Cape Peninsula University of Technology

An Effective Quality Management Approach for New Product Development Process

by

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DECLARATION

I, Bongiwe Mali-Swelindawo, hereby declare that the contents of this dissertation represent my own unaided work, and that this dissertation has not been submitted previously for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

Signed:_____ **Date:** 21 November 2012

ABSTRACT

New Product Development (NPD) is a complicated process that determines success or failure of any company engaging in product development processes. Over the past years, due to the current highly competitive market environment, poor management skills, lack of innovation and customer concern, many companies are struggling to develop new products while simultaneously maintaining high quality of each of these new products. Various studies described that quality management is critical to prolong the life cycle of new products. Thus, this study focused on the key success factors of NPD and integrated quality management strategies into NPD process.

This study was conducted at a local plastic packaging and load securing company in the Western Cape Province of South Africa. A combination of both qualitative and quantitative research approaches was conducted. Both management (n_1=5) the staff members (n_2=24) who are involved in the NPD process were selected as samples. A semi-structured questionnaire and several interviews (in-depth and focused group) were utilised for data collection. A statistical programme (SPSS V20) was employed to generate descriptive statistical results and test the reliability of all the variables.

The study results identified that the key quality determinants of the NPD process were are NPD reviews, verifications and validations. In addition, for the NPD process to be successful, the company should focus on the development of the NPD strategy, availability of skills and resources including NPD competence, product quality, empowered multidisciplinary teams and effective risk management. Based on the research findings, this study recommends that the company should have more focuses on the areas of customer dissatisfaction, product quality, and prototype planning in their NPD processes.

Keywords: Quality management, new product development, leadership, customer requirements, product strategy, and multidisciplinary teams

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To my Mama (in-law), Nomayeza (Nothawuzeni) Betty Maseti-Swelindawo, for being an inspiration in my life; thank you for your love, support, life guidance and compliments. "I am few miles away from your dream, of at least, one of your children, let us patiently wait and see what the Lord has in store for us!"

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GLOSSARY OF TERMS

Customer Satisfaction:	A customer's perception of the degree to which said customer's requirements have been fulfilled (ISO9000, 2005).
Quality:	The totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs (Yang, 2003: 1).
Quality Management:	Coordinated activities to direct and control an organisation with regard to quality (ISO9000, 2005).
Review:	Activity undertaken to determine the suitability, adequacy and effectiveness of the subject matter to achieve established objectives (ISO9000, 2005).
Validation:	Confirmation through the provision of objective evidence that the requirements for a specific intended use or application have been fulfilled (ISO9000, 2005).
Verification:	Confirmation through the provision of objective evidence that specified requirements have been fulfilled (ISO9000, 2005).

ABBREVIATIONS

BOM:	Bill of Materials
CAR:	Corrective Action Report
CI:	Continuous Improvement
COA:	Certificate of Analysis
COC:	Certificate of Conformance
CPUT:	Cape Peninsula University of Technology
FMEA:	Failure Mode Effects and Analysis
FP Spec:	Finished Product Specification
GDP:	Gross Domestic Product
IBC:	Intermediate Bulk Container
KPIs:	Key Performance Indicators
M Spec:	Manufacturing Specification
NPD:	New Product Development
OTIF:	On Time – In Full
PPAP	Production Parts Approval Process
R&D:	Research and Development
TSM:	Technical Sales Manager

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CHAPTER 1: GENERAL ORIENTATION OF THE STUDY

1.1 INTRODUCTION AND MOTIVATION

Product quality is a critical determinant to product life cycle as the quality of any new products relies on new product performance. A company's overall new product performance depends on a number of NPD components: the New Product Development (NPD) process; the organisation of the NPD programme; the NPD strategy; culture and climate for innovation; and senior management commitment to NPD (Anderson, 2008: 553). NPD is a critical and risky process that determines success or failure of any company engaging in product development processes (Choi, Ahn, Jeung & Kim, 2010:45). Over the past decades, many companies endeavoured to manage their NPD processes in order to maintain the quality of new products. However, in the current highly competitive business environment, companies are struggling to successfully develop new products while simultaneously maintaining high quality of each of these new products. Therefore, rapid and successful product development, of high quality, has become a vital business endeavour (Cooper, 1996: 465).

Based on the current literature, there are a number of factors that affect the success of NPD. These factors include pressures of globalisation, lack of innovative leadership, lack of skilled management and poorly trained workforce; have become major hindrances to countless companies. In addressing this critical situation, this study aims to investigate the key factors that impact on NPD in order to identify an effective quality management approach to ensure the success of the NPD process. The investigation was conducted at Cape Pak (Pty), a local plastic packaging and load securing company located within the Western Cape, South Africa.

This chapter provides an overall structure of the dissertation that is comprised of, but not limited to, the background as well as the statement of the research problem. With the purpose of steering the investigation to an applicable path, research questions and investigative questions are examined. Correspondingly, Chapter 1 outlines objectives of the research as these that

underpin the value of this research. To sum up, this chapter briefly touches on the research design and methodology, in conjunction with applied ethics.

1.2 BACKGROUND TO THE RESEARCH PROBLEM

Cape Pak (Pty), a privately owned business established in 1990, is a global supplier of in transit product care solutions and trading products. Over recent years, the company has determined and implemented quality techniques such as process management, quality assurance and quality control as key elements in NPD processes. They also frequently do 'product modification designs' (i.e. customising current products to suit diverse and unique customer requirements and processes). With the voice of customer in mind, the company is also involved in developing new products from inception, according to each customer's specific requirements. In view of the company's competence (i.e. industry knowledge, skills, and behaviour), all requirements that are not stated by the customer but necessary for product performance are put into practice, monitored and measured in order to determine and control quality of the NPD process.

Cape Pak (Pty)'s NPD department is responsible for translating customer-specific requirements and transforming these requirements into prototypes. Prototypes are later dispatched to customers for approval prior to customer's official order and/or a big commercial run of such products. Cape Pak (Pty)'s NPD process is not a structured process; however, it is made possible by multidisciplinary personnel in which diverse business processes outputs becomes inputs to the NPD process. Even so, the NPD naturally multidisciplinary workgroup lacks an effective quality management approach to ensure NPD process quality that will guarantee customer satisfaction.

The lack of an effective quality management approach to Cape Pak (Pty)'s NPD process had significant problems that included but were not limited to the following:

- no designated and formalised multidisciplinary NPD team;
- NPD processes were not mapped, described and documented;

- various manufacturing qualifying documentation and equipment were either unavailable, insufficient or outdated; and
- no structured or formalised NPD measurement and monitoring were in place (i.e. planning, reviews, verification and validation).

