or QN) Sample and how you would go about collecting the sample***

***What research instrument, technique or tool you would use.***

If I wished to study the world views of the aborigines in Australia to determine their perceptions regarding spirituality

Aimed to study if Panado is more effective in reducing headaches in a sample of people

Aimed to test the hypothesis of whether or not my group of MBA Students had a higher IQ level than the average population?

Aimed to investigate what resources were considered by that community as the most important

Determine if productivity has decreased since 30% of employees have been retrenched as a result of recession

Determine sources of dissatisfaction amongst employees.

## CHAPTER 5: DATA ANALYSIS

### **Learning Outcomes:**

- Apply various types of statistical tools and analyses to solve business-related problems.
- Make logical decisions based on these required outcomes of a given research problem.
- Be able to use the decision making tree to identify the correct statistical technique to yield suitable results
- Understand SPSS Understand and apply the principles of quality assessment of both quantitative (Reliability and Validity) and Qualitative studies (Credibility, Trustworthiness and so forth)



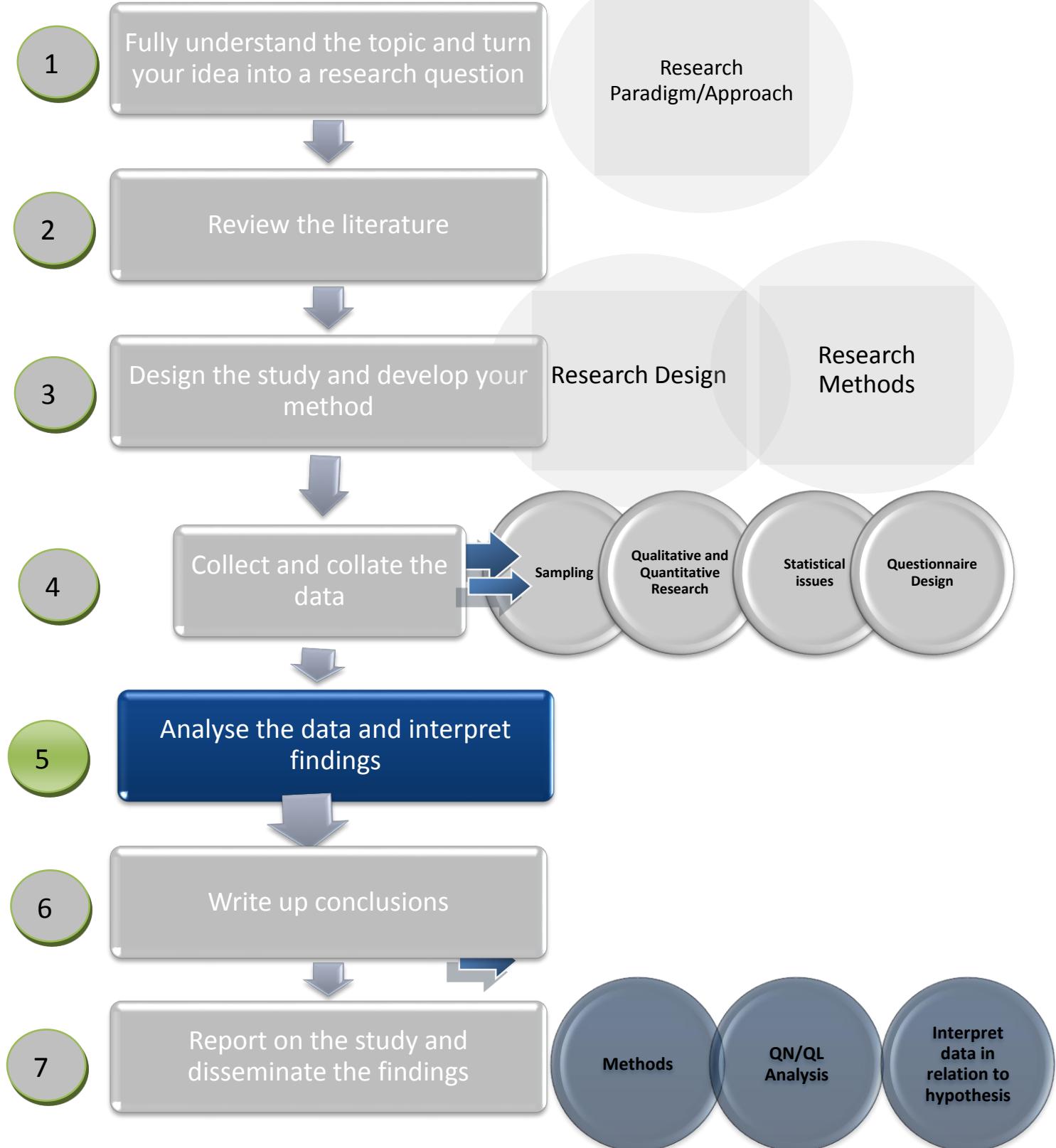
### **Prescribed Reading:**

- Saunders, M.N.K., Lewis, P., & Thornhill, A. (2009). *Research Methods for Business Students* (5th ed.). Harlow, United Kingdom: FT Prentice Hall.
- Groenewald, T. (2004). A phenomenological research design illustrated. *International Journal of Qualitative Methods*, 3 (1).Article 4. Retrieved 2<sup>nd</sup> April 2013 from [http://www.ualberta.ca/~iijqm/backissues/3\\_1/pdf/groenewald.pdf](http://www.ualberta.ca/~iijqm/backissues/3_1/pdf/groenewald.pdf)
- Hepburn, A. (2004). Crying: Notes on description, transcription and interaction. *Research on Language and Social Interaction*, 37, 251-290. Retrieved 2<sup>nd</sup> April 2013, from: <http://homepages.lboro.ac.uk/~ssjap/transcription/hepburncrying2004.pdf>
- Durrheim, K., and Tredoux,C. (2002). *Numbers, Hypotheses and Conclusions: A Course in Statistics for the Social Sciences*. UCT Press: Cape Town.

### **Recommended reading:**

- O'Connor, H., and Gibson, N. (2006).A Step-by-Step Guide to Qualitative Data Analysis. *A Journal of Aboriginal and Indigenous Community Health*, 1(1): 64 – 90.
- Taylor-Powell, E., and Renner, M. (2003). Analyzing Qualitative Data. Cooperative Extension Publishing Operations: Madison. Pages 1- 10.
- Turner, D. W., III (2010). Qualitative interview design: A practical guide for novice investigators. *The Qualitative Report*, 15(3), 754-760. Retrieved from <http://www.nova.edu/ssss/QR/QR15-3/qid.pdf>

## THE QUANTITATIVE RESEARCH PROCESS



## Data Analysis

This section will ensue first by looking at the quantitative considerations, and options available to researchers when conducting statistical data analysis, and secondly, to review the types of qualitative data analysis techniques available to researchers. They both have very different methods for analysis and interpretation, and will yield different output that should best answer your research questions.

### Introduction

Data analysis concerns itself with specific patterns in the data, and serves as a tool to enhance knowledge. The manner in which knowledge is generated varies. Quantitative research, as a very general rule, is deductive, whereas qualitative research tends to be more inductive. What does this mean? Well this not only has implications for our literature review, and the use of existing theory, but also, how we come to know what we know. Deductive research involves the application of existing theories to present observations to prove or disprove an hypothesis. Inductive, qualitative research on the other hand is more theory generating. In other words, we start with observations, on ground level, thereafter build a theory from there.

Again, we are concerned with enhancing knowledge. Here we break down knowledge into elements. These elements can involve concepts, like “motivation”, “engagement” and so forth. They can also involve statements of the relationship between concepts, for example, the relationship between motivation and engagement. In order for us to enhance knowledge, we can break it down into two endeavours, summarization, or the development of concepts, and correlation, or deriving statements about the relationship between those concepts.

In the event of summarisation, in quantitative projects, we focus on Principal Components Analysis, whereas with more categorical data, we focus more on cluster analysis techniques. When focussing specifically on correlational analysis, when we deal purely with quantitative data, we use Regression, and with more categorical data, classifiers.

In order for us to test hypotheses – we need variables. Variables are basically those things or properties we are measuring. In other words, a variable or construct is a theoretical or operational (explains how we are going to measure the variable)

We basically have two types of variables; Independent (IV's) and Dependent Variables (DV's).

The IV is the thing we think causes the DV. In other words, between cigarette smoking and lung cancer, we would think smoking is the IV, or the cause, and lung cancer the DV, is the effect.

When we look for a significant outcome – it is important to understand significant is not meant in traditional terms – but rather that something that is due to actual differences, not differences caused by faulty instruments, samples, events etc.

### **Data classification**

Numerical (Quantitative) data can also be classified as **discrete** (integers or whole numbers – like the number of students in a class room) or **continuous** (when you can have intermediate or fractional values – like height or distance).

Data are sometimes summarised in tables giving the number of data items in each interval.

This is referred to as a frequency distribution.

**Summary or descriptive statistics** use various methods to summarise/describe sample data collected in order to facilitate interpretation. Summary statistics has been covered in sections 1 to 5 of this study guide.

**Inferential statistics** allow us to use the same sample data to infer features of the population from which it is drawn. The most important applications of inferential statistics are confidence interval estimating and hypothesis testing.

Confidence interval testing is not covered in this course.



### **ACTIVITY**

For each of the following examples of data, determine whether the data type is quantitative or qualitative. If the data is quantitative, state further whether it is discrete or continuous:

- a) The number of times an athlete visits the gym weekly.
- b) The make of car driven by each of a sample of executives.
- c) The volume of liquid consumed by a marathon runner.

### **SOLUTION TO ACTIVITY**

- a) Quantitative, discrete.
- b) Qualitative.
- c) Quantitative, continuous.

## What is data and where do I get it?

### **Sources of Data**

#### *Internal*

- Our own organisations, internal data is generated during the course of normal business activities/
- Financial data – sales vouchers, credit notes, accounts receivable.
- Production data – monthly production, defect rates, WIP levels.
- Human Resource data – time sheets, staff demographics, wage and salary schedules.
- Marketing data – monthly sales, advertising expenditure, customer profiles.

#### *External*

- External to our own organisation may be private institutions, trade/ employer/ employee associations, profit motivated organisations and government bodies.
- Internet.
- Business publications.
- Statistics SA.

### **Primary**

- Collected by the researcher himself, and is captured at the point where it is generated for the first time, normally with a specific purpose in mind.

#### **Advantages:**

- Primary data is directly relevant to the problem at hand.
- Primary data generally offers greater control over data accuracy.

#### **Disadvantages:**

- Primary data could be time consuming to collect..
- Primary data is generally more expensive to collect.
- People aren't always supportive of your research endeavours.

### **Secondary**

Collected by individuals or agencies for purposes other than those of our particular research study.

- “Aged” market research figures.
- Previous financial statements.
- An industry market research from which you are extracting data for your company.

### **Advantages of secondary data:**

The data is already in existence.

- Access time is relatively short.
- The data is generally less expensive to acquire.

### **Disadvantages of secondary data:**

- Data may not be problem specific or entirely relevant to your situation.
- Data may be dated and hence inappropriate.
- It may be difficult to determine the data accuracy.
- The data may not be suitable for further manipulation.
- Cant evaluate the reliability of the data.

## **Understanding data**

Why?

- to assess data quality; andto select the appropriate statistical method to use to analyse the data.

Therefore we need to look at:

1. Qualitative and quantitative data
2. Levels of measurement

## **Qualitative and Quantitative data**

### **Quantitative Data**

- How much or how many of something
- A set of observations where any single observation is a number that represents an amount or a count

**Levels of measurement**

- **Nominal**
  - Variables with no inherent order or ranking sequence  
e.g. numbers used as names (group 1, group 2...), gender, etc.
- **Ordinal**
  - Variables with an ordered series  
e.g. "greatly dislike, moderately dislike, indifferent, moderately like, greatly like".  
Numbers assigned to such variables indicate rank order only - the "distance" between the numbers has no meaning.
- **Interval**
  - Equally spaced variables  
e.g. temperature. The difference between a temperature of 66 degrees and 67 degrees is taken to be the same as the difference between 76 degrees and 77 degrees. Interval variables do not have a true zero, e.g. 88 degrees is not necessarily double the temperature of 44 degrees.
- **Ratio**
  - True zero, numbers mean something, it is numeric data with a zero origin.  
Age, distance, time, mass, sales, units and income are examples of ratio data.

**The level of measurement determines what type of tests and level of analysis that can ensue!**

**Discrete Data**

- A random variable whose observation can take on only specific values, usually only integer (whole numbers) values, is referred to as discrete
  - The number of students in a class
  - The number of cars sold in a month by a dealer

**Continuous Data**

- A random variable whose observation can take on any value in an interval is said to generate continuous data, and that any value between a lower and upper limit is valid
- Since continuous variables are real numbers, we usually round them off. This implies a boundary depending on the number of decimal places. For example: 64 is really anything between 63.5 and 64.5. likewise, if there are two decimal places, then 64.03 is really anything between 63.025 and 63.035. Boundaries always have one more decimal place than the data and end in a 5.
  - The time taken to travel to work daily.
  - The tensile strength of steel.
  - The speed of an aircraft.

## Quantitative Data Analysis

### Depends on level of measurement

#### Must answer your research questions



Quantitative data analysis most often utilises statistics in order to analyse the data yielded from the data collection phase with the sole intention of answering (providing proof to support or refute) the research questions. By committing yourself primarily to one type of approach, or framework, you are able to determine certain aspects such as (Kumar, 2005: 241):

- Which variables are of interest
- How you are going to analyse them
- Crosstabs needed to be worked out

**Just remember!** Statistics should be thought of from inception to completion of your project. To do this you need to be aware of multiple strategies, and methods available to you, and what type of data you need to collect to perform that analysis. Just remember, your statistics must always answer your research question! To ensure this is done (GAO, 1992: 108):

Be clear about your research question – how you understand your research question will determine what your testing variables will be.

Understand the topic – data is useless interpreted in context of your study.

Develop an analysis plan – Decide on a set of questions, and plan what methods you will use to answer them. Just remember the methods you choose to adopt to answer these questions will impact what type of data you need to collect.

You should also be aware of the challenges and shortfalls after analysis has been completed. Essentially statistical analysis is the manipulation, summarisation, and interpretation of data.

#### Let's start with some basic concepts:

Term	Definition
<b>Data</b>	Groups of observations
<b>Attribute/Value</b>	Characteristic of the studied phenomenon e.g. female
<b>Variable</b>	Logical collection of attributes, or characteristics, e.g. gender, with attributes male and female
<b>Response Variables</b>	Variables we are interested in
<b>Cases</b>	The individual, person, things, events where we get our information from

## What is “statistics”?

- Science of designing studies, gathering data, and then classifying, summarising, interpreting;
- Presenting data to support decisions that are needed;
- Refers to a range of techniques and procedures for analyzing data, interpreting data, displaying data, and making decisions based on data;

"Statistic" is defined as a numerical quantity (such as the mean) calculated in a sample. Such statistics are used to estimate parameters. In other words, statistics organises and summarises data.

Why? So that can comprehend the better, and in a more understandable fashion, what information is being relayed.

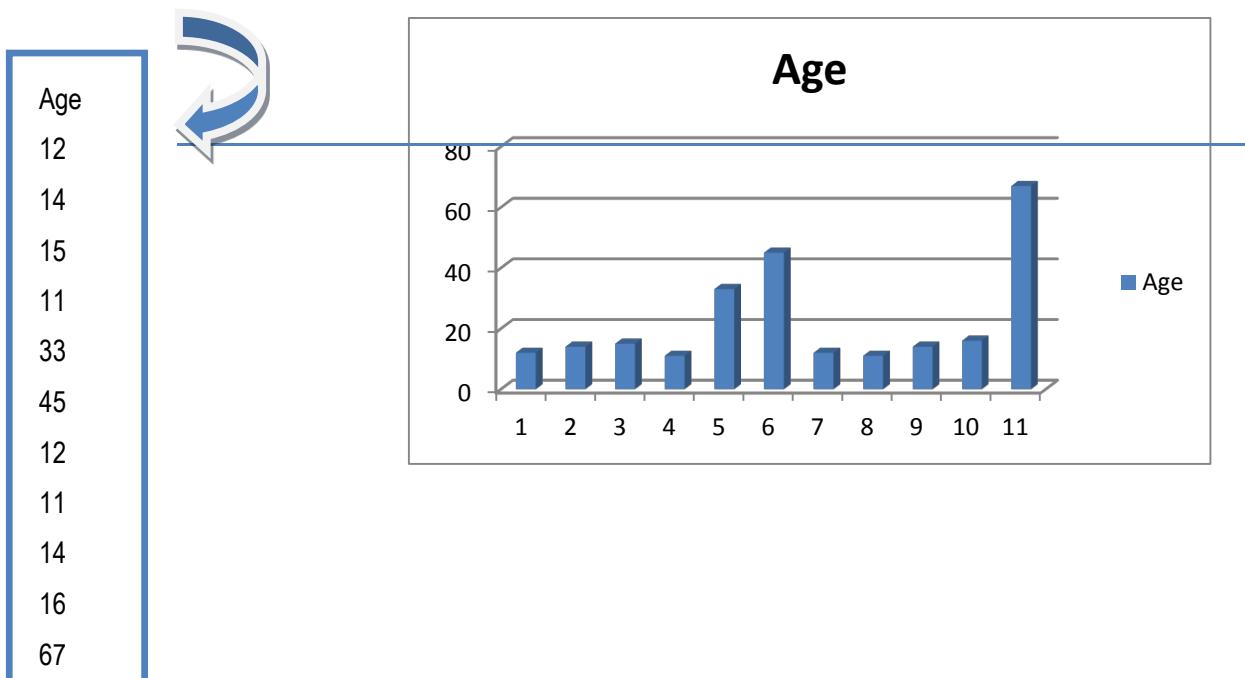
The aim of descriptive analysis or research is merely to describe – not to provide any causal explanations.

e.g. Which is easier to understand?



This ?

Or this?



## Presenting Data

- Major difference between data and information is that the latter is presented in an ordered format

### **Methods for presenting data**

#### **Tables**

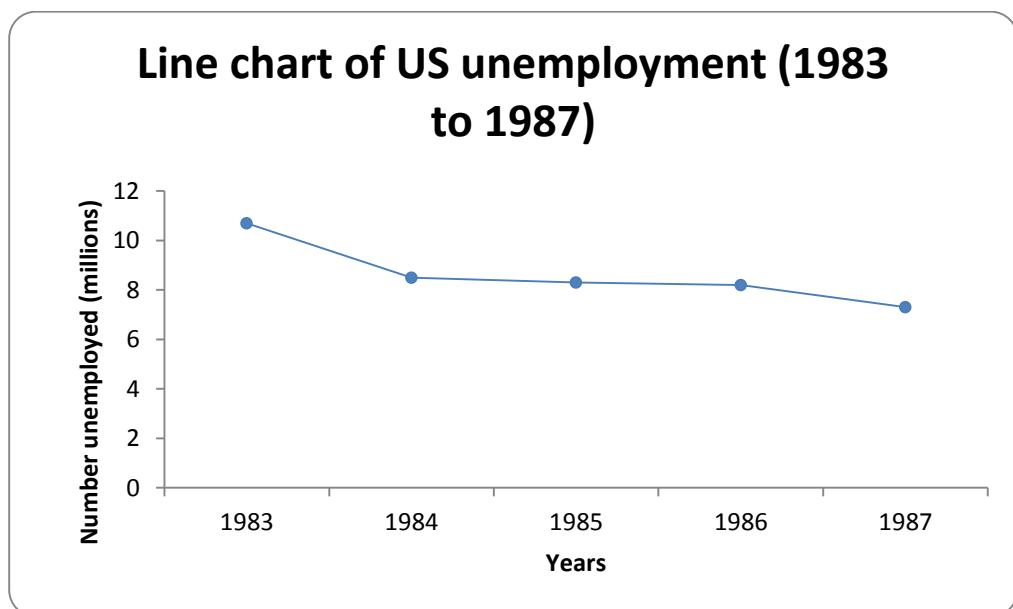
- Make comparisons, within the table and with other data
- Perform additional calculations
- Examine the component structure of the data

#### **Graphs**

- Powerful if we want to focus attention on a particular aspect, such as a dominant feature or a trend
- Examples we'll cover include:
  - Line graph
  - Bar graph
  - Pie chart

#### **Line graph**

- Note the features of a line graph:
  - The vertical (y) and horizontal (x) axes are perpendicular to each other.
  - An appropriate scale is used such that the data points are reasonably spaced.
  - The data points are clearly marked (using small square points in this case).
  - The points are joined

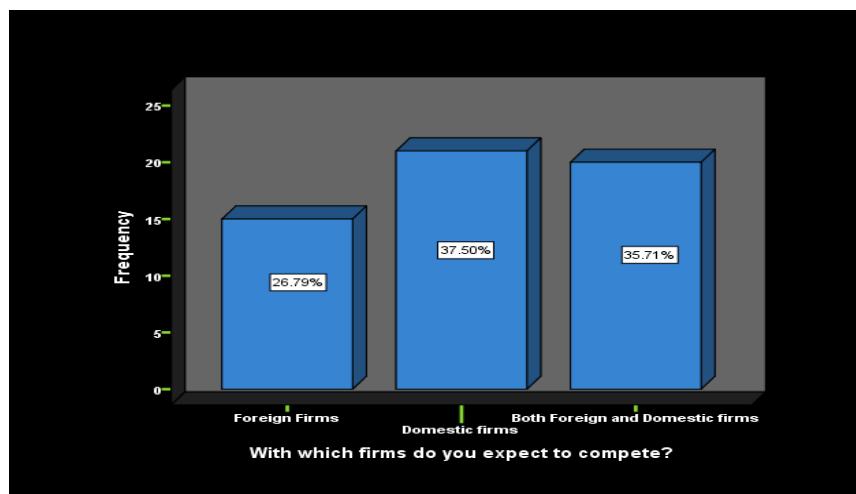


### Bar Chart

- The two most commonly used charts for business presentations are bar charts and pie charts – both of these very clearly and simply convey a large amount of information. We will look at the bar chart first.
- A bar chart consists of a series of bars, the length of each bar representing the value of the variable being plotted. The bars can be either drawn vertically or horizontally.

#### Notice:

- The width of each bar must be the same (we use length to represent magnitude of the value, not width).
- An appropriate scale must be used on each axis such that the lengths of the bars are reasonable.
- The distance between each bar must be kept constant to give the bar chart uniformity.
- The bars may or may not be coloured (this is purely up to the person drawing the bar chart)



### Categorical data:

Most MBA dissertations will involve the use of categorical data. How to best to analyse this type of data will involve the use of some basic descriptive techniques, which include frequency tables, crosstabs and the sort.

### Frequencies

A Frequency is the number of occurrences of a repeating event per unit of time. It is used to summarize a single categorical variable. We generate frequency tables as a basic descriptor of the number of times a particular response/outcome occurs. An example of a frequency table output in SPSS is as follows:

#### B1. How many years have you been working at EThekweni Municipality?

		Frequency	Percent	Valid Percent	Cumulative Percent
	0 - 1 years	8	20.0	20.0	20.0
	1 - 5 years	10	25.0	25.0	45.0
Valid	10 - 15 years	10	25.0	25.0	70.0
	15 or more years	12	30.0	30.0	100.0
	Total	40	100.0	100.0	

From the table above, 20% of respondents have been working in the sulphuric acid industry for 0-1 years, 25% 1-5 years, 25% 10-15 years, and 30% more than 15 years (n = 40).

You use the highlighted column – Valid percent. N represents the number of people used in that table

### ***Cross-tabulations***

Whereas frequency tables are used to summarise a single categorical variable, cross-tabulations are used to summarize the relationship between two categorical variables (also called a contingency table). A cross-tabulation (or crosstab for short) is a table that depicts the number of times each of the possible category combinations occurred in the sample data.

An example of a crosstab in SPSS is as follows:

### **Q1\_3. Position category \* Q2\_2. How easy is it to communicate with your Manager? Cross-tabulation**

Count

		Q2_2. How easy is it to communicate with your Manager?					
		Not satisfied at all	Not satisfied	Somewhat satisfied	Satisfied	Very satisfied	
Q1_3. Position	Task grade 5 - 7	2	4	7	10	7	30
	Task grade 8-11	0	0	3	4	3	10

category	Task grade 12-14	1	1	5	3	1	11
	Task grade 16 - 18	0	1	4	1	3	9
Total		3	6	19	18	14	60

From the table above, you can see how the left-hand column of the table shows Task grades, and the top row, the question under investigation (how easy it is to communicate with their manager), and then the cells contain the frequency with which that certain phenomenon where they meet a particular task grade, and level of satisfaction, occurs.

### Frequency polygon

A frequency polygon is constructed by plotting the frequency of each interval above the **midpoint** of that interval and then joining the points with straight lines. The polygon is closed by considering one additional interval (with zero frequency) at each end of the distribution and extending a straight line to the midpoint of each of these intervals.

Before constructing a frequency polygon, calculate the midpoints for each interval.

### EXAMPLE

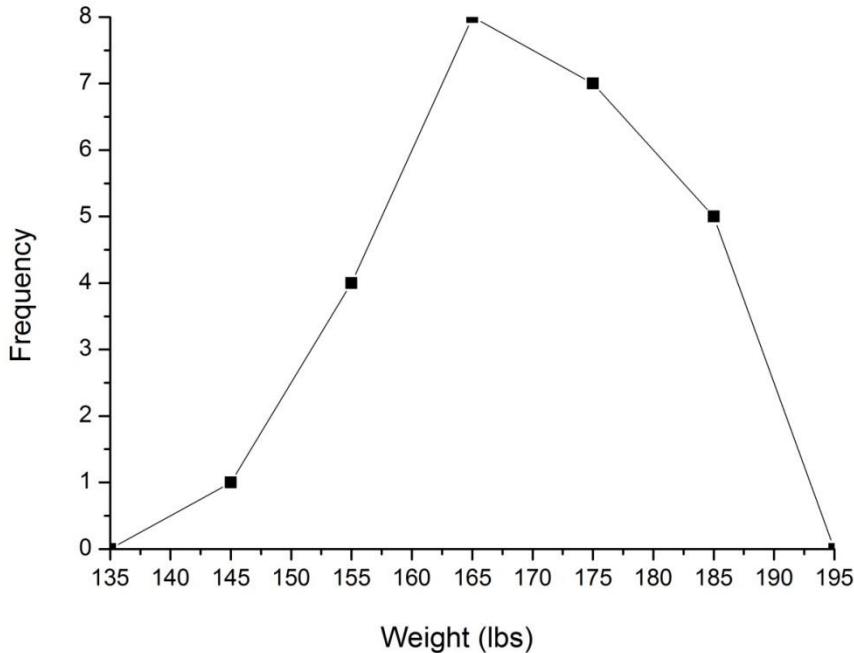
Using the data from the example in section the midpoints are calculated as:

Interval (weight in lbs)	Frequency	Midpoint
140 < 150	1	145
150 < 160	4	155
160 < 170	8	165
170 < 180	7	175
180 < 190	5	185

**NOTE:** The midpoint can be calculated by adding the lower limit of each class to the upper limit and dividing this sum by 2.

$$\text{i.e. } \text{midpoint} = \frac{\text{lower limit} + \text{upper limit}}{2}$$

The frequency polygon can be depicted as:



### **Cumulative frequency distribution**

A cumulative frequency distribution summarises the cumulative frequency of a dataset. It results in a ‘running total’ of frequencies.

The steps in creating a cumulative frequency distribution are as follows:

The first value of the cumulative frequency (first class) is the same as the actual frequency.

The next value is a sum of the first cumulative frequency and the frequency of the second class.

The process is repeated until all the classes have been considered.

### **EXAMPLE**

Using the data from the example in section For each interval, calculate the cumulative frequency by adding the frequency count of the interval in question to the cumulative frequency of the interval before.

Interval (weight in lbs)	Frequency	Cumulative frequency
140 < 150	1	1
150 < 160	4	5
160 < 170	8	13
170 < 180	7	20
180 < 190	5	25

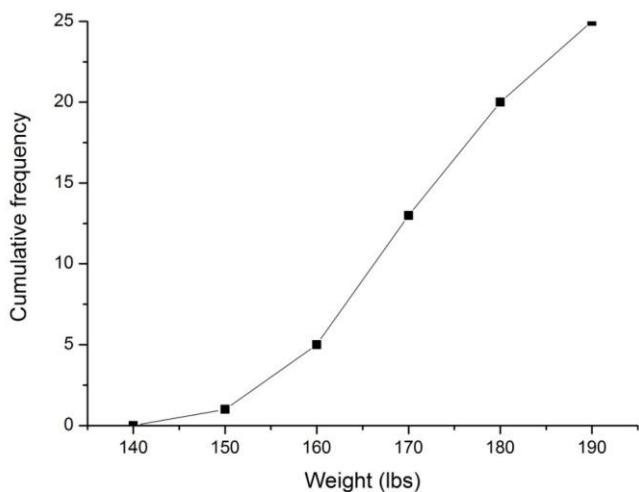
## Ogive

An ogive is a graph of the cumulative frequency distribution.

To construct the ogive, the cumulative relative frequency of each interval is plotted above the upper limit of that interval and the points representing the cumulative frequencies are then joined by straight lines. The ogive is closed at the lower end by extending a straight line to the lower limit of the first interval.

## EXAMPLE

Using the data from the example in section



## Relative distributions

For each of the frequency distribution and the cumulative frequency distribution, relative distributions can be calculated.

A relative frequency distribution includes the percentage of sample size or relative frequency (frequency relative to the total sample size) for each interval.

## EXAMPLE

Using the data from the example in section

Interval (weight in lbs)	Frequency	Relative frequency (factor)	Relative frequency (percentage)
140 < 150	1	0.04	4
150 < 160	4	0.16	16

160 < 170	8	0.32	32
170 < 180	7	0.28	28
180 < 190	5	0.2	20

A relative cumulative frequency distribution includes the cumulative percentage of sample size or relative cumulative frequency (cumulative frequency relative to the total sample size) for each interval.

### EXAMPLE

Using the data from the example in section

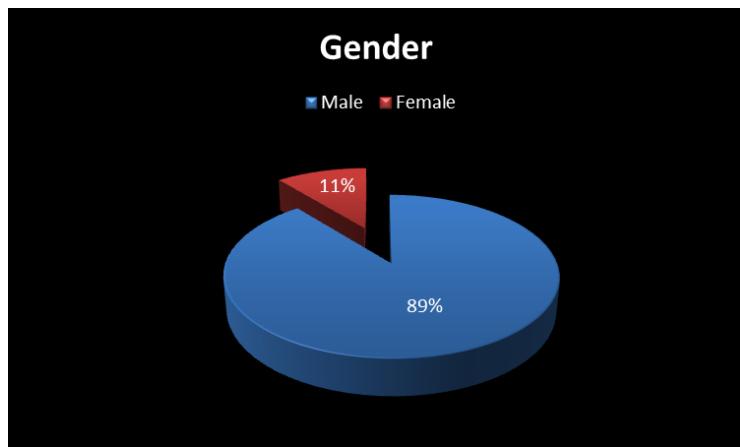
Interval (weight in lbs)	Frequency	Cumulative frequency	Relative frequency (factor)	Relative frequency (percentage)
140 < 150	1	1	0.04	4
150 < 160	4	5	0.20	20
160 < 170	8	13	0.52	52
170 < 180	7	20	0.80	80
180 < 190	5	25	1.00	100

### Pie Chart

- A pie chart is usually used when proportions are to be depicted relative to a whole
- It is a circle divided into segments, with the size of each segment proportional to the value of the variable, relative to the whole, and is usually expressed in percentage terms
- Advantage:
  - Visual impact that they have in conveying information
- Disadvantage:
  - Pie charts are limited to a relatively small amount of data; with more data you will need to resort to a bar chart.

### Note:

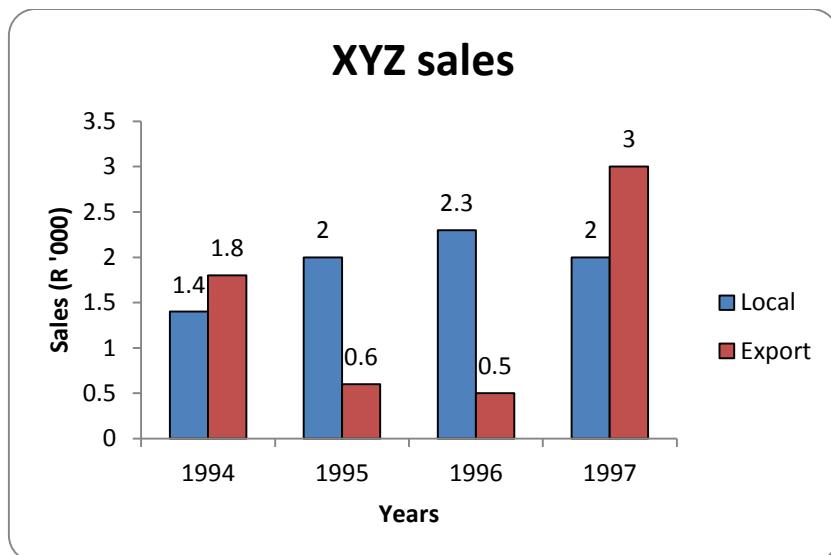
- The segments (or slices) of the pie must be an accurate reflection of the percentage values.
- The slices may or may not be coloured (although colouring each segment in a different colour looks nice!!).
- Each segment must be fully labelled with the percentage it represents and what context it is used



As mentioned previously, the level of measurement determines what level of analysis you can perform on your data. Generally, analysis begins with descriptive statistics, thereafter, inferential.

### **Multiple bar chart**

For multiple or cluster bar charts, two or more bars are grouped together in each category. The use of a key helps to distinguish between the categories.



### **Scatter diagrams**

The relationship between two quantitative variables can be depicted in a scatter diagram. Economists, for example, are interested in the relationship between inflation rates and unemployment rates. Business owners are interested in many variables, including the relationship between their advertising expenditures and sales levels.

A scatter diagram is a plot of all pairs of values ( $x, y$ ) for the variables  $x$  and  $y$ .

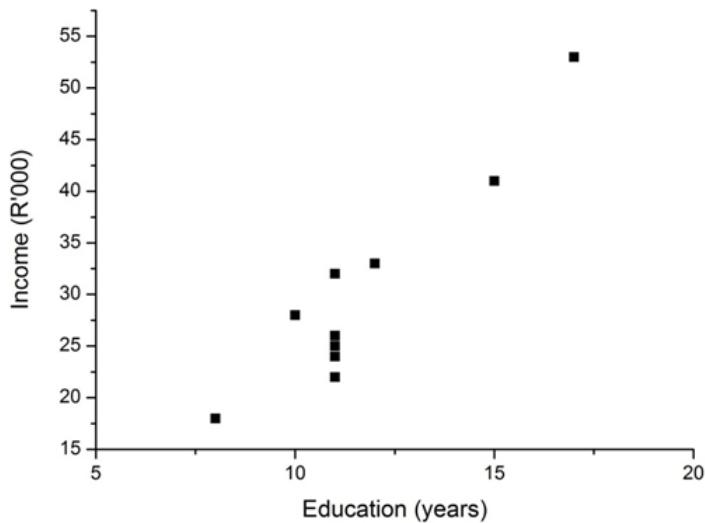
**EXAMPLE**

An educational economist wants to establish the relationship between an individual's income and education. She takes a random sample of 10 individuals and asks for their income (in R '000s) and education (in years).

x (years of education)	y (income in R '000)
11	25
12	33
11	22
15	41
8	18
10	28
11	32
11	24
17	53
11	26

If we feel the value of one variable (such as income) depends to some degree on the value of the other variable (such as years of education), the first variable (income) is called the **dependent variable** and is plotted on the vertical or y-axis. The second variable is the independent variable and is plotted on the x-axis.

**TIP:** Think of the independent variable (x-axis) as the 'cause' and the dependent variable (y-axis) as the 'effect'.



**Figure 1**

The scatter diagram allows us to observe two characteristics about the relationship between education (x) and income (y):

Because these two variables move together, i.e. their values tend to increase together and decrease together; there is a positive relationship between the two variables. The relationship between income and years of education appears to be linear, since we can imagine drawing a straight line (as opposed to a curved line) through the scatter diagram that approximates the positive relationship between the two variables.

The pattern of a scatter diagram provides us with information about the relationship between two variables.

If two variables move in opposite directions and the scatter diagram consists of points that appear to cluster around a straight line, then the variables have a negative linear relationship (see **Figure 2**).

It is possible to have nonlinear relationships (see

**Figure 3** and **Figure 4**), as well as situations in which the two variables are unrelated. In Unit 7, we will compute numerical measures of the strength of the linear relationship between two variables.

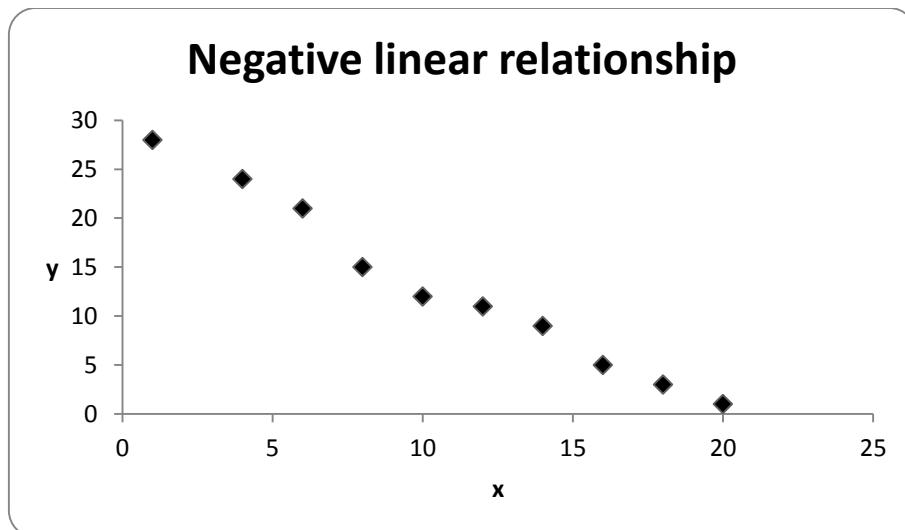


Figure 2

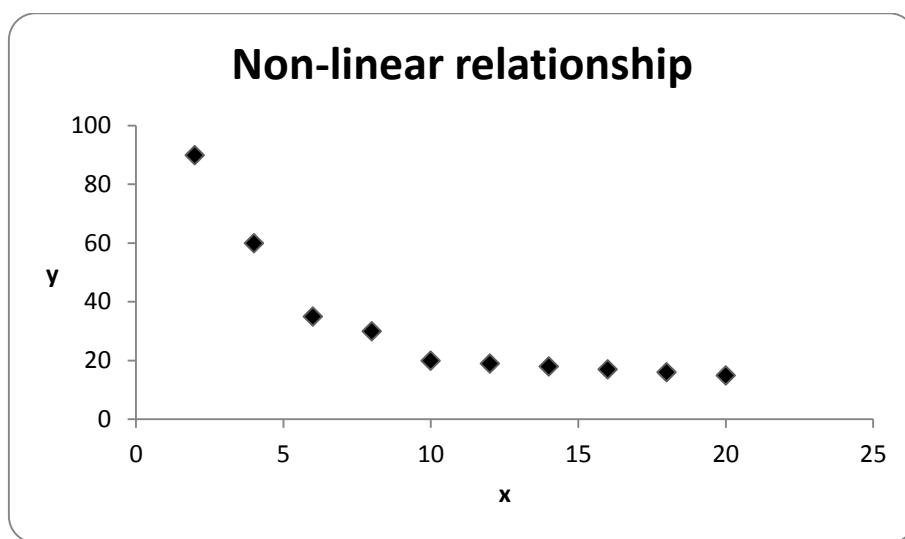


Figure 3

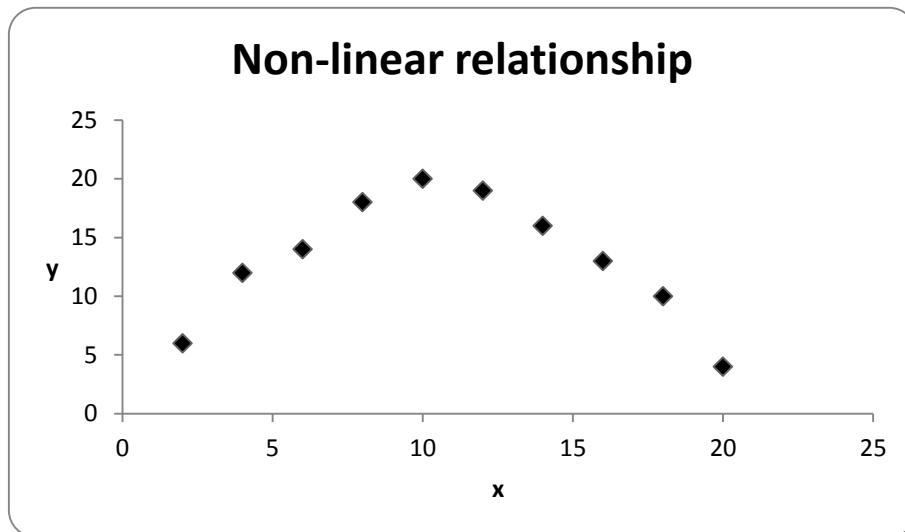
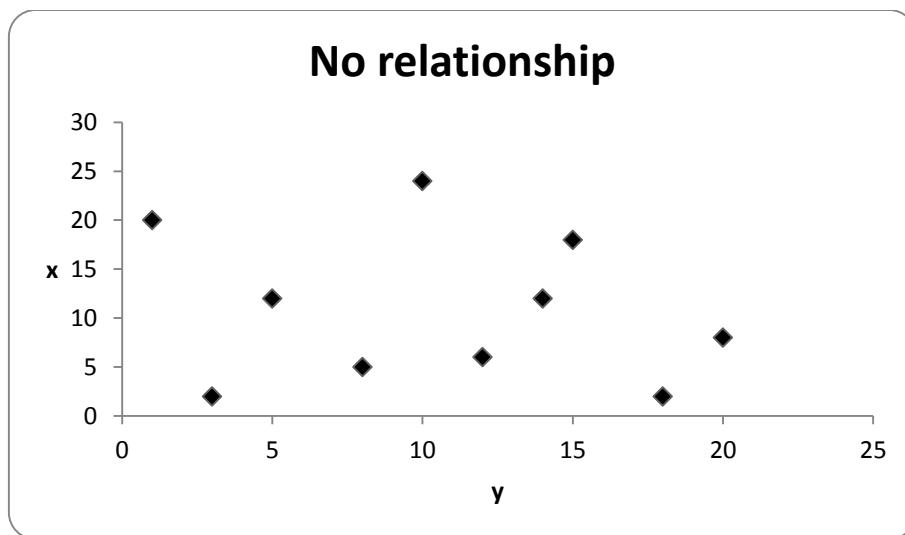
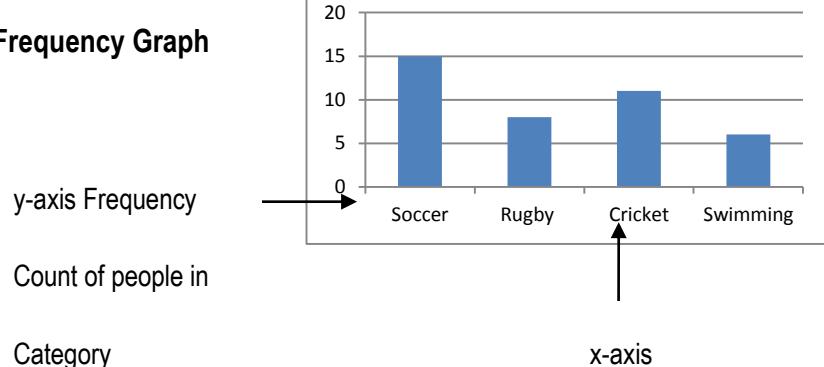


Figure 4

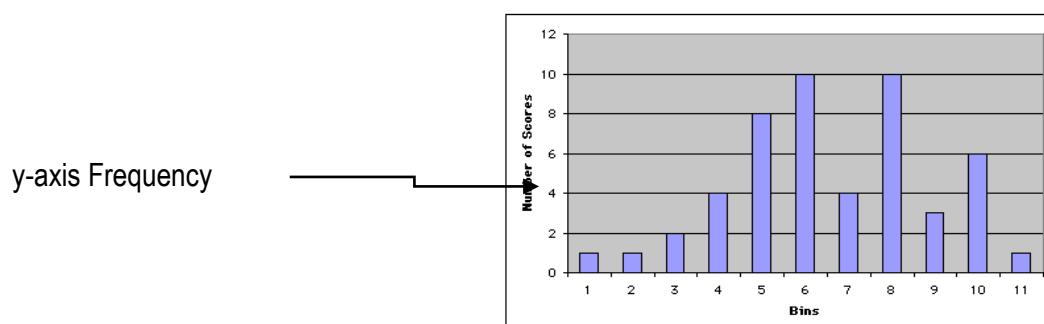
**Figure: 5****Visually representing your data:**

Derived from the datasheet:

- Usually the rows contain the cases
- Usually the column contains information relating to the variables of interest.
- The cells then represent attributes.