An integrated relationship between quality management and NPD is critical and will warrant effective success of the NPD process within companies, whether small, medium *or* large. The lack of effective quality management processes for managing Cape Pak (Pty)'s NPD process is a reason why research of this nature was essential, so as to determine and recommend an effective quality management approach for the NPD process of this particular company. Research demonstrated that various studies have been conducted related to effective quality management of an NPD process. However, none of these studies is unique to Cape Pak (Pty)'s challenge of lacking a 'formal' and structured NPD process. Consequently, it was important that this research be conducted to identify a specific and applicable effective quality management approach that will be appropriate to this specific company's NPD process.

1.2.1 Motivation behind Selecting Cape Pak (Pty) as Company under Investigation

At the instigation of this research, the researcher was employed as a Quality Manager of Cape Pak (Pty). The driving force behind conducting such research of this nature at Cape Pak (Pty) was motivated by the fact that, at that particular time, the company had just enriched the researcher's scope of work to encompass both the management of the quality of the business and also the management of the NPD Function.

Following this personal career enhancement, the researcher found it rather difficult to successfully meet daily requirements of the NPD function because of the dearth of quality systems that should have governed the NPD process of Cape Pak (Pty). In preference to just simply implementing systems 'deemed' to be sufficient to realise the NPD process, the researcher opted for thorough research of readily studied models in order to select the one that would be most conducive for the Cape Pak (Pty) NPD environment.

1.3 STATEMENT OF THE RESEARCH PROBLEM

Based on the above research background, the statement of the research problem is as noted: “Lack of an effective approach to quality management practices within the NPD process result in poor product quality and customer dissatisfaction”.

1.4 THE RESEARCH QUESTION

The following is a primary research question, supplemented by investigative questions as discussed below.

1.4.1 Primary Research Question

The primary research question forming the outcome of the research was posed: “Which effective quality management approach could be implemented to manage NPD process at Cape Pak (Pty)”?

1.4.2 Investigative Questions

In support of the research question, the following investigative questions were addressed:

- What are the key factors that impact the NPD process?
- What are the main quality determinants in the NPD process?
- What are the basic requirements of effective quality management within an NPD process?
- What are the benefits of an effective quality management into an NPD process?
- Which universal effective quality management approach can be used to successfully manage a NPD process?

1.5 PRIMARY RESEARCH OBJECTIVES

Further strengthening this investigation, giving direction and a focal point towards the outcome of the research, were these primary objectives:

- to identify key factors that impact the NPD process;
- to identify main quality determinants in the NPD process;
- to identify basic requirements of an effective quality management of an NPD process;
- to identify benefits of an effective quality management for an NPD process; and
- to investigate and identify a universal approach that could effectively manage quality of an NPD process.

1.6 THE RESEARCH PROCESS

A number of researchers have addressed the issue of research process. Struwig and Stead (2001:22) identified the following seven steps of the research process:

- selecting a research topic;
- formulating a research problem;
- formulating objectives or aims;
- formulating hypotheses;
- planning and drafting a research plan:
    - Identifying the type of data required
    - Determining the method for collecting data
    - Choosing possible techniques and computer programmes for the statistical processing of data
    - Compiling and writing a research proposal
- executing and controlling the research plan:
    - Collecting specified data
    - Determining reliability and validity
    - Classifying and processing the data
    - Evaluating and interpreting the results and drawing conclusions
- writing the research results.

According to Leedy and Ormrod (2001:4), research is the systematic process of collecting and analysing information (data) in order to increase the

understanding of the phenomenon about which the researcher is concerned. Leedy and Ormrod further identified the following research characteristics:

- research originates with a question or problem;
- research requires a clear articulation of a goal;
- research follows a specific plan of procedures;
- research divides the principal problem into manageable sub-problems;
- research is guided by specific research problem or hypothesis;
- research accepts certain critical assumptions;
- research requires the collection and interpretation of data in an attempt to resolve the problem that initiated the research; and
- research is, by its nature, cyclical, or more exactly, helical.

In view of the explanation above, Leedy and Ormrod (2001:9) describe research as a cyclical process, as shown Figure 1.1 below:

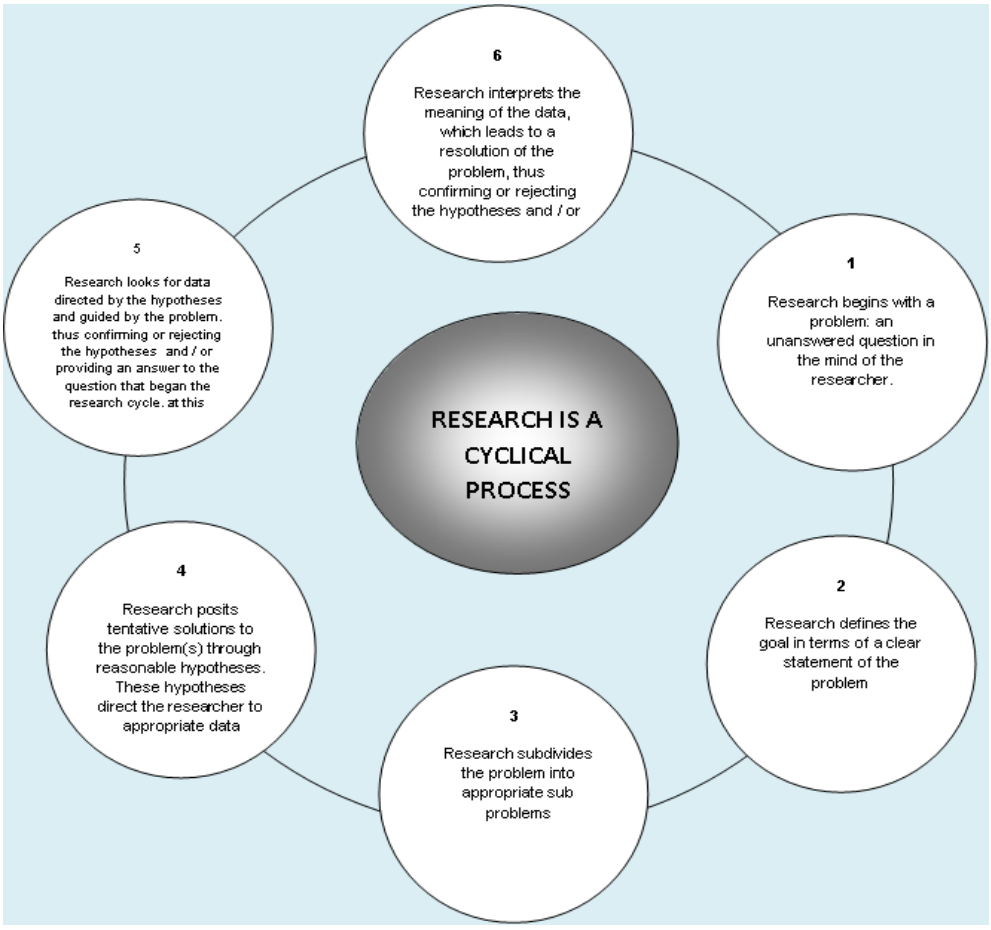


Figure 1.1: Cyclical Research Process
(Source: Leedy & Ormrod, 2001)

According to Mouton (2001:46), a research process should follow a framework of activities. He referred to the framework as ProDEC in which he identified fundamental stages in the research process: Problem, Research Design, Empirical Evidence and Conclusion. That is why the research process includes the following:

- research background and motivation;
- research problem statement;
- holistic overview of the research environment;
- comprehensive literature review;
- research design and methodology;
- data analysis and interpretation of results; and
- conclusions and recommendations.