**Categorical and Ordinal: Bar/Frequency Graph**

Categories of categorical variable

**Distribution of Interval or Ratio: Histogram**

Count of people/percent/proportion

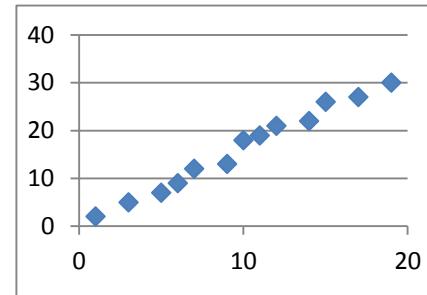
The values on the x-axis can take on any numerical value



x-axis – Variable of interest as category

### Binomial Graphs: Scatterplot

indicates the relationship (direction and strength) between two or more variables.



### Which measure to use?

If the data are qualitative, the only appropriate measure of central location is the mode.

If the data are ranked, the most appropriate measure of central location is the median.

For quantitative data, however, it is possible to compute all three measures.

Which measure you should use depends on your objective. The mean is most popular because it is easy to compute and to interpret (in particular, the mean is generally the best measure of central location for purposes of statistical inference, as you will see in later units). It has the disadvantage that it may be unduly influenced by a few very small or very large observations. To avoid this influence, you might choose to use the median. It could be that the data consists, e.g. of salaries or house prices. The mode, representing the value occurring most frequently (or the midpoint of the interval with the largest frequency) should be used when the objective is to find the value (such as shirt size or house price) that is most popular with consumers.

### There are three basic ways in which we summarise data:

1. Central tendency, or the single value that best describes the sample (Mean, Median, Mode)
2. The spread of the distribution (Variance and Standard Deviation)
3. The shape of the distribution (Skewness and Kurtosis)

## Measures of Central Tendency

### *Introduction*

This unit discusses numerical descriptive measures used to summarise and describe sets of data.

There are three commonly used numerical measures of central tendency or central location of a dataset: the **mean**, the **median** and the **mode**. You are expected to know how to compute each of these measures for a given dataset. Moreover, you are expected to know the advantages and disadvantages of each of these measures, as well as the type of data for which each is an appropriate measure.

Data may be ungrouped (sometimes called ‘raw’ data) or grouped into intervals as covered in the previous unit.

### ***Ungrouped data***

#### ***Arithmetic mean***

The first and most important measure of central location is the arithmetic mean (average), often just referred to as the mean.

To calculate the mean of ungrouped data we merely add the numbers together and divide the total by the number of values.

Definition: Mean:

The **arithmetic mean** of a dataset is obtained by adding each value in the dataset and dividing the total by the number of variables in the dataset. It is referred to simply as the mean.

Formula: Mean:

$$\bar{x} = \frac{\sum x}{n}$$

where,

$\Sigma$  denotes summation of a set of values

$x$  is the variable used to represent raw scores

$n$  represents the number of scores being considered

The result can be denoted by  $\bar{x}$  for the mean of a sample from a larger population

The computed mean of all values of a population is denoted by the Greek letter  $\mu$  (pronounced mu)

### **EXAMPLE**

Find the mean of the dataset:

2	3	6	7	12
---	---	---	---	----

The mean is:

$$\bar{x} = \frac{\sum x}{n} = \frac{2 + 3 + 6 + 7 + 12}{5} = 6$$

### Median

The median is the middle value of an ordered set of numbers.

**Note:** It is important that the values are in sequential order before you choose the middle value.

Definition: Median:

The median of a dataset is the middle value when the values are arranged in order of increasing (or decreasing) magnitude.

After first arranging the original values in increasing (or decreasing) order, the median will be either of the following:

**Step 1.** If the number of values is odd, the median is the number that is exactly in the middle of the list.

**Step 2.** If the number of values is even, the median is found by computing the mean of the two middle numbers.

### EXAMPLE

Over a seven-day period, the number of customers (per day) purchasing at Hides Leather Shop is:

4	80	50	10	60	12	5
---	----	----	----	----	----	---

Array – arranged in order of increasing magnitude:

4	5	10	12	50	60	80
---	---	----	----	----	----	----

The number of values is odd, therefore the median is the middle number of the list:

$$\text{median} = 12$$

### EXAMPLE

Over an eight-day period, the number of customers observed at the shop per day is:

21	5	11	7	12	15	20	5
----	---	----	---	----	----	----	---

Array – arranged in order of increasing magnitude:

5	5	7	11	12	15	20	21
---	---	---	----	----	----	----	----

The number of values is even, therefore the median is the mean of the middle two numbers in the list.

$$\text{median} = \frac{11 + 12}{2} = 11.5$$



## ACTIVITY

The time taken to compete an assembly task has been measured for a group of six employees:

8	2	7	3	6	9
---	---	---	---	---	---

Find the median time taken.

## SOLUTION TO ACTIVITY

Begin by arranging the scores in increasing order.

2	3	6	7	8	9
---	---	---	---	---	---

We note that the numbers 6 and 7 share the middle position thus the median is the average of the 3<sup>rd</sup> and 4<sup>th</sup> values.

$$\text{median} = \frac{6 + 7}{2} = 6.5$$

## Mode

The mode is the most common value. If we look at the set of numbers:

3	4	5	6	6	6	7
---	---	---	---	---	---	---

The mode is 6 because it is the number that appears most often (3 times in this case).

Definition – Mode:

The mode of a dataset is the value that occurs most frequently.

Where no score is repeated there is no mode. Where two scores occur with the same highest frequency, the dataset is **bimodal**. If more than two scores occur with the same highest frequency, each is a mode and the dataset is **multimodal**.

## EXAMPLE

The commission earnings of five salespeople are:

R5 000	R5 200	R5 200	R5 700	R8 600
--------	--------	--------	--------	--------

The modal commission is R5 200.

The lengths of stay (in days) for a sample of nine patients in a hospital are:

17	19	19	4	19	26	4	21	4
----	----	----	---	----	----	---	----	---

The dataset is bimodal with two modes, 19 and 4 days.

### EXAMPLE

There are 40 buck, 25 elephant and 20 smaller animals at a water hole.

The modal category is buck since it has the highest frequency.

The mode is the only central measure that can be used with data at the **nominal level** of measurement.

### EXAMPLE

The hourly income rates (in \$) of five students are:

4	9	7	16	10
---	---	---	----	----

There is no mode.

### Grouped data

Once data is grouped into intervals or classes, the original or raw data is no longer of relevance or may not be known and the frequency distribution data needs to be used for measuring central location.

**TIP:** Formulae can be presented in different ways. In this text we have wherever possible, used the formulae from the textbook.

Remember if a lecturer uses a formula that looks slightly different, it is up to you as a masters' level student to check that it is still the same formula.

### Mean for grouped data

Because the original or raw data is no longer available or of relevance, each dataset observation is assumed to take on the value of the midpoint of its interval. In order to calculate the mean, the total of all values (ie midpoint values) is used.

Formula: Mean for grouped data:

$$\text{mean}, \bar{x} = \frac{\sum fx}{n} \text{ or } \bar{x} = \frac{\sum fx}{\sum f}$$

Where,

$f$  is the frequency

$x$	is the midpoint of the interval
$n$	is the number of observations in the dataset

Steps in calculating the mean of grouped data:

Extend the frequency distribution to add the further columns needed.

- Calculate the midpoint of each interval in the frequency distribution and include in a new column.

$$\text{midpoint} = \frac{\text{lower limit of interval} + \text{upper limit of interval}}{2}$$

Each observation is then ‘allocated’ the midpoint as its value.

- Multiply the frequency of each interval by the midpoint and include in a new column.  

$$fx = \text{frequency} \times \text{midpoint}$$
- The total of this column provides the total of all observations (using their ‘allocated’ midpoint values).
- This total is divided by the total number of observations in the dataset to obtain the mean.

### EXAMPLE

Using the data from the example in section calculate the mean of the grouped data:

Interval (weight in Kgs)	Frequency
140 < 150	1
150 < 160	4
160 < 170	8
170 < 180	7
180 < 190	5

Extend the frequency distribution to add the further columns needed.

Interval (weight in Kgs)	Frequency	Midpoint $x$	$fx$
140 < 150	1		
150 < 160	4		
160 < 170	8		
170 < 180	7		
180 < 190	5		
Total			

Calculate the midpoint of each interval in the frequency distribution and include in a new column.

$$\text{midpoint} = \frac{\text{lower limit of interval} + \text{upper limit of interval}}{2} = \frac{290}{2} = 145 \text{ etc}$$

Each observation is then ‘allocated’ the midpoint as its value.

Interval (weight in Kgs)	Frequency	Midpoint $x$	$fx$
140 < 150	1	145	
150 < 160	4	155	
160 < 170	8	165	
170 < 180	7	175	
180 < 190	5	185	
Total			

Multiply the frequency of each interval by the midpoint and include in a new column.

$$fx = \text{frequency} \times \text{midpoint} = 1 \times 145 = 145 \text{ etc}$$

Interval (weight in Kgs)	Frequency	Midpoint $x$	$fx$
140 < 150	1	145	145
150 < 160	4	155	620
160 < 170	8	165	1 320
170 < 180	7	175	1 225
180 < 190	5	185	925
Total	<b>25</b>		<b>4 235</b>

- The total of this column provides the total of all observations (using their ‘allocated’ midpoint values).
- This total is divided by the total number of observations in the dataset to obtain the mean.

$$\text{mean}, \bar{x} = \frac{\sum fx}{n} = \frac{4 235}{25} = 169.4 \text{ Kgs}$$



## ACTIVITY

The number of times per week that a particular photocopy machine breaks down is recorded over a period of 60 weeks.

Number of breakdowns	0	1	2	3	4	5
Number of weeks	15	12	16	10	5	2

Find the mean number of breakdowns per week over the 60-week period.

### SOLUTION TO ACTIVITY

**TIP:** If the value against the frequency is not an interval, as in this case, the actual value is used and a midpoint does not need to be calculated.

Frequency (number of breakdowns)	Value <i>x</i>	<i>fx</i>
0	15	0
1	12	12
2	16	32
3	10	30
4	5	20
5	2	10
Total	60	104

$$\text{mean}, \bar{x} = \frac{\sum fx}{\sum f} = \frac{104}{60} = 1.73$$

### EXAMPLE

The times taken to complete a particular assembling task have been measured for 250 employees.

Time (minutes)	Number of people ( <i>f</i> )	<i>x</i>	<i>fx</i>
0 < 5	2	2.5	5.0
5 < 10	2	7.5	15.0
10 < 15	3	12.5	37.5
15 < 20	5	17.5	87.5
20 < 25	5	22.5	112.5
25 < 30	18	27.5	495.5
30 < 35	85	32.5	2 762.5
35 < 40	92	37.5	3 450.0
40 < 45	37	42.5	1 572.5
45 < 50	1	47.5	47.5
Total	250		<b>8 585.0</b>

$$\text{mean, } \bar{x} = \frac{\sum fx}{\sum f} = \frac{8\ 585}{250} = 34.34 \text{ minutes}$$



### ACTIVITY

The duration of 100 machine breakdowns are recorded and summarised. Find the mean of the distribution.

Time (minutes)	Frequency
0 < 10	3
10 < 20	13
20 < 30	30
30 < 40	25
40 < 50	14
50 < 60	8
60 < 70	4
70 < 80	2
80 < 90	1
Total	100

**SOLUTION TO ACTIVITY**

Time (minutes)	Frequency	$x$	$fx$
0 < 10	3	5	15
10 < 20	13	15	195
20 < 30	30	25	750
30 < 40	25	35	875
40 < 50	14	45	630
50 < 60	8	55	440
60 < 70	4	65	260
70 < 80	2	75	150
80 < 90	1	85	85
Total	100		3 400

$$\text{mean}, \bar{x} = \frac{\sum fx}{\sum f} = \frac{3 400}{100} = 34 \text{ minutes}$$

**Median for grouped data**

The cumulative frequency is used to find the median for grouped data.

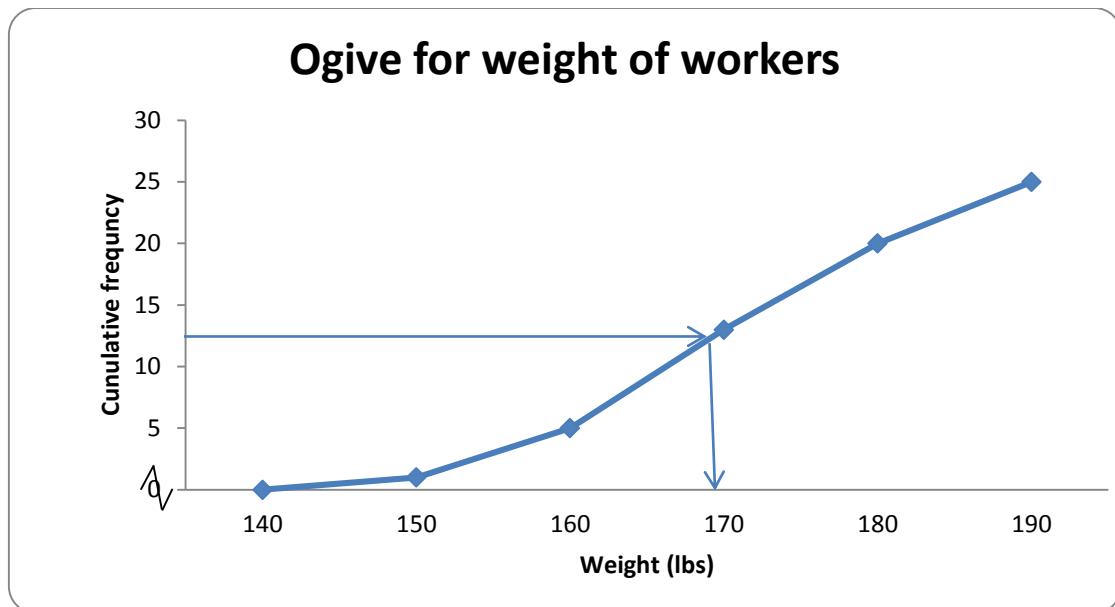
**Graphical approach: Median for grouped data:**

The ogive is used to determine the median value by reading off the x-value associated with the 50% cumulative frequency on the y-axis.

**EXAMPLE**

Using the data from the example in section

$$\text{median frequency} = \frac{n}{2} = \frac{30}{2} = 15$$



The median value reading from the ogive is  $\approx 170$  lbs.

Formula: Median for grouped data:

$$M_e = L_{me} + \frac{c \left[ \frac{n}{2} - f(<) \right]}{f_{me}}$$

Where,

$L_{me}$  is the lower limit of the median interval

$c$  is the interval width

$n$  is the number of observations in the dataset

$f(<)$  is the cumulative frequency count of all intervals before the median interval

$f_{me}$  is the frequency count of the median interval

The formula uses the median interval and calculates how far into the median interval, the median value lies.

### Steps in calculating the median of grouped data:

**Step 1.** Extend the frequency distribution to be a cumulative frequency distribution.

- Establish the median interval from the cumulative frequency. Establish at which point the cumulative frequency exceeds the median point for the first time. This is the median interval.
- Substitute the required values into the formula and calculate the median.

### EXAMPLE

Using the data from the example in section [Error! Reference source not found.](#):

**Step 1.** Extend the frequency distribution to be a cumulative frequency distribution.

Interval (weight in lbs)	Frequency	Cumulative frequency
140 < 150	1	1
150 < 160	4	5
160 < 170	8	13
170 < 180	7	20
180 < 190	5	25

- Establish the median interval from the cumulative frequency. The cumulative frequency for the interval 160 < 170 is 13; this is the point at which the cumulative frequency exceeds the median frequency of 12.5 for the first time.

$$\text{median frequency} = \frac{n}{2} = \frac{25}{2} = 12.5$$

Therefore *median interval* = 160 < 170

- Substitute the required values into the formula and calculate the median.

$$M_e = L_{me} + \frac{c \left[ \frac{n}{2} - f(<) \right]}{f_{me}}$$

$$M_e = 160 + \frac{10 \left[ \frac{25}{2} - 5 \right]}{8} = 169.38 \text{ lbs}$$

**TIP:** Sense test that the calculated median falls within the median interval.

As with the mean, the value for **the median for ungrouped data is more accurate**. If the data is available (eg when you do your research project) it is better to use the ungrouped data to get the median.



### ACTIVITY

The time taken to complete an assembling task has been measured for 250 employees: What is the position of the median?

Time taken (minutes)	Number of people ( $f$ )	Cumulative frequency $f(<)$
0 < 5	2	2
5 < 10	2	4
10 < 15	3	7
15 < 20	5	12
20 < 25	5	17
25 < 30	18	35
30 < 35	85	120
35 < 40	92	212
40 < 45	37	249
45 < 50	1	250
Total	250	

### ACTIVITY

$$\text{median frequency} = \frac{n}{2} = \frac{250}{2} = 125$$

Therefore median interval = 35 < 40

This is the point at which the cumulative frequency (212) exceeds the median frequency (125) for the first time.

$$M_e = L_{me} + \frac{c \left[ \frac{n}{2} - f(<) \right]}{f_{me}}$$

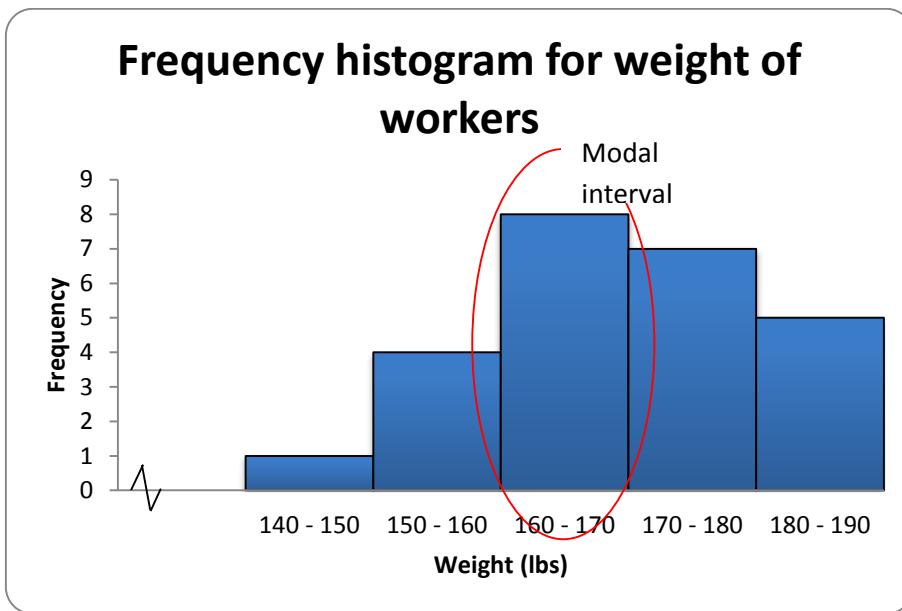
$$M_e = 35 + \frac{5 \left[ \frac{250}{2} - 120 \right]}{92} = 35.27 \text{ minutes}$$

## Mode for grouped data

The mode is the most common value. In the case of grouped data, the mode is the maximum value of the histogram.

### EXAMPLE

Using the data from the example in section [Error! Reference source not found.](#):



Formula: Mode for grouped data:

$$M_o = L_{mo} + \frac{d_1}{d_1 + d_2} \times c$$

Where,

$L_{mo}$  is the lower limit of the modal interval

$d_1$  is the difference between the highest frequency (modal frequency) and the frequency above it.

$d_2$  is the difference between the highest frequency (modal frequency) and the frequency below it.

$c$  is the interval width

This formula uses interpolation to *pull* the modal value within the modal interval towards the interval with the highest frequency.

The modal interval is the interval with the highest frequency.

**EXAMPLE**

Using the data from the example in section Error! Reference source not found.:

Interval (weight in lbs)	Frequency
140 < 150	1
150 < 160	4
160 < 170	8
170 < 180	7
180 < 190	5

The modal interval is  $160 < 170$  with the highest frequency of 8.

$$M_o = L_{mo} + \frac{d_1}{d_1 + d_2} \times c$$

$$M_o = 160 + \frac{4}{4+1} \times 10 = 168 \text{ lbs}$$

Unlike the median and the mean, the value for the mode is more accurate from grouped data. So **whenever possible calculate the mode from the grouped data.**

**Calculation of the mode from a grouped frequency distribution**

It is not possible to calculate the exact value of the mode of the original data in a grouped frequency distribution, since information is lost when the data are grouped. However, it is possible to make an estimate of the mode. The interval with the highest frequency is called the modal interval.

**ACTIVITY**

The durations of 100 machine breakdowns are recorded and summarised. Find the mode of the distribution.

Time (minutes)	Frequency
0 < 10	3
10 < 20	13
20 < 30	30
30 < 40	25
40 < 50	14
50 < 60	8
60 < 70	4
70 < 80	2
80 < 90	1
Total	100

**SOLUTION TO ACTIVITY**

Time (minutes)	Frequency
0 < 10	3
10 < 20	13
20 < 30	30
30 < 40	25
40 < 50	14
50 < 60	8
60 < 70	4
70 < 80	2
80 < 90	1
Total	100

The interval having the highest frequency of 30 is the interval 20 < 30.

$$M_o = L_{mo} + \frac{d_1}{d_1 + d_2} \times c = 20 + \frac{17}{17 + 5} \times 10 = 27.73 \text{ minutes}$$

***The best measure for central location***

The different measures of central location have different advantages and disadvantages and there are no objective criteria to determine the most representative average of all datasets. Each researcher has to use his/her own discretion on a set of data.

Measure	Usage	Advantages	Disadvantages
Mean	Most familiar average.	Exists for each dataset. Takes every score into account. Works well with many statistical methods.	Is affected by extreme scores.
Median	Commonly used.	Always exists. Is not affected by extreme scores. Is often a good choice if there are some extreme scores in the dataset.	Does not take every score into account.
Mode	Sometimes used.	Is not affected by extreme scores. Is appropriate for data at the nominal level.	It might not exist or there may be more than one mode. It does not take every score into account.

The arithmetic mean is more affected by extreme values. If the data have some values that are very large or small (relative to the other values) then it is better to use the median. When we get to the normal distribution in a later unit, you will see why the arithmetic mean is important.

**Exercise:**

Given the following marks from the 2010 MBA final year averages:

44 60 67 54 66 54 53 78 66 62 36 80 82 70 76 43 77 89 65

**Work out:**

1. The mode
2. The median
3. The mean

**Answer (SPSS Output):**

Statistics		
2010 MBA Averages		
N	Valid	28
	Missing	0
Mean		64.7857
Median		66.0000
Mode		54.00

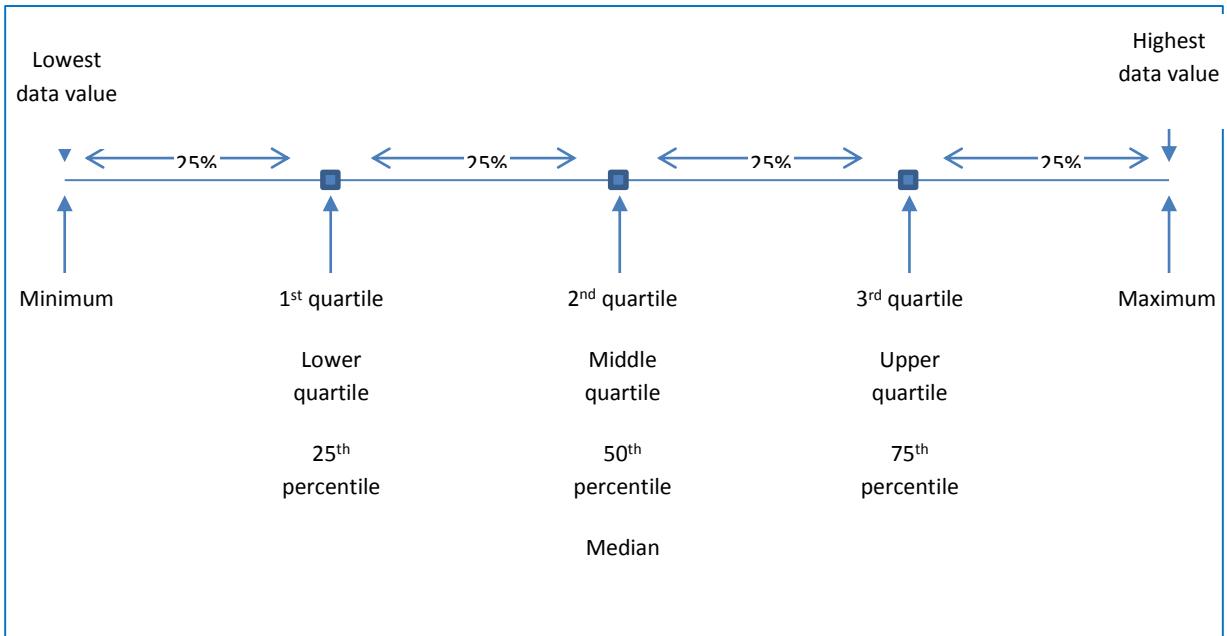
***Non-central location measures – quartiles and percentiles***

Non-central location measures or measures of relative position include quartiles and percentiles.

**Quartiles** are measures that divide the dataset into quarters.

**Percentiles** indicate specific percentage positions of data values within the dataset.

In order to pinpoint quartiles or percentiles, the data need to be **ordered in sequence** from lowest to highest rank.



### **Quartiles and percentiles for ungrouped data**

For ungrouped data, quartiles and percentiles are found by calculating the position. This is similar to the calculations used for determining the position of the median for ungrouped data.

Formula: Quartiles and percentiles for ungrouped data:

$$\text{quartile position} = \frac{q(n + 1)}{4} \text{ (round down)}$$

$$\text{percentile position} = \frac{p(n + 1)}{100} \text{ (round down)}$$

Where,

$q$  is the required quartile, i.e 1,2 or 3

$n$  is the sample size

$p$  is the required percentile, i.e 45 for 45% or 70 for 70%

Note: These formulae will suffice for the purposes of this discussion and the required level of understanding. More precise values for continuous data can be calculated by interpolating the fractional values rather than rounding down. Your textbook describes this process in detail with an example.

### **EXAMPLE**

40 pay TV subscribers have rated their experience (out of 100):

42	43	44	45	45	47	50	51
51	51	51	52	53	54	54	56
57	58	58	59	62	62	62	63
63	64	65	67	67	69	69	72
73	74	75	78	78	83	84	87

Calculate all quartiles as well as the 60<sup>th</sup> and 70<sup>th</sup> percentiles of the dataset.

The data need to be ranked in order to determine these values. This dataset has already been sequenced.

The positions for the required measures are then calculated, after which the position is pinpointed and the value determined:

$$\text{first quartile position} = \frac{1(n + 1)}{4} = \frac{1(40 + 1)}{4} = 10.25 = 10 \text{ (rounded)}$$

value = 51 rating

$$\text{second quartile position} = \frac{2(n + 1)}{4} = \frac{2(40 + 1)}{4} = 20.5 = 20 \text{ (rounded)}$$

value = 59 rating

$$\text{third quartile position} = \frac{3(n + 1)}{4} = \frac{3(40 + 1)}{4} = 30.75 = 30 \text{ (rounded)}$$

value = 69 rating

$$\text{60th percentile position} = \frac{60(n + 1)}{100} = \frac{60(40 + 1)}{100} = 24.6 = 24 \text{ (rounded)}$$

value = 63 rating

$$\text{70th percentile position} = \frac{70(n + 1)}{100} = \frac{70(40 + 1)}{100} = 28.7 = 28 \text{ (rounded)}$$

value = 67 rating

42	43	44	45	45	47	50	51
51	<b>Q1 51</b>	51	52	53	54	54	56
57	58	58	Q2 59	62	62	62	<b>P60 63</b>
63	64	65	<b>P70 67</b>	67	Q3 69	69	72
73	74	75	78	78	83	84	87

**Quartiles and percentiles for grouped data**

For grouped data formulae similar to that of the median are used to calculate quartiles and percentiles.

Formula: Quartiles for grouped data:

$$Q_j = L_{Qj} + \frac{c \left[ \frac{j \times n}{4} - f(<) \right]}{f_{Qj}}$$

Where,

$j$  is the required quartile, ie 1,2 or 3

$L_{Qj}$  is the lower limit of the quartile interval

$c$  is the interval width

$n$  is the number of observations in the dataset

$f(<)$  is the cumulative frequency count of all intervals before the quartile interval

$f_{Qj}$  is the frequency count of the quartile interval

The formula uses the quartile interval and calculates how far into the interval the quartile value lies.

It is important to first calculate the quartile position in order to be able to establish the quartile interval:

$$\text{quartile position} = \frac{j \times n}{4}$$

Formula: Percentiles for grouped data:

$$P_j = L_{Pj} + \frac{c \left[ \frac{j \times n}{100} - f(<) \right]}{f_{Pj}}$$

Where,

$j$  is the required percentile, ie 45%, 70% etc

$L_{Pj}$  is the lower limit of the percentile interval

$c$  is the interval width

$n$  is the number of observations in the dataset

$f(<)$  is the cumulative frequency count of all intervals before the percentile interval

$f_{Pj}$  is the frequency count of the percentile interval

The formula uses the percentile interval and calculates how far into the percentile interval, the percentile value lies.

It is important to first calculate the percentile position in order to be able to establish the percentile interval:

$$\text{percentile position} = \frac{j \times n}{100}$$

### EXAMPLE

Using the data from the example in section calculate all quartiles and the 60<sup>th</sup> and 70<sup>th</sup> percentiles:

Ensure you have a cumulative frequency distribution.

Interval (weight in lbs)	Frequency	Cumulative frequency
140 < 150	1	1
150 < 160	4	5
160 < 170	8	13
170 < 180	7	20
180 < 190	5	25

Calculate the required positions within the dataset:

$$\text{first quartile position} = \frac{j \times n}{4} = \frac{1 \times 25}{4} = 6.25$$

$$\text{second quartile position} = \frac{j \times n}{4} = \frac{2 \times 25}{4} = 12.5$$

$$\text{third quartile position} = \frac{j \times n}{4} = \frac{3 \times 25}{4} = 18.75$$

$$\text{60th percentile position} = \frac{j \times n}{100} = \frac{60 \times 25}{100} = 15$$

$$\text{70th percentile position} = \frac{j \times n}{100} = \frac{70 \times 25}{100} = 17.5$$

Calculate the values associated with the positions.

$$Q_1 = L_{Q1} + \frac{c \left[ \frac{1 \times n}{4} - f(<) \right]}{f_{Q1}} = 160 + \frac{10(6.25 - 5)}{8} = 161.56 \text{ lbs}$$

$$Q_2 = L_{Q2} + \frac{c \left[ \frac{2 \times n}{4} - f(<) \right]}{f_{Q2}} = 160 + \frac{10(12.5 - 5)}{8} = 169.38 \text{ lbs}$$

$$Q_3 = L_{Q3} + \frac{c \left[ \frac{3 \times n}{4} - f(<) \right]}{f_{Q3}} = 170 + \frac{10(18.75 - 13)}{7} = 178.21 \text{ lbs}$$

$$P_{60} = L_{P60} + \frac{c \left[ \frac{60 \times n}{100} - f(<) \right]}{f_{P60}} = 170 + \frac{10(15 - 13)}{7} = 172.86 \text{ lbs}$$

$$P_{70} = O_{P70} + \frac{c \left[ \frac{70 \times n}{100} - f(<) \right]}{f_{P70}} = 170 + \frac{10(17.5 - 13)}{7} = 176.43 \text{ lbs}$$

**TIP:** Sense test that the calculated values fall within the associated intervals.



### ACTIVITY

The time taken to complete an assembling task has been measured for 250 employees:

Time taken (minutes)	Number of people ( <i>f</i> )	Cumulative frequency <i>f(&lt;)</i>
0 < 5	2	2
5 < 10	2	4
10 < 15	3	7
15 < 20	5	12
20 < 25	5	17
25 < 30	18	35
30 < 35	85	120
35 < 40	92	212
40 < 45	37	249
45 < 50	1	250
Total	250	

Calculate the first and third quartiles and the 40<sup>th</sup> percentile.

### SOLUTION TO ACTIVITY

Calculate the required positions within the dataset:

$$\text{first quartile position} = \frac{j \times n}{4} = \frac{1 \times 250}{4} = 62.5$$

$$\text{third quartile position} = \frac{j \times n}{4} = \frac{3 \times 250}{4} = 187.5$$

$$\text{40th percentile position} = \frac{j \times n}{100} = \frac{40 \times 250}{100} = 100$$

Calculate the values associated with the positions.

$$Q_1 = L_{Q1} + \frac{c \left[ \frac{1 \times n}{4} - f(<) \right]}{f_{Q1}} = 30 + \frac{5(62.5 - 35)}{85} = 31.62 \text{ minutes}$$

$$Q_3 = L_{Q3} + \frac{c \left[ \frac{3 \times n}{4} - f(<) \right]}{f_{Q3}} = 35 + \frac{5(187.5 - 120)}{92} = 38.67 \text{ minutes}$$

$$P_{40} = L_{P40} + \frac{c \left[ \frac{40 \times n}{100} - f(<) \right]}{f_{P40}} = 30 + \frac{5(100 - 35)}{85} = 33.82 \text{ minutes}$$

speaks	age	year
17	1	1
9	1	1
19	1	1
21	1	1
7	1	1
6	1	1
0	1	1
7	1	1
3	1	1
10	1	1
0	1	1
17	1	1
31	2	1
24	2	1
10	2	1
81	2	1
2	2	1
5	2	1
40	2	1
65	2	1
32	2	1
30	2	1
44	2	1
7	1	2
12	1	2
40	1	2
20	1	2
12	1	2
14	1	2
12	1	2
4	1	2
36	1	2
8	1	2
24	2	2
60	2	2
54	2	2
19	2	2
45	2	2
148	2	2
34	2	2
26	2	2
27	2	2
26	2	2
53	2	2

### SPSS (Statistical Package for the Social Sciences)

For this task we are going to look at some data collected by an Occupational Therapy student, looking at how age affected OT students' participation in discussion in class. She counted how many times each student contributed orally in a period totalling 12 hours of classes. The students were from the 1st and 2nd years of the course, and were classed as young if under 21 and mature if 21 or over, making 4 groups altogether.

Do older students contribute more frequently in class discussion?

	YOUNG	Y1	MATURE	Y1	YOUNG	Y2	MATURE	Y2
		17			31		7	24
		9		24		12	60	
		19		10		40	54	
		21		81		20	19	
		7		2		12	45	
		6		5		14	148	
		0		40		12	34	
		7		65		4	26	
		3		32		36	27	
		10		30		8	26	
		0		44			53	
		17						

**Descriptives**

Young or Mature				Statistic	Std. Error
speaks	Young	Mean		12.77	2.166
		95% Confidence Interval for Mean	Lower Bound	8.27	
			Upper Bound	17.28	
		5% Trimmed Mean		11.99	
		Median		11.00	
		Variance		103.232	
		Std. Deviation		10.160	
		Minimum		0	
		Maximum		40	
		Range		40	
	Mature	Interquartile Range		11	
		Skewness		1.358	.491
		Kurtosis		2.020	.953
		Mean		40.00	6.603
	Mature	95% Confidence Interval for Mean	Lower Bound	26.27	
			Upper Bound	53.73	
		5% Trimmed Mean		36.43	
		Median		31.50	
		Variance		959.048	
		Std. Deviation		30.968	
		Minimum		2	
		Maximum		148	
		Range		146	
		Interquartile Range		29	
		Skewness		2.125	.491
		Kurtosis		6.469	.953

You can see from the output above that SPSS automatically calculates the following descriptives:

- Mean: lower and upper intervals for the mean;
- median: variance and standard deviation;
- minimum and maximum values;
- interquartile range and the skewness and kurtosis.

Note that it is up to you – the reader/researcher to decide the most appropriate measured that fit the level of measurement of your data. ‘

Note that the two measures of central location, namely, the mean and median are vastly different. Hence, the mature students contribute orally more than the younger students. However, the values of the measures of dispersion (variance, standard deviation, range and interquartile range) shows that there is a much higher degree of variability in the response rate of the mature students.

This highlights the importance of looking at the level of measurement (nominal, ordinal, interval and ratio); and decide what the most suitable measure of central tendency (mean, median or mode) and spread are (variance/standard deviation).

### Measures of Dispersion or spread

**\*As a rule of thumb, when central tendency is reported, so should spread. Once you have your central tendency it is easy to ascertain the degree with which cases are dispersed around it.**

#### Introduction

"Dispersion (or spread) refers to the extent to which the data values of a numeric random variable are scattered about their central location value" Wegner (2012).

Previously, the concept of central location was introduced. The variability among data is one characteristic to which averages are not sensitive. It is possible to have two datasets with identical measures of central location but with wider spreads of data.

Once again, the level of measurement will determine how we gauge the spread of a distribution (GAO, 1992:41)

	Use of Measure			
	Index of Dispersion	Range	Interquartile Range	Std Deviation
Nominal	Yes	No	No	No
Ordinal	Sometimes	Sometimes	Yes	No
Interval/Ratio	No	Yes	Yes	Yes

The best ways to analyse the **spread of the distribution** for each level of measurement is as follows:

Level of measurement	Representation
Nominal	Table or frequency distribution showing frequencies
Ordinal	Tables/frequency distribution, but choosing a single measure is problematic. Use interquartile range if single measure is chosen.
Interval/Ratio	Graphic dispersion, standard deviation provided cases have an approximately normal distribution.

When there is a possibility that the underlying distribution may not be normal, interquartile range is a good alternative.

**EXAMPLE**

Consider two groups of data:

Dataset A	Dataset B
65	42
66	54
67	58
68	62
71	67
73	77
74	77
77	85
77	93
77	100
<b>Computed measures of central location</b>	
Mean = 71.5	Mean = 71.5
Median = 72	Median = 72
Mode = 77	Mode = 77

Although there is no difference in the computed central measures between the two groups, the scores of dataset B are much more widely scattered than those of dataset A.

The measures that are used to measure dispersion are:

- Range
- Variance
- Standard deviation
- Interquartile range
- Quartile deviation

**Range**

The range measures the difference between the highest and lowest values in a dataset. It is considered a rough measure of spread as it depends on only two values. It is affected by outliers and gives no indication of the clustering of the data.

Formula: Range for ungrouped data:

$$\text{range} = \text{highest value} - \text{lowest value}$$

**EXAMPLE**

For the data in a previous example:

Dataset A	Dataset B
$range = 77 - 45 = 32$	$range = 100 - 42 = 58$

The ranges indicate that the data in dataset B are more widely spread than that in dataset A.

Formula: Range for grouped data:

$range = \text{upper limit of highest interval} - \text{lower limit of lowest interval}$

**ACTIVITY:**

The merchandising manager for a retail clothing chain has recorded 30 observations on the number of days between re-orders for a particular range of woman's clothing.

18	26	15	17	7	27	24	17	10	17
23	29	28	18	10	23	16	9	12	26
5	12	23	22	24	14	16	26	19	22

Find the range of the number of days between re-orders.

**SOLUTION TO ACTIVITY**

$range = \text{highest value} - \text{lowest value} = 29 - 5 = 24 \text{ days}$

**Interpretation**

24 days separates the shortest time between successive re-orders from the longest time between successive re-orders for a particular range of women's clothing.

## Variance

The variance ( $s^2$ ) measures the average squared deviation from the mean for a dataset.