This research adopted certain of these steps as discussed by the authors. Refer to Figure1.2 for the research process to which this investigation adhered.

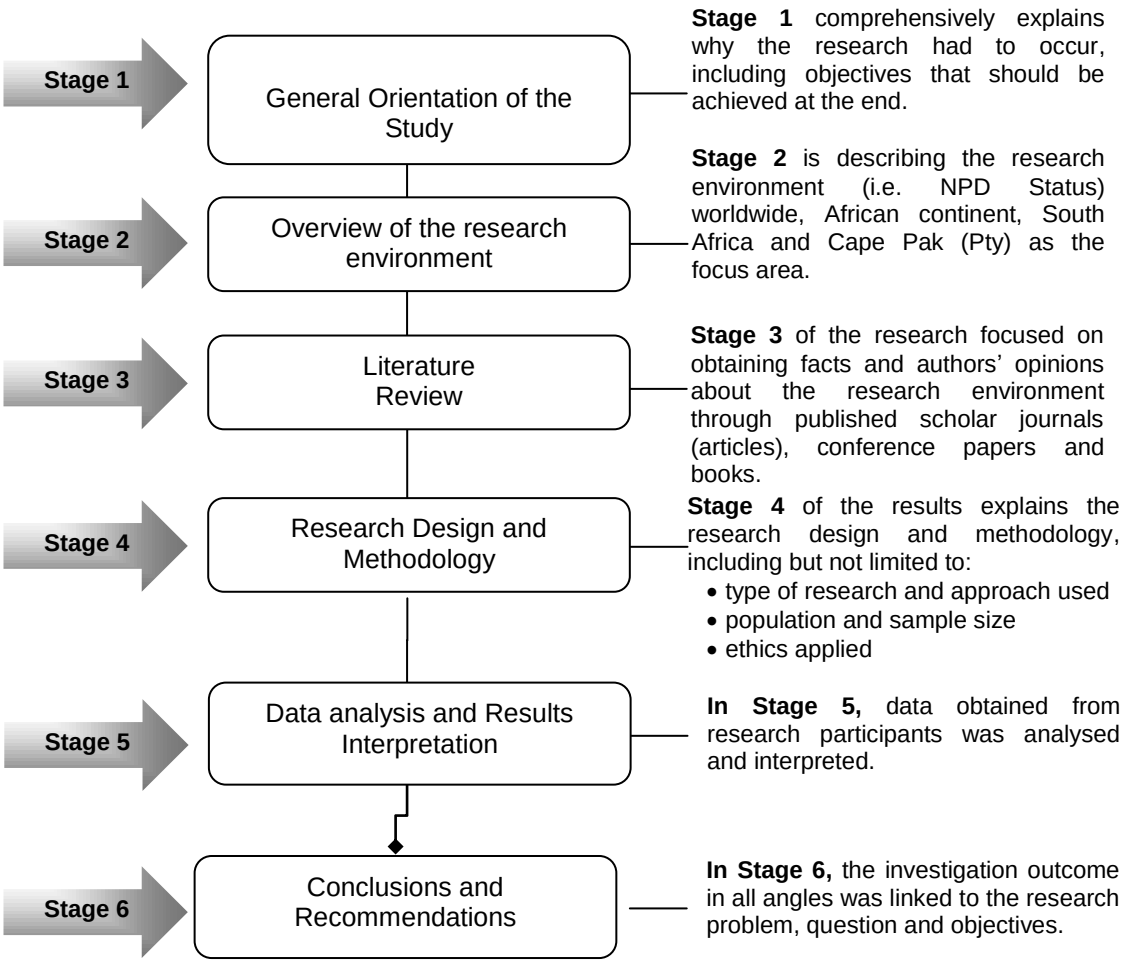


Figure 1.2: Research process flow applied in this study

1.7 RESEARCH DESIGN AND METHODOLOGY

This section of the research introduces the research design and methodology applied in this research.

1.7.1 Research Design

A research design is a plan, a blueprint, as to how a researcher intends to conduct the research, whilst research methodology focuses on the research process and the kind of tools and procedures to be used (Mouton, 2001:55-56). This research followed an action research methodology and a combination of both a qualitative and quantitative research approach. The research design and methodology of this study is discussed comprehensively in Chapter 4.

1.7.2 Data Collection

The research followed a qualitative as well as a quantitative approach and was conducted at Cape Pak (Pty) where the researcher investigated a possible effective quality management approach to facilitate control of this organisation's NPD process.

Due to the nature of adopted research approaches, the researcher designed questionnaires. The sample size was purposively selected and was purely based on Cape Pak (Pty) employees who have direct input into the NPD process of this company, as only these individuals were selected as the sample size.

1.7.3 Data Validity and Reliability

A pilot study was conducted to ensure data validity. Cronbach's Alpha was applied to test for data reliability. These methods are comprehensively discussed in Chapter 5.

1.8 ETHICS

Ethics refers to the appropriateness of the researcher's conduct in relation to the rights of research respondents or participants (Saunders, Lewis & Thornhill,

2000:130). According to Mouton (2001:239), researchers have a right to investigate the truth; however, this should not be detrimental to the rights and privacy of participants involved. That is the reason why the researcher prioritised the following:

- made sure that the organisation under investigation knows, agrees and allows the research to be conducted (refer to Appendix 1 and 2) in their facility; and
- made certain that interactional ethical issues are resolved with respondents prior to the survey, to safeguard against conflict of interest.

1.9 RESEARCH ASSUMPTIONS

An assumption signifies a circumstance that is taken for granted, without which the research study would be a pointless study (Leedy & Ormrod, 2001:62-63). Furthermore, Leedy and Ormrod explain that the requirement to clearly state the assumptions on which the research is based is a necessary requirement so that others know what the researcher assumes with respect to a particular investigation. The following assumptions, then, pertained to this research:

- that the research would benefit Cape Pak (Pty) tremendously as this company, at the time of conducting this research, did not have formal quality management deployed in its NPD process;
- that there would be clear key performance indicators and expectations of the NPD multidisciplinary team;
- that the findings would empower Cape Pak (Pty) Leaders and the NPD multidisciplinary team to effectively manage and make sound decisions where their NPD process is concerned.

1.10 RESEARCH CONSTRAINTS

Struwig and Stead (2001:44) refer to research constraints as ‘demarcation of the study’, where the demarcation of the study is “an imperative part of the research that provides the framework for proposed research and continually serves to guide the research while it is happening”. They further enlighten that

demarcation implies that a decision should be made about what to include and what to exclude from the research.

This research was limited as noted: the study only investigated Cape Pak (Pty)'s South African plant and excluded the India plant. This research was further limited to only two Cape Pak (Pty) South African plants: the Liquid Liners and Dessicants.

1.11 SIGNIFICANCE OF THE RESEARCH

Should the company under investigation decide to value the findings and integrate the recommendations of this research, (i.e. adopt the proposed effective quality management approach for new product development process), such a decision will lead to the improvement in Cape Pak (Pty)'s NPD process, including both product quality and customer satisfaction. Additionally, the academic community will benefit by substantial knowledge that is unique to the relationship between quality management and NPD.

1.12 RESEARCH CHAPTER AND CONTENT ANALYSIS

This research report is inclusive of the following chapters:

Chapter 1: General orientation of the study

This chapter provides a general structure for the research, including an introduction and orientation, background of the research, problem statement, research objectives, research design and methodology.

Chapter 2: A holistic overview of the research environment

Chapter 2 presents the holistic perspective of the research environment (i.e. quality and NPD), which includes the current situation of NPD management worldwide, but with South Africa as a particular focus.

Chapter 3: Literature review

Chapter 3 presents the theoretical framework of this research. The chapter extensively reviews findings of other authors worldwide on the subjects of NPD

and quality management, with special focus on key factors that warrant NPD process success.

Chapter 4: Research design and methodology

Chapter 4 presents the research design and methodology, including detailed information of data design, collection and analysis.

Chapter 5: Data analysis and Results Interpretation

Chapter 5 interprets the findings of the study and provides a detailed discussion of the study results.

Chapter 6: Conclusion and Recommendation

Chapter 6 provides the final conclusions determined from the research objectives and offers invaluable recommendations derived from the outcome of the research.

1.13 CONCLUSION

This chapter provided an orientation of this research, an introduction to the background of the research including the problem statement, research question and objectives. The chapter furthermore touched on the overall research process undertaken. Additionally, Chapter 1 entailed a synopsis of the research design and methodology, data collection, and ethics, subjects which are discussed comprehensively in Chapter 4. Lastly, Chapter 1 presented assumptions, constraints and the significance of this research.

CHAPTER 2: A HOLISTIC OVERVIEW OF THE RESEARCH ENVIRONMENT

2.1 INTRODUCTION

The world is not steady. If it were, there would be no need to evolve business operations and methods, or to understand what has changed and what works well. Today, organisations function in dynamic, ever-changing, unstable environments (Griffin, 1997: 430). The author further suggests changes that could affect the way in which the NPD process is practiced and managed as follows:

- increased levels of competition (more firms competing for the same markets);
- rapidly changing market environments;
- higher rates of technical obsolescence; and
- shorter product life cycles.

Because of this, companies continue to spend large sums of revenue annually on NPD, investing considerable resources into new products with the strategic understanding that these investments will boost both annual turnover and profit (McCracken, 2011:4). Organisations, therefore, must enter the global market by successfully managing their NPD process, better understanding how to achieve successful high quality product development through well-performed tasks in the process (Yan & Makinde, 2011: 2222).

Design has been a human activity for thousands of years, in both its creative and routine forms (Saridakis & Dentsoras, 2007: 202). Saridakis and Dentsoras reported that the scientific society has extensively studied design during recent decades for the establishment of general purpose and domain-independent scientific rules and methodologies. However, according to Cooper (1996: 470), a high quality new product process includes sharp early product definition, before development work begins. With a sharp and early assessment, an organisation should be able to identify the factors that denote a winning

product as opposed to a losing one, in order to justify the winning product's commercialisation (Nyaundi, 2011: 5).

This chapter provides a holistic perspective of the NPD research environment, touching on various industries' ways of managing the NPD process. In particular, the background of NPD management in the local manufacturing company—Cape Pak (Pty)—is discussed in detail.

2.2 GLOBAL ENVIRONMENT FOR NPD MANAGEMENT

With local and global competition pressures, companies, industries and/or sectors have no other choice but to focus on NPD initiatives. As the global original engineering manufacturer (OEM) and exporter of toys, Hong Kong's toys industry previously did not really worry about investing large amounts in R&D activities (i.e. development of new toy designs and the creation of new toys) (Wing & Sun, 2005, 293). However, with the increasing competition in that country, including all other Asian countries, it became increasingly imperative for this industry to focus on R&D and thereby develop their own design capabilities.

According to Deszca, Munro and Noori (199: 613), bringing innovating products to the market can be rather painful and frustrating. They further enlightened that, in one of the telecommunications companies, NPD was rather slower than expected and traditional market research development approaches proved to be unrealistic. In high technology industrial companies, management are faced with the challenge that product development needs are stronger than ever. However, the tools and methods to bring new products to market have not changed dramatically in the last decades (Copper, 1996: 465).

According to Song and Noh (2006:262), the late industrialisation of the Korean economy during the twentieth century was extraordinarily excellent. They reported that the financial crisis of December 1997 apparently brought the Korean economy to the brink of economic doom; a 5.8% growth of real gross domestic product (GDP) was recorded in 1998. They further reported that the

Korean economy made a positive recovery in approaching 9% growth of real GDP in 1999. Korean expenditures on R&D total more than $5.5 billion a year.

Correspondingly, there has been a wave of global innovation. Census Bureau data show that the number of US patents issued to US corporations more than doubled between 1990 and 2001 and that R&D expenditures by industry surpassed government R&D expenditures in 1980 and more than doubled since 1990. However, NPD is snowed under a high level of failure. McCracken (2011:4) cautioned that for every seven new product ideas financed by an organisation, about four enter the development phase, one and a half are launched, and only one succeeds. This example is a similar scenario as the one experienced by the US. According to Iyer, LaPlaca and Sharma (2006), a 1995 US study by information Resources Inc. found that 70-80% of new product introductions fail, with each failure resulting in a net loss of up to $25 million.

Despite these losses, innovation is regarded as the answer to U.S. competitiveness, although there is little understanding of who captures the value from a successful innovation. Linden, Kraemer and Dedrick (2007:2) further argue that in today's economy, no single country stands out as the source of all innovation, so consequently US companies will derive value from working with global partners to bring new products to market.