Formula: Variance for ungrouped data:

$$\text{variance } (s^2) = \frac{\sum(x - \bar{x})^2}{n - 1}$$

or

$$\text{variance } (s^2) = \frac{\sum x^2 - n\bar{x}^2}{n - 1}$$

where,

$x$  is each value of the dataset

$\bar{x}$  is the mean of the dataset

$n$  is the sample size

For grouped data, the original dataset values are changed to the interval midpoints.

Formula: Variance for grouped data:

$$\text{variance } (s^2) = \frac{\sum fx^2 - \frac{(\sum fx)^2}{n}}{n - 1}$$

where,

$f$  is the interval frequency

$x$  is the interval midpoint

$n$  is the sample size

**TIP:** Whenever you see the  $\Sigma$  sign in an equation, you will need a column in the table for the expression immediately following the  $\Sigma$  sign. Consider also having columns for each of the components of the expression. This is illustrated in the next example.

## EXAMPLE

Calculate the variance of the sample scores: 2, 3, 5, 6, 9, 17.

Both variance formulae are used in this example, with all the necessary table columns included for both formulae.

First it is necessary to calculate the mean:

$$\bar{x} = \frac{\sum x}{n} = \frac{42}{6} = 7$$

$$\bar{x}^2 = 49$$

$x$	$x - \bar{x}$	$(x - \bar{x})^2$	$x^2$
2	-5	25	4
3	-4	16	9
5	-2	4	25
6	-1	1	36
9	2	4	81
17	10	100	289
42	0	150	444

$$variance (s^2) = \frac{\sum (x - \bar{x})^2}{n - 1} = \frac{150}{6 - 1} = 30$$

or

$$variance (s^2) = \frac{\sum x^2 - n\bar{x}^2}{n - 1} = \frac{444 - 6 \times 49}{6 - 1} = \frac{150}{5} = 30$$

### Standard deviation

The standard deviation is the square root of the variance. It offers a measure of the average deviation from the mean.

Formula: Standard deviation for ungrouped data:

$$\text{standard deviation, } s = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}$$

or

$$\text{standard deviation, } s = \sqrt{\frac{\sum x^2 - n\bar{x}^2}{n - 1}}$$

where,

$x$  is each value of the dataset

$\bar{x}$  is the mean of the dataset

### EXAMPLE

Find the standard deviation of the sample scores in a previous example.

$$s = \sqrt{s^2} = \sqrt{30} = 5.48$$

For grouped data, the original dataset values have been changed to the interval midpoints.

Formula: Standard deviation for grouped data:

$$\text{standard deviation, } s = \sqrt{\frac{\sum fx^2 - \frac{(\sum fx)^2}{n}}{n - 1}}$$

where,

$f$  is the interval frequency

$x$  is the interval midpoint

$n$  is the sample size

### Notation:

$s$  = standard deviation of a set of sample scores.

$\sigma$  = standard deviation of a set of population scores.

$s^2$  = variance of a set of sample scores.

$\sigma^2$  = variance of a set of population scores.

**Note:** Articles in professional journals and reports often use SD for standard deviation and Var for variance.

### EXAMPLE

Using the data from the example in section **Error! Reference source not found.** and including the additional columns required for the standard deviation formula:

Interval (weight in lbs)	Frequency, $f$	Midpoint, $x$	$x^2$	$fx$	$fx^2$
140 < 150	1	145	21 025	145	21 025
150 < 160	4	155	24 025	620	96 100
160 < 170	8	165	27 225	1 320	217 800
170 < 180	7	175	30 625	1 225	214 375
180 < 190	5	185	34 225	925	171 125
$\sum$	25	825	137 125	4 235	720 425

$$\text{standard deviation, } s = \sqrt{\frac{\sum fx^2 - \frac{(\sum fx)^2}{n}}{n-1}} = \sqrt{\frac{720\ 425 - \frac{4\ 235^2}{25}}{25-1}}$$

$$= \sqrt{\frac{720\ 425 - 717\ 409}{24}} = \sqrt{125.67} = 11.21 \text{ lbs}$$



### ACTIVITY:

The errors in seven invoices are recorded as follows: 120, 30, 40, 8, 5, 20, 29

Calculate the standard deviation.

### SOLUTION TO ACTIVITY

$$\bar{x} = \frac{\sum x}{n} = \frac{252}{7} = 36$$

Number of errors, $x$	$x - \bar{x}$	$(x - \bar{x})^2$
120	84	7 056
30	-6	36
40	4	16

$\sum$	8	-28	784
	5	-31	961
	20	-16	256
	29	-7	49
	252	0	9 158

$$\text{standard deviation, } s = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}} = \sqrt{\frac{9\ 158}{7 - 1}} = 39.07 \approx 39 \text{ errors}$$



### ACTIVITY:

The time (in hours per week) that 50 office staff members spend using personal computers are:

Time (hours per week)	Frequency, <i>f</i>
0 < 3	14
3 < 6	6
6 < 9	6
9 < 12	7
12 < 15	14
15 < 18	3
$\sum$	50

Calculate the standard deviation.

### SOLUTION TO ACTIVITY

Interval (time in hours per week)	Frequency, <i>f</i>	Midpoint, <i>x</i>	<i>x</i> <sup>2</sup>	<i>fx</i>	<i>fx</i> <sup>2</sup>
0 < 3	14	1.5	2.25	21.00	31.50
3 < 6	6	4.5	20.25	27.00	121.50
6 < 9	6	7.5	56.25	45.00	337.50
9 < 12	7	10.5	110.25	73.50	771.75
12 < 15	14	13.5	182.25	189.00	2 551.50
15 < 18	3	16.5	272.25	49.50	816.75
$\sum$	50	54.0	643.50	405.00	4 630.50

$$\begin{aligned} \text{standard deviation, } s &= \sqrt{\frac{\sum fx^2 - \frac{(\sum fx)^2}{n}}{n-1}} = \sqrt{\frac{4\ 630.50 - \frac{405^2}{50}}{50-1}} \\ &= \sqrt{\frac{4\ 630.50 - 3\ 280.50}{49}} = \sqrt{27.55} = 5.25 \text{ hours} \end{aligned}$$

### **Coefficient of variation**

The coefficient of variation offers a measure of the dispersion relative to the mean. This enables comparison between datasets with different means.

Formula: Coefficient of variation:

$$\text{coefficient of } s, CV = \frac{s}{\bar{x}} \%$$

where,

$s$       is the standard deviation

$\bar{x}$       is the mean

**TIP:** In order to express a result as a percentage %, multiply the expression by 100.

The coefficient of variation is therefore:

$$\text{coefficient of variation, } CV = \frac{s}{\bar{x}} \times 100$$

### **EXAMPLE**

Using the data from a previous example, calculate the coefficient of variation.

$$\text{mean, } \bar{x} = \frac{\sum fx}{n} = \frac{825}{25} = 33$$

$$\text{standard deviation, } s = 11.21$$

$$\text{coefficient of variation, } CV = \frac{s}{\bar{x}} \% = \frac{11.21}{33} \% = 33.97\%$$

Interpretation: the data are moderately dispersed around the mean.

All the measures of dispersion described so far have dealt with a single set of data. In practice, it is often important to compare two or more sets of data with different means, sample sizes or measurement units and the coefficient of variation can be used to do this.

The higher the coefficient of variation result, the more variability there is in a set of data.

**EXAMPLE**

A manufacturing company produces a product in two sizes, a 1 000 ml bottle and a 500 ml bottle. Different filling equipment is used for each size. Because of mechanical variability in the filling equipment, there is a standard deviation of 5 ml and 4 ml respectively.

Calculate the coefficient of variation for each filling machine and determine which machine is more consistent.

$$\text{coefficient of variation for 1 000 ml product, } CV = \frac{s}{\bar{x}} \% = \frac{5}{1\,000} \% = 0.5\%$$

$$\text{coefficient of variation for 500 ml product, } CV = \frac{s}{\bar{x}} \% = \frac{4}{500} \% = 0.8\%$$

**Interpretation****ACTIVITY**

Although the machine filling the smaller bottle has a lower standard deviation, the CVs indicate that the machine filling the larger bottle is relatively more consistent.

Two growers of grapefruit have obtained statistics regarding the mass of their current crops:

Grower A:  $\bar{x} = 300$  g with  $s = 20$  g

Grower B:  $\bar{x} = 280$  g with  $s = 40$  g

Which grower's grapefruit are more uniform in mass?

**SOLUTION TO ACTIVITY**

$$\text{coefficient of variation for grower A, } CV = \frac{s}{\bar{x}} \% = \frac{20}{300} \% = 6.67\%$$

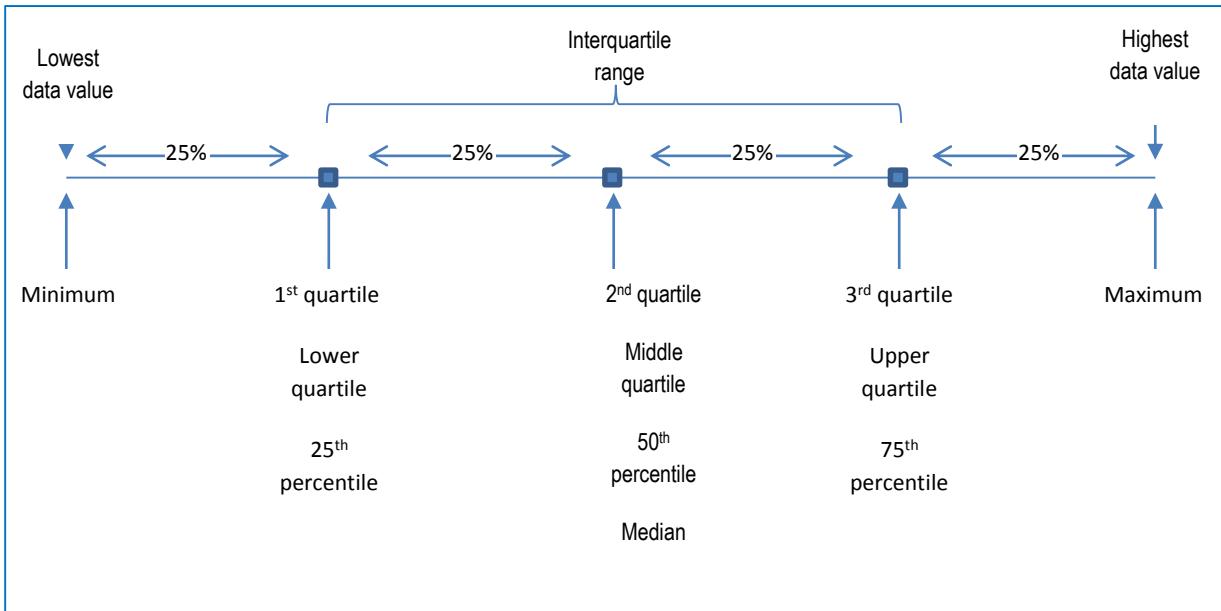
$$\text{coefficient of variation for grower B, } CV = \frac{s}{\bar{x}} \% = \frac{40}{280} \% = 14.29\%$$

Grower A's grapefruit has the lower CV and therefore is more consistent.

**Interquartile and inter-percentile ranges**

In order to eliminate outliers (very low and very high values) and their effect on measures of central location and dispersion, ranges of a dataset to include mid values are often used:

- The interquartile range excludes the highest and lowest quarters of values.
- An inter-percentile or mid-percentile range excludes a certain percentage of values at the lowest and highest ends of the dataset.



Formula: Interquartile range:

$$\text{interquartile range} = Q_3 - Q_1$$

where,

$Q_3$  is the third or upper quartile

$Q_1$  is the first or lower quartile

Refer unit 2 for calculation of quartiles.

### EXAMPLE

Using the data from the example in section calculate the interquartile range:

Interval (weight in lbs)	Frequency	Cumulative frequency
140 < 150	1	1
150 < 160	4	5
160 < 170	8	13
170 < 180	7	20
180 < 190	5	25

The quartiles are calculated in a previous example

$$Q_1 = 161.56 \text{ lbs}$$

$$Q_3 = 178.21 \text{ lbs}$$

$$\text{interquartile range} = Q_3 - Q_1 = 178.21 - 161.56 = 16.65 \text{ lbs}$$



## ACTIVITY

The time taken to complete an assembling task has been measured for 250 employees:

Time taken (minutes)	Number of people ( $f$ )	Cumulative frequency $f(<)$
0 < 5	2	2
5 < 10	2	4
10 < 15	3	7
15 < 20	5	12
20 < 25	5	17
25 < 30	18	35
30 < 35	85	120
35 < 40	92	212
40 < 45	37	249
45 < 50	1	250
Total	250	

Calculate the interquartile range (the first and third quartiles were calculated in a previous self-assessment exercise.

## SOLUTION TO ACTIVITY

Quartiles already calculated in a previous self-assessment activity:

$$Q_1 = L_{Q1} + \frac{c \left[ \frac{1}{4} \times n - f(<) \right]}{f_{Q1}} = 30 + \frac{5(62.5 - 35)}{85} = 31.62 \text{ minutes}$$

$$Q_3 = L_{Q3} + \frac{c \left[ \frac{3}{4} \times n - f(<) \right]}{f_{Q3}} = 35 + \frac{5(187.5 - 120)}{92} = 38.67 \text{ minutes}$$

$$\text{interquartile range} = Q_3 - Q_1 = 38.67 - 31.62 = 7.05 \text{ minutes}$$

Formula: Inter-percentile or mid-percentile range:

The mid-percentile range is the percentage of the range exactly in the middle of the dataset.

To calculate the upper and lower percentiles required for the upper and lower limits of the range:

$$\text{lower percentile of range} = \frac{100\% - \text{required range percentile}}{2}$$

$$\text{upper percentile of range}$$

$$= \text{lower percentile of range} + \text{required range percentile}$$

Calculate the required positions and values for these percentiles

$$\text{interpercentile or mid percentile range}$$

$$= \text{value of upper percentile of range}$$

$$- \text{value of lower percentile of range}$$

### **EXAMPLE**

Using the data from the example in section **Error! Reference source not found.** calculate the mid-70% range:

Interval (weight in lbs)	Frequency	Cumulative frequency
140 < 150	1	1
150 < 160	4	5
160 < 170	8	13
170 < 180	7	20
180 < 190	5	25

Calculate the upper and lower percentiles required for the upper and lower limits of the range:

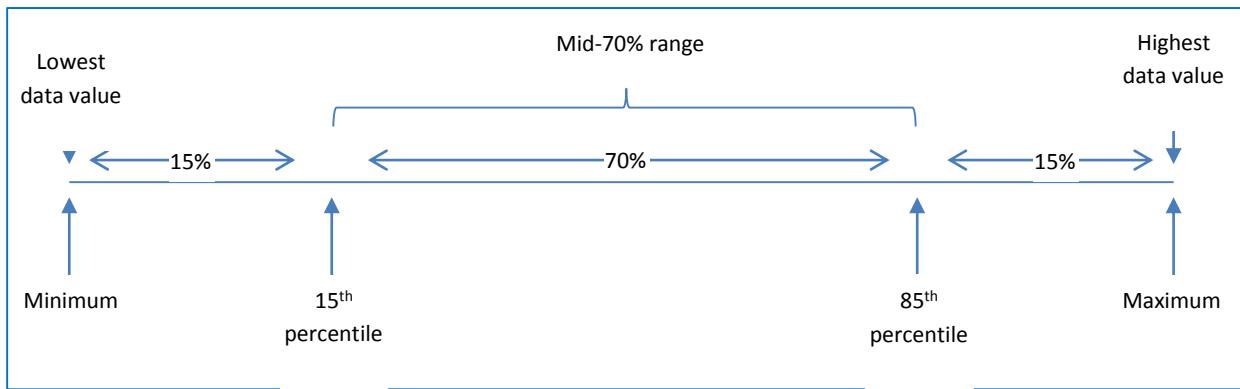
$$\text{lower percentile of range} = \frac{100\% - \text{required range percentile}}{2} = \frac{100\% - 70\%}{2}$$

$$= 15\%$$

$$\text{upper percentile of range}$$

$$= \text{lower percentile of range} + \text{required range percentile}$$

$$= 15\% + 70\% = 85\%$$



Calculate the required positions and values for these percentiles.

$$85\text{th percentile position} = \frac{j \times n}{100} = \frac{85 \times 25}{100} = 21.25$$

$$15\text{th percentile position} = \frac{j \times n}{100} = \frac{15 \times 25}{100} = 3.75$$

$$\begin{aligned} \text{upper percentile, } P_{85} &= L_{P85} + \frac{c \left[ \frac{85 \times n}{100} - f(<) \right]}{f_{P85}} = 180 + \frac{10(21.25 - 20)}{5} \\ &= 182.5 \text{ lbs} \end{aligned}$$

$$\begin{aligned} \text{lower percentile, } P_{15} &= L_{P15} + \frac{c \left[ \frac{15 \times n}{100} - f(<) \right]}{f_{P15}} = 150 + \frac{10(3.75 - 1)}{4} \\ &= 156.88 \text{ lbs} \end{aligned}$$

*interpercentile or mid percentile range*

*= value of upper percentile of range*

*- value of lower percentile of range = 182.5 - 156.88 = 25.62 lbs*

### ACTIVITY

The time taken to complete an assembling task has been measured for 250 employees:

Time taken (minutes)	Number of people ( <i>f</i> )	Cumulative frequency <i>f(&lt;)</i>
0 < 5	2	2
5 < 10	2	4
10 < 15	3	7
15 < 20	5	12
20 < 25	5	17
25 < 30	18	35
30 < 35	85	120
35 < 40	92	212
40 < 45	37	249
45 < 50	1	250
Total	250	

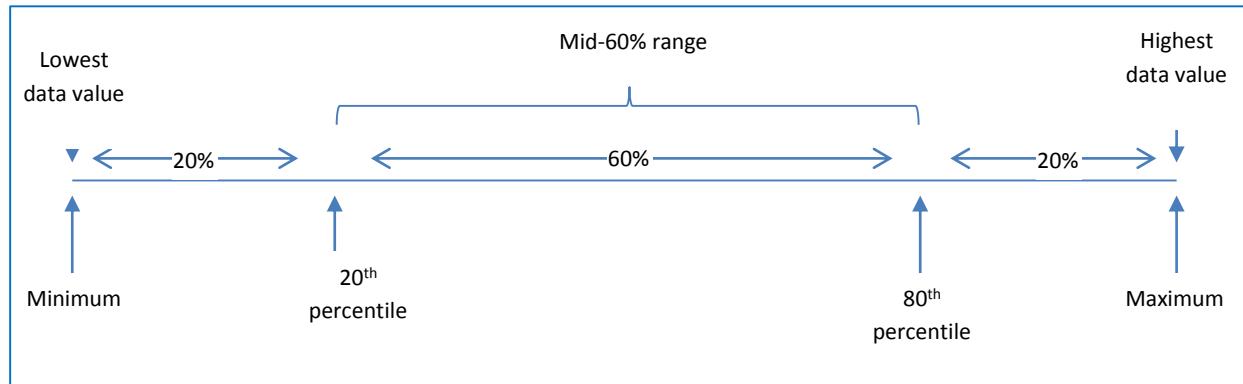
Calculate the mid-60% range.

### SOLUTION TO ACTIVITY

Calculate the upper and lower percentiles required for the upper and lower limits of the range:

$$\text{lower percentile of range} = \frac{100\% - \text{required range percentile}}{2} = \frac{100\% - 60\%}{2} = 20\%$$

$$\begin{aligned}\text{upper percentile of range} &= \text{lower percentile of range} + \text{required range percentile} \\ &= 20\% + 60\% = 80\%\end{aligned}$$



Calculate the required positions and values for these percentiles

$$80\text{th percentile position} = \frac{j \times n}{100} = \frac{80 \times 250}{100} = 200$$

$$20\text{th percentile position} = \frac{j \times n}{100} = \frac{20 \times 250}{100} = 50$$

$$\begin{aligned}\text{upper percentile, } P_{80} &= L_{P80} + \frac{c \left[ \frac{80 \times n}{100} - f(<) \right]}{f_{P80}} = 35 + \frac{5(200 - 120)}{92} \\ &= 39.35 \text{ minutes}\end{aligned}$$

$$\begin{aligned}\text{lower percentile, } P_{20} &= L_{P20} + \frac{c \left[ \frac{20 \times n}{100} - f(<) \right]}{f_{P20}} = 30 + \frac{5(50 - 35)}{85} \\ &= 30.88 \text{ minutes}\end{aligned}$$

*interpercentile or mid percentile range*

= value of upper percentile of range

– value of lower percentile of range =  $39.35 - 30.88$

= 8.47 minutes

### Quartile deviation

The quartile deviation is half the interquartile range of a dataset. It is a measure of the spread through the middle half of the dataset. It can be useful because it is not influenced by extremely high or extremely low values.

Formula: quartile deviation:

$$\text{quartile deviation} = \frac{IQR}{2} = \frac{Q_3 - Q_1}{2}$$

where,

$IQR$  is the interquartile range

$Q_3$  is the third or upper quartile

$Q_1$  is the first or lower quartile

Refer unit 2 for calculation of quartiles and formula for the calculation of the interquartile range.

### EXAMPLE

Using the data from the example in section **Error! Reference source not found.** calculate the quartile deviation:

Interval (weight in lbs)	Frequency	Cumulative frequency
140 < 150	1	1
150 < 160	4	5
160 < 170	8	13
170 < 180	7	20
180 < 190	5	25

The interquartile range was calculated in example

$$IQR = 16.65 \text{ lbs}$$

$$\text{quartile deviation} = \frac{IQR}{2} = \frac{16,65}{2} = 8.33 \text{ lbs}$$



## ACTIVITY

The time taken to complete an assembling task has been measured for 250 employees:

Time taken (minutes)	Number of people (f)	Cumulative frequency f(<)
0 < 5	2	2
5 < 10	2	4
10 < 15	3	7
15 < 20	5	12
20 < 25	5	17
25 < 30	18	35
30 < 35	85	120
35 < 40	92	212
40 < 45	37	249
45 < 50	1	250
Total	250	

Calculate the quartile deviation (the interquartile range was calculated in a previous self-assessment exercise.

## SOLUTION TO SELF-ACTIVITY

Interquartile deviation already calculated in the previous self-assessment activity:

$$\text{interquartile range} = 7.05 \text{ minutes}$$

$$\text{quartile deviation} = \frac{\text{IQR}}{2} = \frac{7.05}{2} = 3.53 \text{ minutes}$$

## Shape of the distribution

The shape of the distribution is the third likely way to summarise findings, and understand data as information. The most common way in which you ascertain this information is by looking at the graphs.

**When you are analysing graphs - Look at:**

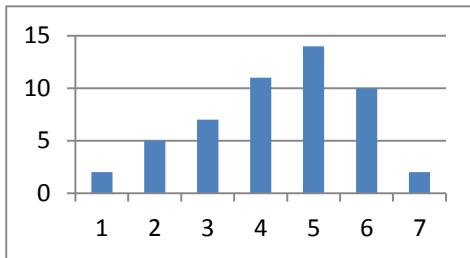
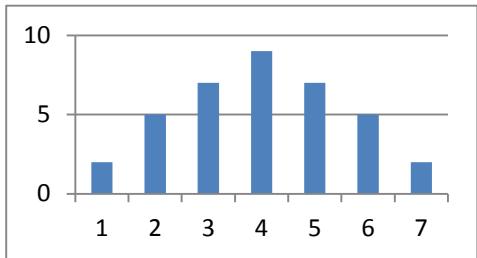
Symmetry

Highest point

Skewness (leaning in a certain direction)

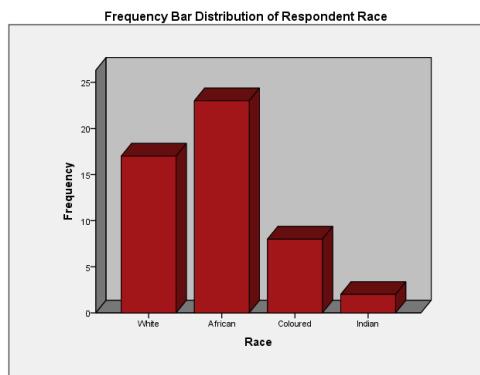
Dispersion (spread out)

Outliers (extreme variables)

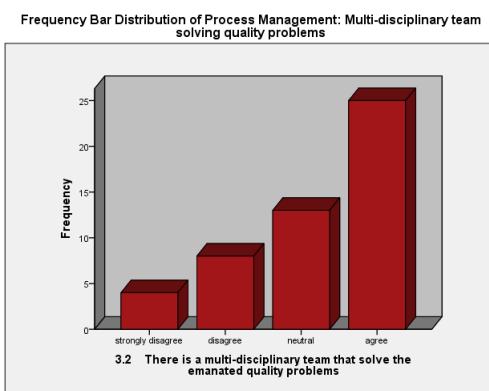


**Symmetry:**

**Approximately symmetrical distribution**

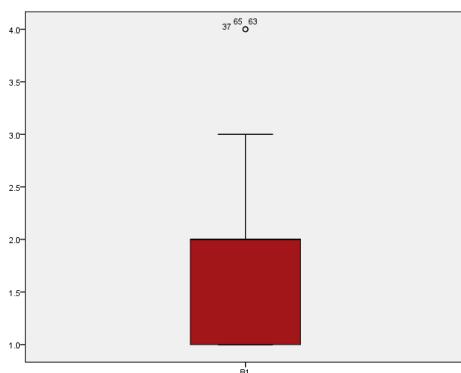


**Asymmetrical Distribution**



**Skewness:**

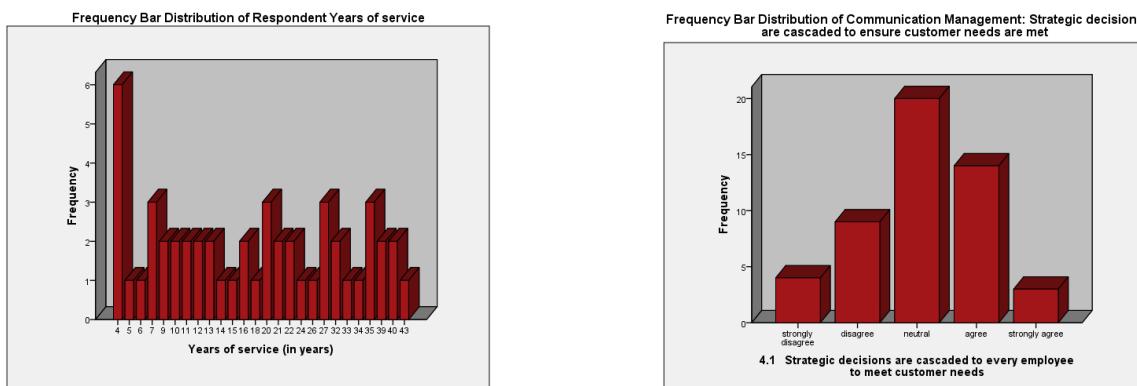
**Positively Skewed Distribution**



### Outliers:

These are values that contain extreme values that do not fit with the rest of the dataset, and therefore lie on the outer edges of the distribution. Outliers can both contribute to a new understanding of a phenomenon, but at the same time, can also produce misleading results.

In the Box and Whisker plot above, 37/65/63 are outliers



### Kurtosis:

Flat Distribution

Peaked Distribution

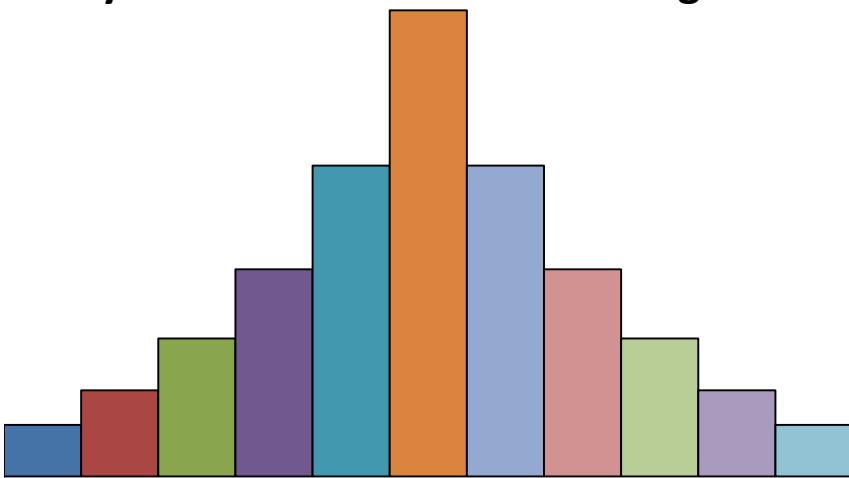
### Skewness

If there are large extreme values in the data the mean is pulled to the right or left and we say that the distribution exhibits skewness or kurtosis.

For a **symmetrical distribution** or **normal distribution** the mean, median and mode will be about the same.

$$\text{mean} \approx \text{median} \approx \text{mode}$$

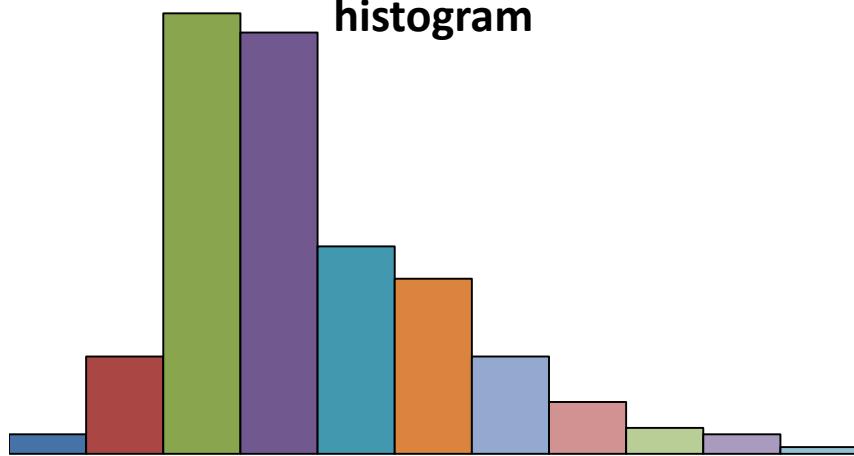
### Symmetrical distribution histogram



For a distribution that is **skewed to the right** the mode will be less than the median and the median will be less than the mean.

$$\text{mode} < \text{median} < \text{mean}$$

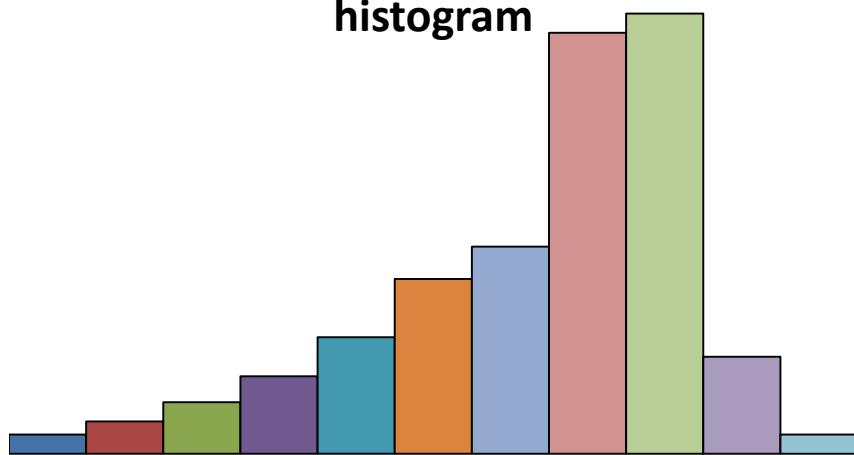
### Skewed to the right (positive skew) histogram



For a distribution that is **skewed to the left** the mean is the smallest, followed by the median, while the mode is the largest.

**TIP:** A negatively skewed distribution (skewed to the left) has the mean, median and mode in alphabetical order.

### Skewed to the left (negative skew) histogram



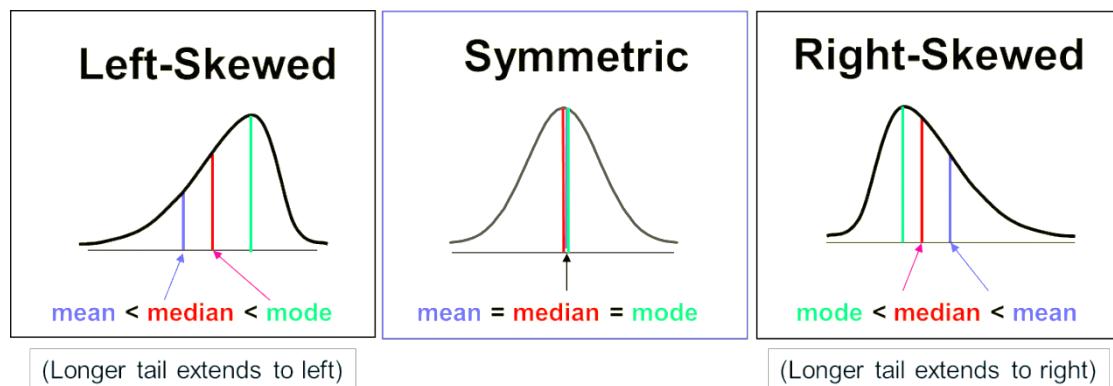
As a general rule the difference between the median and the mode is about twice the difference between the mean and the median.

If the data are skewed to the left there are some outliers on the left (small values). If the data are skewed to the right then there are some large outliers.

**Revision:**

For a dataset that is approximately symmetrical with one mode, the mean, median and mode tend to have about the same value. For a dataset that is obviously asymmetrical, it is preferable to report both the mean and median. The mean is relatively reliable; that is, when samples are drawn from the same population, the sample means tend to be more consistent than other averages.

A comparison of the mean and median can reveal information about skewness. Data can be identified as skewed to the left, symmetrical or skewed to the right. Data skewed to the left will have the mean and median to the left of the mode:



Source: Groebner et al. (2011)

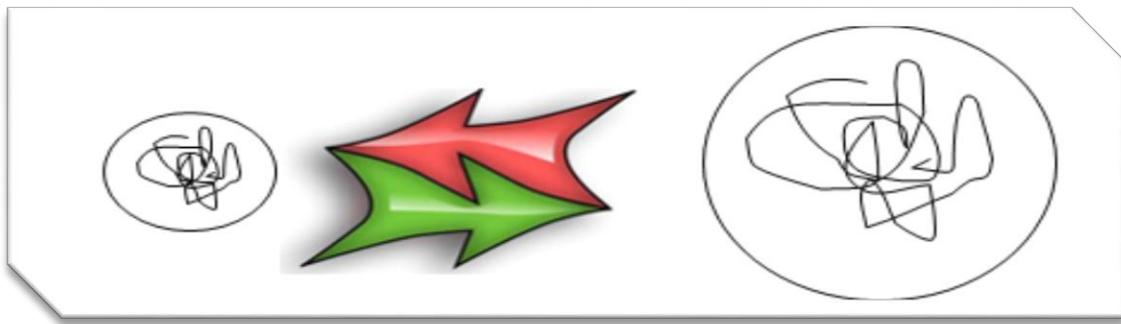
If we were to extend our (level of measurement permitting) analysis beyond merely descriptive statistics, we delve into the world of inferential statistics.

### Inferential Statistics

The crux of inferential statistics is to, through the use of a sample, say something about the whole population of interest.

Remember we spoke earlier of not being able to, due to financial, and other resource constraints, not being able to include all the members of a given population, if sufficiently large enough. As such, we draw representative samples so that, using that sample, we can generalise or findings back to the broader population. This is an act known as drawing inferences. We infer from a sample of the population of interest those characteristics of interest.

**Why?** Can you imagine having to collect information from the whole population to draw conclusions? This would be near impossible! So statistics have derived means for drawing a sample in such a way, and using certain statistical methods to be able to generalise to that population conclusions based on that manageable sample.



Once you have set up your research questions, it is necessary to ascertain what level of measurement is needed to yield data of a certain complexity in order to answer them. This should be done from the outset of your research project.

Inferential statistics include methods for answering questions about cases we have no observations for by using a sample of that population of interest to make inferences about that population.

### **Quick Recollection!**

Why do we collect samples and not information about the whole population of interest?

1. Time constraints
2. Financial constraints
3. Practically infeasible
4. Populations are just too large – can't handle and process ALL that data

We can't just draw the sample in any haphazard way, it needs to occur in such a way that the sample we have drawn is representative of our population, and therefore generalisable to the larger population, and that the manner in which we select our sample will relinquish information about the inherent biases of that sample that may affect our outcomes and conclusions. Sampling to ensure these criteria are met is called probabilistic sampling, or statistical sampling, and every member of that population has a known and equal chance of being selected in the sample, and random selection is key. Random assignment helps to ensure that the groups to which they are randomly assigned are approximately equal with respect to the variables at question. If we were to take, as a crude example, the population distribution of IQ:

The mean population IQ is 100, with a Standard Deviation of 15. This means that most people will have an IQ from between 85-115. Similarly, not a lot of people (as demonstrated in the figure above) have an IQ of above 130, or below 50. This means that, if I were to randomly select my sample, the more there is of something, the more likely they will be included in my sample. Similarly, the less there is of something, the less likely they will be included in my sample at a high frequency. So the theory is that, if randomly chosen, where each unit in the population has an equal chance of being selected (randomness), then the more likely the sample will be representative of the population.

Furthermore, the larger our sample, the more likely we can reduce sampling errors, and thereby ensure that the difference we are seeing actually exists, as our sample is representative of the population from which it was drawn.

### ***Populations, probability, samples***

#### **Completeness of data**

If the data is incomplete, and we are making inferences about the population based on our probability sample, the inferences we will make will most likely be erroneous, and therefore, researchers will be unable to draw them.

### ***How Inferential Statistics Work***

#### ***Population Parameters***

These are numbers that describe a population. Parameters are numbers about the characteristics of a given population, whereas statistics are numbers that summarise and describe samples. Statistics are used to estimate population parameters. The population we wish to draw conclusions about is known as the target population.

There are two estimates that we can make about population parameters based on statistics. When we decide on what statistics to produce, and what output is required to yield evidence related to answering our research questions, achieving our objectives, and ultimately the aim of our study – it is important that we choose the correct statistical tests to run. The most useful technique for doing so, is through the use of the Decision Making Tree (Adapted from Tredoux and Durrheim, 2002: 427).

## The Decision Making Tree

We use what is known as the decision making tree in order to identify the appropriate statistical tests we need to run in order to derive accurate, reliable, and valid results in order to answer our research questions.

If the wrong decision is made, and the inappropriate tests are run, we will have erroneous output. As a result, decisions made based on that output will be problematic.

Decisions regarding what the appropriate test is, is determined by:

- Level of measurement
- Number of groups/samples in the comparison
- Testing for differences, associations, or trends (determined by the purpose of the research)
- Whether or not the data meets the assumptions underlying parametric tests
- Data is single units, or paired
- The number of Dependent and Independent Variables
- Once-off measure, or the same sample is measured numerous times (One-shot vs. Repeated measures)

One will utilise these trees in order to arrive at the appropriate statistical test, by following the tree in a flow-like manner, from the top, until you arrive at the appropriate test. When making decisions around what type of test to use, it is important to check whether or not the assumptions underlying each statistical test has been met or not. This will inform you as to whether you should utilise parametric, or non-parametric tests.

## Non-Parametric Tests

- Non-parametric tests are used when assumptions of parametric tests are not met:
  - level of measurement (e.g., interval or ratio data);
  - normal distribution; and
  - homogeneity of variances across groups.
- They make fewer assumptions about the type of data on which they can be used
- Many of these tests will use “ranked” data

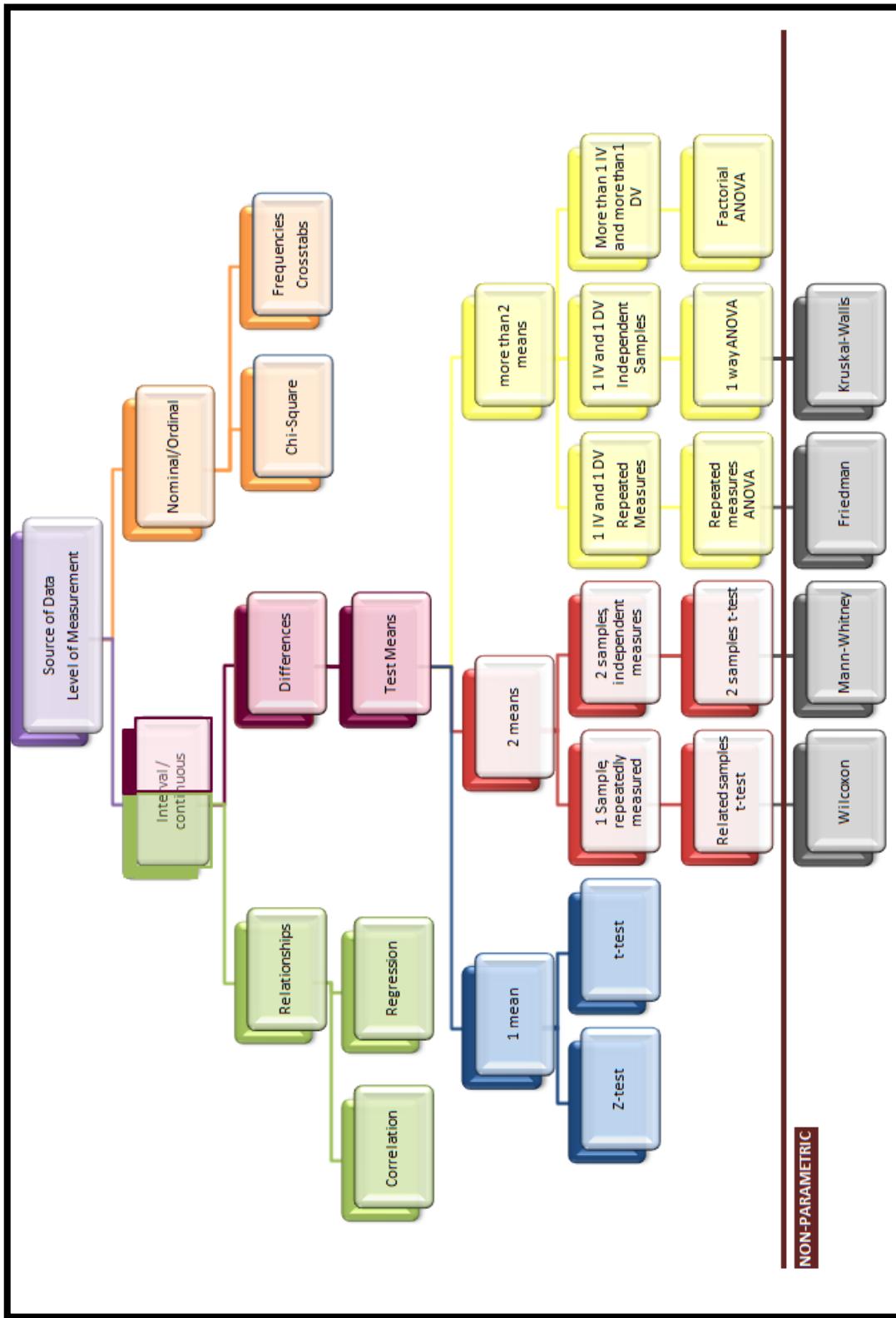
## Parametric Tests

### ***The assumption of normality***

- It is assumed that all the samples you are analysing have been drawn from populations that are normally distributed.
- You can get a rough idea if data is normally distributed by drawing a histogram of the data and examining the shape of the distribution.
- If the histogram has a bell shape, then it is probably normally distributed.