Global business is increasingly committed to positioning itself to develop the commercial opportunity that exists within Africa (Nyaundi, 2011:1). Nyaundi argued that one of the ways they are doing this is by developing products conducive to African consumers. Africa's economy is flourishing as its real GDP increased by 4.9% a year from 2000 through 2008. This is reported to be more than twice its rate in the 1980s and 1990s (Leke, Lund, Roxburgh & Wamelen, 2010). It has not always been rosy for Africa though: challenges such as conflicts, disease and deep poverty have been continually assaulting Africa for years now. However, according to Nyaundi, it is with great pleasure to announce that Africa is beginning to show signs of progress (Nyaundi, 2011:5). In agreement with Leke *et al*. (2010), Nyuandi (2011) explained that Africa's collective GDP was at $1.6 trillion in 2008, which was roughly equal to

Brazil's or Russia's GDP. Leke *et al.* (2010) reported that telecommunications, banking, and retailing industries continue to flourish, as well as construction and private-investment. According to the authors, the reason for Africa's economic incline is linked to the following actions taken by relevant African governments:

- increasingly adopted policies to rejuvenate markets;
- privatisation of state-owned businesses (Nigeria, for example, privatised more than 116 organisations between 1999 and 2006);
- increasing openness of trade (It is reported that Morocco and Egypt struck free-trade agreements with major export partners);
- lowered corporate taxes;
- strengthened regulatory and legal systems; and
- provision of critical physical and social infrastructure.

For these reasons, local organisations are also empowered to develop incremental and radical innovations designed for the bulging bottom of the pyramid, rapidly increasing middle class and establishing cream of the crop (Nyaundi, 2011:1). Nyaundi further indicated two of the successful NPD innovations that Africa successfully managed to generate as follows:

The M-PESA:

Kenya's M-PESA is a global leader in mobile money transfer and has so far over KSh 432 billion ($5.4 billion) that have been transferred through the network (Nyaundi, 2011:19).

BRT Scheme:

Nyaundi (2011: 9) is of the opinion that in March 2008, Lagos became the first city in Africa to get underway with the Bus Rapid Transit (BRT) scheme. The objective of this initiative was to serve its population estimated at between 15 and 18 million. The BRT buses in Lagos have charted the way for rising metropolitan areas across the African continent.

2.3 THE ENVIRONMENT OF NPD MANAGEMENT IN SOUTH AFRICA

According to the South Africa's National Research and Development Strategy (2002: 81), the following countries managed to successfully make clear technology development preference within an overall national development framework:

- the newly industrialised South Korea;
- the natural resources oriented Chile and Australia;
- the fast-follower Malaysia; and
- the high technology, research and development intensive Finland.

The preference that these countries made largely smoothed the progress of rapid progress towards R&D prosperity. According to South Africa's national R&D strategy, the strategy itself depends significantly on the right investments being made to underpin its R&D ambitions. It is said that should South Africa benchmark from these countries, South Africa could also make a clear technological development that will aid successful NPD. Song and Noh (2006: 262) agreed with this strategy by stating that to reach the goal established by the Korean government of placing greater importance on high-tech industries and encouraging innovation growth, Korea had to sustain its competitiveness and global dominance in selected fields by focusing on the country's limited R&D resources.

Research shows that NPD is both country and industry specific (Wing & Sun, 2005: 293). This is a reason why, when conducting research in South Africa, it is important to be cognisant of socio-historical, temporal and contextual factors and the role that they play in the research process (Struwig & Stead, 2001:21). According to the South Africa's national R&D strategy (2002:46), appropriate knowledge impacts on the advanced sectors of the manufacturing industry (e.g. the automotive industry that has integrated value chains). The strategy reports that industries such as the automotive industry are global, assuming levels of technological integration (such as in design, quality control and inventory management). From the time of the establishment of the South African national

R&D strategy, design, quality control and inventory management were not fully implemented in South Africa's manufacturing industry. This meant that if South Africa made use of the automotive knowledge-intensive aspects, this could certainly have benefited the country into the future (South African National R&D Strategy, 2002:46).

There was a major decline in per capita incomes in South Africa, 15 years prior to the country's political transformation. Only after 1995 did GDP growth begin to pull alongside with population growth (Kaplinsky, Morris & Readman, 2001:22). According to Nyaundi (2011: 1 & 19), South Africa is the leader of Africa in terms of innovation investment and output as well as in intellectual property rights legislation. Additionally, South Africa continues to be a research leader. Below are inventions that originated in South Africa:

Sasol: Oil from Coal

One of the earliest South African inventions was the oil from coal of Sasol Coal which became a vital feedstock for South Africa's unique synfuels and petrochemicals industries, and is used by Sasol as a feedstock to produce synthesis gas (CO and H2) via the Sasol-Lurgi fixed bed dry bottom gasification process (van Dyk, Keyser & Coertzen, 2006:243). Van Dyk, Keyser and Coertzen explained that this is a fixed bed coal gasification process for more than fifty years, with ninety seven units in operation, and still remains the world's largest commercial application of this technology. The combined operational and engineering expertise vested in Sasol represents a formidable capability in the field of coal and gasification science.

CAT scan

Another one of South African's inventions is a CAT scan developed by South African physicist Allan Cormack and Godfrey Hounsfield of EMI Laboratories. This development secured them the 1979 Nobel Prize in Physiology or Medicine. The CAT scan clearly demonstrates X-ray source and electronic detectors rotated about the body; data is analysed by a computer to produce a map of the tissues within a cross-section of the body (Oransky, 2004:32).

KreepyKrauly

More recently, South Africa once more demonstrated its NPD capabilities. According to Nyaundi (2011: 10 & 19), the KreepyKrauly is a leading modern world innovation that originated in South Africa as a solution to swimming pool cleaning. The KreepyKrauly was invented by Ferdinand Chauvier, a South African citizen, who explained that the success of the KreepyKrauly is due to the fact that it was a pioneer in its category and succinctly solved the problems consumers were having with the cleaning of their pools.

2.4 CAPE PAK (PTY) NPD PROCESS ENVIRONMENT

2.4.1 The Company Profile—Cape Pak (Pty)

Cape Pak (Pty) is a small privately owned business within the plastics packaging industry, established in 1990. The company is situated in the southern suburbs of the cape peninsula within the Western Cape province of South Africa. Cape Pak (Pty) employs a total of 60 employees, of which about 20% of these employees are temporarily contracted to realise the manufacturing process of the business (i.e. operators). In its South African division (i.e. the division where the research was conducted), the company has two plants, namely Liquids and Desiccants plants. R&D is a continuous process driven by in-house innovation and customer requirements at Cape Pak (Pty). The company is also involved in trading products such as silica gel. Cape Pak (Pty)'s philosophy of continuous innovation and research has moved the company to the fore in design and performance of cargo-securing methods.

Cape Pak (Pty) has been certified on ISO9001 (i.e. quality management system requirements) for over 15 years. Another of Cape (Pty) certifications is US FDA Standards (i.e. fabrication of single service containers and closures for milk and milk products).

2.4.2 NPD process at Cape Pak (Pty)

Customising liquid liners is one of the reasons why Cape Pak (Pty) frequently does 'adaptive design' (i.e. customising current products to suit diverse and

unique customer processes). Additionally, with the ‘voice of the customer’ in mind, this company is capable of developing new products from inception, according to each customer’s specific requirements. In that Cape Pak (Pty) has determined and implemented quality (i.e. management, assurance and control) and NPD as some of the company’s key business processes.

Cape Pak (Pty)’s NPD department is responsible for translating customer specific requirements, transforming these requirements into prototypes. According to Wing and Sun (2005: 293), in the prototype and development stage, much focus should be put into producing the pilot product, meeting customer needs as per the previous specifications, conducting external laboratory tests, and shortening the time for tool-building. Prototypes are later dispatched to customers for approval prior to customer’s official order and a big commercial run of such products. Although Cape Pak (Pty)’s NPD is not a structured process, it is made possible by multidisciplinary personnel in whom diverse business process outputs become inputs to the NPD process. Figure 2.1 is an illustration of Cape Pak (Pty) NPD process flow:

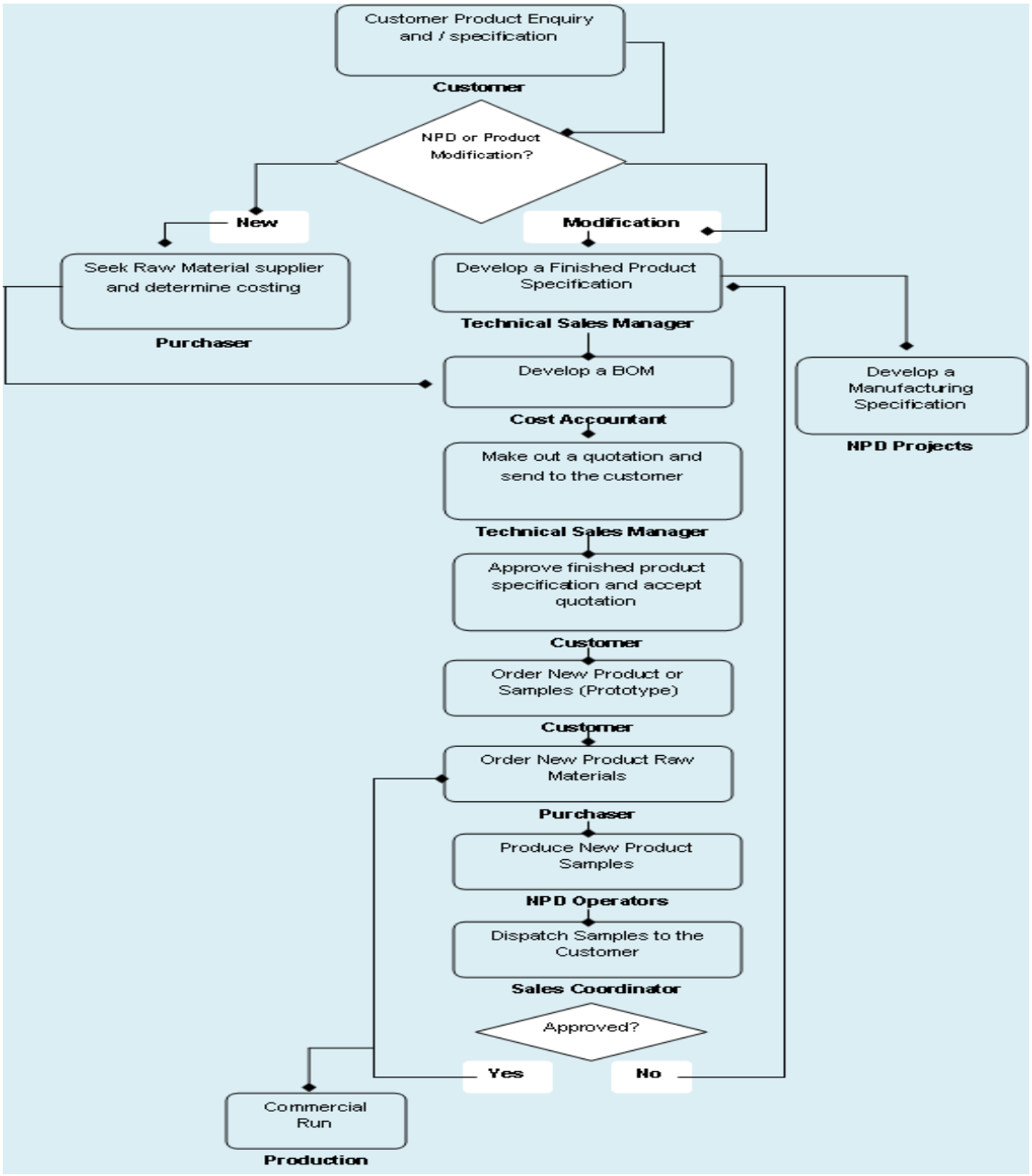


Figure 2.1: Cape Pak (Pty) NPD Process Flow

Description of Cape Pak (Pty) NPD Process Flow

Cape Pak (Pty) NPD process begins with the 'voice of customer' where the customer either makes an enquiry about a particular product and capacity thereof, or forwards a comprehensive specification that details requirements of such a product. In most cases, customers who forward specifications are customers who know that Cape Pak (Pty)'s manufacturing process is capacitated to produce such requirements. Generally, this happens with product re-engineering (i.e. modifications). A communication of this nature

happens between the customer representative and Cape Pak (Pty)'s Technical Sales Manager (TSM). Once an understanding is reached between the two parties, the TSM informs the NPD Projects Manager of the new product or requested modification. In the case of a new product, the purchasing department is required to look for appropriate raw material suppliers and to determine raw material costs involved, where the Cost Accountant is required to develop a Bill of Materials (BOM).

In the case of current product modification, the TSM develops and sends to the customer a Cape Pak (Pty) Finished Product Specification (FP Spec.) and a formal quotation. The customer is required to approve (by signing) the FP Spec and accept the quotation. At this stage, the NPD Projects Manager is responsible for developing a manufacturing specification that will be used by the sample (prototype) production line as soon as the customer approves the FP Spec. The customer orders samples, the purchaser purchases applicable raw materials, samples are produced and dispatched to the customer and the customer is required to feedback on such products. When the samples meet customer requirements and are approved, the customer would then order final products and a commercial run will commence. However, when samples are rejected, problem solving takes place and the process flow begins by amending the FP Specification to the stage where the customer is required to reapprove the specification.

2.4.3 Cape Pak (Pty) Products

Liquid Liners

Cape Pak (Pty) is a manufacturer of liquid liners, desiccants and trade-in silica gel and more. The company is operating more in a niche market where a large and lucrative business is the Liquid Liner manufacturing. Cape Pak (Pty) is a manufacture of a wide range of bulk liquid liners for local and international (exports) markets. Its core expertise in this kind of production is converting film material into usable packaging bags. Therefore, the company specialises in Cutting, Sealing, Stitching and/or Trimming (CSST) of material. A market of this

nature is not massive locally, so Cape Pak (Pty) exports the majority of its products.

Typical usage of liquid liners includes liquids, powder and granular products. The liquid liner is used by liquid product distributors (i.e. customers) who are the manufacturers of Intermediate Bulk Containers (IBC) or packaging drums. Cape Pak (Pty) offers a wide range of standard and custom-designed liquid bags as liners to IBCs and Drums. Depending on their application and origin, IBCs or drums are not uniform products. They come in different shapes, styles, sizes, material, and some are in a form of plastic, steel or cartons. As a result, different customers specify different requirements.