### ***The assumption of homogeneity of variance***

- If your samples have variances that are highly different, then it is difficult to get accurate results from a *t*-test
- This can be formally checked for, but is quite complex. We can ‘cheat’ and say that if the two variances differ by a factor of less than 4, the variance is probably homogenous. This is a rule of thumb, so it is not perfect, but seems to work a lot of the time.



NON-PARAMETRIC

### The assumption of independence.

The majority of *t*-tests (with the exception of the repeated measures *t*-test) assume that the samples the means were calculated from did not influence each other's scores in any way. For example, if you collect two datasets from the same group of people (as in a pre-test/post-test design), then these two datasets are not independent.

### **Chi-square**

- Significance test used where the data consists of *frequencies* rather than scores
- Appropriate for the analysis of counts is the  $\chi^2$  test
- Used as a *goodness of fit* test (i.e. does the existing data fit a theoretical distribution, such as a normal distribution?)
- The null hypothesis would be that no association exists between the sets of categories

Classifications:

**Step 2.** *Dichotomous* classifications: married and single, children and adults, politically active and politically indifferent, etc.

**Step 3.** *Multiple* classifications: Sheldon's classification of body types as ectomorphic (thin), mesomorphic (muscular), and endomorphic (fat).

Classifications are of interest to a researcher mainly when they are *exhaustive* and *mutually exclusive*

### **Assumptions of the $\chi^2$ test**

There are two assumptions that must be satisfied if a  $\chi^2$  test is to be used appropriately

1. Expected frequency minimum:

- The number of subjects expected in each cell must reach a certain minimum
- A rule of thumb that is frequently used is that the expected frequency should be no less than 5 in at least 80% of the cells
- If the dataset does not comply to this assumption, categories can be combined to overcome the limitation

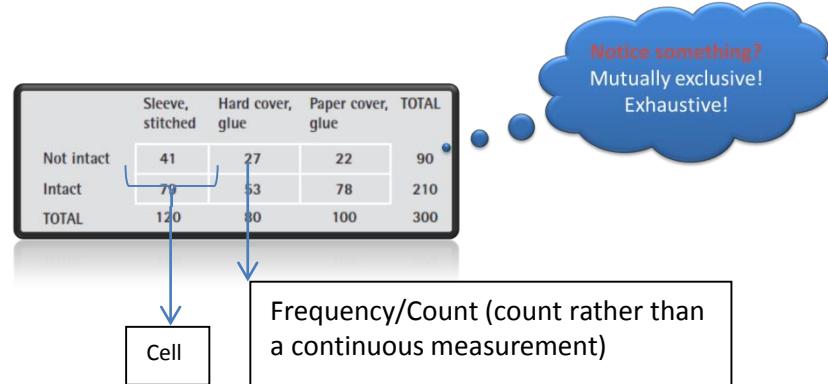
2. All the items or people involved in the test are independent of each other:

- Each observation comes from a different subject.
- No subject should be omitted from the table.

Your two variables should also be measured at an ordinal or nominal level (i.e. categorical data).

### **Contingency tables**

- When data are classified with respect to two or more variables



### **Chi-squared hypothesis tests – hypothesis testing for multiple comparisons**

The z- and t-hypothesis tests use measures of central location. Chi-squared hypothesis tests test for patterns of outcomes using frequency counts where observed frequencies are compared to expected frequencies.

The chi-squared test is used to test for:

- The dependence or independence of association between two categorical variables, eg are spending amounts related to gender?
- Comparisons of proportions across more than two populations.
- Conformance by data to a pattern.

The same hypothesis testing steps are used as in other hypothesis testing with the following differences:

#### **Step 1: Formulate the null and alternative hypotheses**

When determining associating between variables, the chi-squared hypotheses can be stated in English rather than using a formula.

#### **Step 2: Determine the rejection region and formulate the rejection rule**

The chi-squared hypothesis test is formulated using a contingency table.

From the chi-squared distribution, the critical value is determined using the level of significance,  $\alpha$ , and the degrees of freedom,  $df$ , calculated as

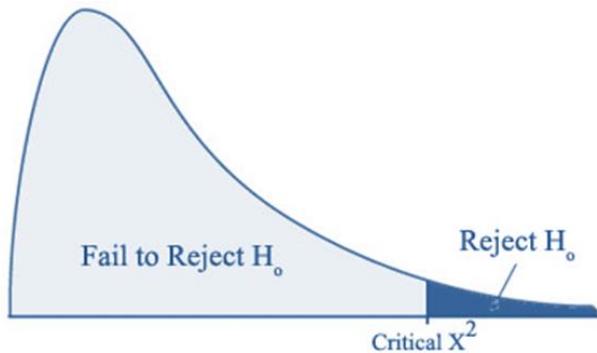
$$df = (r - 1)(c - 1)$$

where

$r$  = number of rows in the contingency table

$c$  = number of columns in the contingency table

The value of  $\chi^2_{crit}$  can then be read from the chi-squared table.



### Step 3: Calculate the sample test statistic

To calculate the test statistic for the chi-squared distribution, the formula is:

$$\chi^2_{calc} = \sum \frac{(f_o - f_e)^2}{f_e}$$

The sample statistic elements are calculated from the contingency table comprising sample values. The observed frequencies,  $f_o$  are the actual sample values. The expected frequencies,  $f_e$  are the frequencies that apply if each sample follows the same probability as the total and are calculated as:

$$f_e = \frac{\text{row total} \times \text{column total}}{\text{overall total}}$$

The examples in each section provide step by step instructions. Work through each example carefully to aid your understanding of the process.

### **Test of independence between variables**

It is often important to determine whether relationships exist between different variables or whether the variables may be considered independent of each other.

### **EXAMPLE**

A random sample of adults is selected from each of 4 ethnic groups in Cape Town. Respondents are asked to specify their primary source of news.

The results are:

News source	Ethnic group				
	A	B	C	D	Total
TV	30	20	25	20	95
Radio	25	25	20	20	90
Newspaper	10	10	5	30	55
<b>Total</b>	<b>65</b>	<b>55</b>	<b>50</b>	<b>70</b>	<b>240</b>

Is there a relationship between ethnic group and source of news, at a 2.5% level of significance?

- Formulate the null and alternative hypotheses

We are dealing with multiple comparisons – a test of relationship.

$H_0$ : *There is no relationship between ethnic group and source of news*

$H_1$ : *There is a relationship between ethnic group and source of news*

**Important note:** For a chi-squared hypothesis test of association, words are permissible for the null and alternative hypotheses. Note, however, that the hypotheses still follow the ‘rules’. The null hypothesis is still one of ‘equality’, indicating there is no difference between the groups; they are all the same or equal with respect to their source of news.

- Decide on the level of significance

$$\alpha = 0.025$$

- Determine the rejection region and formulate the rejection rule

$$df = (r - 1)(c - 1) = (3 - 1)(4 - 1) = 6$$

**Important note:** remember for the degrees of freedom to only include the data rows and columns and not the total rows and columns.

Using the degrees of freedom and the level of significance, look up the critical value in the chi-squared table and formulate the rejection rule:

$$\chi^2_{crit} = 14.45$$

$$Reject H_0 \text{ if } \chi^2_{calc} > 14.45$$

**Important note:** For the chi-squared hypothesis test, the rejection rule is always  $>$ . The calculated statistic calculates the extent to which the samples are different from each other. If the test statistic is sufficiently different from expectation, ie it exceeds the critical value, the null hypothesis is rejected.

- Calculate the sample test statistic

$$\chi^2_{calc} = \sum \frac{(f_o - f_e)^2}{f_e}$$

Each element of the formula needs to be in a column in order to calculate the required  $\sum$  value:

Observed frequency $f_o$	Expected frequency $f_e$	$f_o - f_e$	$(f_o - f_e)^2$	$\frac{(f_o - f_e)^2}{f_e}$
30	$f_e = \frac{95 \times 65}{240} = 25.7292$	4.2708	18.2397	0.7089
25	$f_e = \frac{90 \times 65}{240} = 24.375$	0.625	0.3906	0.016
10	$f_e = \frac{55 \times 65}{240} = 14.8958$	-4.8958	23.9689	1.6091
20	$f_e = \frac{95 \times 55}{240} = 21.7708$	-1.7708	3.1357	0.144
25	$f_e = \frac{90 \times 55}{240} = 20.625$	4.375	19.1406	0.928
10	$f_e = \frac{55 \times 55}{240} = 12.6042$	-2.6042	6.7819	0.5381
25	$f_e = \frac{95 \times 50}{240} = 19.7917$	5.2083	27.1264	1.3706
20	$f_e = \frac{90 \times 50}{240} = 18.75$	1.25	1.5625	0.0833
5	$f_e = \frac{55 \times 50}{240} = 11.4583$	-6.4583	41.7096	3.6401
20	$f_e = \frac{95 \times 70}{240} = 27.7083$	-7.7083	59.4179	2.1444
20	$f_e = \frac{90 \times 70}{240} = 26.25$	-6.25	39.0625	1.4881

Observed frequency $f_o$	Expected frequency $f_e$	$f_o - f_e$	$(f_o - f_e)^2$	$\frac{(f_o - f_e)^2}{f_e}$
30	$f_e = \frac{55 \times 70}{240} = 16.0417$	13.9583	194.8341	12.1455
$\Sigma$	240			<b>24.8161</b>

The **observed frequency column** lists the actual values of the samples. These can be in any sequence from the original contingency table. In this case, the first ethnic group is listed, followed by the second etc.

The **expected frequency column** applies the proportions of all groups to each group (the point is to establish whether these proportions hold true). The formula for the expected frequency is:

$$f_e = \frac{\text{row total} \times \text{column total}}{\text{overall total}}$$

**TIP:** A good sense test is to ensure that the totals for the observed and expected frequency columns are equal.

- Apply the rejection rule to the sample test statistic.  
24.82 is  $> 14.45$
- Draw a conclusion, both statistically and from a management perspective (ie in English).  
The null hypothesis is rejected in favour of the alternative hypothesis.  
The conclusion then is that there is a relationship between ethnic group and news source (at a 2.5% level of significance).



## ACTIVITY

A manufacturer of women's clothing is interested to know if age is a factor in whether women would buy a particular garment depending on its quality. A researcher samples 3 age groups and each woman is asked to rate the garment as excellent, average or poor. Test the hypothesis, at a 5% level of significance, that rating is not related to age group.

Rating	Age group		
	15 – 20	21 – 30	31 – 60
Excellent	40	47	46
Average	51	74	57
Poor	29	19	37

## ACTIVITY SOLUTION

1. Formulate the null and alternative hypotheses

We are dealing with multiple comparisons – a test of relationship.

$H_0$ : *There is no relationship between age group and quality assessment*

$H_1$ : *There is a relationship between age group and quality assessment*

- Decide on the level of significance  
 $\alpha = 0.05$
- Determine the rejection region and formulate the rejection rule

$$df = (r - 1)(c - 1) = (3 - 1)(3 - 1) = 4$$

$$\chi^2_{crit} = 9.49$$

*Reject  $H_0$  if  $\chi^2_{calc} > 9.49$*

- Calculate the sample test statistic

In this case, the totals for the contingency table need to first be calculated:

Rating	Age group			
	15 – 20	21 – 30	31 – 60	Totals
Excellent	40	47	46	133
Average	51	74	57	182
Poor	29	19	37	85
<b>Totals</b>	<b>120</b>	<b>140</b>	<b>140</b>	<b>400</b>

Observed frequency $f_o$	Expected frequency $f_e$	$f_o - f_e$	$(f_o - f_e)^2$	$\frac{(f_o - f_e)^2}{f_e}$
40	39.9	0.1	0.01	0.0003
51	54.6	-3.6	12.96	0.2374
29	25.5	3.5	12.25	0.4804
47	46.55	0.45	0.2025	0.0044
74	63.7	10.3	106.09	1.6655
19	29.75	-10.75	115.5625	3.8845
46	46.55	-0.55	0.3025	0.0065
57	63.7	-6.7	44.89	0.7047
37	29.75	7.25	52.5625	1.7668
$\Sigma$	400			<b>8.7505</b>

- Apply the rejection rule to the sample test statistic.  
 $8.75 \text{ is } < 9.49$
- Draw a conclusion, both statistically and from a management perspective (ie in English).

The null hypothesis is not rejected in favour of the alternative hypothesis.

The conclusion then is that there is no relationship between age group and quality assessment (at a 5% level of significance).

### ***Test for the difference between proportions***

The chi-squared hypothesis test is also used for testing whether two or more proportions are statistically equal.

### **EXAMPLE**

Consider the process of assembling television sets. Management may be interested in testing the hypothesis that the proportion of defective units produced is the same for each of 6 possible assembly-line speeds. 6 samples of 100 each are recorded. Use a 1% level of significance.

	Assembly-line speed (units per hour)						
Quality	A = 60	B = 70	C = 80	D = 90	E = 100	F = 110	Total
Defective	6	4	5	5	6	4	30
Acceptable	94	96	95	95	94	96	570
Total	100	100	100	100	100	100	600

**Step 1.** Formulate the null and alternative hypotheses

We are dealing with multiple comparisons of proportions.

$$H_0: \pi_A = \pi_B = \pi_C = \pi_D = \pi_E = \pi_F$$

$$H_1: \pi_A \neq \pi_B \neq \pi_C \neq \pi_D \neq \pi_E \neq \pi_F$$

- Decide on the level of significance

$$\alpha = 0.01$$

- Determine the rejection region and formulate the rejection rule

$$df = (r - 1)(c - 1) = (2 - 1)(6 - 1) = 5$$

$$\chi^2_{crit} = 15.09$$

$$Reject H_0 \text{ if } \chi^2_{calc} > 15.09$$

- Calculate the sample test statistic

Observed frequency $f_o$	Expected frequency $f_e$	$f_o - f_e$	$(f_o - f_e)^2$	$\frac{(f_o - f_e)^2}{f_e}$
6	5	1	1	0.2
94	95	-1	1	0.0105
4	5	-1	1	0.2
96	95	1	1	0.0105
5	5	0	0	0
95	95	0	0	0
5	5	0	0	0
95	95	0	0	0
6	5	1	1	0.2
94	95	-1	1	0.0105
4	5	-1	1	0.2

Observed frequency $f_o$	Expected frequency $f_e$	$f_o - f_e$	$(f_o - f_e)^2$	$\frac{(f_o - f_e)^2}{f_e}$
96	95	1	1	0.0105
$\Sigma$	600			<b>0.842</b>

- Apply the rejection rule to the sample test statistic.

0.842 is < 15.09

- Draw a conclusion, both statistically and from a management perspective (ie in English).

The null hypothesis is not rejected in favour of the alternative hypothesis.

The conclusion then is that the population proportion of defectives is the same for each assembly-line speed tested (at a 1% level of significance).



### ACTIVITY

A manufacturer of car batteries conducts a study to determine whether there are any differences in recall with respect to an advertisement when different media are used.

Recall	Media		
	Magazine	TV	Radio
Remember	25	10	7
Don't remember	73	93	108

At the 10% level of significance, determine whether there is evidence of a difference in recall of an advertisement for different media.

### SOLUTION TO SELF-ASSESSMENT ACTIVITY

#### Step 1. Formulate the null and alternative hypotheses

We are dealing with multiple comparisons of proportions.

$$H_0: \pi_M = \pi_T = \pi_R$$

$$H_1: \pi_M \neq \pi_T \neq \pi_R$$

- Decide on the level of significance

$$\alpha = 0.10$$

- Determine the rejection region and formulate the rejection rule

$$df = (r - 1)(c - 1) = (2 - 1)(3 - 1) = 2$$

$$\chi^2_{crit} = 4.61$$

Reject  $H_0$  if  $\chi^2_{calc} > 4.61$

- Calculate the sample test statistic

First total the contingency table:

	Media			
Recall	Magazine	TV	Radio	Total
Remember	25	10	7	42
Don't remember	73	93	108	274
Total	98	103	115	316

Observed frequency $f_o$	Expected frequency $f_e$	$f_o - f_e$	$(f_o - f_e)^2$	$\frac{(f_o - f_e)^2}{f_e}$
25	13.0253	11.9747	143.3934	11.0088
73	84.9747	-11.9747	143.3934	1.6875
10	13.6899	-3.6899	13.6154	0.9946
93	89.3101	3.6899	13.6154	0.1525
7	15.2848	-8.2848	68.6379	4.4906
108	99.7152	8.2848	68.6379	0.6883
$\Sigma$	316			<b>19.0223</b>

- Apply the rejection rule to the sample test statistic.

19.02 is  $> 4.61$

- Draw a conclusion, both statistically and from a management perspective (ie in English).

The null hypothesis is rejected in favour of the alternative hypothesis.

The conclusion then is that there is a difference in recall for different media (at a 10% level of significance).

### **Goodness-of-fit test**

The chi-squared goodness-of-fit test is used to determine whether a set of sample data differs significantly from what is expected.

#### **EXAMPLE**

A manufacturer of soap wishes to know if consumers have a preference for bath soap fragrances. To answer the question, a random sample of 200 adult shoppers is offered a free bar of soap. The recipients choose from 4 fragrances. Determine at a 1% level of significance.

Rose	Lavender	Sandalwood	Lemon
66	53	45	36

#### **Step 1.**

Formulate the null and alternative hypotheses

We are dealing with multiple comparisons to decide goodness-of-fit.

$H_0$ : There is no fragrance preference, ie all fragrances are equal

$H_1$ : There is fragrance preference

- Decide on the level of significance

$$\alpha = 0.01$$

- Determine the rejection region and formulate the rejection rule

$$df = c - 1 = 4 - 1 = 3$$

Important note: with only one row, only the columns are used to calculate the degrees of freedom.

$$\chi^2_{crit} = 11.345$$

Reject  $H_0$  if  $\chi^2_{calc} > 11.345$

- Calculate the sample test statistic

Observed frequency $f_o$	Expected frequency $f_e$	$f_o - f_e$	$(f_o - f_e)^2$	$\frac{(f_o - f_e)^2}{f_e}$
66	50	16	256	5.12
53	50	3	9	0.18
45	50	-5	25	0.5
36	50	-14	196	3.92
$\Sigma$	200			<b>9.72</b>

Note: if no preference is expected, all fragrances should have an equal weighting for the 400 women surveyed. For this type of chi-squared hypothesis test, the expected frequencies need to be carefully thought through.

- Apply the rejection rule to the sample test statistic.

$9.72 \text{ is } < 11.345$

- Draw a conclusion, both statistically and from a management perspective (ie in English).

The null hypothesis is not rejected in favour of the alternative hypothesis.

The conclusion then is that there is no fragrance preference (at a 1% level of significance).

#### EXAMPLE

The expected frequencies are then calculated by applying the total proportions to each group (some rounding difference may occur using this method, but they're generally not material):

News source	Ethnic group					Proportions for the whole
	A	B	C	D	Total	
TV	$0.3958 \times 65 = 25.727$	$0.3958 \times 55 = 21.769$	$0.3958 \times 50 = 19.79$	$0.3958 \times 70 = 27.706$	95	<b>0.3958</b>
Radio	$0.375 \times 65 = 24.375$	$0.375 \times 55 = 20.625$	$0.375 \times 50 = 18.75$	$0.375 \times 70 = 26.25$	90	<b>0.375</b>
Newspaper	$0.2292 \times 65 = 14.898$	$0.2292 \times 55 = 12.606$	$0.2292 \times 50 = 11.46$	$0.2292 \times 70 = 16.044$	55	<b>0.2292</b>
Total	65	55	50	70	240	<b>1</b>

#### Chi-Square in SPSS

**Gender \* Years\_of\_Experience Crosstabulation**

		Years_of_Experience				Total	
		0-3 years	4 - 7 years	8-11 years	12-15 years		
Gender	Male	Count	2	1	2	0	5
		Expected Count	1.0	1.0	1.5	1.5	5.0
	Female	Count	0	1	1	3	5
		Expected Count	1.0	1.0	1.5	1.5	5.0
Total		Count	2	2	3	3	10
		Expected Count	2.0	2.0	3.0	3.0	10.0

**Chi-Square Tests**

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.333 <sup>a</sup>	3	.149
Likelihood Ratio	7.271	3	.064
Linear-by-Linear Association	3.645	1	.056
N of Valid Cases	10		

a. 8 cells (100.0%) have expected count less than 5. The minimum expected count is 1.00.

When reading this table we are interested in the results of the "Pearson Chi-Square" row.

We can see here that  $\chi^2 (3) = 5.333$ ,  $p = 0.149$ .

This tells us that there is no statistically significant association between Gender and Years of Experience; that is, both Males and Females have roughly equal numbers of years of service at this particular company.

## Alternative measures for contingency tables

- Why?
  - size of the sample, confounding sample size and effect size

- The simplest measure of effect size, the *mean square contingency coefficient* (usually denoted by  $\phi^2$ ) simply divides  $\chi^2$  by the size of the sample:

### **Cramer's V**

- $\phi^2$  is, however, not considered a good measure of association, largely because it does not generate scores that fall between 0 and 1 in the same way as a correlation does
- Nevertheless  $\phi^2$  is used, with some modifications, in meta-analytic studies
- A measure of association in contingency tables with somewhat better properties is *Cramer's V*, usually denoted by  $\phi_c$
- Cramer's V can be difficult to interpret:
- No published rules of thumb for how large Cramer's V has to be to have a large, medium or small effect,
- Cannot be interpreted probabilistically
- Not directly comparable to any other measure of correlation, such as Pearson's r
- Cramer's V equals 0 when there is no relation between the variables, there may not be perfect association between the variables when Cramer's V equals 1

### **Odds Ratio**

- Unaffected by sample size or by unequal row or column totals
- 2 x 2 tables
  - Collapse over one of the categories to generate a  $2 \times 2$  table.
  - Collapsing over categories is in general not a good idea because it can (sometimes) alter the meaning of the data, either obscuring or exaggerating the association between the categories.

If you look at the decision making tree – and we move towards more interval/continuous data, we will first look to the left (relationships), which includes correlation and regression, and thereafter move to the right to examine differences (where we look at determining differences between means).

The difference introduced here is that we are not dealing with individual scores – we start to look at relationship between variables, otherwise known as paired data.

### **Correlation and Regression**

Regression and correlation analysis are statistical tools used to study the relationship between two variables, one of which is dependent and the other independent.

This type of analysis is used to determine:

- Whether there is a relationship between the variables.
- How good that relationship is.
- How the relationship can be used to make estimates.

We will restrict ourselves to cases involving only two variables and will assume that the relationship between the two variables approaches a straight line graphically.

In other words we are dealing with, paired data

- Allows us to measure the relationship between two measures
- Collected from two INDEPENDENT measurements

Regression offers a refined way of analysing *scatterplots*, and allows us to make predictions. The regression equation is essentially a mathematical summary of what we think the relationship between the two variables might be

- We can use this mathematical relationship to make predictions, though not without some danger of making a mistake

### ***Simple linear regression***

Linear regression analysis finds the straight line equation representing the relationship between two numeric variables, the independent variable,  $x$  and the dependent variable,  $y$ .

**TIP:** In using regression analysis it is very important to understand which variable is which.

It can be helpful to think of  $x$  as the ‘cause’ and  $y$  as the ‘effect’, because  $x$  determines or influences.

Linear regression is conducted using the following steps:

1. Identify the dependent and independent variables
2. Identify the predictor or independent variable,  $x$  and the dependent or variable which needs to be estimated,  $y$ .

It can be useful to construct a table containing the known variable values.

3. Construct a scatter plot

A scatter plot is a graph of the variable values and can be useful in visually determining the relationship between the variables:

- Whether the relationship approximates a straight line.
- How strong this relationship is.

- Whether the relationship is direct (as the value of  $x$  increases, so does the value of  $y$ ) or inverse (as the value of  $x$  increase, the value of  $y$  decreases).
- See also section 1.4.7 Scatter diagrams.

#### 4. Calculate the linear regression equation

Formula Straight-line graph:

$$y = a + bx$$

where:

- $x$  is the values of the independent variable
- $y$  is the values of the dependent variable
- $a$  is the y axis intercept
- $b$  is the slope of the straight line
- $n$  is number of observations

Regression analysis uses the method of least squares to find the straight line equation of best fit:

$$\text{slope } b = \frac{n(\sum xy) - \sum x \sum y}{n(\sum x^2) - (\sum x)^2}$$

$$\text{intercept } a = \frac{\sum y}{n} - b \left( \frac{\sum x}{n} \right)$$

Make estimations from the regression equation

Use the straight line equation to estimate values of  $y$  from values of  $x$  and establish the validity of these estimations.

#### EXAMPLE

The number of sales made by sales people in an organisation are listed against the number of sales calls made:

Sales	32	24	40	22	32
Sales calls made	14	10	16	8	12

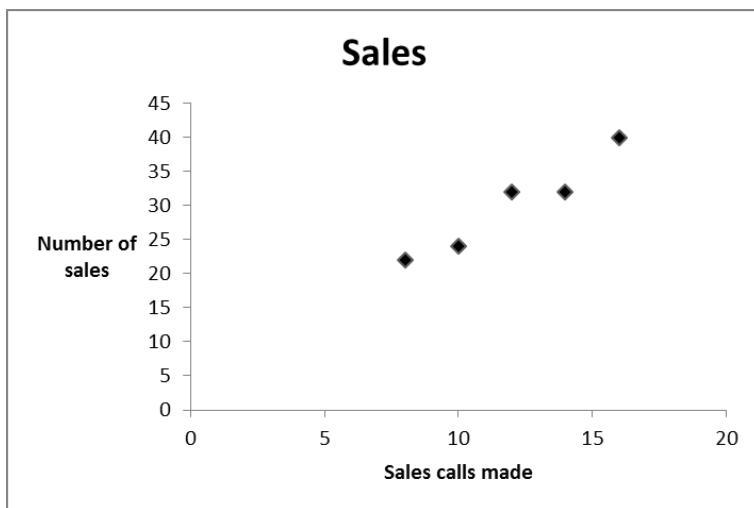
Using a scatter plot, comment on the relationship between sales called and sales made. Calculate straight line equation which bets fits the data and estimate the sales which will be concluded from 15 sales calls.

Identify the dependent and independent variables

Sales calls made,  $x$  is used to estimate sales,  $y$ .

Sales calls made, $x$	Sales, $y$
14	32
10	24
16	40
8	22
12	32

- Construct a scatter plot



A visual review of the scatterplot indicates that there is a strong positive linear relationship between sales calls made and number of sales concluded.

- Calculate the linear regression equation

Start by extending the data table to include all the required values for the formula:

Sales calls made, $x$	Sales, $y$	$xy$	$x^2$
14	32	448	196
10	24	240	100
16	40	640	256
8	22	176	64
12	32	384	144
$\Sigma$	60	1 888	760

$$\text{slope } b = \frac{n(\sum xy) - \sum x \sum y}{n(\sum x^2) - (\sum x)^2} = \frac{5 \times 1 888 - 60 \times 150}{5 \times 760 - (60)^2} = 2.2$$

$$\text{intercept } a = \frac{\sum y}{n} - b \left( \frac{\sum x}{n} \right) = \frac{150}{5} - 2.2 \left( \frac{60}{5} \right) = 3.6$$

$$y = 3.6 + 2.2x$$

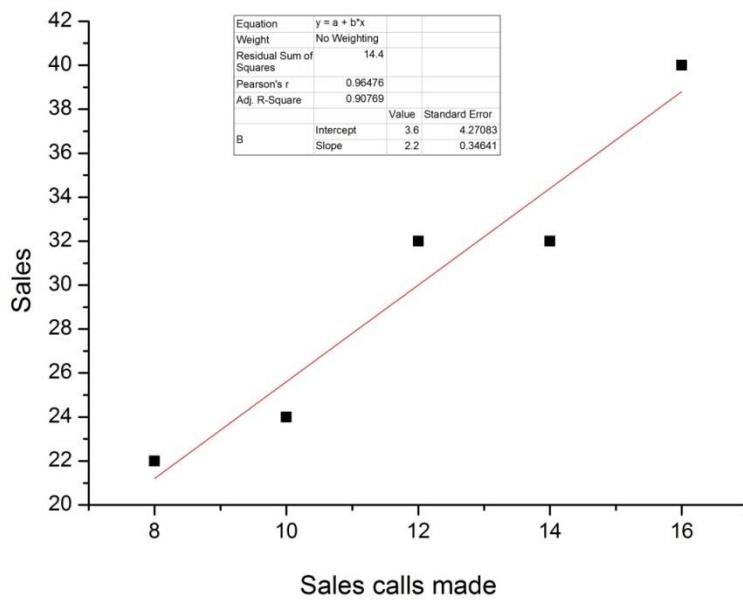
- Make estimations from the regression equation

For 15 sales calls:

$$x = 15$$

$$y = 3.6 + 2.2 \times 15 = 36.6 \approx 37$$

15 sales calls is estimated to result in 37 sales.



### ACTIVITY

You have observed 10 workers on the shop floor and have timed how long it takes each to produce an item. You have been able to match these times with the length of the workers' experience. The results are:

Person	Experience (months)	Time taken (minutes)
A	2	27
B	5	26
C	3	30
D	8	20
E	5	22
F	9	20
G	12	16
H	16	15
I	1	30
J	6	19

Draw a scatterplot for the data and comment. Determine the straight line equation and estimate how long a workers with 4 months', 10 months' and 24 months' experience will take to produce an item. If the company would like an item to be produced within 22 minutes, advise how much experience workers need.

### SOLUTION TO ACTIVITY

- Identify the dependent and independent variables  
Experience,  $x$  is used to estimate time taken,  $y$ .
- Construct a scatter plot



A visual review of the scatterplot indicates that there is a strong inverse (or negative) linear relationship between worker experience and time taken to produce one item.

**TIP:** If the relationship between the variables is inverse, except the value of  $b$ , the slope of the straight line equation, to be negative.

- Calculate the linear regression equation

Person	$x$ , Experience (months)	$y$ , Time taken (minutes)	$xy$	$x^2$
A	2	27	54	4
B	5	26	130	25
C	3	30	90	9

Person	$x$ , Experience (months)	$y$ , Time taken (minutes)	$xy$	$x^2$
D	8	20	160	64
E	5	22	110	25
F	9	20	180	81
G	12	16	192	144
H	16	15	240	256
I	1	30	30	1
J	6	19	114	36
$\Sigma$	67	225	1 300	645

$$\text{slope } b = \frac{n(\sum xy) - \sum x \sum y}{n(\sum x^2) - (\sum x)^2} = \frac{10 \times 1300 - 67 \times 225}{10 \times 645 - (67)^2} = -1.06$$

$$\text{intercept } a = \frac{\sum y}{n} - b \left( \frac{\sum x}{n} \right) = \frac{225}{10} + 1.06 \left( \frac{67}{10} \right) = 29.6$$

$$y = 29.6 - 1.06x$$

- Make estimations from the regression equation

With 4 months' experience:

$$x = 4$$

$$y = 29.6 - 1.06 \times 4 = 25.36 \approx 25$$

A worker with 4 months' experience is estimated to take 25 minutes to produce one item.

With 10 months' experience:

$$x = 10$$

$$y = 29.6 - 1.06 \times 10 = 19$$

A worker with 10 months' experience is estimated to take 19 minutes to produce one item.

To produce an item within 22 minutes:

With 24 months' experience:

$$x = 24$$

$$y = 29.6 - 1.06 \times 24 = 4.16 \approx 4$$

A worker with 24 months' experience is estimated to take 4 minutes to produce one item.

Important note: this estimation is ***outside the range of the sample data and is therefore considered unreliable***. Because the sample doesn't extend to include this experience time, we can't be sure what will happen. It's always possible that very experienced workers may even display a decline in productivity!

To produce an item within 22 minutes:

$$y = 22$$

$$22 = 29.6 - 1.06x \therefore x = 7.17$$

A worker will need at least 7 months' experience to produce one item within 22 minutes.

### So what's the problem?

- The regression line is a useful statement of the underlying trend, but it tells us nothing about the strength of the relationship.
- Correlation is a measure of the strength of linear association between two variables

The output of the example of regression in SPSS:

#### Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.904 <sup>a</sup>	.818	.795	2.47329

a. Predictors: (Constant), Experience

R-Square here denotes the proportion of variance in the dependent variable (time taken) which can be explained by the independent variable (experience in months). This is an overall measure of the strength of association, but does not reflect the extent to which any particular independent variable is associated with the dependent variable. It is important to note too is the Adjusted R-Squared column.

The adjusted R-Square is essentially a modified R-Squared value that takes into account the number of predictors in the model. Every predictor added to a model will increase R-Squared, whereas, adjusted R-squared will only increase if the predictors introduced into the model better explain the variance, beyond chance.

### ANOVA<sup>a</sup>

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	219.563	1	219.563	35.893	.000 <sup>b</sup>
Residual	48.937	8	6.117		
Total	268.500	9			

Model is significant

a. Dependent Variable: Time\_taken

b. Predictors: (Constant), Experience

### Coefficients<sup>a</sup>

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	29.589	1.418		20.860	.000
Experience	-1.058	.177	-.904	-5.991	.000

a. Dependent Variable: Time\_taken

$$y = 29.589 - 1.06x$$

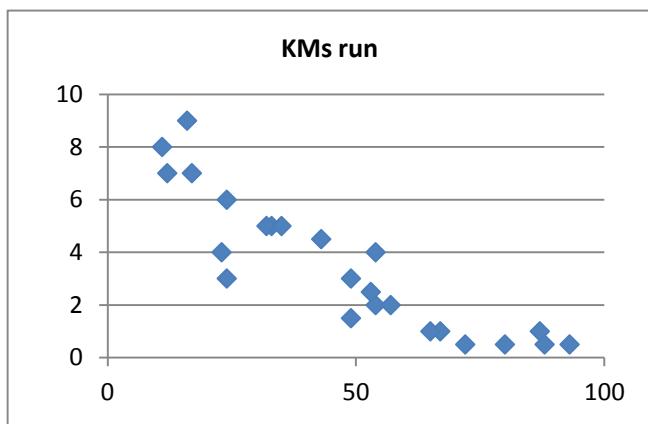
a (y-axis intercept)

b (the slope of the straight line)

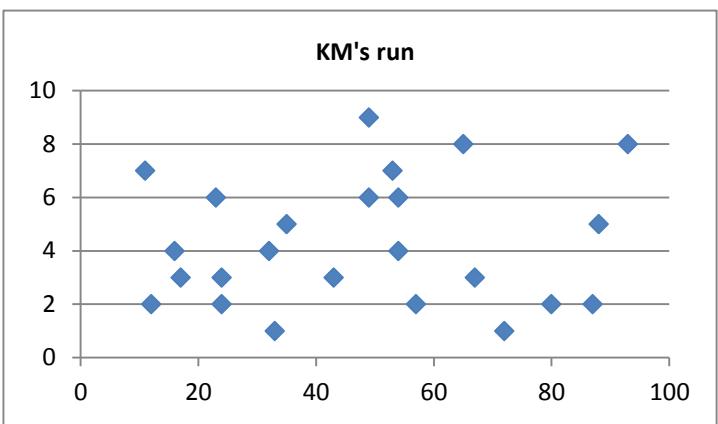
When more than two variables are used in regression analysis, it is called multiple regression. This topic falls outside this course, but do be aware that more techniques exist.

### Correlation

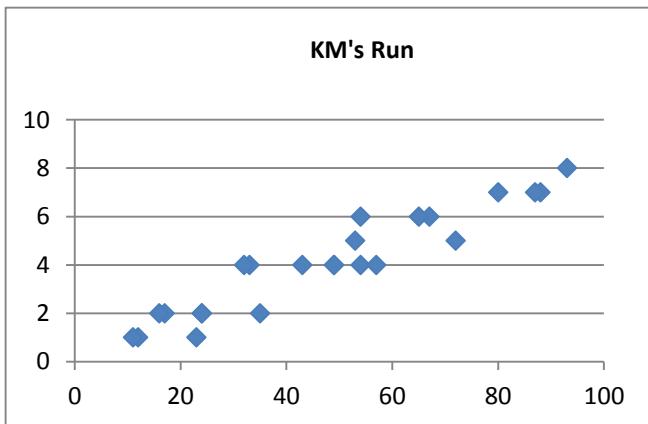
Useful to gauge the nature of a relationship between two variables by looking at a scatterplot



$r = -0.9$  (Strong, Negative Correlation)



$r = 0$  (No Correlation)



$r = 0.9$  (Strong, Positive, Correlation)

Calculated on the basis of how far the points lie from the 'best-fit' regression line.

As a very crude rule of thumb, a correlation coefficient of the following values roughly imply:

**Strength**

0.0 to 0.2	-	Very weak to negligible correlation
0.2 to 0.4	-	Weak, low correlation (not very significant)
0.4 to 0.7	-	Moderate correlation
0.7 to 0.9	-	Strong, high correlation
0.9 to 1.0	-	Very strong correlation

You need to determine whether or not the correlation is significant (i.e.  $p < 0.05$ ). Secondly, and just as a word of caution, the above classifications of correlations according to a weak – strong scale is not always advisable and can create confusion. A “moderate correlation” of say 0.60 might be not significant and thus meaningless in the case of a small n. Similarly, a “weak” correlation of say 0.30 might be highly significant given a large sample. A weak correlation may only explain 9% of the covariance and the “moderate” correlation will only explains 36% of the covariance for example. Therefore, it would be more prudent to classify correlation coefficients according to the extent that they can explain covariance. It is important, and highly encouraged to use what is known as the coefficient of determination.

***The coefficient of determination***

The coefficient of determination measures the extent to which the independent variable determines the dependent variable.

Formula: Coefficient of determination:

$$\text{coefficient of determination} = r^2$$

where:

$r$  is the sample correlation coefficient

***EXAMPLE***

Calculate and interpret the coefficient of determination for the data in example.

$$\text{coefficient of determination} = 0.96^2 = 0.92$$

Interpretation: 92% of the sales concluded are determined by the sales calls made. The remaining 8% are determined by other factors.

## **Parametric and Non-Parametric Correlations**

### **Parametric**

#### **Product-moment coefficient of correlation OR Pearson's correlation coefficient**

Symbolised by the small letter r

r will fall within the range -1 to +1.

-1 means a perfect negative correlation (a perfect inverse relationship, where, as the value of x rises, so the value of y falls)

+1 means a perfect positive correlation (where the values of x and y rise or fall together)

An r of 0 means zero correlation, which means that there is no relationship between x and y

### **Non-Parametric Correlations**

#### **Spearman's Rho**

- Spearman's p is a statistic for measuring the relationship between two variables
- It is a non-parametric measure-avoids assumptions that the variables have a straight-line relationship
- Used when one or both measures is measured on ordinal scale.
- A value of 0 indicates no relationship and values of +1 or 1 indicate a one-to-one relationship between the variables or 'perfect correlation'
- The difference is that Spearman's rho refers to the ranked values rather than the original measurements

Formula Pearson's correlation coefficient:

$$r = \frac{n(\sum xy) - \sum x \sum y}{\sqrt{[n(\sum x^2) - (\sum x)^2] \times [n(\sum y^2) - (\sum y)^2]}}$$

where:

- r is the sample correlation coefficient
- x is the values of the independent variable
- y is the values of the dependent variable
- a is the y axis intercept
- b is the slope of the straight line
- n is number of observations

Correlation analysis again uses the method of least squares.

**TIP:** You'll notice that the numerator for the correlation coefficient is the same as that for the slope of the regression equation. Additionally the first part of the denominator is also the same as the denominator for the slope. If you have already calculated the slope, you can therefore re-use that part of the calculation when calculating the correlation coefficient.

**TIP:** The correlation coefficient gives the factor for strength of the linear relationship. The important point is that the correlation coefficient can never exceed 1 if positive or be below -1 if negative.

### **EXAMPLE**

Calculate and interpret the correlation coefficient for the data in example

Start by extending the data table to include all the further required values for the formula:

Sales calls made, $x$	Sales, $y$	$xy$	$x^2$	$y^2$
14	32	448	196	1 024
10	24	240	100	576
16	40	640	256	1 600
8	22	176	64	484
12	32	384	144	1 024
$\Sigma$	60	1 888	760	4 708

$$r = \frac{5 \times 1888 - 60 \times 150}{\sqrt{[5 \times 760 - 60^2] \times [5 \times 4708 - 150^2]}} = 0.96$$

Interpretation: there is a strong (0.96) positive correlation between sales calls made and sales concluded.



## ACTIVITY

Calculate the correlation coefficient for the data in the previous self-assessment activity.

### SOLUTION TO SELF-ASSESSMENT ACTIVITY

Person	$x$ , Experience (months)	$y$ , Time taken (minutes)	$xy$	$x^2$	$y^2$
A	2	27	54	4	729
B	5	26	130	25	676
C	3	30	90	9	900
D	8	20	160	64	400
E	5	22	110	25	484
F	9	20	180	81	400
G	12	16	192	144	256
H	16	15	240	256	225
I	1	30	30	1	900
J	6	19	114	36	361
$\Sigma$	67	225	1 300	645	5 331

$$r = \frac{10 \times 1\,300 - 67 \times 225}{\sqrt{[10 \times 645 - 67^2] \times [10 \times 5\,331 - 225^2]}} = -0.90$$

Interpretation: there is a strong inverse relationship between months of experience and the time taken to produce one item.

**TIP:** If the slope of the regression equation is negative, this indicates an inverse relationship between the variables. The correlation coefficient will then also be negative.

### Correlations in SPSS

**PARAMETRIC CORRELATIONS** – use if data meets assumptions

## Correlations

		Time_taken1	Time_taken2	Time_taken3
Time_taken1	Pearson Correlation	1	.917**	.876**
	Sig. (2-tailed)		.000	.001
	N	10	10	10
Time_taken2	Pearson Correlation	.917**	1	.959**
	Sig. (2-tailed)	.000		.000
	N	10	10	10
Time_taken3	Pearson Correlation	.876**	.959**	1
	Sig. (2-tailed)	.001	.000	
	N	10	10	10

\*\*. Correlation is significant at the 0.01 level (2-tailed).

There is a significant, strong, positive correlation between time taken between test 1 and test 2 ( $r = 0.917$ ,  $N = 10$ ,  $p < 0.0001$ ). You could even report these statistics as  $r(10)=0.917$ ,  $p<0.0001$ )

There is a significant, strong, positive correlation between time taken between test 2 and test 3 ( $r = 0.959$ ,  $N = 10$ ,  $p < 0.0001$ ).

There is a significant, strong, positive correlation between time taken between test 1 and test 3 ( $r = 0.876$ ,  $N = 10$ ,  $p < 0.0001$ ).

## Non-parametric correlations (SPEARMAN'S RHO) - use if data does not meet assumptions

### Correlations

		Stress_level	Subject	
Spearman's rho	Stress_level	Correlation Coefficient	1.000	.235
	Sig. (2-tailed)	.	.319	
	N	20	20	
Subject	Correlation Coefficient	.235	1.000	
	Sig. (2-tailed)	.319	.	
	N	20	20	

Of course, the correlation between “Stress level” and “Stress level”, and “Subject” and “Subject” correlation will be perfect, thus the correlation coefficient is exactly 1.000.

The correlation coefficient between subject and stress level is 0.235, implying a slight correlation – however,  $p > 0.05$ , which means the correlation is not significant.

Let's move a little away from working with paired data, to determining differences, something that underlies, or is found at the heart of testing hypotheses.

## Differences

All statistical tests need to estimate probabilities, and if distribution-free tests do not use the well-understood characteristics of the normal curve, how do they estimate probabilities? Most distribution-free tests use either the characteristics of ranked data or they use randomisation procedures to calculate probabilities.

### ***Hypotheses Testing***

***Hypothesis testing*** uses sample evidence to statistically test whether a claim made about a population is valid. The results of the sample are used to make an inference about the population as a whole. Requires the identification of Independent, and Dependent variables.

EXAMPLE of a claim: a product manufacturer claims more people use their product than any other.

The hypotheses covered in the course relate to:

- A single population mean,  $\mu$ , eg on average 200 customers pass a store every hour.
- A single population proportion,  $\pi$ , eg 4 out of 10 students study part-time.
- A comparison or the difference between two population means,  $\mu_1 - \mu_2$ , eg on average people under 25 spend more on clothing than those older than 50.
- A comparison or the difference between two population proportions,  $\pi_1 - \pi_2$ , eg 60% of Durban students are under 35 whereas only 40% of Johannesburg students fall into that age category.
- Multiple comparisons,  $\chi^2$ , eg the accident profiles of three market segments are all the same.

### ***Hypothesis testing concepts***

In this section, we will present the basic concepts of hypothesis testing. The next section takes you through the step by step process of testing a hypothesis.

### **The null hypothesis ( $H_0$ ) and the alternative hypothesis ( $H_1$ )**

For every hypothesis statement there needs to be an opposite statement, ie claim and counterclaim, eg:

Statement: “The defendant is guilty”; alternative: “The defendant is not guilty”.

The first statement we refer to as the null hypothesis ( $H_0$ ).

The second statement we refer to as the alternative hypothesis ( $H_1$ ).

Important note - when formulating hypothesis statements:

- The null hypothesis always contains an equality sign (= or  $\geq$  or  $\leq$ ).
- The alternative hypothesis always contains an inequality sign counter to that of the null hypothesis (< or > or  $\neq$ ).

### **EXAMPLE**

Statement: Our sales average R1 million per month.

Null hypothesis:  $H_0: \mu = R1\text{ million}$

Alternative hypothesis:  $H_1: \mu \neq R1\text{ million}$  or  $\mu <> R1\text{ million}$

### **Rejection region and significance level**

Except in the case of multiple comparisons, a normal distribution is used to assess whether the null hypothesis is accepted or rejected.

The two possible errors encountered in hypothesis testing are:

A **type I error** where a valid null hypothesis is rejected, with probability of  $\alpha$ .

A **type II error** where a false null hypothesis is accepted, with probability of  $\beta$ .

The error probabilities of  $\alpha$  and  $\beta$  are inversely related which simply means that any attempt to reduce the one will increase the other one (Keller: 2005, p326).

Reducing the probability of one type of error results in the probability of the other error type increasing.

The limits of acceptance and rejection are set (using the tails of the normal distribution) based on a level of significance,  $\alpha$  (the probability of a type I error).

These limits, or cut-off points, reflect the level of risk considered acceptable in drawing a wrong conclusion.

The level of significance defines the likelihood of rejecting the null hypothesis when in fact it is true (significance levels are related to confidence levels used in probability sampling).

If the statistical test used to test the hypothesis finds in favour of the alternative hypothesis, we reject the null hypothesis. If not, the null hypothesis is not rejected.

Note: we **never** say that we accept the null hypothesis. We either reject the null hypothesis in favour of the alternative or not.

### **Steps in hypothesis testing**

Once the type of hypothesis test has been identified, five process steps are performed:

- Formulate the null and alternative hypotheses.
- Decide on the level of significance (usually provided in example questions).
- Determine the rejection region and formulate the rejection rule. This step includes establishing the critical value about which the hypothesis value is tested.
- Calculate the sample test statistic.
- Apply the rejection rule to the sample test statistic.
- Draw a conclusion, both statistically and from a management perspective (i.e. in English).

Each step is now examined further.

- **Formulate the null and alternative hypotheses**

The null and alternative hypothesis are formulated from the management question.

Important note: the null hypothesis is not always the claim; the hypotheses may be formulated in such a way that the alternative hypothesis is the claim, in which case you need to be very careful when drawing conclusions at the end of the test.

The null and therefore alternative hypotheses are formulated based on the identified approach:

Approach	Null hypothesis formats	Alternative hypothesis formats
<b>Single population mean</b>	$H_0: \mu =$	$H_1: \mu \neq$
	$H_0: \mu \leq$	$H_1: \mu >$
	$H_0: \mu \geq$	$H_1: \mu <$
<b>Single population</b>	$H_0: \pi =$	$H_1: \pi \neq$
	$H_0: \pi \leq$	$H_1: \pi >$

proportion	$H_0: \pi \geq$	$H_1: \pi <$
<b>Comparison of two population means</b>	$H_0: \mu_1 = \mu_2$ or $H_0: \mu_1 - \mu_2 = 0$ or a specified value	$H_1: \mu_1 \neq \mu_2$ or $H_1: \mu_1 - \mu_2 \neq 0$ or a specified value
	$H_0: \mu_1 \leq \mu_2$	$H_1: \mu_1 > \mu_2$
	$H_0: \mu_1 \geq \mu_2$	$H_1: \mu_1 < \mu_2$
<b>Comparison of two population proportions</b>	$H_0: \pi_1 = \pi_2$ or $H_0: \pi_1 - \pi_2 = 0$ or a specified value	$H_1: \pi_1 \neq \pi_2$ or $H_1: \pi_1 - \pi_2 \neq 0$ or a specified value
	$H_0: \pi_1 \leq \pi_2$	$H_1: \pi_1 > \pi_2$
	$H_0: \pi_1 \geq \pi_2$	$H_1: \pi_1 < \pi_2$
<b>Multiple comparisons – see section 6.5</b>	$H_0: \pi_1 = \pi_2 = \pi_3 = \pi_4$ etc or $H_0:$ The groups being compared all have the same proportions	$H_1: \pi_1 \neq \pi_2 \neq \pi_3 \neq \pi_4$ etc or $H_1:$ The groups being compared have different proportions

### EXAMPLE

Management question: A store owner believes that on average at least 200 people pass by his store every hour.

$$H_0: \mu \geq 200$$

$$H_1: \mu < 200$$

Management question: A store owner believes that fewer than 4 out of 10 of his customers are female.

$$H_0: \pi \geq 0.4$$

$$H_1: \pi < 0.4$$

where  $\pi$  is the proportion of female customers.

Management question: A store owner believes that more customers enter his store than his neighbouring store.

$$H_0: \mu_1 \leq \mu_2$$

$$H_1: \mu_1 > \mu_2$$

where  $\mu_1$  is the average number of customers entering the store and  $\mu_2$  is the average number of customers entering the neighbouring store.

Note: in this case the store owner's claim becomes the alternative hypothesis, because it doesn't contain an equality sign.

Management question: A store owner believes that he has fewer female customers than his neighbouring store.

$$H_0: \pi_1 \geq \pi_2$$

$$H_1: \pi_1 < \pi_2$$

where  $\pi_1$  is the proportion of female customers and  $\pi_2$  is the proportion of the neighbouring store's female customers.

Note: again the store owner's claim becomes the alternative hypothesis, because it doesn't contain an equality sign.

Management question: A store owner believes that customers in each of three different age categories have different spending patterns across a group of products.

$$H_0: \pi_1 = \pi_2 = \pi_3$$

$$H_1: \pi_1 \neq \pi_2 \neq \pi_3$$

where  $\pi_1$  is the spending proportion displayed by the first age category,  $\pi_2$  is the spending proportion displayed by the second age category and  $\pi_3$  is the spending proportion displayed by the third age category.

In the case of multiple proportions it is often easier (and easier to understand) to state the hypotheses in English:

$H_0$ : The age categories all have the same spending patterns

$H_1$ : The age categories have different spending patterns

Note, an English hypothesis statement is only permissible for multiple comparisons.

- **Decide on the level of significance (usually provided in example questions)**

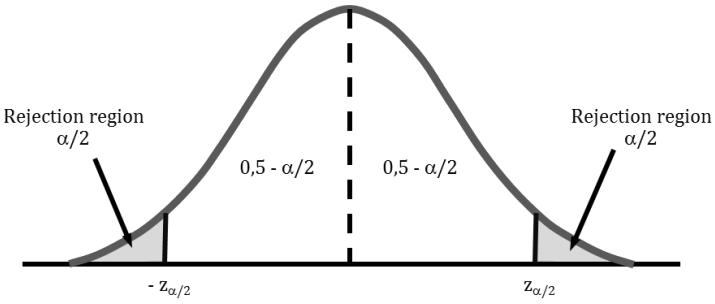
The probability that the test statistic falls into the rejection region (ie a type I error) is given by the level of significance,  $\alpha$ .

**TIP:** the level of significance is usually given as a percentage, eg 5%. A good idea is to immediately change this to a probability, eg 0.05, so as to make it easier to calculate or look up critical values.

- **Determine the rejection region and formulate the rejection rule**

(This step includes establishing the critical value about which the hypothesis value is tested.)

The rejection region is formulated from the alternative hypothesis (if the alternative hypothesis holds true, then the null hypothesis is rejected), using the level of significance.

Alternative hypothesis sign	Type of test	Rejection region
$<>$ , ie $\neq$	<p>Two-tailed</p> <p>Important note: the level of significance is divided between the two tails</p>	

<	One-tailed to the left	
>	One-tailed to the right	

The critical z-value is determined from the standard normal tables, eg if the test is one-tailed to the right and  $\alpha = 0.05$ :

$$P(0 - z) = 0.45 \text{ therefore } z = 1.645$$

The **rejection rule** is the decision rule for rejecting the null hypothesis and is formulated in line with the rejection region. The rejection rule will read as:

**Reject  $H_0$  if  $z_{calc} > 1.645$  where  $z_{calc}$  is the calculated sample test statistic**

- Calculate the sample test statistic

The sample test statistic is calculated using the sample data gathered. The formula used depends on the hypothesis approach:

Approach	Formula
Single population mean	$z_{calc} = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$
Single population proportion	$z_{calc} = \frac{p - \pi}{\sqrt{\frac{\pi(1 - \pi)}{n}}}$

Approach	Formula
<b>Comparison of two population means</b>	$z_{calc} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$
<b>Comparison of two population proportions</b>	$z_{calc} = \frac{p_a - p_b}{\sqrt{(p \times q) \left( \frac{1}{n_a} + \frac{1}{n_b} \right)}}$ where: $p = \frac{n_a p_a + n_b p_b}{n_a + n_b}$ $q = 1 - p$
<b>Multiple comparisons – see section 6.5</b>	$\chi^2_{calc} = \sum \frac{(f_o - f_e)^2}{f_e}$

**TIP:** The numerator of the hypothesis test statistic formula aligns with the hypothesis approach and the null hypothesis.

- **Apply the rejection rule to the sample test statistic**

Once the test statistic has been calculated, the rejection rule can be applied to see whether the test statistic value relative to the critical value will result in the null hypothesis being rejected or not.

- **Draw a conclusion, both statistically and from a management perspective (ie in English)**

The results of the test are interpreted and a conclusion relating to the claim is drawn.

### **EXAMPLE**

A statistical analyst who works for a large insurance company is in the process of examining several pension plans. Because the length of life of pension plan holders is critical to the plans' integrity, the analyst needs to know if the average age has changed. In the last census (2011), suppose the average age of retirees is 67.5 years. To determine whether the average age has increased, the analyst selects a random sample of 100 retirees and finds that  $\bar{x} = 68.2$ . If we assume that the population standard deviation is  $\sigma = 3.1$  can we conclude at a 5% level of significance that the average of retirees has increased since 2011?

The question asks if there is sufficient evidence to conclude that  $\mu$  (the mean age at present) is greater than the mean age in 2011 (67.5).

**Step 1.** Formulate the null and alternative hypotheses

We are dealing with a single population mean.

$$H_0: \mu \leq 67.5$$

$$H_1: \mu > 67.5$$

- Decide on the level of significance

$$\alpha = 0.05$$

- Determine the rejection region and formulate the rejection rule

This is a one-tailed test to the right with  $z_{crit} = 1.645$

*Reject  $H_0$  if  $z_{calc} > 1.645$*

- Calculate the sample test statistic

$$z_{calc} = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{68.2 - 67.5}{\frac{3.1}{\sqrt{100}}} = 2.26$$

- Apply the rejection rule to the sample test statistic.

2.26 is  $> 1.645$

- Draw a conclusion, both statistically and from a management perspective (ie in English).

The null hypothesis is rejected in favour of the alternative hypothesis.

The conclusion then is that the average age is greater than that of 2011 (at a 5% level of significance).



## ACTIVITY

It is important for airlines to know the approximate total weight of baggage carried on each plane. An airline researcher believes that the average baggage weight for each adult is 60 kg.

To test his belief, he draws a random sample of 50 adult passengers and weighs their baggage.

He finds the sample mean to be 57.1 kg. If he knows that the population standard deviation is 10 kg, can he conclude at a 5% significance level that his belief is incorrect?

## SOLUTION TO ACTIVITY

Step 1. Formulate the null and alternative hypotheses

We are dealing with a single population mean.

$$H_0: \mu = 60$$

$$H_1: \mu \neq 60$$

- Decide on the level of significance

$$\alpha = 0.05$$

- Determine the rejection region and formulate the rejection rule

This is a two-tailed test with  $z_{crit} = -1.96$  and  $+1.96$

*Reject  $H_0$  if  $z_{calc} < -1.96$  or  $> 1.96$*

or

*Reject  $H_0$  if  $-1.96 > z_{calc} > 1.96$*

- Calculate the sample test statistic

$$z_{calc} = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{57.1 - 60}{\frac{10}{\sqrt{50}}} = -2.05$$

- Apply the rejection rule to the sample test statistic.

$-2.05 \text{ is } < -1.96$

- Draw a conclusion, both statistically and from a management perspective (ie in English).

The null hypothesis is rejected in favour of the alternative hypothesis.

The conclusion then is that the average baggage weight is not 60 kgs (at a 5% level of significance).

### Z-tests and t-tests

- The z-test is used to determine whether a sample mean differed from a population mean.
- t-tests are used to determine the difference between means in situations where we have to estimate the population standard deviation from sample data.
- Difference between the two tests are that with z-tests the population parameters ( $\sigma$  and  $\mu$ ) are known, however, with t-tests, they are unknown.
- The one-sample t-test uses a similar formula to the z-test, but the standard error is estimated from the sample standard deviation.
- The aim of the t-test is to compare distributions that are normally distributed. We can represent such distributions with a bell curve.
- The t-test formula always has the same general form
- Have the following assumptions:
  - The assumption of normality

- The assumption of homogeneity of variance
- The assumption of independence
- For comparisons involving a population mean or the comparison of two population means where the population standard deviation is unknown, ie the sample size is small  $n \leq 30$  or the sample sizes together are small  $n_1 + n_2 \leq 30$ , the t-distribution using  $t_{crit}$  and  $t_{calc}$  is used. (Theoretically the t-distribution should be used any time the population standard deviation is unknown, but the use is usually limited to the smaller sample sizes, because the z-distribution offers a good approximation for larger sample sizes).

### ***Different types of t-tests***

#### ***1. One-sample t-test***

- Standard error is estimated from the sample standard deviation.

#### ***2. Independent samples t-test***

- Used to compare two distributions that are independent of each other
- Suitable in most situations where you have created two separate groups by random assignment.
- It is not necessary to have equal sample sizes for your samples.
- It is quite important to ensure that the assumption of homogeneity of variance is not violated for this test

#### ***3. Repeated measures t-test***

- used to compare means when the samples are not independent. It is also known as the related samples t-test

Using the t-distribution affects two steps of the hypothesis testing process:

#### **Determine the rejection region and formulate the rejection rule**

From the t-distribution, the critical value is determined using the level of significance,  $\alpha$ , and the degrees of freedom,  $df$ , where for a single population mean,

$$df = n - 1$$

And for the comparison of two population means,

$$df = (n_1 - 1) + (n_2 - 1)$$

The value of  $t_{crit}$  can then be read from the t-table

### Calculate the sample test statistic

To calculate the test statistic for the t-distribution, the formula for a single population mean is:

$$t_{calc} = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$$

The formula for the comparison of two means is:

$$t_{calc} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2} \left( \frac{1}{n_1} + \frac{1}{n_2} \right)}}$$

### EXAMPLE

The desired percentage of silicon dioxide in a certain type of cement is 5. A random sample of 27 specimens give a sample average percentage of 5.21% and a sample standard deviation of 0.38%. Use a 1% level of significance and test whether the sample result indicates a change in the percentage average.

#### Step 1. Formulate the null and alternative hypotheses

We are dealing with a single population mean with a sample size smaller than 30.

$$H_0: \mu = 5$$

$$H_1: \mu \neq 5$$

- Decide on the level of significance

$$\alpha = 0.01 \text{ and } \frac{\alpha}{2} = 0.005$$

- Determine the rejection region and formulate the rejection rule

$$df = 27 - 1 = 26$$

This is a two-tailed test with  $t_{crit} = -2.78$  and  $+2.78$

*Reject  $H_0$  if  $t_{calc} < -2.78$  or  $> 2.78$*

or

*Reject  $H_0$  if  $-2.78 > t_{calc} > 2.78$*

- Calculate the sample test statistic

$$t_{calc} = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}} = \frac{5.21 - 5}{\frac{0.38}{\sqrt{26}}} = 2.82$$

- Apply the rejection rule to the sample test statistic.

2.82 is  $> 2.78$

- Draw a conclusion, both statistically and from a management perspective (ie in English).

The null hypothesis is rejected in favour of the alternative hypothesis.

The conclusion then is that there is a change in the average percentage of silicone dioxide in a certain type of cement (at a 1% level of significance).



### ACTIVITY

A machine is supposed to be adjusted to produce components to a dimension of 2.0 cm. In a sample of 50 components, the mean is found to be 2.001 cm and the standard deviation 0.003 cm. Is there evidence to suggest that the machine is set too high? Use a 5% level of significance.

### SOLUTION TO ACTIVITY

#### Step 1. Formulate the null and alternative hypotheses

We are dealing with a single population mean with a sample size greater than 30.

$$H_0: \mu = 2.0$$

$$H_1: \mu > 2.0$$

- Decide on the level of significance

$$\alpha = 0.05$$

- Determine the rejection region and formulate the rejection rule

This is a one-tailed test to the right with  $z_{crit} = 1.645$

*Reject  $H_0$  if  $z_{calc} > 1.645$*

- Calculate the sample test statistic

$$z_{calc} = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{2.001 - 2.0}{\frac{0.003}{\sqrt{50}}} = 2.36$$

- Apply the rejection rule to the sample test statistic.

$2.36 \text{ is } > 1.645$

- Draw a conclusion, both statistically and from a management perspective (ie in English).

The null hypothesis is rejected in favour of the alternative hypothesis.

The conclusion then is that the machine is set too high (at a 5% level of significance).

### **EXAMPLE**

The management of a mine wishes to investigate the effect of a 4-day workweek on absenteeism. 2 random samples each of size 40 are selected. Employees of group 1 work 10-hour days (4-day week) and group 2 work 8-hour days (5-day week). If group 1 averages 4 hours of absenteeism per week, with a standard deviation of 1.2 and group 2 averages 4.4 hours of absenteeism per week, with a standard deviation of 1.5, should we conclude that the shorter workweek reduces absenteeism at a 5% level of significance?

#### **Step 1. Formulate the null and alternative hypotheses**

We are dealing with the comparison of two population means which together have sample size greater than 30.

$$H_0: \mu_1 \geq \mu_2$$

$$H_1: \mu_1 < \mu_2$$

where  $\mu_1$  is the mean for group 1 and  $\mu_2$  is the mean for group 2.

- Decide on the level of significance.

$$\alpha = 0.05$$

- Determine the rejection region and formulate the rejection rule

This is a one-tailed test to the left with  $z_{crit} = -1.645$

*Reject  $H_0$  if  $z_{calc} < -1.645$*

- Calculate the sample test statistic

$$z_{calc} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} = \frac{4 - 4.4}{\sqrt{\frac{1.2^2}{40} + \frac{1.5^2}{40}}} = -1.32$$

- Apply the rejection rule to the sample test statistic.

$-1.32$  is not  $< -1.645$

- Draw a conclusion, both statistically and from a management perspective (ie in English).

The null hypothesis is not rejected in favour of the alternative hypothesis.

The conclusion then is that the shorter week does not reduce absenteeism (at a 5% level of significance).



### ACTIVITY

In order to determine whether there is a difference in the performance of 2 training methods, samples of individuals from each of the methods are checked. For the 6 individuals from method 1, the mean efficiency score is 35, with a standard deviation of 6. For the 8 individuals from method 2, the mean efficiency score is 27, with a standard deviation of 7. Use a 2% level of significance.

### SOLUTION TO SELF-ASSESSMENT ACTIVITY

#### Step 1. Formulate the null and alternative hypotheses

We are dealing with the comparison of two population means which together have sample size of less than 30.

$$H_0: \mu_1 = \mu_2$$

$$H_1: \mu_1 \neq \mu_2$$

where  $\mu_1$  is the mean for method 1 and  $\mu_2$  is the mean for method 2.

- Decide on the level of significance

$$\alpha = 0.02 \text{ and } \frac{\alpha}{2} = 0.01$$

- Determine the rejection region and formulate the rejection rule

$$df = (6 - 1) + (8 - 1) = 12$$

This is a two-tailed test with  $t_{crit} = -2.68$

Reject  $H_0$  if  $t_{calc} < -2.68$  or  $> 2.68$

- Calculate the sample test statistic

$$t_{calc} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2} \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}} = \frac{35 - 27}{\sqrt{\frac{(6 - 1)6^2 + (8 - 1)7^2}{6 + 8 - 2} \left(\frac{1}{6} + \frac{1}{8}\right)}}} \\ = 2.24$$

- Apply the rejection rule to the sample test statistic.

$2.24$  is not  $> 2.68$

- Draw a conclusion, both statistically and from a management perspective (ie in English).

The null hypothesis is not rejected in favour of the alternative hypothesis.

The conclusion then is that there is no difference between the two training methods (at a 2% level of significance).



### ACTIVITY

Workers in two different mine groups are asked what they consider to be the most important labour-management problem. In group A, 200 out of a random sample of 400 workers feel that fair adjustment of grievances is the most important problem. In group B, 60 out of a random sample of 100 workers feel that this is the most important problem. Would you conclude that these 2 groups differ with respect to the proportion of workers who believe that fair adjustment of grievances is the most important problem? Test at a 10% level of significance.

### SOLUTION TO ACTIVITY

#### Step 1. Formulate the null and alternative hypotheses

We are dealing with the comparison of two population proportions.

$$H_0: \pi_a = \pi_b$$

$$H_1: \pi_a <> \pi_b$$

where  $\pi_a$  is the mean for group A and  $\pi_b$  is the mean for group B.

- Decide on the level of significance

$$\alpha = 0.10 \text{ and } \frac{\alpha}{2} = 0.05$$

- Determine the rejection region and formulate the rejection rule

This is a two-tailed test with  $z_{crit} = -1.645$  and  $1.645$

*Reject  $H_0$  if  $z_{calc} < -1.645$  or  $> 1.645$*

- Calculate the sample test statistic

$$z_{calc} = \frac{p_a - p_b}{\sqrt{(p \times q) \left( \frac{1}{n_a} + \frac{1}{n_b} \right)}}$$

where:

$$p = \frac{n_a p_a + n_b p_b}{n_a + n_b}$$

$$q = 1 - p$$

Calculating:

$$p_a = \frac{200}{400} = 0.5 \text{ and } p_b = \frac{60}{100} = 0.6$$

$$p = \frac{n_a p_a + n_b p_b}{n_a + n_b} = \frac{400 \times 0.5 + 100 \times 0.6}{400 + 100} = 0.52$$

$$q = 1 - p = 1 - 0.52 = 0.48$$

$$z_{calc} = \frac{p_a - p_b}{\sqrt{(p \times q) \left( \frac{1}{n_a} + \frac{1}{n_b} \right)}} = \frac{0.5 - 0.6}{\sqrt{(0.52 \times 0.48) \left( \frac{1}{400} + \frac{1}{100} \right)}} = -1.79$$

- Apply the rejection rule to the sample test statistic.

$$-1.79 \text{ is } < -1.645$$

- Draw a conclusion, both statistically and from a management perspective (ie in English).

The null hypothesis is rejected in favour of the alternative hypothesis.

The conclusion then is that the two groups do differ in their beliefs (at a 5% level of significance).

**SPSS Output****Independent Samples Test**

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Time_taken	Equal variances assumed	.058	.816	1.401	8	.199	4.60000	3.28329	-2.97128
				1.401	7.315	.202	4.60000	3.28329	12.29658

You can see from the table above that there is no significant difference in the time taken between males and females, as the column that says Sig (2-tailed) is  $> 0.05$ . We are going to assume homogeneity of variance, so you would report your findings using these statistics:  $t(8) = 1.401$ ,  $p = 0.199$ .

**ANOVA**

- **ANOVA** is used to test for differences between the means of more than two groups
- Allows us to test the difference between more than two groups of subjects and the influence of more than one independent variable
- Because we are examining a set of possible differences, instead of testing for a *difference* between two means, we test for an *effect*.
- A significant effect is present in the data when at least one of the possible comparisons between group means is significant.

### How does it work?

- As the name suggests, the procedure involves analysing variance.
- Variance is a measure of the dispersion in a set of scores, and is calculated by determining the ‘average distance’ of a set of scores from its ‘centre’ or mean, by the formula:
- In ANOVA terminology, the independent variables are called *factors*.
- Instead of talking about variance, in ANOVA terminology we talk about *Mean Squares* (abbreviated to MS).
- This is essentially what variance is – the mean or average of the sum of squared differences between each score in a set of scores and the mean of those scores.
- ANOVA we need to distinguish between, and estimate, two different types of variance – *random/error variance*, and *systematic variance*.

### Error variance and systematic variance

- Error variance random or unexplained variance between the means of samples drawn from the same population.
- variance between sample means is unexplained, random variance, and is also commonly known as error variance
- Systematic variance is the variance in a set of scores that we can explain in terms of the independent variable.

The whole aim of computing ANOVA is to determine whether there is *systematic variance* present. If there is systematic variance present in a dataset, we have a significant effect.

### Detecting systematic variance

- To determine whether or not there is systematic variance present in a dataset, we have to follow a rather indirect path by comparing the variance *within* the groups to the variance *between* the groups.

**Table 14.3** Two datasets for aggression scores in three TV violence conditions

Dataset 1			Dataset 2		
Non-violent	Kung Fu	Domestic violence	Non-violent	Kung Fu	Domestic violence
3	2	7	2	5	9
9	8	4	2	3	7
2	7	1	1	3	9
5	1	9	3	4	8
1	4	3	1	6	5
$\bar{x} = 4$	$\bar{x} = 4.4$	$\bar{x} = 4.8$	$\bar{x} = 1.8$	$\bar{x} = 4.2$	$\bar{x} = 7.6$

**Source: Tredoux and Durrheim, 2002: 260**

If you compare the distribution of scores within the cells of Dataset 2 with the differences between the means, you will note a very different pattern.

- Little variance within the cells (look at the range of scores within each cell), but there are large differences between the cell means.
- Here it appears as though there may be systematic differences between the groups, since, although there is error variance present, it appears to be relatively small in comparison with the differences between the group means.

It is quite likely that a significant effect would be found for this pattern of data since the difference in group means is large in comparison with the error variance between individual scores within the groups.

This is a situation where the null hypothesis,  $H_0: \mu 1 = \mu 2 = \mu 3$ , is very likely to be false.

- If the variance between the group means (error variance + systematic variance) is much greater than the variance within the cells (error variance), then this must be due to the presence of systematic variance
- In technical language, the variance within the cells is known as MSError - estimate of error variance.
- The variance between the groups is known as MSGroup - estimate of error variance plus systematic variance.
- To determine whether an effect is present in an ANOVA, we should estimate mathematically the size of MSGroup and MSError, and then compare them. To the extent that MSGroup (error variance + systematic variance) is larger than MSError (error variance), it is likely that there is a significant effect.

### ***Post-hoc tests***

- Useful for determining precisely where the differences between the means lie
- Tukey's Honestly Significantly Difference test (HSD):
  - The HSD statistic is a critical range applied to pairwise comparisons between groups. What this means is that if any of the differences between the group means is greater than this critical range, we can conclude that there are significant differences between these groups.

### ***ANOVA in SPSS***

To determine if there is a significant difference in stress levels, and the subject student is studying.

## ANOVA

Stress\_Levels

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2466.600	2	1233.300	111.855	.000
Within Groups	297.700	27	11.026		
Total	2764.300	29			

Sig. < 0.05, therefore, findings are significant. One can conclude that there is a significant difference in stress levels, and subject student is studying ( $F(2, 27) = 111.855, p < 0.0001$ ).

### Post Hoc Tests

#### Multiple Comparisons

Dependent Variable: Stress\_Levels

Tukey HSD

(I) Subject	(J) Subject	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Statistics	Management	-10.50000*	1.48499	.000	-14.1819	-6.8181
	HR	-22.20000*	1.48499	.000	-25.8819	-18.5181
Management	Statistics	10.50000*	1.48499	.000	6.8181	14.1819
	HR	-11.70000*	1.48499	.000	-15.3819	-8.0181
HR	Statistics	22.20000*	1.48499	.000	18.5181	25.8819
	Management	11.70000*	1.48499	.000	8.0181	15.3819

\*. The mean difference is significant at the 0.05 level.

There is a significant difference in the means of student stress levels between the subjects Statistics and Management subjects ( $p < 0.0001$ ), Statistics and HR ( $p < 0.0001$ ). There were also significant differences in stress levels between Management and HR ( $p < 0.0001$ ).

### One-Way MANOVA

**Step 2.** Multivariate analysis of variance (MANOVA) is simply an ANOVA with several dependent variables.

**Step 3.** ANOVA tests for the difference in means between two or more groups, whereas MANOVA tests for the difference in two or more vectors of means.

**SPSS Output:**

**Between-Subjects Factors**

		Value Label	N
Gender	1.00	Male	5
	2.00	Female	5
Years_of_Experience	1.00	0-3 years	2
	2.00	4 - 7 years	2
	3.00	8-11 years	3
	4.00	12-15 years	3

**Multivariate Tests<sup>a</sup>**

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.992	84.495 <sup>b</sup>	3.000	2.000	.012
	Wilks' Lambda	.008	84.495 <sup>b</sup>	3.000	2.000	.012
	Hotelling's Trace	126.743	84.495 <sup>b</sup>	3.000	2.000	.012
	Roy's Largest Root	126.743	84.495 <sup>b</sup>	3.000	2.000	.012
Gender	Pillai's Trace	.769	2.224 <sup>b</sup>	3.000	2.000	.325
	Wilks' Lambda	.231	2.224 <sup>b</sup>	3.000	2.000	.325
	Hotelling's Trace	3.336	2.224 <sup>b</sup>	3.000	2.000	.325
	Roy's Largest Root	3.336	2.224 <sup>b</sup>	3.000	2.000	.325
Years_of_Experience	Pillai's Trace	.955	.622	9.000	12.000	.758
	Wilks' Lambda	.191	.544	9.000	5.018	.799
	Hotelling's Trace	3.507	.260	9.000	2.000	.938
	Roy's Largest Root	3.291	4.388 <sup>c</sup>	3.000	4.000	.094
Gender	* Pillai's Trace	.414	.471 <sup>b</sup>	3.000	2.000	.733
Years_of_Experience	Wilks' Lambda	.586	.471 <sup>b</sup>	3.000	2.000	.733
	Hotelling's Trace	.707	.471 <sup>b</sup>	3.000	2.000	.733
	Roy's Largest Root	.707	.471 <sup>b</sup>	3.000	2.000	.733

a. Design: Intercept + Gender + Years\_of\_Experience + Gender \* Years\_of\_Experience

b. Exact statistic

c. The statistic is an upper bound on F that yields a lower bound on the significance level.

The Multivariate Tests table is where we find the actual result of the one-way MANOVA. You need to look at the second Effect, labelled "School", and the Wilks' Lambda row (highlighted in table above). To determine whether the one-way MANOVA was statistically significant you need to look at the "Sig." column.

We can see from the table that we have a "Sig." value of > 0.05, therefore, we can conclude that both gender and years of experience did not significantly impact on the speed with which the test was completed.

### Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Time_taken1	90.833 <sup>a</sup>	5	18.167	.409	.823
	Time_taken2	63.100 <sup>b</sup>	5	12.620	.570	.725
	Time_taken3	70.233 <sup>c</sup>	5	14.047	.424	.814
Intercept	Time_taken1	4455.360	1	4455.360	100.308	.001
	Time_taken2	3620.512	1	3620.512	163.639	.000
	Time_taken3	3192.744	1	3192.744	96.264	.001
Gender	Time_taken1	31.500	1	31.500	.709	.447
	Time_taken2	31.500	1	31.500	1.424	.299
	Time_taken3	14.000	1	14.000	.422	.551
Years_of_Experience	Time_taken1	37.258	3	12.419	.280	.838
	Time_taken2	14.292	3	4.764	.215	.881
	Time_taken3	16.658	3	5.553	.167	.913
Gender	* Time_taken1	.643	1	.643	.014	.910
Years_of_Experience	Time_taken2	.643	1	.643	.029	.873
	Time_taken3	.286	1	.286	.009	.931
Error	Time_taken1	177.667	4	44.417		
	Time_taken2	88.500	4	22.125		
	Time_taken3	132.667	4	33.167		
Total	Time_taken1	5331.000	10			
	Time_taken2	4232.000	10			
	Time_taken3	3775.000	10			
Corrected Total	Time_taken1	268.500	9			
	Time_taken2	151.600	9			
	Time_taken3	202.900	9			

a. R Squared = .338 (Adjusted R Squared = -.489)

b. R Squared = .416 (Adjusted R Squared = -.313)

c. R Squared = .346 (Adjusted R Squared = -.471)

### ***Factorial analysis of variance***

- Used for research designs that have more than one independent variable.

### **Why use factorial designs?**

Factorial designs are preferable to one-way designs for three related reasons:

1. They are realistic, capturing the complexity of social and psychological phenomena.
2. They allow us to analyse interactions between variables.
3. They are economical, allowing many hypotheses to be tested simultaneously.

### ***Assumptions***

#### Normality

- The populations represented by the data should be normally distributed, making the mean an appropriate measure of central tendency.
- Estimate the distribution of the parent populations from the data at hand. When we have small cell numbers, therefore, we should tolerate deviations from normality, appreciating that our estimates are unreliable.
- In addition, ANOVA is a robust statistical procedure: the assumption of normality can be violated with relatively minor effects. Nevertheless, ANOVA is inappropriate in situations where you have unequal cell sizes and distributions skewed in different directions.

#### Homogeneity of variance

- The populations from which the data are sampled should have the same variance. With balanced designs (i.e. equal numbers of subjects per cell) this assumption can be violated without major effects on the final results.

**SPSS Output:****Between-Subjects Factors**

		Value Label	N
Subject	1.00	Statistics	10
	2.00	Management	10
Time	1.00		10
	6.00		10

**Tests of Between-Subjects Effects**

Dependent Variable: Stress\_level

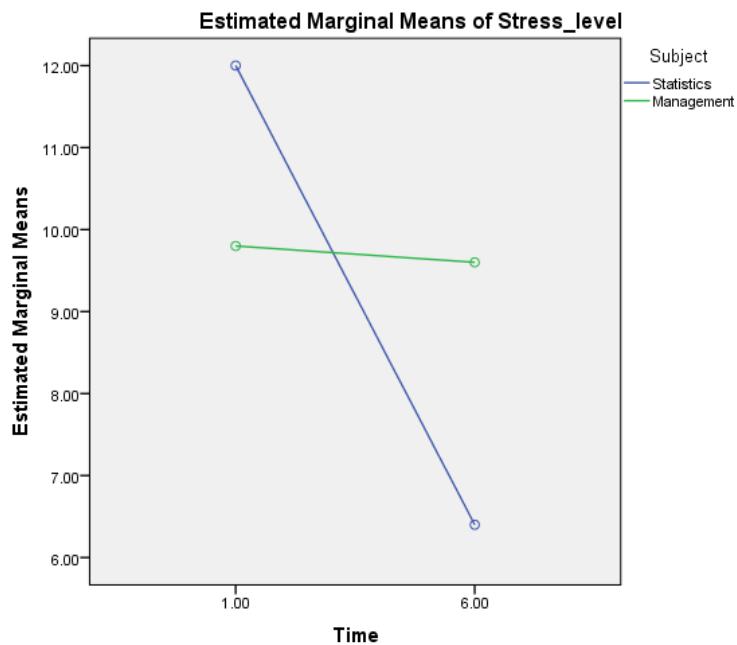
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	79.750 <sup>a</sup>	3	26.583	3.692	.034
Intercept	1786.050	1	1786.050	248.063	.000
Subject	1.250	1	1.250	.174	.682
Time	42.050	1	42.050	5.840	.028
Subject * Time	36.450	1	36.450	5.063	.039
Error	115.200	16	7.200		
Total	1981.000	20			
Corrected Total	194.950	19			

a. R Squared = .409 (Adjusted R Squared = .298)

From “subject” in the second table, the p-value for the main effect of field of study is 0.682 and therefore the effect of field of study is not significant. We can conclude that on average, the stress levels of management students and statistics students are the same.

From “time”, the p-value for proximity is 0.028; we can therefore conclude that the main effect of proximity is significant. From C, the p-value for the interaction is 0.039; the interaction is significant and we can conclude that the effect of the remaining time until exams (in weeks) on stress levels for management students and statistics students are not the same.

## Profile Plots



The interaction plot above suggests that as the final exam approaches, the stress level of statistics students soars but that of management students remains roughly much the same.

Again – when the assumptions of normality and homogeneity of variance have not been met – we need to start looking at equivalent tests that do not rely on the requirements underlying normal distributions, and that require homogeneity of variance. These kinds of tests are known as non-parametric tests.

## Non-Parametric tests

### ***Mann-Whitney U-test***

- Perhaps the most common distribution-free test for differences between unrelated samples
- Used for research designs similar to those for which the independent samples *t*-test is used
- This means that it can be used whenever you have two groups of scores that are independent of each other

## SPSS Output

### Test Statistics<sup>a</sup>

	Time_taken
Mann-Whitney U	6.500
Wilcoxon W	21.500
Z	-1.261
Asymp. Sig. (2-tailed)	.207
Exact Sig. [2*(1-tailed Sig.)]	.222 <sup>b</sup>

a. Grouping Variable: Gender

b. Not corrected for ties.

You can see that Sig is  $> 0.05$  in both Asymp and Exact Sig, which means that there is no significant difference in time taken, based on respondents gender. You report your findings as:  $U = 6.500$ ,  $p = 0.207$ .

### Kruskal-Wallis test

- Test the difference between three or more groups in much the same way as ANOVA does in parametric statistical procedures
- Extension of the Mann-Whitney U-test for three or more independent samples
- Omnibus test for the equality of independent population medians

## SPSS Output:

### Test Statistics<sup>a,b</sup>

	Experience	Time_taken
Chi-Square	2.470	1.590
df	1	1
Asymp. Sig.	.116	.207

a. Kruskal Wallis Test

b. Grouping Variable: Gender

The difference between Mann-Whitney and Kruskal-Wallis is that you can include more than two DV's in your test, as you can see in this case we looked if there was any significant difference in both experience, and time taken between each gender. You can see that Sig is  $> 0.05$ , which means that

there is no significant difference in time taken, based on respondents gender. You report your findings for experience as:  $H(1) = 2.470$ ,  $p = 0.116$ , and Time Taken as:  $H(1) = 1.590$ ,  $p = 0.207$ .