The liner product ranges from 55gal (210L) for drums to 370gal (1400L) for IBCs. End-users of the liquid liners range but are not limited to the following:

- fruit processors;
- petroleum Industry;
- food Industry (specialising in liquids); and
- skin care/cosmetic industry.

In this niche market, competitive edge is always advantageous for companies capable of designing and developing products to meet unique customer requirements and companies that are fully capacitated to produce such designs.

Desiccants

Another product of Cape Pak (Pty) is a desiccant. The company manufactures and distributes a variety of desiccants which are packed in a range of materials in various packing sizes. Desiccants are defined as hydrating agents that attract moisture from the atmosphere, absorbing and holding the water. Most porous adsorbents such as silica gel, activated clay or molecular sieves rely upon physical absorption to perform their function.

Desiccants are used when transporting cargo to decrease the risk of cargo damage due to condensation, known as ‘cargo sweat’. Desiccants are distributed, but not limited to, the following industries:

- coco beans industry;
- pharmaceutical industry; and
- container packaging and/or distribution industry.

Depending on customer product applications and needs, the company manufacturers desiccants using various formulations of ingredients. As a result of this, Cape Pak (Pty) is constantly engaged in Research and Development (R&D) of desiccant products.

Silica Gel

Silica Gel, a porous, synthetically-manufactured desiccant, has interconnected pores which form a vast surface area that attracts and retains water. Cape Pak (Pty) distributes Silica Gel that is either ‘Indicating’ or ‘non-Indicating’. ‘Indicating’ Silica Gel starts changing colour (blue to pink) once the desiccant has absorbed in excess of 8% moisture. The absorption capacity of Silica Gel is approximately 25% - 30%.

Cape Pak (Pty) makes use of SYSPRO software that provides an integrated business solution for all main facets of the business including accounting, manufacturing and distribution operations. The software also includes the following:

- Enterprise Resource Planning (ERP);
- business process modelling;
- customisation; and
- workflow management.

2.5 CONCLUSION

Successful organisations understand that the creation of value through innovation is not a zero-sum game, and profits are essential all along the supply chain to sustain innovation by all participants (Linden *et al.,* 2007:2).

This is one of the reasons why Africa's unique landscape calls for innovations that are tailored to its specific needs (Nyaundi, 2011: 2). This chapter explored New Product Development initiatives in several parts of the world, examining South Africa as the particular focus of this research. The background of Cape Pak (Pty)'s NPD initiatives as a source of this research was explained as well.

CHAPTER 3: LITERATURE REVIEW

3.1 INTRODUCTION

In this chapter, a literature review was presented concerning critical issues correlated to an effective quality management approach for New Product Development (NPD) process. The literature review focused on the following fundamental topics: NPD and NPD process; key factors that impact on NPD process; the main quality determinants in an NPD process; basic requirements of an effective quality management into an NPD process; benefits of an effective quality management into an NPD process; and most importantly, the investigation of a universal approach that could be used to effectively manage quality of the NPD process.

Furthermore, the literature review investigated published scholars' opinions and information leading to the resolution of the stated problem: 'Lack of effective approach to quality management practices in NPD process result in poor product quality and customer dissatisfaction'. This included taking advantage of scholars' opinions and previous research findings to see how these compare to the research questions and objectives at hand. The literature review suggested that product quality is a fundamental aspect of the NPD process. Additionally, the literature comprehensively revealed that when customers are not wholly satisfied, companies will cease to enjoy competitive advantage. Consequently, the 'voice of the customer' is imperative for the NPD process. This led to the research question: 'Which effective quality management approach could be implemented to manage NPD process at Cape Pak (Pty)'? Once more, the literature review had demonstrated that there were several developed, studied and successfully tested universal models for managing the NPD process.

3.2 NPD AND NPD PROCESS

3.2.1 Definition of NPD

The roots of the NPD field can be traced through the R&D and engineering management literatures of the 1960s and early 1970s (Nambisan, 2003:4).

According to Ebrahim, Ahmed, and Taha (2009:212), there are different definitions to NPD, but most commonly, NPD is defined as the process that covers the following:

- product design;
- production system design; and
- product introduction processes and initiation of production.

Alternatively, Filho Rozenfeld and Pigoso (2007:355) suggest that NPD is the overall process with the following components:

- strategy;
- organisation;
- concept generation;
- product and marketing plan formation; and
- evaluation and commercialisation of a new product.

They further explain that NPD is also frequently referred to as just ‘product development’. This is an understatement, as NPD is an important and complex business process. In agreement, Hung, Kao and Juang (2008:338) argue that NPD is a complicated interdisciplinary activity that requires many knowledge inputs to generate a suitable product solution as well as an appropriate project plan in the time-competitive environment. This indicates that for this study (i.e. literature review and survey sampling), it was necessary to investigate the impact of different business functions and/or processes deemed to have direct inputs into the NPD process as such. It can be concluded that the leading models of NPD place emphasis on an interdisciplinary mode of inquiry and require contributions from most functional business areas (Nambisan, 2003:3).

Similarily, Harmancioglu, McNally, Calantone, and Durmusoglu (2007: 421) are of the opinion that NPD is a system encompassing the dynamic interface between internal and external factors, involving cross-function integration. In support of this statement, Krishnan and Ulrich (2001:1) explain that product development is the conversion of a market opportunity and set of assumptions about product technology into a product available for sale.

As NPD is an environment with sudden and remarkable changes, lack of sufficient competence may hold back NPD process success (Harmancioglu *et al.,* 2007:417). Additionally, Rundquist and Chibba (2004: 39) view NPD as a process from a new product idea (generated by marketing and R&D) to the promotion and sale of the product. They further suggest that NPD involves several activities:

- concept generation;
- user tests;
- construction; and
- design and development for manufacturability.

Harmancioglu *et al.* (2007: 400) concur that NPD involves competing goals of minimising risk by acquiring sufficient market information while also reducing costs and time to market, thus escalating the importance of NPD process design and implementation. Unlike the manufacturing processes, product development is a creative and discovery process intended to create something new from trial-and-error, learning from errors made. Therefore, iterations occur frequently during product development to hopes of improving the product quality for satisfying market need (Wang and Lin, 2009:460). Wynn, Eckert, and Clarkson (2007) agree that different kinds of iteration are features of different stages of the design process in such a way that exploring plays a key role during early concept design as alternative solutions are proposed and evaluated.

Hsu, Wu, Sung, You & Chen (2009:305) are also of the opinion that NPD is an innovative process that takes shape gradually, from abstract concept to concrete fact. Product development is there to translate customer expectations for functional requirements to the exact engineering and quality characteristics (Gryna, 2001:335) in such a way that Bills of Material, Target Costing, Design for Assembly, Failure Modes and Effects Analysis, and Control Plans function as a set of product development tools to support the development process (Kumar, Balasubramanian & Suresh, 2009:72).