### **Related Samples: The sign test**

- Related samples occur when the same group of people is measured more than once, such as in 'before and after' research designs.
- Non-parametric equivalent of related samples *t*-test
- Considers the difference between two related samples

### **SPSS Output:**

#### **Frequencies**

		N
Time_taken2	- Negative Differences <sup>a</sup>	8
Time_taken1	Positive Differences <sup>b</sup>	0
	Ties <sup>c</sup>	2
	Total	10

a.  $\text{Time\_taken2} < \text{Time\_taken1}$

b.  $\text{Time\_taken2} > \text{Time\_taken1}$

c.  $\text{Time\_taken2} = \text{Time\_taken1}$

You can see how many participants decreased (the "Negative Differences" row), improved (the "Positive Differences" row) or witnessed no change (the "Ties" row) in their performance between the two trials.

#### **Test Statistics<sup>a</sup>**

	Time_taken2 -
	Time_taken1
Exact Sig. (2-tailed)	.008 <sup>b</sup>

a. Sign Test

b. Binomial distribution used.

The statistical significance of the sign test is found in the "Exact Sig. (2-tailed)" row of the table above. However, if you had more than a total of 25 positive and negative differences, an "Asymp. Sig. (2-sided test)" row will be displayed instead. You report your findings as:

An exact sign test was used to compare the differences in the speed with which in the two trials were completed. The respondents elicited a statistically significant median decrease in time between the two tests ( $p = 0.008$ ).

### **Related samples: The Wilcoxon matched pairs test**

- Similar to the sign test except that when we have obtained the difference scores between the two samples we must rank-order the differences, ignoring the sign of the difference
- Tests whether two related samples have the same median
- More powerful than the sign test.

### **SPSS Output:**

#### **Ranks**

		N	Mean Rank	Sum of Ranks
Time_taken2	- Negative Ranks	8 <sup>a</sup>	4.50	36.00
Time_taken1	Positive Ranks	0 <sup>b</sup>	.00	.00
	Ties	2 <sup>c</sup>		
	Total	10		

a. Time\_taken2 < Time\_taken1

b. Time\_taken2 > Time\_taken1

c. Time\_taken2 = Time\_taken1

The Ranks table provides some interesting data on the comparison of participants' Before (Pre) and After (Post) speed at which they completed the test's score. We can see from the table's legend that 8 participants had a higher pre-intervention time than after the intervention. And 0 participants had a higher time post the intervention, whilst 2 participants saw no change in their time taken.

#### **Test Statistics<sup>a</sup>**

	Time_taken2 - Time_taken1
Z	-2.536 <sup>b</sup>
Asymp. Sig. (2-tailed)	.011

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

We report it as follows:

The Wilcoxon signed-rank test revealed that the intervention yielded a statistically significant difference in the time taken to complete the test ( $Z = -2.536$ ,  $p = 0.011$ ).

### **Friedman rank test for related samples**

- Friedman test is an extension of the Wilcoxon test for three or more related samples
- Analogue of one-way repeated measures analysis of variance
- It is used for the analysis of within-subjects designs where more than two conditions are being compared
- In general, the degrees of freedom for an estimate is equal to the number of values minus the number of parameters estimated *en route* to the estimate in question

### **SPSS Output:**

#### **Descriptive Statistics**

	N	Mean	Std. Deviation	Minimum	Maximum	Percentiles		
						25th	50th (Median)	75th
Time_taken1	10	22.5000	5.46199	15.00	30.00	18.2500	21.0000	27.7500
Time_taken2	10	20.2000	4.10420	15.00	28.00	16.5000	20.5000	22.5000
Time_taken3	10	18.9000	4.74810	12.00	29.00	15.0000	18.0000	22.0000

#### **Ranks**

	Mean Rank
Time_taken1	2.90
Time_taken2	1.85
Time_taken3	1.25

The Friedman test compares the mean ranks between the related groups and indicates how the groups differed, and it is included for this reason. However, you are not very likely to actually report these values in your results section, but most likely will report the median value for each related group.

**Test Statistics<sup>a</sup>**

N	10
Chi-Square	15.943
df	2
Asymp. Sig.	.000

a. Friedman Test

If you look at the contents of this table – you can see that Sig. is significant ( $< 0.05$ ), therefore there is a significant difference in the amount of time taken to complete the three tests ( $\chi^2 (2) = 15.943$ ,  $p < 0.0001$ ).

**Data Analysis And Reporting Findings: Some considerations**

- Check data for missing values and errors.
- Simple errors:
  - Labelling e.g. male = 1, female = 2, but there is a value 4 – doesn't fit.
  - Force format in MS packages e.g. force dates into dd/mm/yyyy format.
  - If-then checks e.g. if male, can't be pregnant
- Missing Values:
  - Can return to source and retrieve information
  - Drop the case for analysis, either entirely, or just on that attribute
- Create a value for 'missing data'
  - If missing data is substantial, and it cannot be shown that the respondents and non-respondents are not similar on attributes, population parameter estimates based on this sample may be viewed suspiciously.
  - Understanding your data
    - Get a feel for your data, one of the best ways to do this is to represent it graphically. Some graphic representations of your data are particularly resistant to pitfalls in your data e.g. stem and leaf plot, box and whiskers plot.

***Experimental control***

Sometimes there are certain variables and events that impact on the outcomes in your data – to create "differences", "associations", "correlations" and so forth, where there aren't any statistically significant relationships between variables.

### **Extraneous variables**

These are external and uncontrolled variables that impact on a relationship. These interfere in multiple ways:

- Where the change in the DV is attributable to a variable other than the IV (third variable problem)
- Results are “confounded” by interactions between the DV’s
- Additional variables outside of the “experiment” enter the experimental condition, and impact on the results

### **Confounding or “third” variables**

This is where a third variable could be accountable for the observed relationship between two variables. For example, the relationship between cigarette smoking and lung cancer is well documented. However, this relationship could be confounded by a third variable – let’s say the additional carcinogens in the environment that they are exposed to when they go outside to smoke. So whereas it seems that smoking causes cancer – it’s actually the carcinogens in the external environment causing/contributing to lung cancer incidence. This “third variable” can **moderate** or **mediate** these relationships:

- **Moderator variables** - Moderator variables impact the strength of the relationship between two variables.
- **Mediator variables** - This occurs when the variables affect each other.

This is why it is important to assert **control**.

One asserts control when you set up, and describe the conditions for an experiment, such that it acts as a baseline against which the experimental manipulation will be compared and evaluated. Here the experimenter attempts to hold all other variables constant in effort to observe only those changes in the DV and IV. And in those instances where he cannot hold them constant – he will measure their effect.

### **Make sure your data answers your research questions!!**

Just remember when you are reporting your data, be frank about uncertainty in findings, errors in measurements used, sampling bias, errors in data entry and processing, and ultimately how all these errors could have influenced the findings of the study, and to what extent.

## What makes a good study?

### **Quantitative Studies**

There are two measures of quality in Quantitative studies, these being, reliability and validity. Not only would you, as an MBA student be required to understand, theoretically, the concepts, but apply them to your study too.

#### **Reliability**

Reliability refers to the extent to which your instrument repeatedly measures what it should. In other words, it measures consistency, and repeatability.

#### **Validity**

Validity refers to whether or not your instrument measures what it is supposed to measure. In other words, it measures strength and accuracy of a research design (Stivastava and Rego, 2011). For example, if the test claims to measure shyness, whereas in fact it actually measures happiness, then your test is not valid.

If we were to represent the concepts visually – they would look a little like this:



by [Experiment-Resources.com](http://Experiment-Resources.com)

As you can see from the above figure, reliability refers to how consistently the survey/questionnaire measures a construct, regardless of what it is measuring. Validity on the other hand refers to whether the survey/questionnaire accurately and actually measures the specific construct of interest it intended to measure.

For example, if I were to stand on a scale, and the scale told me I weighed 83kgs, the next week, I stand on the scale, it tells me that I weigh 80kgs.

Reliability would hold it that the difference in weight means I have managed to lose 3kgs in a week, and that the difference in weight is not attributable to a fault in the scale such that it is measuring my weight inconsistently.

Validity would hold that the scale is measuring what it purports to measure – that is, my weight.

Let's explore the concepts of Reliability and Validity a little further.

***Reliability:***

A test's consistency in measuring a specific construct, or in other words, how repeatable measures are.

Central to validity are three concepts:

**Stability:** If the test is re-administered to the same respondents, will it yield similar results?

Stability is measured through test-retest reliability

**Test-retest reliability:**

- An index of a tests stability over time
- The extent to which results compare when retesting the initial test at later stages

**Equivalence:** Will the test employed by different investigators yield similar results? Tested through multiple forms reliability

**Alternate forms reliability:**

- An index of consistency between different versions of a test

**Parallel forms reliability:**

- The extent to which results compare between two similar tests

**Homogeneity/internal consistency:** Will there be a high degree of correlation between results were the same instrument, with similar operationalisation of the construct? And, will the measure be internally consistent? This type of reliability is best measured through split-half, inter-item, and average inter-item correlations.

**Internal consistency (split half reliability):**

- The extent to which all questions within in test measure the same thing

**Inter-rater reliability:**

- The extent to which different examiners produce similar results with a test
- The extent to which different raters agree when measuring a the phenomenon of interest

Listed in test manuals and expressed as a reliability coefficient ( $r$ )

**Step 4.**  $r$  values range from 0.00 to 1.00

**Step 5.** Higher  $r$  values indicate higher reliability

**Step 6.**  $r$  values should be around .70

***Validity***

The extent to which a test measures what it claims to measure

Revolves around two broad questions:

- What does a test measure?
- How well does it measure it?

Is directly related to the purpose of a test. There are generally speaking, two types of validity.

***Internal validity***

If a study has internal validity, what this implies is that the findings flow directly and unproblematically from its methods.

The confidence with which the Independent Variable is said to bring about changes in the Dependent Variable. To be able to make confident statements regarding the effect of the Independent Variable on Dependent Variable, independently of other extraneous variables, the researcher needs to consider all other plausible explanations that may be impacting on the observed change in the DV.

It is important to note that, because internal validity attempts to ascertain causality, it is not relevant to descriptive, exploratory, or observational studies.

***External Validity***

Refers to the generalizability of results to contexts outside of the study context. Here context includes the population, and operationalized constructs representing measuring of variables.

This is when you should review:

1. Research Participants: look at the population the participants are drawn from – is it representative of all other populations of similar concern? Were appropriate sampling techniques used to ensure representativeness?
2. Independent Variables/Manipulations: are they highly specific or can you generalise them to other operationalisations?
3. Dependent Variables/Outcomes: will DV findings be able to be generalised to other, similar variables?

In general, internal and external validity can be broken up into eight different types/measures of validity. External Validity, or the generalisability of your research findings, refers to the extent to which your findings can be applied to settings superseding that of a controlled environment.

Threats to validity include (Silverstein, 1999):

- **Chance** - Random error attributable to unknown sources of variation in findings, and can be overcome by increasing sample size and performing statistical analyses.
- **Bias** - A systematic error skewing the sample or measure. Overcome by standardising your measurement, training and certifying the observer, refining the instrument, automating instruments and blinded measures.
- **Confounding variables** - An external influence that confounds the relationship between the predictor and outcome variable. Overcome by identifying and measuring potential confounding variables, and performing a multivariate analysis.

According to Bornheimer *et al.* (2008), Validity in quantitative studies can be achieved by using measurements, scores, instruments and rigorous research design, and reliability by assumption of repeatability.

## 1. Content Validity

- The extent to which the items on a test are representative of the constructs it claims to measure
- In other words, does the tool measure what it says its measuring
- Face validity is a version of content validity
  - How thoroughly are you measuring the desired construct or trait?
  - Does the test measure the domain of interest?
  - Are the test questions appropriate?

- Does the test contain sufficient information to appropriately cover what it is supposed to measure?
- What is the level of mastery at which the content is being assessed?

## 2. Construct Validity

- Is there a degree of congruence between the measure, and the underlying theory
- Should correlate with tests measuring similar constructs

### ***Convergent Validity***

- Measuring the same construct in different ways, and obtaining the same or similar results

### ***Discriminant Validity***

- Where one concept is different from other closely related concepts

## 3. Criterion-Related Validity

- The relationship between test scored and some type of outcome
- Other outcomes can include ratings, classifications, or other test scores
- Measure through concurrent and predictive validity

### ***Concurrent Validity:***

- the extent to which a test is related to other assessments of the same construct that have been proven to be valid
- uses already in existence and well-tested and accepted measures against which test scores can be compared
  - e.g. will a child who earns good grades in math also score highly on a test measuring math skills?

### ***Predictive Validity:***

- the extent to which a test predicts future outcomes on a related criteria
  - e.g. does a reading test given at the start of the school year predict reading performance at the end of the year?

## Factors Affecting Validity

- Overly difficult and complex sentence structure
- Inconsistent and subjective scoring
- Untaught items (achievement tests)

- Failure to follow standardized administration procedures
- Cheating by the participants or someone teaching to the test items

## Qualitative Data Analysis

As previously mentioned – qualitative analysis involves the analysis of language, or otherwise, discourse. It extends beyond just what people say, but taps into non-verbal communication, implied meaning, deeper understandings that individuals hold. Here the participant is the “expert”, and you, the researcher, are the instrument for eliciting meaning. Again, Qualitative analysis tends to be more inductive, and focuses on identifying patterns and relationships during observations, with very limited utilisation of pre-existing theory. Unlike breaking observations into separate, measurable parts, Qualitative research focuses on the whole, and analyses phenomena within context. Therefore, the whole should be understood as being greater than the sum of the parts therefore careful attention should be paid to the social context, thoughts and actions of interactions.

Given such, Qualitative analysis usually extends beyond merely analysing transcripts, taking fieldnotes, Memoing – it is the detailed and intensive process of doing all of them in concert with each other, and continuously as the research unfolds. At all times the researcher is required to be reflexive. Reflexivity refers to the researcher's acknowledgement of their influence over the research process, and how they influenced the emergence of meaning and outcomes.

This means there are stark differences between the qualitative and the quantitative approach (Denzin and Lincoln, 2000; Patton, 2002):

- Step 1.** Focus falls on meaning rather than quantification
- Step 2.** Collect a lot of data from a few cases, rather than a little data from a lot of cases
- Step 3.** Focus is on obtaining depth and detail, none of which are pre-determined
- Step 4.** The researcher themselves is the data collection instrument, rather than administering a questionnaire/survey as a means of data collection
- Step 5.** Focus is on context rather than objective, universal laws that exist outside of the researcher
- Step 6.** Researcher acknowledges their role and influence over the research process, collection of data, and emergence of meaning

Unlike Quantitative analysis which begins once your data has been captured, and entered into a database, Qualitative Data Analysis begins when data collection begins. Unlike the linear, pre-determined and set manner in which quantitative analysis ensues, Qualitative Analysis involves reading, rereading, intuiting, analyzing, synthesizing, and reporting on data. This means the Qualitative analysis process is essentially iterative. There is nothing linear about the manner in which QL analysis unfolds.

In other words, Qualitative analysis is a very non-linear, iterative process. This is known as interim analysis (i.e. the cyclical process of collecting and analyzing data during a single research study). Interim analysis continues until the process or topic the researcher is interested in is understood (or until you run out of time and resources!). Most often, data collection and analysis begins with transcribing , memo taking and analysis.

These are general steps taken to analyse qualitative data, however there are subtle differences in the types of information looked for, and the type of analysis that ensues.

What is key here in analysing your data is the following:

In general, Qualitative Data Analysis goes through the following stages (Taylor-Powell & Renner, 2003: 2):

### **Step 1: Get to know your data**

You need to understand the data in order to perform a good analysis. This means you need to repeatedly re-read transcripts, listen to tape recordings repeatedly, write down ideas and impressions as you do so.

### **Step 2: Focus the analysis**

You need to keep in mind, at all times, the questions you wish to answer to ensure that you do no veer off track. Once you have key questions you wish to answer written down, it should indicate where to start.

These original questions are likely to change as you deal with data, and come to grapple with meaning.

### **Step 3: Categorise information**

Read, and re-read the information, and identify coherent categories/themes. Here meaning is given by identifying themes or patterns, and organising them into coherent categories.

You can code by using abbreviated letters, or words, or symbols, and placing them next to the themes and ideas that emerge. By doing this, you are organising data into categories/themes.

Each category/theme must then be given a descriptive label, or name.

### **Step 4: Identify patterns and connections between categories/themes**

As you categorise data, you will start to identify emergent patterns within and between the categories/theme. You can summarise all of the information pertaining to a theme, highlighting consistencies, or differences in how people have provided their answers pertaining to that theme. You may also start to see that two or more themes may occur together throughout the text.

### **Step 5: Interpretation**

Use the themes you have identified in your data, together with the relationships between them.

Interpretation occurs when we attach meaning, and significance to the analysis.

## Transcriptions and Memos

### Transcriptions

- Qualitative researchers usually transcribe their data; that is, they type the text (from interviews, observational notes, memos, etc.) into word processing documents

The Jefferson Transcription System	
The transcription system uses standard punctuation marks (comma, stop, question mark); however, in the system they mark intonation rather than syntax. Arrows are used to mark intonation rather than syntax. Arrows are used to mark intonation rather than syntax.	
[ ]	Square brackets mark the start and end of overlapping speech. They are aligned to mark the precise position of overlap as closely as possible.
-	Vertical arrows precede marked pitch movement, over and above normal rhythms of speech. They are used for notable changes in intonation.
®	Side arrows are used to draw attention to features of talk that are relevant to the current analysis.
Underlining	indicates emphasis; the extent of underlining within individual words locates emphasis and also indicates how heavy it is.
CAPITALS	mark speech that is hearably louder than surrounding speech. This is beyond the increase in volume that comes as a by-product of speaking louder.
'I know it.'	'degree' signs enclose hearably quieter speech.
that's r*ight.	Asterisks precede a 'squeaky' vocal delivery.
(0.4)	Numbers in round brackets measure pauses in seconds (in this case, 4 tenths of a second). If they are not part of a particular symbol, they indicate a pause between turns.
(.)	A micropause, hearable but too short to measure.
((stocatto))	Additional comments from the transcriber, e.g. about features of context or delivery.
she wa:nited	Colons show degrees of elongation of the prior sound; the more colons, the more elongation.
hhh	Aspiration (out-breaths); proportionally as for colons.
.hhh	Inspiration (in-breaths); proportionally as for colons.
Yeh,	'Continuation' marker, speaker has not finished; marked by fall-rise or weak rising intonation, as when delivering a list.
y'know?	Question marks signal stronger, 'questioning' intonation, irrespective of grammar.
Yeh.	Full stops mark falling, stopping intonation ('final contour'), irrespective of grammar, and not necessarily followed by a pause.
bu-u-	hyphens mark a cut-off of the preceding sound.
>he said<	'greater than' and 'lesser than' signs enclose speeded-up talk. Occasionally they are used the other way round for slower talk.
solid.=We had	'Equals' signs mark the immediate 'latching' of successive talk, whether of one or more speakers, with no interval.
heh heh	Voiced laughter. Can have other symbols added, such as underlinings, pitch movement, extra aspiration, etc.
sto(h)p i(h)t	Laughter within speech is signalled by h's in round brackets.
Additional notation for crying and similar 'emotional expression'	
Hepburn, A. (2004). Crying: Notes on description, transcription and interaction. <i>Research on Language and Social Interaction</i> , 37, 251-290.	
``help''	Whispering – enclosed by double degree signs.
.shih	Wet sniff.
skuh	Snorty sniff.
~grandson~	Wobbly voice – enclosed by tildes.
	Very high pitch – represented by one or more upward arrows.
k(hh)ay	Aspiration in speech – an 'h' represents aspiration: in parenthesis indicates a sharper more plosive sound.
hhhelp	outside parenthesis indicates a softer more breathy sound.
Huhh .huh	Sobbing – combinations of 'hhs', some with full stops before them to indicate inhaled rather than exhaled, many have voiced vowels.
Hhuyuhh	some also have voiced consonants.
>hhuh<	If sharply inhaled or exhaled enclosed in the 'greater than/less than' symbols (> <).
Mm.. hh (3.5)	Silence – numbers in parentheses represent silence in tenths of a second.

Transcriptions are analysed

### An example

Here is an excerpt provided by Alexa Hepburn (2004: 252):

1. AD Two twelve year old girls
- 1 Caller 2: Um::
- 2 (0.6)
- 3 Yeah I'm ok(h)ay.
- 4 CPO: Y'okayab't- al:right then.
- 5 (0.1)
- 6 .HHH so::=um:: (0.1) okay.=so ↑Kathryn was
- 7 just sayinabou::t
- 8 (0.2)
- 9 [ye know th-]
- 10 Caller 2: [ AHH HH]Hk ↑↑iuHHhh ↑uhh
- 11 (.)
- 12 ↑↑I ↑↑ca(h)n't ↑↑ta(hh)lk.
- 13 (1.2)
- 14 Caller 1: Hello:?
- 15 CPO: Hello::?
- 16 Caller 1: I'm sorry she's just li:ke>broke out in
- 17 tears< she can't spea:k.
- 18 CPO: Right.

### ***Memoing***

- recording reflective notes about what you are learning from your data
- should occur throughout the entire process of qualitative data analysis
- write memos to yourself when you have ideas and insights and to include those memos as additional data to be analysed

Once you have captured your data through the use of transcriptions, you then move onto coding.

### ***How to derive meaning***

After the data has been textually captured through transcription, segmenting, and coding ensues.

#### ***Segmenting:***

- Divide data into meaningful analytical units

#### ***Coding:***

- It is a means by which a qualitative researcher organises his or her data into categories, represented by codes.
- Process of marking segments of data with symbols, descriptive words, or category names

- Coding helps the researcher to make sense of the data
- One of the main processes used to analyse qualitative data
- To discover concepts within the data
- When you locate meaningful segments, you code them
- Keep a master list (i.e., a list of all the codes that are developed and used in the research study)
- Codes are reapplied to new segments of data

There are three types of coding (Wiersma, 1995: 217):

- Setting or context codes – codes relating to describing the setting, and context under which the phenomenon is described
- Perception Codes – relate to the subjects perception, understanding about particular phenomena
- Process Codes- these describe factors leading to change

There are different ways in which you can analyse your data. The method chosen is determined largely by the assumptions, and objectives aimed to be achieved through the research as each type of analysis produces different analyses as they focus on different aspects of written data.

### ***Interpretation***

***Identifying the core meaning of the data, remaining faithful to the perspectives of the study participants but with wider social and theoretical relevance***

- Search for core meanings of thoughts, feelings, and behaviours described
- Overall interpretation
  - Identify how themes relate to each other
  - Explain how study questions are answered

Herewith is an example of a “typical” qualitative write-up:

### **Example**

#### **4.2.1 Driving force for change: Technology**

##### **4.2.1.1 Technology both drives and enables organizational change**

In an attempt to highlight technology as a driver of organizational change, Nelson and Quick (2009:515) elaborate that technological innovations bring about profound change because they are not just changes in the way work is performed, but instead, the innovation process promotes associated changes in work relationships and organizational structures. The foregoing is supported by the respondents as reflected by their respective reactions to whether technology can be regarded as a force for change in the media industry.

Respondent 1(an African male, a member of Newspaper X managerial team with 12 years of experience in the editorial department):

Respondent 1:

"Yes, as I said, newspapers have always been made to react to technology like radio, television and now, of course, the internet. But, ja [Pause] I have to admit that the internet is touching the newspaper industry in ways that it has never been touched by other technology like errr... radio and television."

From the statements of respondent 1 it emerges that the activities of a business organization are continually subjected to the advances in technology. The different technologies that continually emerge appear to have pertinence to different industries, and accordingly, drive such industries to change. This is simply to say, for example, that an invention such as radiology has pertinence to the health industry, and therefore, influences such an industry to change. Also, an invention such as the internet has pertinence to the media industry, and likewise, drives the industry to adapt in some way.

It appears that the technological innovations that the world witnesses, increasingly change in their usefulness and, as a result, increasingly drive business organizations to change. Apparently, in the business landscape, the significance of a previous technological innovation is lessened by the present innovation, a reality that not only suggests continual change but advancing change. Respondent 1 noted the heightened intensity of the internet compared to the previous technologies that acted as the drivers of change to the newspaper industry. It appears that the newspaper industry and Newspaper X specifically, is continually driven to make incremental changes as dictated by the technological advances of pertinence to the industry.

As emphasized by Martin (2006:308), the rate of recent technological progress, the ubiquity of information and communications technologies (ICT) at most workplaces and the emerging cluster of related technologies to which ICT has helped give birth, promises to transform most economies and businesses. In fact Respondent 2, an African female representing the marketing department in the company's managerial team with 13 years of experience, endorses the idea of technology as a trigger of organizational change. Reacting to whether technology influences organizational change, Respondent 2 said:

Respondent 2:

"Yes, certainly, I would safely say that nothing is bigger than technology in everything that forces us to change. Just because of technology, our work systems have to change. Mhhh... newspaper companies have to have satellite offices nowadays to receive and print news sent by the central office".

From the utterances of Respondent 2 it emerges that the advent of technology brings with itself significant organizational changes that go as far as altering the organizational working arrangements. In essence, from the technological innovations business organizations are not merely driven to make vague changes, but are actually enabled to put in place well-defined progressive changes. The emergence of certain technologies with predefined functionality both drives and enables an organization to modify its activities such that improvement materializes. With itself, technology brings increased efficiency and is therefore a significant source of competitive advantage.

Based on the statements of Respondent 2, by virtue of its ability to modify operational activities, technology drives and enables organizational structural changes. As defined by Pierce and Gardner (2002:463), organizational structure includes the interaction patterns that link people to people and people to work and these patterns are continually evolving. The organizational abilities brought about by technology change the interaction patterns, a reality that highlights technology as both a driver and an enabler of change.

About technology as a driver of organizational change, Respondent 4, a white male with 29 years of experience in the company's finance department commented as reflected hereunder:

Respondent 4:

"Absolutely! Without the internet, television and the radio, you know as well as I do that companies in the print industry would only be fighting among themselves today and things would be a bit easier for us, but unfortunately, technology is here and we have to come up with ways to survive. So, nobody in the entire world can tell you a different story, technology-related changes are at the top of the list of all newspaper changes."

A point worth analyzing about the statements made by respondent 4 is that technology brings increased levels of competition and therefore necessitates increased survival strategies. To the media industry, technological advances suggest that the means of mass communication are no longer confined to the print media as technology provides alternative platforms. Technology therefore prompts newspaper organizations to display a measure of flexibility that would see them making use of alternative media

platforms made available by technology. Summarily, technology diminishes the exclusivity of the newspapers or the print media by some measure and therefore renders the usage of alternative platforms more enticing.

Like Respondent 2, Respondent 5 an African female, an advertising department managerial team member who has been with Newspaper X for 14 years, regards technology as a driver of change more because of efficiency improvement (technology enabling change).

Respondent 5:

"You cannot ignore the changes in technology. In a restaurant, do you make use of a coal stove when you can easily switch on an electrical stove? It's all about doing things easier than before, and technology enables you to do that. So, definitely, technology will make you change, and as a newspaper company, technology requires us to change".

The idea of technology being a trigger of organizational change as noted by respondent 5 is an endorsement of the assertions of Singh, Singh and Chauhan (2005:82) that the technology tools used, help in overcoming the complexities of time and distance in communication and co-ordination. The 'redressal of complexities' suggests ease, improved efficiency and therefore saving of a variety of resources such as time, finance and the human resources. Hersey, Blanchard and Johnson (2001:4) echo these sentiments by stating that technology is giving organizations the systems and tools to be relentless cost cutters as the traditional layers of management are being stripped away because the Internet is reducing the need for brokers and distributors. Summarily, from the combined arguments by respondent 5 and those residing in the literature, it appears that technology both prompts and enables change.

As endorsed by Higham, cited in Robbins et al. (2009:484), new technology opens markets giving companies a wider reach and simplifies the transaction process, and companies that use the internet to improve their operations and drive down costs, will be the ones that succeed.

However, from the primary data gathered it becomes apparent that Newspaper X does not take advantage of the cost-cutting benefits brought about by the internet. The internet allows newspaper companies to print newspapers at satellite stations that are placed closer to the readers. These stations enable newspaper companies to cut down transportation costs. However, from the primary study findings, it appears that Newspaper X has no satellite stations.

#### **4.2.1.2 Failure to embrace continued technological innovations has unfavourable consequences for an organization.**

As noted in the introductory section of this study that in the business landscape, what has been useful yesterday and today may be largely or entirely obsolete tomorrow, Nelson and Quick (2009:515) echo the same sentiments along the lines of technological change by arguing that rapid technological innovation is another force for change in organizations, and those who fail to keep pace can quickly fall behind. In concurrence, Respondent 5 pointed out the potential for unfavourable consequences in instances where technological advances are ignored by stating that:

Respondent 5:

“The internet is here and it tells us to do things differently, really it does. Cell phones are here and they tell us to communicate with our readers through sms lines. If you do not interact with them others will and you will certainly be left behind by others in the industry”.

It emerges from the statements of Respondent 5 that organizational success hinges on efficiency. However, the world of business is the world of unending obsolescence in that today's tools of efficiency may yield inefficiency tomorrow. The foregoing therefore suggests that the arguably most sought-after organizational ideal of competitive advantage becomes unattainable where present practices are ignored. Technological advances breed efficiency improvement possibilities and therefore determine the success or failure for a business organization. As suggested by the statements of Respondent 5, an organization that disregards technological change renders itself obsolete and therefore surrenders success to its rivals.

The utterances of Respondent 4 also highlight the possibility of unfavourable consequences where an organization is largely oblivious of technologically-induced changes.

Respondent 4:

“Newspapers just have to change. What else would you do but change? Newsrooms have to move away from print but post news onto websites, but you know what? That as well comes with some problems. Firstly, circulation revenues will be lost. Secondly, on-line posting revenues have to be split among many. But there is nothing you can do but to make changes. I think it's better to change in some way than to be too wary of change. But [Pause] let me tell you there are some positive aspects. We can charge for subscription on the web, so our readers will have to access the websites for a small charge [said with a rather excited voice]. We can also run competitions by sms line.

We can also set up sites for breaking news to be accessed for a bigger charge than the usual news [said with a rather excited voice]. All that is needed is creativity here and creativity there [said with a rather excited voice with physical gestures used to emphasize the “here” and “there”]. But certainly, total reliance on the print media is a recipe for disaster [said with noted conviction].”

The mere usage of “total reliance on the print media is a recipe for disaster” by Respondent 4 emphasizes the unfavourable consequences carried by the disregard of technological advances by business organizations.

Among the benefits brought about by technology, as aforementioned, is the ability to decrease a number of costs. In concurrence, Singh (2005:9) states that advances in technology have contributed to the development of economies (economic advantages). Among the unfavourable consequences of failure to embrace technological innovations by an organization is that of incurring unnecessary production costs. The ease with which certain organizational activities are performed, such as the usage of the intranet or the internet to communicate with internal and external stakeholders respectively, has financial implications that need not be disregarded.

In essence, the emergence of technologies is about solving a variety of human and business problems. The non-exploitation of these technological solutions amounts to a backward movement and ineffectiveness on the part of a business organization. Put simply, it appears that failure to adapt to technological advances gives birth to negative business consequences.

Reflecting agreement with the foregoing are the statements of Respondent 2

Respondent 2:

“Just because of technology, our work systems have to change. Mhhh... newspaper companies have to have satellite offices nowadays to receive and print news sent by the central office. Do you print a paper in Durban and transport it all the way to Cape Town? Is that the way to go when the printing can be done there? Is that cost-effective, Can’t you do something better with technology? Certainly you can. So, definitely, technology forces us to change.” [Questions by the interviewee posed in a rather emotional manner].

The manner in which the statements of Respondent 2 were uttered reflects frustration and dissatisfaction. The questions posed by Respondent 2 suggest that a technological deficiency exists at Newspaper X such that the company’s success is hindered in some way. Summarily, Respondent 2’s statements contain a hint that technological changes are not fully embraced at Newspaper X.

## CHAPTER :6 RESEARCH METHODOLOGY

The statements of Respondent 2 are also a noteworthy acknowledgement of the economic significance of technological developments prevailing in the environment that influence organizational change. The arguments of Jones (2004) about technology and organizational effectiveness highlight the significance of technology as an indispensable force of change. Jones (2004:266) argues that we usually think of technology only at the conversion stage while technology is present in all organizational activities: input, conversion and output.

At the input stage technology allows each organizational function to handle relationships with outside stakeholders, for example, suppliers and potential employees,

At the conversion stage technology allows an organization to add the most value to its inputs at the least cost of organizational resources, and

At the output stage technology allows an organization to effectively dispose of finished goods and services to external stakeholders.

According to Jones (2004:267) the technology of an organization's input, conversion, and output processes is an important source of a company's competitive advantage. It follows that technology is a force of organizational change that organizations require to make optimum usage of. In essence, the questions posed by Respondent 2 are a mirror of the cost saving possibilities rooted on technological advances. Respondent 2's statements should therefore be seen as two sides of the same coin where, one side advocates for continual technological adaptation, and the other side warns against the negative consequences of failure to embrace emerging technologies.

### Project Write-Up

There are many different ways in which we can analyse qualitative data:

- Thematic analysis
- Content analysis
- Discourse analysis
- Hermeneutics
- Semiotics
- Narrative analysis
- Grounded theory
- Ethnography
- Interpretive Phenomenological Analysis

Regardless of what analytic technique you choose to use, when you present your findings, you need to do this in a convincing manner. You need to convince your reader that you have captured the meaning of respondents. Much like statistics provide evidence for our findings, in qualitative research, most often people's words, their implied and explicit meanings, provide evidence for what it is that you, as the researcher, are presenting as your findings. You need to present and discuss the emergent coding system and respondent meanings to your reader in such a manner that they can easily understand and digest it. In other words, you need to present what they say, you need to discuss what they say, you need to use their words, their non-verbal behaviours, their utterances as evidence to back up your claims and build a convincing argument.

Not all of which will be discussed in this module, as business research very often is not suitable for such analyses.

### Types of Data Qualitative Analysis

#### ***Content Analysis***

Data is usually yielded from Focus Groups are most adequately analysed using content analysis, or grounded theory. A research method that detects, records and analyses the presence of specified words or concepts in a sample form of communication. Inferences can then be made about the messages within the texts. The method that most closely resembles a quantitative method, **content analysis**. It's a method to make sense, systematically, to analyse large amounts of content from documents. It classifies written or oral material into identified categories of similar meanings (Moretti et al., 2011). Here categories can refer to either explicit, or inferred communication (Hsieh and Shannon, 2005). These materials can refer to interviews, open-ended questionnaires, newspapers, books, websites, facebook, twitter and so forth. Generally this type of data is "objective" as you are not relying on people's memory and recall of events, it's actually of what has occurred, and has been recorded. So basically, it's a systematic way of collecting either qualitative or quantitative data. It is a research method that detects, records and analyses the presence of specified words or concepts in a sample form of communication. Inferences can then be made about the messages within the texts. The process involves coding the text (e.g. by word, theme). It's important to note here that codes can be explicit (e.g. objective 'facts') or implicit (e.g. implied meaning), and should be exhaustive (all aspects of concern identified), exclusive (avoid overlap of codes) and enlightening (interesting/coherent). So basically, you are going through the text, and you identify categories or codes. You then assign numbers to these codes, and analyse these numbers statistically.

Process:

- Text is coded (e.g. by word, theme)
- Codes can be explicit (e.g. objective ‘facts’) or implicit (e.g. implied meaning)
- Codes should be exhaustive (all aspects of concern identified), exclusive (avoid overlap of codes) and enlightening (interesting/ coherent)

Steps to conducting a content analysis (Kumar, 240)

**Step 1:** Identify the main themes

- Go through what your participants have responded and try to understand the meaning they are attempting to relay. From this understanding develop broad themes

**Step 2:** Assign codes to main themes

- Identify all themes, and assign codes. Identify all themes until saturation, and assign codes.

**Step 3:** Classify Responses under main themes

- Go through all your responses and classify them under all main themes

**Step 4:** Integrate themes and responses into text of your dissertation/report

- You are left with responses falling under particular themes, integrate them into your report. To do this you could either discuss the main themes emerging from your study, providing verbatim reposes to support themes

### ***Discourse/Conversational Analysis***

The goal of discourse analysis is to understand how people use language to create and enact identities and activities. The focus here is more on the structure of language and texts, pauses, emphasis etc. Here attention is paid to active and passive voice, ambiguity, tone of language used to target particular audiences, clustering terminology to convey a particular tone/message, describing the political, social, cultural, historical context of language, and generally any activity designed to convey meaning. In short, basically looking at **why** they are saying **what** they are saying...i.e. **how** are people using language to say something rather than what they are saying in itself, and what world view the actor is communicating from. So the researcher and the researched both engage in dialogue, where the researcher probes specifically for intertextual meaning.

**Conversation Analysis** (Silverman, 2001) is described as the analysis of the structure of texts independent of who uttered them. The focus is on looking at sequence (e.g. turn-taking in conversations), which exceeds merely the words that were uttered. In addition, one tries to identify (Silverman, 1999):

- Speaker roles and identities merely from talk
- Outcomes of talk like laughter, hesitations, pauses, umm's etc

And avoid trying to:

- Arrive at an understanding of a speakers intentions using information external to the analysed talk
- Isolate a sentence to examine without considering the talk surrounding that sentence

**Discourse Analysis** on the other hand is not interested in the “underlying reality” of a situation, but more so in how people, engaged in conversation construct their own social worlds and identities. Probably the hardest method of analysis is **discourse analysis**. The central question asked by discourse analysts is: *“What discourses are used and how do they shape identities, activities and relationships?”*.

Discourse is basically a term for all forms of communication, arguing that communication shapes the world around us. Discourse analysts argue that words themselves are meaningless, but that we rather communicate through a shared understanding of what those words mean. When we communicate we draw from a set of assumptions, norms, and generally accepted knowledge. We use this to make statements that make sense to others. These statements either reinforce existing knowledge, or challenge it.

Discourse is therefore commonly accepted knowledge, and includes visual elements. Language here also defines the social roles that are available to us, and which we use to enact our identities. When we examine the significance, identities, relationships, politics, connections and sign systems (Gee, 2005) we can arrive at understandings of how social norms are both created and maintained, how we create our own identity and negotiate social and political interactions.

There is a link between knowledge and power, thereby highlighting the importance of language by making explicit the social and political context of how language is deployed. As such it encourages a more politicised view of language, and serves as a tool for revealing power, and showing the agency of people. In other words, it is how we, during social interaction, deploy strategies during talk to achieve particular roles, aspirations, and identities, and how we try to sustain them during our interactions. It is these routines that people use to achieve a particular objective that DA theorists are interested in.

DA theorists then, analyse the sequences of talk, and how people have constructed their talk during interactions with others, rather than the talk itself.

Generally the analytic technique used follows (Starks, 2007: 1373):

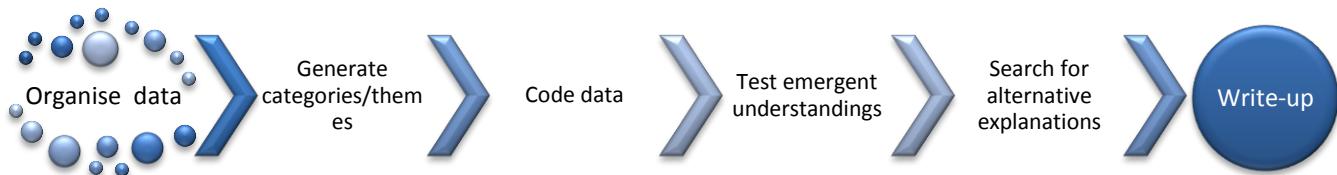
- Examine words to determine how understanding is produced
- Pay significant attention to HOW the story is told
- Determine what identities, activities, relationships and shared meanings are created and communicated implicitly through language

The ultimate outcome of Discourse Analysis then is describe the language in use and see how different discourses shape how identities, relationships, and other social identities are negotiated and produced.

### ***Thematic Analysis***

This type of analysis is probably the most commonly used method of analysis. Themes are defined as “units derived from patterns such as conversation topics, vocabulary, recurring activities, meanings, feelings, or folk sayings and proverbs” such that they bring “together components or fragments of ideas and experiences, which often meaningless when viewed alone”.

Generally we analyse the data, and look for themes that link and exist across it. The steps of analysis involve:



#### ***1. Organise the data***

You need to familiarise yourself with the data. This means you will need to read, and re-read, come to start to develop some ideas regarding what it is you are reading, make notes as observations and trends in the data become apparent (these are called memos).

Here you are not just reading, but you are reading the data in a particular manner, literally, interpretively and reflexively (Mason, 2002).

***Literal*** – This involves a focus on the actual structure of the document, and what the documents intended use was

***Interpretive*** – This is where you, the reader, will start to try to perceive what you think the meaning is behind what it is you are reading. This involves documenting this meaning, and finding ways to best present and provide evidence for it

**Reflexive** – This involves taking a step back and acknowledging your influence over the data, and the role you played during the data collection process. Specifically, your role in, and influence over, generating and interpreting the data



## 2. Generate categories or themes

This part of the analysis involves looking for patterns in the data. Themes here refer to ‘super-categories’ or high-level categories, and give structure to the data. The typical ideal number of themes should be around four or five (rule of thumb, not definitive). Within each theme, you can have sub-themes, or categories which will be related to each other, and explain different aspects of the overarching theme.

Categories can be imposed on the data (deductive categorisation where you read the literature first, then look for these same themes) or they can emerge from the data itself (inductive, where no prior coding scheme is imposed on the data).

Categories or themes should be (Marshall and Rossman, 1999: 54):

**Internally Consistent** – The category should link same things together

**Externally Divergent** – The categories themselves should be different from one another – i.e. they cannot overlap



## 3. Code the data

You code the data according to the patterns or categories that you have previously identified. In other words, you apply the categories (inductive or deductive) to the data in a systematic way. In other words, if one of your categories that you identified was “poor communication”, then you would look for instances of this in the data, and then code for it under the code called “poor communication”.

From the above you can see that coding generally serves two purposes:

- Systematic application of categories to data
- Quotes to be used as evidence informing category formation in the write-up of the analysis

#### **4. Test emergent understandings of the data**

Alongside the development of themes and categories, emerges an associated understanding of the data. As we gain an increased understanding, so too do we start developing theories. Either this theory fits in with existing theory, or we develop new theories according to what we are starting to see in the data.



#### **5. Search for alternative explanations of the data**

We cannot irrefutably accept that the theories that develop from the data, we need to try and challenge them and look for alternative and contrary instances thereof.



#### **6. Write-up the data analysis**

To do this you could need to discuss the main themes emerging from your study, providing verbatim reposes to support your identified themes.

### ***Interpretive Phenomenological Analysis***

Phenomenology aims to describe the meaning of lived experiences of phenomena through thick descriptions, understanding and meaning from a subjects point of view, and provides a descriptive account of their lived experience. It aims to answer the question: “*what is the lived experience of the phenomenon of interest*”. It attempts to describe these lived experiences by making explicit taken-for-granted assumptions about we know (Starks, 2007). In order to do so, the researcher allows the respondent to describe their lived experience, and probes for detail and clarity.

The analytic methods used in this method involve (Starks, 2007: 1373):

- Identify descriptions of the phenomenon
- Cluster into categories
- Use categories to describe essence or core commonality and structure of experience

In other words, the researcher identifies themes, and provides a structural explanation of findings across numerous people, usually more than 5 people. It looks at shared experiences and different accounts of these shared experiences across different subjects, thereby providing a good sense of the lived experience of this phenomenon as a whole. In addition, it attempts to understand what an experience is, and how they experienced the same phenomenon. Even though there may be

differences in accounts – you can extract shared experiences across accounts, and provide a general account of that particular phenomenon. By doing this, they attempt to get to the **essence** of the experience. What needs to be reported is an account of what was experienced, and how the individuals experienced it. Usually, the steps involved in conducting this type of analysis involves locating people who are knowledgeable on a particular subject area, allowing them to describe their experiences regarding the phenomenon, to gain a sense of wholeness and examine experiences beyond human awareness, and that which cannot be communicated.

So the ultimate outcome of Phenomenology is a thematic description of the pre-given “essences” and structures of lived experiences.

### ***Grounded Theory***

This type of analysis is exactly that, generating theory, inductively, from the ground up. Observations are captured and summarised into conceptual categories, and these categories are linked, and further refined through repeated observations, and across multiple settings.

Grounded theory is characterised by two things:

1. Constant comparative analysis
2. Theoretical sampling

Constantly comparing data and theory (known as “constant comparison”). Here the researcher has to once again be cognisant of their role in theory development, and try to be as objective as possible so as to avoid biasing any emergent theory.

Often we utilise non-random sampling techniques to gather evidence for our developing theory,

The steps involved in conducting a grounded theory analysis is much the same as those listed for Thematic Analysis, but diverges in the fact that categories and theories are developed from the data, and never a preconceived framework. In addition, there is a strong emphasis on “immersing” oneself in the social environment, and data within which the actors under study exist. By immersing oneself in such a manner, it can be assumed that the representation and understanding of the observed is “true” to the participants in that setting. Corbin (1998) mentions the need to examine the 6 C's of social processes, these include causes; contexts; contingencies; consequences; covariances; and conditions.

In general, the analysis follows the following structure (Starks, 2007: 1373):

- Open, axial and selective coding
- Examine concepts across data and develop an explanatory framework that integrates the concepts into a core category

When writing the project up, much like statistics provide evidence for claims in Quantitative research, large amounts of what people have said, their direct quotes are used in Qualitative research to provide evidence for the purported theory. In this way we demonstrate that the theory is truly grounded in the data, and “speaks for itself”. The role then of the researcher is merely to bring structure to the data. The ultimate outcome of Grounded Theory is to generate a theory from a range of participants experience. There are several limitations to Grounded Theory, however. Not all research aims to develop a theory. Some projects are concerned with applying existing theory to a particular setting. This highlights, again, the thrust of qualitative research, which is not to make generalisations, but to capture, in great detail, and provide thick, rich descriptions of phenomena in that particular setting. It also assumes that there is a single reality experienced by all people in a particular setting, which is untrue, you will need to detail the different interpretive frameworks by different people in the same setting.

### ***Ethnography***

Analysis involves describing culture as it appears, in other words, it studies a culture, or a culture that a group of people share. Usually data collection involves observation, and it usually occurs over a long period of time. It is characterised by immersion, whereby the investigator immerses themselves within the context within which they are making observations. Because the researcher immerses themselves within the natural context in order to come to understand and describe the norms of that culture, it is otherwise known as being “naturalistic”.

### ***Narrative Analysis***

Narrative analysis focuses primarily on how respondents come to understand and explain their various life experiences. Studying how they explain or give order to these events, the researcher is able to generate a sense of how they come to give order to, and understand various life experiences. The focus is on the story itself, and looking at common patterns between various respondent stories as a whole.

### ***Case Studies***

Case studies (as previously denoted) can be either qualitative, or quantitative. Qualitative case studies involve an in-depth analysis of a single unit, or a cluster of homogenous sub-sets that can be classified as all falling under a single unit. Case study research ultimately aims to understand the complexity of a case from every conceivable aspect, and as such employs multiple methods of data collection, including

observation, interviewing, and collecting other written materials, or what are otherwise known as artefacts. There are inherently three different types of cases (Crabtree and Miller, 1999):

- Intrinsic – studies a particular case, as the case is of interest itself
- Instrumental – case is of interest as it adds to, or refines a pre-existing theory. So in this case, the case is not the primary focus, rather, it helps us to come to understand something else.
- Collective – a number of cases are examined in order to examine a particular phenomenon

Focus on one case, an individual or a group. You will organise the data around that particular case rather than grouping respondents answers by question or topic.

#### ***Software available for Qualitative data analysis: Nvivo***

There is a program known as Nvivo that assists with the analysis of Qualitative data. Now, remember it was mentioned that QL data is often a vast amount from a small sample. QL Data is usually **ENORMOUS**, and **OVERWHELMING**, therefore it is important to extract relevant ideas and themes, helps make things more manageable, and helps to streamline your project. When you extract these ideas/themes from text – create what NVivo calls **nodes**. Themes must include contextual data so that they don't lose meaning.

Data is usually segmented, or divided and classified into “nodes”. Nodes is the term given to a coded source. They allow you to extract underlying themes from large volumes of data. When you link data to nodes, this process is known as coding. Nodes can be organised hierarchically – themes and sub-themes falling under them. Node structure will determine how well you answer your research questions – so create nodes with research questions in mind.

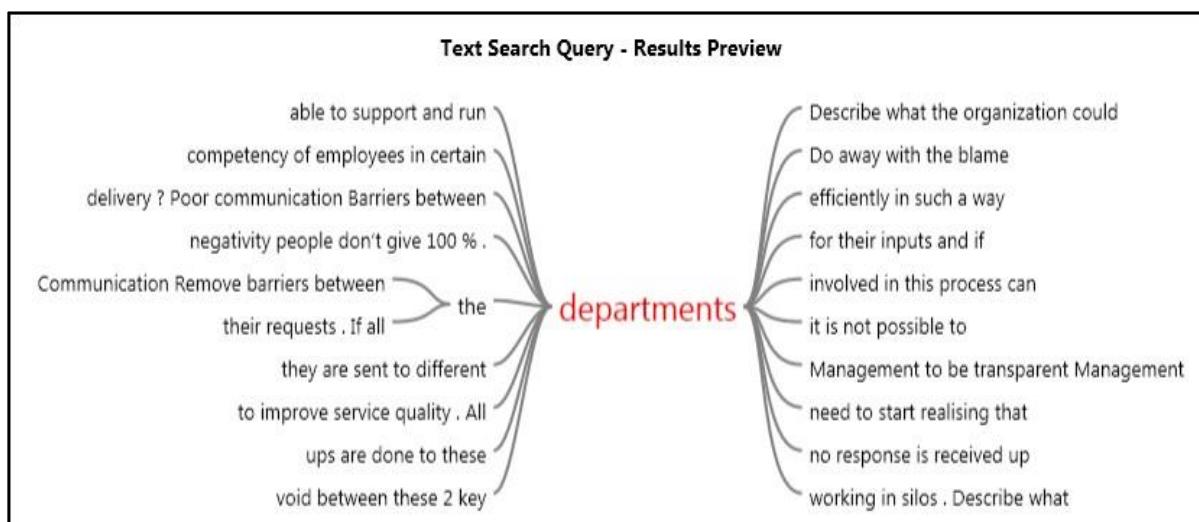
Other than the ability to effectively organise and segment data using Nvivo – there are certain tools the programme contains that assist in the development and discussion of major themes/patterns across data.



## **Word Frequency**

A word frequency is generated to identify the most frequently occurring words in the dataset. The more the word appears, the more frequently it is used by respondents. It helps to identify trends in the words used by respondents.

## Word Tree



A word tree shows you what the respondents are generally saying with reference to particular words. It allows you to gauge what respondents are saying in relation to particular identified, and significant words, and therefore roughly determine trends emerging from respondent's speech. It allows for a quick overview of emergent themes, and directs the researcher in a particular direction.

## Nodes

Nodes, as previously mentioned, are containers in which a whole or a portion of sources are kept for analysis. When you code into nodes that follow a particular theme, and hold all quotes relevant to that patterned response, what you will generate is a list:

Name	Sources	References	Created On
Interview Questions	4	12	2014/01/16 03:45 PM
Commitment to worker participation in decision making	4	4	2014/01/16 03:45 PM
Levels of Employee participation in decision making	4	4	2014/01/16 03:45 PM
Participation in Decision Making	4	4	2014/01/16 03:45 PM

**Commitment to worker participation in decision making**

1. In what ways can employees be involved in decision making? Why do you think so?

- o Through engagement forums, even though a decision will have been made regardless of whether input is needed or not, some engagement is necessary.

2. What are the obstacles you have noted that hinder participation in decision making

The top window shows the nodes that have been coded, and the bottom part of the window shows you what respondents have said (direct quotes) with reference to the node. In this example, respondent transcripts have been coded into three child nodes, “commitment to worker participation”, “levels of employee participation in decision making”, and “participation in decision making”. These child nodes fall under the parent node “interview questions”. As you can see, the red part in the window below is the actual words that a respondent has uttered, and that has been coded under “commitment to worker participation” child node. These quotes will then be used as evidence to what the researcher is discussing in terms of findings, for example:

There are some manners in which respondents suggested that they be involved in decision making, one of which was in the form of engagement forums:

“Through engagement forums”

The respondent mentions further that no matter the form in which engagement takes, and/or whether or not decisions have already been made, it is, employee engagement is however, imperative and necessary:

“even though a decision will have been made regardless of whether input is needed or not, some engagement is necessary”

These are just some of the manners in which coding, segmenting and discussing qualitative findings can be made, and presented. In the manner in which quantitative research uses statistics to provide evidence for research claims, respondent quotes should be used as evidence for claims made by qualitative researchers.

### Example

Qualitative researchers often make use of programmes such as Nvivo to code and analyse data. This is taken from a MANCOSA student's project entitled: *An Investigation of the Factors that Render Change and Continuous Improvement Indispensable Managerial Tools at Newspaper X in Durban*.

The codes used in this study were obtained deductively from

The screenshot shows the Nvivo software interface. At the top, there is a table listing four interview transcripts with their respective node counts, reference counts, creation and modification dates, and users. Below this is a transcript window titled "interview transcript V" containing a question and a large amount of text. To the right of the transcript is a vertical ribbon of colored bars representing different themes. A legend on the far right maps colors to theme names: Orange for "Change", Green for "Demographics", Yellow for "Challenges", Blue for "Processes", and Grey for "Coding Density".

Name	Nodes	References	Created On	Created By	Modified On	Modified By
interview transcript V	12	38	2012/11/28 08:00 AM	J	2012/11/30 04:08 PM	J
interview transcript IV	16	60	2012/11/28 08:00 AM	J	2012/11/30 03:17 PM	J
interview transcript III	17	56	2012/11/28 08:00 AM	J	2012/11/30 02:28 PM	J
interview transcript II	16	40	2012/11/28 08:00 AM	J	2012/11/30 01:00 PM	J

**interview transcript V**

content and not just the size of our paper.

**Fol-UQ: What sort of changes did you make in terms of the content of the paper?**

We tried and maintained a balance between the “granny stuff” and the ‘youth stuff’ which was almost non-existent in our older editions. The youth make up a very large percentage of our population, and they have to be part of your market, really they have to. As I said before, if you don't provide them with what they need, somebody else will. We then made our paper to appeal to the youth by including their stuff. If I had a 1940 issue here I would have asked you to make a comparison with today's paper, and you would definitely see that the former was, in fact, a conservative, grannies newspaper. Today's paper tells you about entertainment, places to meet people and other things that young people have an interest in. Today's paper shows you young sexy women, ads about sexual health and all sorts of things. The 1940 paper didn't have such at all.

**Fol-UQ: What would you say about the effectiveness of these strategies?**

the literature, and inductively from the interviews themselves. These codes were then used to identify themes, and patterns and relationships between themes identified. This picture above was taken of the Nvivo programme, and if you look at the ribbon on the right – you will see different colours indicating coded sections. On the left pane – you see the transcript as it appears.

## Measures of quality for Qualitative studies

Ultimately, Lincoln and Guba (1985) say that all Qualitative studies need to be Trustworthy. Trustworthiness here, is said to be the Qualitative equivalent of Reliability and Validity. In order for a study to be trustworthy, the study needs to meet four criteria, namely, Credibility, Transferability, Dependability, and Confirmability.

### ***Credibility (QL equivalent of internal validity)***

This refers to the accuracy of the study. In other words, how similar are the findings with reality? How “true” are the findings? The descriptions provided must be plausible and recognized by participants.

Generally, it is enhanced by spending prolonged time in the field repeatedly observing and interacting, persistent observation, peer debriefing, member checks, archiving data, and using different data sources, methods, data type i.e. triangulation. Triangulation refers to more than two methods are used in a study with a view to double (or triple) checking results, thereby increases the credibility and validity of the results. There are multiple ways in which you can triangulate findings:

- **Data triangulation:**  
involves time, space, and persons
- **Investigator triangulation:**  
involves multiple researchers in an investigation
- **Theory triangulation:**  
involves using more than one theoretical scheme in the interpretation of the phenomenon
- **Methodological triangulation:**  
involves using more than one method to gather data, such as interviews, observations, questionnaires, and documents.

### ***Dependability (QL equivalent of reliability)***

This refers to the stability and trackability of the changes in data over time and conditions. Determined by the extent to which another researcher with similar training and rapport with participants would make the same observations. Can track it through an audit trail which involves auditing research process, documenting all the raw data generated, and assessing method of data analysis, how data was kept, and how accurate it is.

### ***Transferability (QL equivalent of generalisability/external validity)***

This refers to the generalizability of the study findings to other settings, populations, and contexts. Requires that the report must provide sufficient detail so that readers can assess this. Lack of transferability is viewed as a weakness of qualitative methods. Lincoln and Guba (1985) state that

transferability is enhanced by providing thick descriptions. Thick descriptions as referred to here, denotes a description that explains not just the behaviour, but the context within which the behaviour occurs, an in such a way that the behaviour becomes meaningful to an outsider.

### ***Confirmability (QL equivalent of objectivity)***

Refers to the objectivity of the data, in other words, would another researcher agree about the meanings emerging from the data.

Ultimately, Silverman and Marvasti (2008: 295) conclude that research can be considered of good quality when it:

- it has been thought through theoretically and with data
- the methods used are appropriate to the research problem
- Where possible, contributes to practice and policy
- Findings are empirically sound

#### **THINK POINT**

Think about your topic that you have been working on throughout this module.

Think about how you have analysed it – now look at the above measures of quality. Does your research have the markers of a quality dissertation?

#### **If it is quantitative:**

Is it reliable?

Is it valid?

#### **If its qualitative:**

Is it credible?

Trustworthy?

Will your reader be able to follow your train of thought?

Would your reader agree with the conclusions that you have drawn?

## Writing your project up

CARE (2009: 2) suggests that when writing up your dissertation, it needs to be:

- **Responsive** - When writing up your findings – consider who will be reading it – and pitch it at that level
- **Concise** – Information must be readily available, and easy, unconjugated, and to-the-point
- **Interesting** – Present only that information that your audience would find interesting
- **Highlight Key Points** – Make it visually impacting
- **Logical** – Present your findings logically – avoid confusion
- **Useful** – Your recommendations must be accessible, logical, practical and doable. Show exactly how to implement suggested changes as this will most likely secure buy-in and implementation thereof
- **Attractive** – Make sure that presentations, reports and so forth are visually appealing

## Ethical considerations

### Research Ethics

Good business research requires the student to translate his/her personal ethics into sound business ethics and that both codes of ethic must find expression in the research process itself. The challenges that ethical social sciences research demands have produced a whole field of academic and practical interest called research ethics. Below are some of the critical issues that relate to research ethics.

#### ***Scientific validity***

The research must be conducted in a manner that ensures its academic integrity and scientific validity. Academic dishonesty is a corrosive force in the academic life of any higher education institution. It jeopardizes the quality of research and depreciates the genuine achievement of others. Some common forms of unethical practice in research are:

- Fabrication which involves the intentional and deliberate falsification or invention of any information or citation in a study.
- Plagiarism which involves intentionally or knowingly representing the words or ideas of another as one's own.

## **Plagiarism**

Stolley, Brizee, and Paiz (2015) state that plagiarism can be defined as, “the unaccredited use (both intentional and unintentional) of somebody else’s words or ideas”. Plagiarism is, in essence, cheating and stealing. Plagiarism can also include a complete or partial translation of text that has been written by somebody else.

Rules to effectively avoid plagiarism uOttawa,(2009: 2):

- If you are going to use another person’s words – use “” – inverted commas, and reference the author, year, and page number
- Acknowledge internet sources
- Acknowledge other people’s ideas – DO NOT present them as your own
- Do not attempt to paraphrase without acknowledging the source of the idea

uOttawa (2009: 2) summarise by saying that if you use someone else’s words as they stand – you need to use inverted commas, and provide entire reference. If using somebody’s idea, then provide a complete reference.

<b>You wrote*:</b>	<b>This is unacceptable because:</b>
<p>Research has shown that technology has been instrumental in increasing industrial and agricultural production, improving transportation and communications, advancing human health care and overall improving many aspects of human life. However, much of its success is based on the availability of land, water, energy, and biological resources of the earth.</p>	<ul style="list-style-type: none"> <li>• Other than the first four words, the text has been copied word for word from the original document without any quotation marks that would indicate that the passage is a quote.</li> <li>• The source you are using is not cited.</li> </ul>
<p>Research has shown that the advancement of technology has been instrumental in increasing industrial and agricultural production, improving transportation and communications, health care and overall many aspects of human life. (Pimental, 1998)</p>	<ul style="list-style-type: none"> <li>• Even though you mention your source, you use many of the author’s words without quotation marks.</li> </ul>
<p>Research has shown that the advancement of science has been beneficial to the areas of agricultural and industrial production and communication and transportation fields. Furthermore, science has greatly improved health care and is the prime factor in a higher standard of life for many people.</p>	<ul style="list-style-type: none"> <li>• Though most of the words have been changed, the sentence structure has remained the same.</li> <li>• This is paraphrasing without indicating the original source.</li> </ul>

You wrote:	This is acceptable because:
In his article on the effects of population growth on the environment, Pimental argues that “technology has been instrumental in increasing industrial and agricultural production, improving transportation and communications, advancing human health care and overall improving many aspects of human life. However, much of its success is based on the availability of land, water, energy, and biological resources of the earth” (1998).	<ul style="list-style-type: none"> <li>The author has been acknowledged, and the quoting technique which has been used is adequate since this is an Internet source. However, when you quote a printed source (book, journal, etc.), be sure to include the page numbers.</li> </ul>
According to Pimental, “technology has been instrumental in increasing industrial and agricultural production, improving transportation and communications, advancing human health care and overall improving many aspects of human life” (1998). He cautions, however, that technological progress is dependent on natural resources.	<ul style="list-style-type: none"> <li>You have properly quoted and paraphrased the author.</li> </ul>
According to Pimental (1998), technology has greatly improved our standard of living. He cautions, however, that technological progress is dependent on natural resources.	<ul style="list-style-type: none"> <li>This is the proper way to paraphrase and the author's ideas have been credited.</li> </ul>

uOttawa (2009: 4 – 5)

### **Recruitment**

A key requirement for ethical research is that subjects must never be forced or coerced into participation in a study. The threat of sanctions against those who refuse to participate, for example, is evident in a situation where workers and junior staff members are asked by senior managers to participate in surveys and other forms of research.

### **Participation**

Participation in a study must not expose participants to an invasion of their privacy. The anonymity of participants must be maintained. Equally anything learned about participants during their involvement in a study must be maintained in the strictest confidence

### **Protection from harm**

Subjects must be protected from physical, psychological or general work-related harm. The researcher must ensure that participants will not be placed in any danger. The potential benefits of the research cannot be used to justify the possible adverse consequences on participants.

### ***Informed consent***

The informed consent of participants is critical to research ethics. Every participant must understand the nature and consequences of his participation before engagement in the research. Good research ethics, in fact, requires the participant to read, understand and sign an informed consent form.

This consent document must be presented in simple and clear language to ensure full communication. Some points that must be included in this document are the purpose of the research, the length of participation, potential benefits and harms, assurances of anonymity and confidence, and communication of the results of the study.

### ***Sharing results***

All research is directed at broadening the base of knowledge in the field. Therefore scientific knowledge must be placed in the public domain as soon as practical and possible. Among those with whom the knowledge has to be shared are those who participated in the study.

In general, there are two different manners in which your findings can be communicated to a particular readership, or audience, these include:

- Writing for publication
- Conference presentations

Just remember, that sometimes you have an obligation to the respondents, and participants in your study to share with them your findings.

### **Just remember!**

**Who you target determines how and in what form your findings and reports will take.**

### **You may want to:**

1. Write an executive summary for the organisation involved
2. Write a technical report according to the criteria for such report.
3. Prepare a presentation for a conference, following the guidelines of the conference organisers.
4. Write an academic article following the publication guidelines of the targeted Journal.
5. Write a popular article following the editorial guidelines of e.g. a newspaper or popular magazine.

## Referencing

### ***What is referencing?***

Referencing is the practice of letting the reader of any written work know the source of any idea, opinion or information included in the text. It is an acknowledgement of a piece of writing by another author which has been referred to or quoted directly in a written piece of work. Referencing enables the student to identify whose ideas or arguments they are using. There are three specific reasons for using referencing:

To let the reader know whose ideas are being used. In the academic system, ideas are a kind of property of those who develop them. To not acknowledge the source of information, opens the student to accusations of plagiarism.

To enable the reader to check the information. The reader might want to go back to that author's original work for her/himself and check the accuracy of the information.

To provide information for the reader. The current research into a topic might produce an interesting book or journal article which may be new to the reader. If referenced accurately, the reader will be able to find that book or article to get a fuller grasp of the original material.

### ***How referencing is done?***

Different institutions and publications have different ways of citing references. MANCOSA suggests that all students use the Harvard System of referencing described here. Some advantages of this style are:

**Step 1.** It ensures one alphabetical list of all references in the text, facilitating easy identification of sources.

**Step 2.** Last minute additions and deletions can be made without having to renumber all references.

**Step 3.** Only one entry is necessary in the list even though the work may have been referred to more than once.

There are two parts to the Harvard System, one relates to the in-text references and the other to the reference list at the end of the text.

Underlining is an indication to the printer to print the underlined section in italics. You have the option to either underline or to put the necessary words in italics. With modern word processing facilities and the ease of using it, it tends to look better if italics are used.

### ***In-text references***

General requirement for in-text references is that the writer must insert the surname of the author whose idea/ information/ argument is being used, the year in which the work was published, and the page number(s) where the information is located. The underlying principle here is that ideas and words of others must be formally acknowledged. The reader can obtain the full source citation from the list of references that is supplied at the end of the text.

The source is part of the sentence.

When the names of the author(s) of a source are part of the formal structure of the sentence, the year of the publication and the page number/s with a colon separating the two, appear within brackets following the identification of the author/s. Below are some examples:

- (a) As Smith (1990:25) points out, the ....
- (b) Mitchell and Smith (2000:72-73) found that ....
- (c) Smith, Jones, Sherwin and Pearson (1997:45) maintain that ....

When there are two authors, the names of both authors occur in every in-text reference. For multiple author citations (three to five authors), the names of all authors must be noted with the first reference, and then the reference is shortened to the name of the first author with et al. Thus, in the case of example (C) above, all later uses in the text would be:

- (d) Smith et al. (1997:56-57) argue that mergers and acquisitions ...

For references with six or more authors, students must use et al. with the first reference and provide the final citation in the references list:

- (e) Jones et al. (1996:101-102) state that work stoppages often reflect ....

If two or more multiple author references shorten to the same et al. form, making it ambiguous, the student must give as many authors as necessary to make them distinct before et al.

(f) Marketing, as Smith, Jones, et al. (1990:36) observe, is pivotal to:

Occasionally the student may want to write about one author's research (primary reference) which is mentioned by another author (secondary reference). Both need to be identified:

(g) Smith's research in 1982 (cited in Hanson, 1998:55) found that .....; or

(h) Hanson (1998:55) in reporting Smith's (1982) research maintains that .....

Generally, however, students should avoid secondary referencing if at all possible.

If the author that the student wants to reference has published more than one text in a particular year and he/she wants to reference more than one item from the same year in the dissertation, then he/she must add a, b or c after the date to distinguish the publications both in the text and the reference list at the end:

(i) Drucker (1999a:75) argues that managers .....

(j) Strategic planning, as Robertson (1998c:210) observes, is often not a systematic process

.....

### ***Source is not part of the sentence***

When the author(s) of a source are NOT part of the formal structure of the sentence, the author(s), year of publication, and page number/s must appear within brackets. For the exact format see the example below:

(k) A recent study (Robertson, 1998:210) noted that strategic planning is often not a systematic process .....

If the student is citing multiple works by the same author at the same time, they should be arranged in date order:

(l) Several studies (Johnson, 1988, 1990a, 1990b, 1995) came to a similar conclusion about the impact of management styles.

In example (l) there are no page references. This suggests that the writer is referring to each publication in its entirety. Where several writers are referred to in the same context, they should be listed by date and then alphabetically by first authors' surnames, each citation is separated from the next by a semi-colon:

(m) Reviews of research on religion and health have concluded that at least some type of religious behaviours are related to higher levels of physical and mental health

(Ronald and Smith, 1992; Gortner, Larson and Allen, 1991; Levin and Vanderpool, 1991; Palomarana and Pendleton, 1991; Payne et al., 1991; Benner et al., 1987; Appleton, Smith and Jones, 1984).

References with multiple authors cited in full imply that this is the first reference to those citations in the study.

### **Quotations**

When a direct quotation is used in the text, the student must always include author(s), year and page number within the brackets, exactly in the manner noted above.

Short quotes of up to two lines

Short quotations of up to two lines should be incorporated into the formal structure of the sentence and enclosed in quotation marks. Consider the following example:

- (n) Weir (1995:10) states that “defining roles and their remits is not simple”. A similar view is expressed by Holmes and Arthur (1996:210) who argue that “role definitions must be precise to avoid a blurring of functions”.

### **Larger quotations**

Larger quotations should be indented in a separate paragraph in block format:

- (o) Thomas and Ingham (1995:33) in discussing staff development state:

*Development is infectious, and staff who previously have recoiled from undertaking a degree or conversion course have been encouraged by the success of others.*

If part of the quotation has been omitted then this can be indicated by using three dots:

- (p) Weir and Kendrick (1995:88) state that ‘networking is no longer solely within the male domain ... but is part of general staff interaction’.

It needs to be stressed that the student must only use three dots when omitting material from quotations, four if the omitted material includes the end of the sentence. Students should not use dots at the beginning or end of a quotation.

**Reference list at the end of the text**

References should be listed in alphabetical order by authors/ first author's surname and then, if the writer has several works that have been cited in the text, by date (earliest first), and then if more than one item has been published during a specific year by letter (1995a, 1995b, etc.). Details must be taken from the title page of a publication and not from the front cover, which may be different. Each reference should include the elements and punctuations given in the examples below. Title of the publication should be in italics or underlined. The examples given below are underlined.

**A book with one or two authors.**

Smith, D. (1990) Elements of Management. London: MacMillan.

Mitchell, John and Smith, David (2000) Decision theory: conduct, critique and utilization. 3rd Edition. New York: Bantam Books.

**Book with three or more authors**

Deighton, Jane; Horsley, Rosanne; Stewart, Sarah and Cain, Cathy (1983) Sweet ramparts: women in revolutionary Nicaragua. London: War or Want and the Nicaraguan Solidarity Campaign.

**A book by a corporate author (e.g. a government department)**

Department of Prime Minister and Cabinet (1989) Office of the Status of Women: an introduction. Melbourne: Australian Government Publishing Service.

Australian Nursing Federation (1989) Standards for nursing practice. Melbourne: Australian Nursing Federation.

**An edited book**

Swanepoel, B.J.; Slabbert, J.A.; Erasmus, B.J.; and Nel, P.S. (eds.) (1999) The management of employment relations: organizational level perspectives. Special student edition. Durban: Butterworths.

Wellington, J. J. (ed.) (1986) Controversial issues in the curriculum. Oxford: Basil Blackwell.

Basford, Lynn and Slevin, Oliver (eds.) (1995) Theory and practice of nursing: An integrated approach to patient care. Edinburgh: Campion.

***Books with no publisher, place of publication or date of publication given***

Saulwick, Weller and Associates (1995) Sex role portrayal of women in advertising: a content analysis. Canberra: [publisher unknown].  
Kelly, F. (1996) Will trees survive? [place of publication unknown]: Western Publications.

Wolverton, H. [date unknown] Management issues for reservation Indians. Wilmington, South Dakota: Prairie Press.

***A chapter in a book***

Capra, F. (1983) The systems view of life. In Kendrick, K and Johnathan, Y. (eds.) (1983) The turning point: science, society and the rising culture. London: Fontana Press, pp. 285-322.

Weir, P. (1995) Clinical practice development role: a personal reflection. In Smith, Albert (ed.) (1995) Innovations in nursing management. London: Edward Arnold, pp. 5-22.

***An article in a periodical/journal***

Boydell, D. (1975) Pupil behaviour in junior classrooms. British Journal of Educational Psychology, 45(1), pp. 122-129.

**NB 45(1) signifies Volume 45, Number 1.**

Phillips, E. R. (1957) The South African labour market. South African Journal of Industrial Relations, 1(3), pp. 25-39.

***Review or interview when titled***

Cormond, T.P. (1982) A new look at medicine from the social perspective [review of Social contexts of health care management by Carol Senn]. Contemporary Society, 27(1), pp. 208.

***An article in a newspaper***

White, M. (1998) £68m to cut NHS waiting lists. Guardian, Manchester Monday, 18 May, p.8.  
Chopra, R. (1990) Frustration and despair [letter to the editor]. The Daily News, Durban, Monday, 21 June, p. 21.

**A newspaper article with no obvious author**

[Author Unknown] (1999) Recruitment: lessons in leadership. Sunday Times, Johannesburg, 11 March, p. 32.

**Government publications**

Department of Health (1996) Choice and opportunity: primary care: the future. CM 3390. London: Stationery Office.

**A thesis or dissertation**

Ngubane, M.E. (2000) An investigation of the impact of affirmative action policy as a strategy for removing discrimination in the workplace. Unpublished MBA dissertation. High Wycombe, Buckinghamshire: Buckinghamshire Chilterns University College.

Rameshur, H. (1996) Education policy implementation in a system in transition: A multivariate systems approach. Unpublished doctoral thesis. Pretoria: University of South Africa.

**A secondary reference**

Fidler, F. and Chemers, M. (1974) Leadership and effective management. Glenview, Illinois: Scott Foresman and Co. Cited in: Lawrence, David (1996) Leadership and management. New York: Wiley.

**Referencing electronic sources**

References must be correct, complete and consistent.

**Reference to an Internet source**

Basically the information required are author's name, year, title [online], edition, place of publication, publisher (if ascertainable), where available and date on which it was accessed.

Barnett, M. (1996) Management issues for the contemporary office [online]. London: Eastern Highlands University. Available from:

<http://easternhigh.ac.uk/busfac/resources/mico.html> [Accessed 27 September 2000].

The term **[online]** indicates the type of medium and is used for all Internet resources. **[Accessed Date]** is the date on which the document was viewed. This allows for any subsequent modifications to the document. The term publisher can cover both publishers or printed sources as well as organizations responsible for maintaining sites on the Internet, such as the University of the Witwatersrand. If no specific author is cited ascribe authorship to the smaller organizational unit:

Library Services (1995) Internet user's guide [online]. Johannesburg: University of Johannesburg. Available from <http://joburgun.co.za/library/guides/> [Accessed 30 September 2000].

#### ***Reference to an electronic journal***

The reader needs to know the author's or editor's surname and initials, year of publication, title of article, journal title, volume number, issue number in brackets, location within the list available from, URL, and [accessed date].

Church, K.B. (1995) People machines: on robot-consciousness. Psychology [online], 6(15). Available from: <gopher://wwachaw.ai.univie.ac/Psychology/1654/> [Accessed 17 June 2000].

The location within the host is the equivalent of pagination used with printed sources. It should be given if the format of the document includes page numbers or an equivalent internal referencing system. The specification of location should be chosen according to the following order of preference:

- Page, screen, paragraph or line number where the features are a fixed feature of the online source (e.g. 5-21 indicating that it is page 5 of 21 pages; lines 100-150)
- Labelled part, section, table, etc.
- Any host-specific designation.

If the document does not include pagination or internal referencing system, the extent of the item may be indicated in such terms as the total number of lines, screens, etc. (e.g. [35 lines] or [approx. 12 screens])

#### ***Example of a typical bibliography***

Allen, A. (1993) Changing theory in nursing practice. Senior Nurse, 13(1), 43-5.

Basford, L. and Slevin, O. (eds) (1995) Theory and practice of nursing: an integrated approach to patient care. Edinburgh: Campion.

Burns, N. and Grove, S.K. (1997) The practice of nursing research: conduct, critique and utilization. 3rd edition. London: Saunders.

Canetti, E. (2000) Crowds and power. Translated from German by C. Stewart. London: Phoenix.

Department of Health (1996) Choice and opportunity: primary care: the future. Cm.3390. London: Stationery Office.

Department of National Health (1990) National Health Service and Community Care Act 1990. pp. 20-37. London: HMSO.

Fiedler, F. and Chemers, M. (1974) Leadership and effective management. Glenview, Illinois, Scott Foresman and Co. Cited in: Douglass, L.M. (1996) .The effective nurse: leader and manager. 5th Edition. St. Louis, Missouri: Mosby.

Marieb, E. (2000) Essentials of Human anatomy and Physiology: AWL Companion Web Site [online]. 6th Edition. San Francisco: Benjamin Cummings. Available from: <http://occ.awlonline.com/bookbind/pubbooks/marieb-essentials/> [Accessed 4th July 2001].

McConnell, D. (D.McConnell@sheffield.ac.uk) (28th November 1997) Follow up to your interview. Personal email to L.Parker ([l.a.parker@sheffield.ac.uk](mailto:l.a.parker@sheffield.ac.uk)).

Osman, S. (1998) R68m to cut NHS waiting lists. Guardian, Monday May 18 1998, p.8.

Proctor, P. (1998) The tutorial: combining asynchronous and synchronous learning. In: Banks, S. et al. Networked Lifelong Learning: innovative approaches to education and training through the Internet: Proceedings of the 1998 International Conference held at the University of Sheffield. Sheffield, University of Sheffield. pp. 3.1 - 3.7.

Redman, G. M. (1997) LPN-BSN: education for a reformed healthcare system. Journal of Nursing Education 36 (3), 121-7. Abstract [online]. Available from: <http://www.mancosa.co.za> [Accessed 28th May 1998].

Sandall, J. (2001) Free web-based virtual midwifery library. Midwifery-research [online]. Available from: <http://www.iiscmail.ac.uk/lists/midwifery-research.html> [Accessed 5th July 2001].

Seedhouse, D. (1997) Health promotion: philosophy, prejudice and practice. Chichester: John Wiley.

Stones, M. (1995) Women, nurses, education: an oral history taking technique. Unpublished M.Ed. dissertation, University of Sheffield.

Weir, P. (1995) Clinical practice development role: a personal reflection. In: K. Kendrick et al. (eds) Innovations in nursing practice. London: Edward Arnold, pp. 5- 22.

## Dissemination of findings

### **SOME STYLE RULES**

#### ***Abbreviations and acronyms***

Avoid abbreviations except for long, familiar terms. The student must use it in full the first time the term occurs and then put the acronym or abbreviation in brackets.

The South African Qualifications Authority (SAQA) is very rigorous in...

A list of abbreviations/ acronyms must be presented at the beginning or as part of the appendices.

#### ***Plurals of abbreviations***

To form the plurals of abbreviations, add s alone without an apostrophe (PhDs, Iqs, Eds).

#### ***Avoiding biased and pejorative language***

In general, avoid anything that causes offense. Below are some examples:

**Step 4.** Do not use ethnic labels (e.g. Hispanic) when you can use geographical labels (e.g. Mexican Americans).

**Step 5.** ‘Men’ (when referring to all adults) when you can use men and women.

**Step 6.** ‘Chairman’ when you can use ‘Chairperson’ and ‘Chair’.

#### ***Current use of the terms ‘gender’ and ‘sex’***

The term “gender” refers to culture and should be used when referring to men and women as social groups. The term “sex” refers to biology and should be used when biological distinctions are emphasized. Avoid gender stereotypes. Below is an example:

“A South African boy’s fascination with rugby” can be replaced with, “A South African youth’s fascination with rugby”.

#### ***Sensitivity to labels***

In general, students should call people what they want to be called. Students should use a neutral term:

“Non-whites in South Africa are now given greater access ...” should be replaced by “Blacks in South Africa are now given greater access ...”

In referring to **age**, the student should be specific about age ranges and avoid open-ended definitions like “under 16” or “over 65.” Similarly, the term “elderly” should be avoided as the term “older person” is preferable.

### **Numbers**

Below are some general pointers:

- Spell out common fractions and common expressions (one-half, Sixteenth of June)
- Spell out numbers at the beginning of sentences (Ten respondents ...)

Use numerals for numbers 10 and above, or lower numbers grouped with numbers 10 and above (e.g. from 6 to 12 hours of work ...)

- Spell out numbers which are inexact or below 10 and not grouped with numbers over 10 (eight items, nine pages, five trials)
- To make plurals out of numbers, add s only with no apostrophe (the 1950s)
- Use combinations of written and Arabic numerals for back-to-back modifiers (five 4-point scales)
- Use combinations of numerals and written numbers for large sums (over 3 million people)
- Use numerals for exact statistical references, scores, sample sizes and sums (multiplied by 3; or 5% of the sample; “We used 30 subjects, all with over two years of work experience, and spent an average of 1hr. 20 min per day not engaged in direct work-related activities.”)
- Use the percent symbol (%) only with figures (5%) and not with written numbers (five percent).

### **General Hints on Language**

Errors of language spelling and punctuation can severely affect the overall assessment of a dissertation. Therefore students must exercise great care in editing and re-editing their completed dissertations to ensure that they are free of errors.

Indeed, some universities require a statement from the student declaring that he/ she has carried out this process or has sought the assistance of a language expert to ensure accuracy of language and expression.

Below are some words of advice for the student:

- Always re-read your work for spelling errors, grammar errors and errors of expression. If possible, secure the services of a knowledgeable friend or expert to do this.
- Do not place over-reliance on a computer spell-check programme. Also ensure that the spell-check is set to the UK or South African and not the American form of English.
- Check the logic of the numbering system and where there is a reference to another page ensure that it is the right page.
- Check the accuracy of references to appendices and ensure that each appendix is correctly numbered.
- Keep sentences short as this makes them easier to read.
- Use complete sentences, which flow logically from one to the next with appropriate connectors.
- Each paragraph should contain one key idea. Short paragraphs are easier to read than paragraphs which extend over the full page.

### **Assessment criteria**

Dissertations are marked both by an internal and an external examiner. The following are the assessment criteria:

- Relevance and significance of research problem
- Clarity in definition of research purpose
- Depth, adequacy and currency of literature review
- Quality and appropriateness of research design

- Soundness of research methodology
- Application of theory
- Quality of data collection and data analysis
- Coherence of argument
- Logicality of conclusions
- Relevance and appropriateness of recommendations and implementation guidelines
- Language, style and presentation factors

### **Roles and Responsibilities of Supervisor and Student**

The relationship between the **supervisor** of a dissertation and the **student** is a reciprocal one with clearly defined roles and responsibilities.

#### ***The supervisor***

- Supervisors are there to guide you only...
- They will not:
- Provide you with literature
- Proof read your work or edit your work
- Write sections for you
- Be available to you 24/7
- Be paid by you, they are paid by Mancosa
- The supervisor is the 'senior' in the relationship

**The student**

- The dissertation is an independent piece of research. It is your responsibility to work consistently and independently.
- You are responsible for your deadlines, communicating them to your supervisor and adhering to them.
- You must make first contact with the supervisor (they are not obligated to meet with you face to face – this is a distance program). You must report to both your supervisor and research coordinator (RC's do pastoral care, you must respond to it).
- Develop a project plan with set timelines for the timely completion of your dissertation.

**Conclusion**

As a rule any Masters level management study which does not include a dissertation can immediately be judged to be below international norms for such qualifications. The dissertation provides the student with a wide range of academic and business-related skills which include:

- Understanding the theory-practice linkage
- Applying research method in the investigation of a defined management problem
- Exercising individual judgement in collating primary data in a problem
- Marshalling information in arriving at sound conclusions and recommendations.

This manual has sought to be comprehensive and useful and has provided a variety of exercises requiring student involvement and problem solving. Nevertheless, it cannot replace the **prescribed textbook**. Therefore students are advised to study their textbook as the primary source for it often presents a more comprehensive coverage of concepts and a wide range of practical examples and guidelines.

## **Appendix A: Example of a research proposal Cultural Factors Influencing the Implementation of Lean Management at a Private Hospital on the Cape Flats**

Nickie Crookes

Student Number: 108012

### **LIST OF ACRONYMS**

<b>ANC</b>	African National Congress
<b>CVF</b>	Competing Values Framework
<b>DoH</b>	Department of Health
<b>EN</b>	Enrolled Nurse
<b>ENA</b>	Enrolled Nursing Auxiliary
<b>NHI</b>	National Health Insurance
<b>NHS</b>	National Health Service
<b>OCAI</b>	Organisational Culture Assessment Instrument
<b>OHSC</b>	Office of Health Standards Compliance
<b>PN</b>	Professional Nurse
<b>WHO</b>	World Health Organisation

## 1 INTRODUCTION

Lean healthcare has become a global trend. In seeking to address escalating costs and preventable errors that compromise patient safety, healthcare leaders around the world have been turning to the philosophy and tools of Lean. In accordance with this healthcare trend the researcher, a Hospital Administrator, intends managing a strategic change initiative with the execution of a new corporate strategy of Lean management at a private hospital in Cape Town.

Whilst there are many examples of how Lean has cost effectively improved healthcare quality, these achievements are limited to specific hospital departments with significant challenge in sustaining the advantage achieved. Leaders in Lean strategy execution blame senior managements' failure to comprehend the contributing influence of organisational culture on the successful adoption of Lean. An organisational culture assessment will be undertaken in the hospital using the Competing Values Framework and its matched Organisational Culture Assessment Instrument. Secondary data collected from a literature search on organisational culture and Lean will be used to discuss the results of the survey. The research will establish whether Lean methods can be successfully implemented within the context of the existing culture of the hospital or whether cultural transformation will be needed ahead of the strategy execution.

## 2 RESEARCH CONTEXT: BACKGROUND

Healthcare in South Africa is facing the most significant transformation in its history. The Department of Health (DoH) published the White Paper for National Health Insurance (NHI) on 12 August 2011 with the intention of bringing about health reform that will ensure equal access to quality health services for all (DoH, 2011a:7). The current NHI reform has its origins in the African National Council (ANC) policy document, A National Health Plan for South Africa (1994), which set about changing the apartheid policies that sustained racial segregation and discrimination in healthcare resulting in profound health inequality.

Guided by resolution 58.33, World Health Assembly (2005:124) that urges countries to develop health financing systems where all people can access healthcare without incurring catastrophic costs, the World Health Organisation (WHO) in its 2008 Health Report calls on countries to address health inequalities through universal coverage which provides the whole population with the same quality service, according to needs and preferences, regardless of an ability to pay (WHO, 2008:25). The promulgated NHI policy typifies universal coverage.

The 2010 WHO report, WHO (2010: 90) emphasizes that any effective strategy for health financing policy needs to be home-grown to which end South Africa's Minister of Health, the Honourable Aaron

Motsoaledi, in his media statement of the 11 August 2011 advises that every effort has been made to design a system that works with and builds on the resources South Africa has. These resources do include the private health system but the Minister cautions that the existing disproportionate private sector pricing needs to be aggressively addressed if NHI is to succeed (DoH, 2011b:1). According to the DoH (2011c:5) the current two tier system preserves inequality therefore the intention is to create a single, NHI funding pool that will reimburse public and private healthcare providers on exactly the same basis. The rate at which the NHI fund will pay healthcare providers will be higher than the present cost of public health services but lower than rates in the private sector to encourage health care providers to operate efficiently whilst providing the same standard of care from both (DoH, 2011c:14).

But the NHI fund will only contract health facilities that meet strict quality standards as certified by the Office of Health Standards Compliance (OHSC) to guarantee that standards of hygiene, safety and respect for patients are being met (DoH, 2011c:31). Whilst the government predicts it will take 14 years to complete the NHI project, a 132 bed private hospital in a previously disadvantaged community of the Cape Flats, in the Western Cape, has adopted a long term strategy to be ready for the business changes NHI will bring. The hospital operates at 100 % occupancies according to its licensed acuties and specialities already. If the price paid for services is to be reduced then it can be anticipated that revenue will be reduced since sales cannot be increased sufficiently to counterbalance decreased turnover. If the hospital still wants to maximise profits then the hospital has to proportionately reduce expenses. The reduction of expenses cannot sacrifice quality if the hospital wishes to meet OHSC standards to contract with the NHI fund or continue to provide safe services to patients.

Therefore two critical success factors have been identified; one, the ability to meet the quality standards of OHSC and two, the ability to reduce expenses. The significant challenge is reducing the underlying costs in a system where prices are set by the market and not the hospital. Given WHO (2010:79) estimates that 20–40 % of all health spending is waste and suggests that low-income countries could save 12–24 % of their total health spending annually by improving hospital or workforce efficiency, hospital management has identified the tools and philosophies of Lean as a good strategic fit to meet the critical success factors of improving efficiencies whilst eliminating waste.

But Bhasin and Burcher (2006: 56) and Drake, Brennan and Gortz (2008:303) reveal only 10 % of Lean change initiatives are successfully implemented. A major contributing factor to the failure is a focus on the technological tools of Lean without an equal focus on the people (Graban 2009:133; Liker 2004:358; Bhasin and Burcher 2006:62).

Denison and Spreitzer (1991: 2) advise that organisational development researchers have learnt that core values and assumptions are at the root of organisational systems and structures and in order to change an organisation one must first examine the relationships between underlying values, organisational structures and individual meaning.

### **3 THE RESEARCH PROBLEM**

To remain profitable when NHI changes the way the hospital conducts its business the Hospital Administrator has chosen to execute a new corporate strategy of Lean management. Unfortunately the first step of the first Lean tool attempted failed to be adopted by the staff. Research into this management problem revealed that organisational culture can impede the successful execution of a Lean strategy. The purpose of this study is to investigate the culture and sub-cultures of the hospital using the Competing Values Framework to establish whether Lean can be implemented within the context of the existing culture or if cultural transformation will be needed ahead of the Lean strategy execution.

### **4 AIM OF THE STUDY**

The aim of this study is to analyse the existing culture and sub-cultures of the organisation to determine cultural impact on management's intention to execute a Lean strategy at the hospital. Comparison will be made from the findings of the primary data obtained, through the administration of the Organisational Culture Assessment Instrument to the staff, and the literature presented. It is expected that the results of the research will make recommendation to management to transform the existing culture before executing a Lean strategy.

### **5 RESEARCH OBJECTIVES**

1. To examine the hospital's existing cultural typologies, cultural strength and cultural congruence using the Competing Values Framework.
2. To identify inter-departmental and professional group culture, congruence and their alignment with the identified organisational culture.
3. To understand if the existing culture and sub-cultural elements are compatible with the Lean cultural elements required to sustain the strategy.
4. To understand to what extent the existing culture and sub-culture will constrain or facilitate the strategic change initiative.

## 6 RESEARCH QUESTIONS

RQ 1 What are the hospital's existing cultural typologies, cultural strength and cultural congruence using the Competing Values Framework?

RQ 2 What are inter-departmental and professional group culture, congruence and their alignment with the identified organisational culture?

RQ 3. Are the existing culture and sub-cultural elements compatible with the Lean cultural elements required to sustain the strategy?

RQ 4. To what extent will the existing culture and sub-cultures constrain or facilitate the strategic change initiative?

## 7 SIGNIFICANCE OF THE STUDY

NHI presents as a burning platform to the South African private health industry. This study is significant to the Hospital Administrator who needs to lead and manage the hospital successfully through a change in the external environment. Whilst there is much academic commentary on the development and structure of NHI, a search on how private healthcare intends surviving the healthcare transformation revealed no results. International literature links Lean and healthcare reform in numerous studies but only limited information was available on Lean initiatives in South African hospitals. International studies also correlate the influence of organisational culture on Lean strategy execution but no organisational culture studies could be found for South African hospitals. This research is pertinent to any hospital that recognises the integral bearing of organisational culture on the ability to successfully execute a change initiative. It has particular significance to the implementation of sustained Lean initiatives in South African hospitals.

## 8 LITERATURE REVIEW

### 8.1 Introduction

The literature review opens by validating the use of Lean manufacturing in the service environment of hospitals and discusses reasons for the difficulty in successfully implementing and sustaining Lean. This leads into an overview of organisational culture, how culture influences the workforce, discusses cultural strength and introduces the concept of assessing subculture. The first two sections are tied together with a discussion on Lean culture. The review concludes with a comprehensive evaluation of the Competing Values Framework in the assessment of organisational culture which creates the background for the research methodology and findings.

## 8.2 A Case for Lean in Healthcare

WHO (2010: xvii) believes all countries could save on health expenditure by 1) getting the most out of technologies and health services, 2) motivating health workers, 3) improving hospital efficiency, 4) getting care right the first time by reducing medical errors, 5) eliminating waste and corruption, and 6) critically assessing what services are needed. Hollingsworth (2008: 1107) asserts that hospitals could achieve 15 % better efficiencies at the same cost or could offer the same level of service but at a cost reduction of 15 % following his review of 300 studies investigating the efficiency and productivity of health-care delivery which found that hospital efficiency was on average only 85%.

The growing application of Lean thinking in the healthcare industry can be well understood when viewed against the WHO's deductions. Healthcare services around the world have turned to Lean process improvement methodologies from the manufacturing sector to address issues of quality, cost and inefficiency (Institute for Healthcare Improvement, 2005:17; Graban, 2009: iii; Radnor, Holweg and Waring 2011: 364; Radnor and Burgess 2010:11)

Papadopoulos (2010:209) describes Lean in healthcare as a focus on the continual assessment and improvement of clinical processes to identify and eliminate waste from the patient pathways, to enable staff to examine their own workplace, and to increase quality, safety, and efficiency in processes.

The United States of America (USA) began experimenting in the mid-1990's with adapting Lean processes from manufacturing for the health services industry informs Toussaint and Gerard (2010: v). In the United Kingdom, Fillingham (2007:232) reports that the Bolton Hospitals NHS Trust has proven that Lean can save lives with their own interpretation of the Toyota Way, adapted to suit the hospital's culture called the Bolton Improving Care System (BICS). Radnor and Burgess (2010: 2) report that in a literature review of Business Process Improvement Methodologies carried out on behalf of the National Audit Office, 51% of the publications sourced focused on Lean and of these 35 % were in the healthcare industry, indicating that Lean is the most often cited process improvement methodology in the health sector.

In South Africa, the Lean Institute Africa reports a substantial increase in requests for information and training in Lean principles from both the private and the public sectors in recent years (Faull, 2009: 1). The Lean Institute Africa also reports the successful implementation of Lean projects at Groote Schuur Hospital which have drawn the attention of role-players in South Africa's healthcare industry. In May 2010 the Lean Institute Africa set out to test the efficiency of Lean methodologies in 18 South African public hospitals in rural and penurious trial sites.

Sixty five percent of the hospitals reported improved processes with opportunity to enhance practices further or at least sustain the advantage achieved without the need for any additional resources (Faull, 2011:1).

Not all the hospitals in the trial were as successful, 35% of the hospitals affected little if any change at all. Whilst nurses and doctors tend to be hard working and dedicated Faull (2011:1) suggests that hospital management lacked the same level of engagement to support staff. Included in the possible causes for failure was organisational culture where staff are resistant to change believing that the way things have always been done is best.

### **8.3 Difficulty in Implementing and Sustaining Lean**

There is a plethora of research commentary on the reasons why Lean initiatives fail to take root. Bhasin and Burcher (2006: 56) report on the research of multiple authors who conclude that contributing factors to the failures are an incorrect philosophy, ineffective human resource management, inadequate leadership, financial conflict and poor Lean implementation procedure. Jenei (2009:77) also discusses organisational features linked to sustainability such as the availability and quality of resources, knowledge transfer, support of senior management and the need for an aligned strategic objective. But by far the most significant factor influencing sustainability of outcomes is organisational readiness related to the culture of the organisation.

Radnor and Burgess (2010:1) make reference to a number of authors who inform that hospitals have taken a tools based and fragmented approach to Lean implementation which has led to pockets of best practice and at the worst dysfunctional results in the patient pathway. Dahlgaard and Dahlgaard-Park (2006: 278- 279) urge managers to understand that building quality into people is not the same as building competencies into people and therefore there should be more focus on the human factor of the company culture and less emphasis on the tools and techniques.

The dependence of organisational improvement on culture change is ascribed by Cameron and Quinn (2011: 397) to the fact that when strategies are altered but values, orientation, definitions and goals stay the same organisations return quickly to the previous status quo. Vest and Gamm (2009:2) concur saying quality transformation in healthcare settings frequently face adverse cultures and will fail to translate into sustainable results if managers wrongly assume that employees will automatically adhere to new philosophies without attention to changes in organisational culture.

Papadopoulos, Radnor and Merali (2011:169) agree declaring that the fundamental success to Lean implementation is a change in behaviour, culture and staff mindset. Jenei (2009:173) concludes that organisational culture affects the potential of Lean and in the converse Lean has effects on culture. To be more effective, organisational culture needs to be contiguous with a Lean culture of organisational learning where there is close co-operation between professional groups.

## **8.4 Organisational Culture**

### **8.4.1 Overview**

According to Cameron and Quinn (2011: 486) the theory of organisational culture has emerged from a combination of organisational psychology, social psychology and anthropological psychology. The anthropological foundation assumes that organisations are cultures and the sociological foundation assumes that organisations have cultures. This research assumes the sociological foundation in which Davies, Nutley and Mannion (2000:112) declare that organisational culture is the emergent property of a group making it possible to describe and assess culture as well as create, change and manage culture in pursuit of organisational goals.

Scott, Mannion, Davies and Marshall (2003b: 925) advise that organisational culture represents a wide range of social phenomena including dress, language, behaviour, beliefs, values, assumptions, symbols of status and authority, myths, ceremonies, rituals and modes of esteem and subversion. Because of this array of phenomena there is little consensus on the exact definition of culture. This research uses Schein's (2009:555) definition of culture which says,

"Culture is a pattern of shared tacit assumptions that was learned by a group as it solved its problems of external adaption and internal integration that has worked well enough to be considered valid and therefore to be taught to new members as the correct way to perceive, think and feel in relation to those problems."

### **8.4.2 Cultural Influence on the Workforce**

Schein (2009: 440) points out that culture not only resides within individuals but is the hidden driving force inside and outside the organisation since employees are members of an occupation, country, community, family and social group. Culture forms at all levels including small teams, work groups, departments, hierarchical levels, professional groups, occupations, whole industries, regions and countries due to language, ethnicity, religion and shared experience. According to Liker (2004:6) organisational culture has three levels, 1) artefacts on the surface which are the visible organisational

structures and processes, 2) espoused values depicting strategies, goals and philosophies and 3) underlying assumptions below the surface which are taken for granted beliefs, perceptions and thoughts that are the ultimate source of values and action.

Culture therefore has significance as the influential, implicit and often unconscious set of forces that determines individual and collective behaviour. Organisational culture in particular has importance because cultural elements determine strategy, goals and modes of operating. Heskett (2012:545) sees culture as an element of organisational strategy capable of fostering stability and facilitating strategic change.

#### **8.4.3. Cultural Strength**

Thompson, Strickland and Gamble (2008:420) advise that corporate culture can vary in strength and influence. Strong cultures develop over considerable time, are deeply embedded and dominate the culturally-approved behaviour of staff. Whilst it is believed strength contributes to organisational effectiveness and reinforcement of strategy, Thompson et al. (2008: 445) caution that strong cultures can be a liability if they resist strategic change. The closer the strategy-culture fit the more employees will adopt behaviour, work practices and actions supportive of the strategy and the more peer pressure will assist in squashing culturally-disapproved behaviour.

#### **8.4.4 Importance of Sub-Culture**

Lok, Rhodes and Westwood (2011: 507) assert that researchers often reflect on organisational culture monolithically which neglects the impact of subculture. Subculture forms from individuals affiliations with subgroups such as occupational and professional identification, work location, functional locus, hierarchical levels and demographic factors such as age, ethnicity and gender. By example nurses identify more closely with their localised area of work, the ward or unit they work in, rather than with the hospital as a whole.

In relation to Lean, Fillingham (2007: 232) observes that because most hospitals work in departmental silos there is difficulty when seeking to remove waste across the entire patient pathway. If the subculture of a department is incongruent with the culture of the hospital or incompatible with a Lean culture there can be difficulty in applying Lean to the patient's journey throughout the hospital. Brown and Harvey (2006: 42) view an organisation as a system of interrelated parts, where change in one part of an organisation has consequences in other parts. Recommendation is made for a systems approach to managing change where managers consider the interrelationships among the sub elements of the organisation.

## 8.5 Lean Culture

According to the Institute for Healthcare Improvement (2005:4) Lean principles will only take root if managers have first worked to create an organisational culture that is amenable to Lean thinking. A Lean culture is the framework against which Lean tools and techniques are implemented. Drake et al. (2008: 300) suggest that to successfully implement Lean processes, companies need to develop a responsible self-leadership culture. Ahrens (2006: 25) supports the theory of a less hierarchical organisation operating with empowered teams where there is decentralization of decision making through the enablement of co-workers to problem solve instead of management telling them what to do. Leaders in successful Lean enterprises motivate, coach and train the shop floor to continuously improve by facilitating experimentation with changes, where appropriate. Al-khalifa and Aspinwall (2000:1024) conclude that the ideal cultural characteristics to support the philosophy and facilitate its implementation are group and adhocracy cultures because the characteristics lean towards flexibility, customer orientation emphasizing participation, innovation, concern for human resource development and the decentralisation of decision making.

## 8.6 The Competing Values Framework

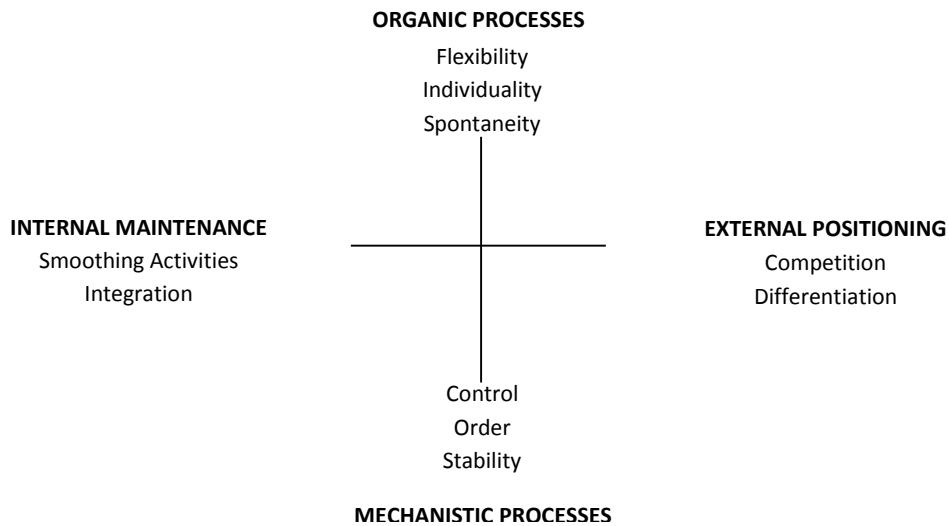
The Competing Values Framework (CVF) is considered one of the 40 most important theoretical models in the history of business for assessing organisational culture. It follows the classification of culture represented by the sociological disciplinary foundation say Cameron and Quinn (2011:2419).

Yu and Wu (2009:37) cite Quinn and Rohrbaugh (1983) as the originators of the framework with their analysis of organisational effectiveness criteria which grouped together in two major dimensions and four main clusters. Scott et al. (2003a: 68) inform that the effectiveness indicators clustered together in a way that almost exactly replicated Jung's (1923) model of psychological archetypes. These psychological archetypes help to organise the underlying assumptions and understandings that occur among individual organisations and which become labelled cultures.

According to Cameron, Quinn, DeGraaf and Thakor (2006: 15) the two main dimensions represented graphically in Figure 1 by a horizontal axis (x-axis) and a vertical axis (y-axis), depict the tensions or competing values that occur in all organisations. The y-axis reflects the competing values of change and stability. At one end of the axis the organisation is effective if it is changing, adaptable and organic and at the opposing end the organisation is effective if it is stable, predictable and mechanistic. The x-axis reflects the competing values of the internal organisation and the external environment.

At one end effectiveness is demonstrated through efficient internal processes and integration and at the opposing end, effectiveness is demonstrated if the organisation maintains a competitive external position in relation to customers and clients.

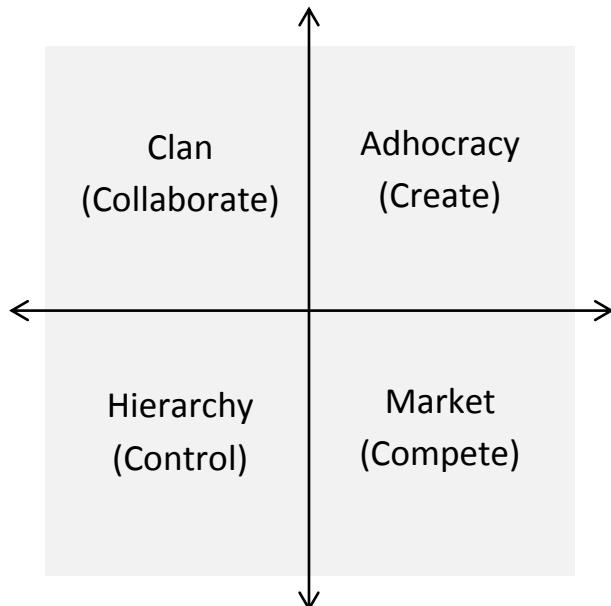
**Figure 1. A Model of Culture Types for Organisations**



**Source:** Scott et al. (2003a: 67)

The four main clusters, each representing a culture type are labelled according to their most notable characteristics as clan, adhocracy, market and hierarchy, see Figure 2.

**Figure 2. The Competing Values Framework**



**Source:** Cameron and Quinn (2011:764)

### 8.6.1 Clan Culture

Clan culture, in the upper left quadrant of the framework is described by Cameron and Quinn (2011: 896) as a culture with shared values and common goals. The working environment is friendly; people have a lot in common and share personal information, much like an extended family. Leaders are facilitators, mentors and team builders, and can be seen as nurturing parent figures. Management style is to reward team work, participation and consensus. There is a premium on open communication. The glue that holds the organisation together is loyalty, tradition and mutual trust; colleagues are bonded by morals. Strategic emphasis is the long-term development of human resources, empowerment of employees and employee participation to improve their own work and the performance of the company. Success is defined by addressing the needs of clients and caring for people.

### 8.6.2 Adhocracy Culture

The root of the word adhocracy advises Cameron and Quinn (2011:915) is *ad-hoc* denoting something temporary. The adhocracy culture, in the upper right quadrant, is like a transient institution which reinvents itself whenever new projects are implemented. The working environment is creative, dynamic and entrepreneurial. People are willing to experiment and take risks. Leaders are innovators, visionaries and risk takers. Management style is to reward individuality, initiative, innovation, freedom and uniqueness. Trialling and prospecting for new opportunities and finding creative solutions are valued. The glue that holds the organisation together is inspiration, commitment to readiness to change and cutting edge development. The emphasis is on continuous improvement, acquiring new resources, anticipating the future and creating new challenges. Criteria for success are defined on the basis of having the most unique products or services with the long term goal of being the product or service leader.

### 8.6.3 Market Culture

Market culture, positioned in the lower right quadrant, is results orientated where the first priority is to get the job done. People are competitive, goal driven and achievement orientated. Organisational leadership demonstrates an aggressive, no-nonsense approach towards productivity, outcomes and profits. Leaders have high expectations, are tough on employees and demand achievements. The glue that holds the organisation together is an aggressive emphasis on outpacing competitors, winning and goal accomplishment. Strategic emphasis is on rival activities, competitive actions, achieving stretch targets and dominating the market. Success is defined on the basis of triumphing over competitors, penetrating the market and increasing stock (Cameron and Quinn, 2011:825).

#### **8.6.4 Hierarchy Culture**

According to Cameron and Quinn (2011:792) organisations with a hierarchy culture are very controlled and structured, formal procedures and routine rule what people do. Leadership demonstrates efficiency based coordination and the effecting of smooth running of operations. Clear lines of decision-making authority, predictability, stability, and conformity exemplify management style. The glue that holds the organisation together is security, order and rules. Dependable delivery, control, standardisation and low cost delivery are strategically important. Success criteria are defined by employment stability, smooth execution of tasks and efficiency.

#### **8.6.5 Interpreting the Framework**

Each of the quadrants represents a core value with an opposite or competing assumption. Clan culture emphasises flexibility with an internal focus on integration and unity which contradicts market culture on the diagonal opposite which emphasises stability with an external orientation. The adhocracy culture emphasises flexibility and change with focus on the external environment and its polar opposite is the hierarchy culture which emphasises control and stability with an internal focus. It is the presentation of these contrasting and competing values that gives the framework its name (Cameron and Quinn, 2011:761).

Denison and Spreitzer (1991:16) explain that the CVF's focus on the inherent tensions and conflicts of organisational life is useful for the conceptualisation of paradoxical phenomena in the organisation, the examination of balance as well as the ability to diagnose cultural strength, cultural type and cultural congruence. Scott et al. (2003a: 68) assert that by examining a typology of cultural attributes, researchers are able to pragmatically investigate to what extent elements of culture are congruent. Cultural congruence is demonstrated in the CVF when the dominant characteristics of the organisation match organisational leadership style, management of employees, bonding mechanisms, criteria for success and the strategic emphasis.

### **9 RESEARCH DESIGN AND METHODOLOGY**

#### **9.1 Research Methodology**

This study takes a positivist approach to understanding the hospital's cultural typologies, cultural strength and cultural congruence. To investigate the research questions the researcher will apply a cross-sectional, simple descriptive survey called the Competing Values Framework (CVF), to the staff of the hospital. The CVF provides a quantitative measurement of organisational culture and has a strong and well established empirical basis for cultural diagnosis.

Kwan and Walker (2004: 21) assert that of all the quantitative instruments available, the CVF and its matched OCAI has become the dominant model in quantitative research on organisational culture. In particular Helfrich, Li, Mohr, Meterko and Sales (2007: 2) state that the OCAI is the most commonly used instrument in health services research.

Scott et al. (2003b:941) remark on the significance of the use of the Competing Values Framework (CVF) to analyse sub-culture in health settings where professional cultures are strong because the CVF is specifically designed to represent the balance of different cultures within the same hospital.

## **9.2 Sampling Strategy**

Data will be collected by issuing the OCAI survey instrument to the population of 228 permanently employed staff who engage in the patient pathway in the hospital. This research population is a well-defined collection of individuals that have the common characteristic of impacting patient experience, quality outcomes and patient costs. Due to the size of the hospital it is both possible and necessary to include all elements in this research population to comprehensively add value to the theory.

Pathology and Radiology services are excluded because they are contracted out companies with their own organisational culture. Non-nursing categories such as catering, housekeeping and maintenance are excluded because these departments do not have a direct influence on the patient pathway. Sessional agency staff are also excluded because whilst demonstrating occupational and regional similarities they are transient workers and have not been exposed to the espoused values beliefs and assumptions of the hospital sufficiently to contribute to the study.

Demographic data has emphasis on hierarchical position, department of work and differentiation between night duty staff and day duty staff for sub-group analysis. Length of employment has significance in determining adoption of culture and influence of founders and previous leadership.

## **9.3 Data Collection Instrument**

The data collection instrument is based on an established tool, the Organization Culture Assessment Instrument (OCAI) which is rooted in the CVF (Cameron and Quinn, 2011). The OCAI can be found in Appendix B.

Cameron and Quinn (2011:2497) have detailed that the manner in which individuals describe the cultures of their organisations is congruent with the dimensions of the competing values framework.

Therefore the key to assessing organisational culture is to give individuals an instrument that creates an opportunity to respond to cues that identify aspects of the organisation's core values and assumptions. Organisation members are presented with a survey instrument containing six dimensions, each dimension has four scenarios that describe certain fundamental culture aspects of organisations. Individuals rate their own organisation's similarity to the scenarios by dividing one hundred points among the four scenarios. Individuals give the highest allocation of the one hundred points to the scenario that best describes their organisation and divide the balance of the points amongst the remaining scenarios as per their similarity to the organisation. The total must always equal one hundred. The six dimensions of organisational culture presented for assessment are;

1. the dominant cultural characteristics of the organisation;
2. the organizational leadership style;
3. human resource management, describing the way employees are treated;
4. the organizational 'glue' or bonding mechanisms that hold the organisation together;
5. the strategic emphasis that defines what drives the organisation's strategy; and
6. the criteria for success that determines victory and what gets rewarded.

### **9.3.1 Reliability of the OCAI**

Reliability refers to the extent to which the items of the OCAI measure culture types consistently. Cameron and Quinn (2011: 2576) attest to the internal consistency, a measure based on the correlations between different items on the same test, of the OCAI with the following Cronbach's alpha results from multiple large studies, clan culture scored .79, adhocracy .80, market .77 and hierarchy .76. The reliability coefficients according to Streiner (2003: 103) are acceptable for basic research tools. The results matched or exceeded the reliability of the most commonly used instruments in social and organisational studies.

### **9.3.2 Validity of the OCAI**

Validity is considered to be the degree to which the tool measures what it claims to measure. Cameron and Quinn (2011: 2594) make reference to Cameron and Freeman's (1991) analysis that produced results that were highly consistent with the espoused values and attributes claimed to be typical of each culture type in the CVF therefore providing strong evidence for concurrent validity. Cameron and Quinn (2011: 2628) also cite the work of Quinn and Spreitzer (1991) who found strong support for convergent validity and discriminant validity using multitrait- multimethod and multidimensional scaling analysis.

In this study two different instruments to assess organisational culture were used as the two methods, one was the ipsative scale and the other was a Likert-type scale where each alternative was rated 1-5. The scales of the four culture quadrants represented the four traits.

A moderate level of convergent validity was found on all diagonal correlation coefficients in the same quadrant, ranging between .212 and .515 ( $p < .001$ ). Three discriminant validity tests were used. In test one, 23 out of 24 comparisons were consistent with the expectations providing strong evidence of discriminant validity. In test two, moderate discriminant validity was found when sixteen out of the twenty four comparisons were consistent with the expectation. In the third test, Kendall's coefficient of concordance was computed producing a score of .764 ( $p < .001$ ) indicating strong support for discriminant validity. Cameron and Quinn (2011: 2640) also report that the multi-dimensional scaling procedure produced a Guttman and Lingoe's coefficient of alienation of,  $r = .076$  and a Shepherd and Kruskal's stress coefficient of, stress = .056 indicating a satisfactory fit of the data to the model. In the study each culture type appeared in a different quadrant as well as the correct quadrant with like cultures positioned closer to each other than unlike cultures.

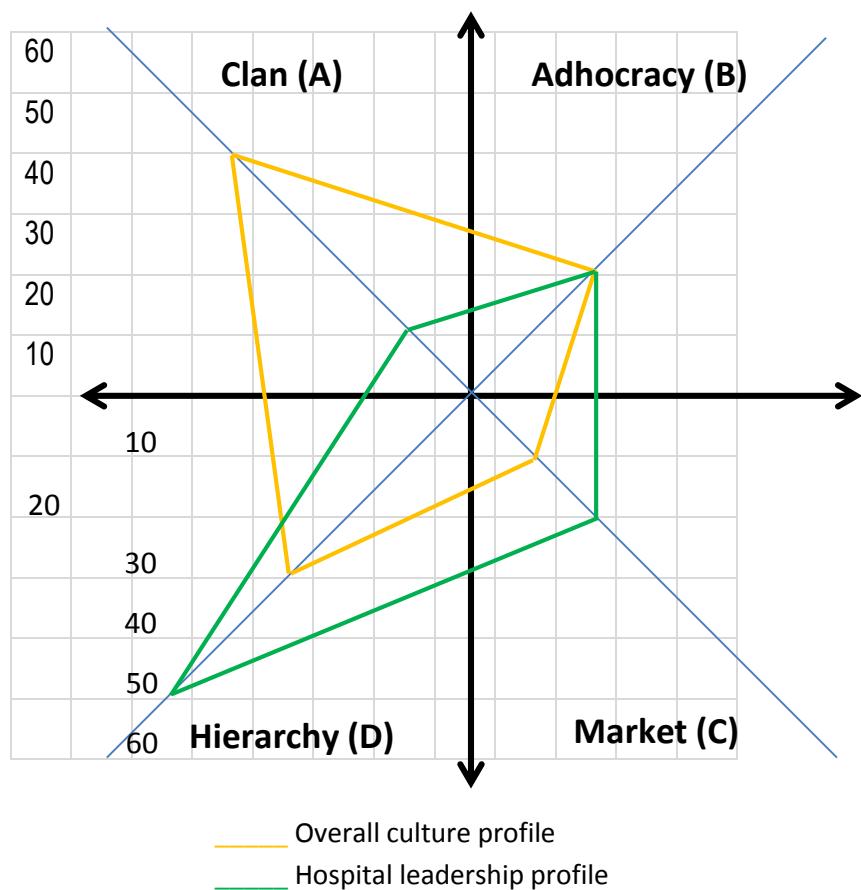
Cameron and Quinn (2011: 2657) conclude that of all the reliability and validity studies undertaken none have produced contradictory disconfirmatory evidence therefore empirical evidence suggests the OCAI measures what it claims and does so in a reliable way.

#### **9.4 Data Analysis**

The OCAI response scale is called an ipsative rating scale. The researcher has chosen to use the ipsative method of scoring the survey as opposed to alternative Likert-scale method because this study is not seeking to use correlation –based statistical analysis, such as factor analysis and regression, which are based on the assumption of independent responses for each item (Prajogo and McDermott, 2009:720). Ipsative response scales do not produce independent responses say Cameron and Quinn (2001: 2668) who also record a second disadvantage of the Likert scale in that respondents tend to rate all quadrants high or all quadrants low resulting in less differentiation. The primary advantage is to identify and differentiate the cultural uniqueness of the hospital.

The OCAI is scored using excel worksheets to calculate the mean of each of the alternatives. The mean is then plotted on the culture profile framework. By joining the plotted values with a solid line, a kite-like picture of the organisational culture is created allowing the dominant type to be identified as depicted by the orange diagram in Figure 3. Each of the six dimensions assessed are then plotted against the overall culture profile in a series of graphs to examine cultural congruence. By example the green diagram overlaying the orange diagram in Figure 3 demonstrates the comparison.

Using the demographic data, cultural profiles of each department will be plotted against the overall profile to identify sub-culture type, congruence and the organisation's cultural strength.



**Figure 3. Graph for Plotting Cultural Profile**

Source: Cameron and Quinn (2001:3589)

### 9.5 Pilot Study

Ten candidates were selected by convenience sampling from the research population. Initial face validity response whilst reading the original OCAI survey, see Appendix C, was that it was not easy to understand what the scenarios were describing. Pilot respondents advised that the words used were too sophisticated in their orientation towards business language and the reference to products and manufacturing was confusing. Suggestion was made to change wording slightly to orientate the items for recognition to the hospital. The revised wording was carefully selected so as to not influence the connotation of the cultural attributes.

The survey was then reissued and all pilot participants confirmed better face validity and were able to complete the survey in 20-25 minutes. Each pilot participant reported they understood the comparisons and experienced no confusion in the interpretation of the items presented. There were no further suggestions for changes.

## **9.6 Ethical Considerations**

Permission to conduct the survey in the hospital was obtained from the Chief Executive Officer of the hospital's holding company and appears in Appendix A of this proposal. The opening paragraph of the survey thanks participants for consenting to participate and advises that participation is voluntary. Informed consent is therefore obtained by voluntary participation. Identity is withheld, no demographic questions will compromise the privacy of participants and collection methods of surveys will be unsystematic.

## **10 CHAPTER ORGANISATION**

Chapter one contains an introduction to the research, provides the background and context for the research, defines the research problem, explains the aim of the study, offers the research objectives and provides the research questions. The chapter concludes with the significance of the study. Chapter two provides a review of the literature and provides the theoretical framework for the research by discussing the Toyota Production System, Lean, Lean in healthcare and the difficulties implementing and sustaining Lean. The chapter continues with a review of organisational culture, the importance of sub-culture and ties the content together with a discussion on Lean culture. The chapter concludes with a review of the Competing Values Framework.

Chapter three discusses the research design and methodology and includes the sampling strategy, the data collection instrument, data analysis and pilot study. The chapter ends with ethical considerations for the research.

## **11 PROPOSED TIMETABLE**

As soon as approval for this proposal is received the OCAL will be issued to four shifts of staff in the hospital over a period of four days and nights. The surveys will be collected over a period of two weeks. It is anticipated that collation of the results and graphing of the findings will take a further ten days.

## **12 CONCLUSION**

Without doubt NHI will change how private hospitals in South Africa conduct business. Brown and Harvey (2006: 35) advocate that managers in a changing environment need to do more than just react, they need to anticipate change and develop a renewal orientation before conditions occur if they are to maintain a competitive edge or even survive external forces. Thompson et al. (2008:16) inform that the central thrust of an organisation's strategy is undertaking moves to build and strengthen long-term competitive position and financial performance through pro-active and purposeful actions. In thinking strategically about the external and internal environment, the researcher has formed a strategic vision of where the hospital needs to be, has identified promising strategic options with the implementation of Lean methodologies to the operations and culture of the hospital and has selected an incremental, renewing change strategy that focuses on the influence of organisational culture on strategy execution. This proposal has identified a business management problem confronting the hospital and demonstrates how MBA knowledge obtained in the studies of Corporate Strategy, Human Resources, Quantitative Methods and Managing Strategic Change will be used to solve the problem.

**APPENDIX A**

**LETTER OF PERMISSION TO CONDUCT SURVEY**

Templar Road, Gelvalla,  
P.O. Box 204 Gelvalla,  
7764, South Africa.



Tel: +27 21 599 9939 Fax: +27 21 599 1023  
website: <http://www.melomed.co.za>  
e-mail: [info@melomed.co.za](mailto:info@melomed.co.za)

15 March 2012

Mrs. Mutaa Jaboon  
Research Coordinator  
Management College of South Africa  
26 Samora Machel Street  
Durban  
40001

Dear Madam

**RE: NICOLA CROOKES: STUDENT NUMBER 108012**

This serves to confirm that the above student has received permission to conduct research through an administration survey involving the staff of the Melomed Mitchells Plain hospital.

Yours Faithfully

Melomed Hospital Holdings

Mr. R. Allie  
CEO

**MELOMED BELLVILLE**

**MELOMED GATESVILLE**

**MELOMED MITCHELLS PLAIN**

Directors: L. Myeni (Chairman), R. Allie, B. E. Botha, J. S. Morris, B. S. Govender, J. Naidoo  
Reg. No. 1994/025628/07

## **APPENDIX B: THE ORGANISATIONAL CULTURE ASSESSMENT INSTRUMENT**

Thank you for consenting to help with this study on the organisational culture of our hospital. Participation is voluntary only. Please complete the questions below on your own without checking answers with others because your own response is unique and very important. There are no right or wrong answers and this is not a test. Your name will not appear on the paper and when you hand the paper back it will go into a box with all the other studies so you remain anonymous.

Each question has four sentences describing something about the hospital A. B. C. and D. Please give a score to each sentence so the answers add to 100. You will give the highest score to the sentence that best describes the hospital, the next highest score to the next best answer, another score to the next best answer and the lowest score to the answer that least describes the hospital.

### **Section A: Demographics**

What category of work do you do? By example, Unit Manager, HOD, PN, EN, ENA, Care Giver, Technician, Pharmacist, Administration.

What ward, unit or department do you work in? By example, Surgical, Theatre, Maternity, Admin

Do you work mostly night duty or day duty? Mark with an X.

Night duty	Day duty
------------	----------

How long have you worked at the hospital? Mark with an X.

Less than 1 year	
2 years – 5 years	
6 years – 10 years	
More than 10 years	

**Section B: Organisational Culture Assessment**

<b>1.</b>	<b>Dominant Characteristics</b>	<b>Score</b>
A.	The hospital is a very personal place.	
B.	The staff are like an extended family.	
C.	The hospital is a very dynamic innovative place. People are willing to stick their necks out and take risks.	
D.	The hospital is very results driven.	
E.	The hospital is a very controlled and structured place. Formal policies and procedures rule what people do.	
	<b>Total</b>	<b>100</b>
<b>2.</b>	<b>Hospital Leadership</b>	
A.	The leadership in the hospital generally shows nurturing or teaching.	
B.	The leadership in the hospital generally shows risk taking.	
C.	The leadership in the hospital generally shows a no-nonsense approach.	
D.	The leadership in the hospital generally shows coordination, smooth running, efficiency and good organising	
E.	The leadership in the hospital generally shows a Very results focused approach.	
	<b>Total</b>	<b>100</b>
<b>3.</b>	<b>Management of Employees</b>	
A.	The management style of the hospital is characterised by teamwork, consensus and participation.	
B.	The management style of the hospital is characterised by individual risk-taking, innovation, freedom and uniqueness.	
C.	The management style of the hospital is characterised by hard-driving competitiveness.	
D.	The management style of the hospital is characterised by security of employment.	
E.	The management style of the hospital is characterised by security of stability in relationships.	
	<b>Total</b>	<b>100</b>
<b>4.</b>	<b>Hospital Glue</b>	
A.	The glue that holds the hospital together is loyalty. Commitment to the hospital runs high.	
B.	The glue that holds the hospital together is commitment to innovation and	

	development. There is emphasis on being on the cutting edge.	
C.	The glue that holds the hospital together is achievement and goal success. Forcefulness and winning are common themes.	
D.	The glue that holds the hospital together is formal rules and policies. Keeping a smooth running hospital is important.	
E.	The glue that holds the hospital together is mutual trust.	
	<b>Total</b>	<b>100</b>
<b>5.</b>	<b>Strategic Emphasis</b>	
A.	The hospital emphasises human development. High trust, openness and participation are important.	
B.	The hospital emphasises getting new resources and creating new challenges.	
C.	The hospital emphasises competitive actions and achievement. Hitting targets and winning against other hospitals is important.	
D.	The hospital emphasises steadiness and stability. Efficiency, control and smooth operations are important.	
E.	Trying new things and looking for new opportunities are important.	
	<b>Total</b>	<b>100</b>
<b>6.</b>	<b>Criteria of Success</b>	
A.	The hospital sees success on the basis of the development of the staff, teamwork, employee commitment.	
B.	The hospital sees success on the basis of having the most unique service or latest developments. It is a service leader and innovator.	
C.	The hospital sees success on the basis of winning against other hospitals. Leading the market is important.	
D.	The hospital sees success on the basis of efficiency. Reliable delivery of service and smooth cost effective processes are very important.	
E.	The hospital sees success on the basis of concern for people.	
	<b>Total</b>	<b>100</b>

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