Contrary to design and development perception as NPD being the job of a functional department, often called ‘Design and Development’, NPD must also

be viewed as a process (Gryna, 2001:333). Process development refers to the improvement of the various stages so that objects produced in bulk conform to the design specification so that their performance meets the target values (Murthy, Rausand & Virtanen, 2009:1597). According to Filho *et al*. (2007:355), NPD is therefore a critical process for improving a company's competitiveness, as this process plays a fundamental role in enhancing the performance of new products.

In agreement, Harmancioglu *et al.* (2007: 413) are of the opinion that design and implementation of NPD processes is, in fact, at the centre of the business. Sanongpong (2009b) does not disagree, as he also says that NPD's success depends on how this process is controlled and how the control leads to improvements. The author highlighted that, due to constant changes in the times we leave in, NPD plays a more considerable part to any organisation that engages itself in NPD process. This is the reason why, during the NPD process, external and internal communication in NPD teams is one of the critical success factors of NPD (Hsu, et al., 2009:304).

In support, Rejeb, Boly and Morel-Guimaraes (2011:231) say that, during the front-end stages of NPD process, suitable personnel in the NPD process should direct their attention towards one key question and that is, what is the best conception to be developed in an inventory of prospective further product concepts? They further suggest that the selection criteria for answering this important question should include the following:

- NPD value creation;
- existence of a market; and
- technical feasibility.

3.2.2 NPD PROCESSES

A 'process' is a group of activities that generate an output or an outcome. NPD process is arguably the most important dynamic capability within a firm (Nelson, 1991). Song and Noh (2006:276) are of the opinion that product development is vigorously multifaceted and a multi-stage process which ranges from idea generation through product launch. It has also been determined that

NPD is a risky process. To support this statement, Choi *et al.* (2010:45), are of the opinion that because of high capital investment and low success prospect, organisations regard NPD process as a complex and difficult decision-making process for setting the priorities of various options. They further warn that if the firm does not defend NPD risks effectively and efficiently on the basis of a distinctive strategy, it will likely lose its competitive advantage in the market. This argument comes down to one particular objective of the study that focused on identifying basic requirements of effective quality management of an NPD process. Subsequently, risk management was identified as one of the basic requirements for quality management of the NPD process. This is one of the reasons why, among numerous activities pertaining to an NPD project, the screening of new product ideas is perhaps the most critical NPD activity. The final stages of the NPD process have a greater outcome on new product success (Song & Noh, 2006:276).

According to Kumar *et al.* (2009:72), NPD is a business process that needs to be defined and managed just as any other business process. Rundquist (2009: 80-81) agreed, suggesting that a formal NPD process must be documented in some recognisable form and then be implemented. The NPD process describes the evolution towards an optimised NPD process (Kumar *et al*., 2009:72). They have further identified characteristics of a well-managed NPD process as follows:

- well-defined process inputs in the form of customer needs and product specifications;
- well-defined process steps, process outputs (deliverable documents), and responsibilities;
- flexibility to support multiple processes and tailor the NPD process to the particular project requirements;
- process output templates to improve efficiency in creating process outputs and improve consistency;
- process controls in the form of dual opportunity stage gate value stream mapping reviews and design reviews;

- process definition based on best practices and our extensive experience in assisting companies improve the NPD process (can be used as-is or can be compared to your existing NPD process and borrowed from).

  Either way supports the definition of the NPD process with the following elements:
- a defined set of stages and gates;
- a task breakdown and deliverable documents associated with each stage-task plan;
- a set of templates for the deliverable documents to support the process, along with guidance how to prepare each document;
- a set of Product Development Tools to support the development process including Bills of Material, Quality Function Deployment, Target Costing, Design for Assembly, Failure Modes and Effects Analysis, and Control Plans;
- two project management methodology alternatives; and
- agendas and guidelines for gate reviews and design reviews.

A documented and widely known NPD-process helps all business functions to coordinate and participate in activities in a cross-functional way (Rundquist & Chibba, 2004: 52) as all functions involved know when and how they are expected to contribute to the NPD process. This draws attention back to the research question seeking to determine an implementable effective quality management approach for managing the NPD process at Cape Pak (Pty) Ltd. It is therefore reassuring to realise that there are actually diverse techniques or methodologies of product development. Even within the same industries, there will always be a clear distinction in the important methodologies of product development (Foster, 2001:177).De Mozota (2006) agreed with this statement, saying that designers should keep in mind that there are more dissimilarities among organisations in the same industry than among companies across industries, as in every industry, technology distribution, and marketing tend to be similar. As an example, the NPD process documentation requirement for a new medical device product would vary greatly from that for a product from the electrical industry, though the underling best practice of having a system in

place to guarantee the process is documented and applies in both (Nicholas, Ledwith & Perks, 2011:227-243). So in an attempt to respond to the research question, despite the fact that NPD is a lengthy and complex process, studies conducted by Product Development Management Association (PDMA) indicated that NPD processes are more stringently relied upon because of the fact that awareness and use of methods and processes for NPD clearly increase the success rate of NPD projects (Rundquist, 2009: 79).

According to Tanomsakyut, Thawesaengskulthai and Anuntavoranich (2010), an NPD process consists of six phases. The process begins with a planning phase which has a relationship to advanced research, current market situation and selected technology. They further say that ideas for product development come from many sources, both internal and external. Whereas Kim, Kang and Bae (2008:1273) differ slightly by insisting that NPD processes are categorised into only three stages:

- opportunity exploration or idea generation;
- product development or test; and
- products launch and after-service.

Then again, Hsu *et al. (*2009:304) are of the opinion that NPD is usually a lengthy process with a variety of activities involving the following:

- strategy development;
- product planning;
- concept generation;
- screening;
- market analysis; and
- manufacturing development.

Murthy *et al.* (2009: 1598) have a slightly different perspective from Hsu *et al. (*2009:304) and others as they have determined that there are eight phases to product life cycle, with some of these phases entailing a number of sub-phases. The phases are as follows:

- *Phase 1*

  In this phase the need for the new product is identified and the decisions regarding the product attributes made from an overall strategic management of a business (customer's view of product).
- *Phase 2*

  In this phase the product attributes are translated into product characteristics (engineer's view of product).
- *Phase 3*

  In this phase the detail design of the product (proceeding from product to component) is carried out so as to arrive at a set of specifications to ensure that the product has the required characteristics.
- *Phase 4*

  This phase deals with product development proceeding from component to product and resulting in the product prototype.
- *Phase 5*

  In this phase the prototype is released to a limited number of consumers to evaluate customers' assessment of product features.
- *Phase 6*

  This phase deals with production of products starting from component and ending with the product for release to customers.
- *Phase 7*

  This phase looks at field performance of the product, taking into account the variability in usage intensity and operating environment from the customer perspective.
- *Phase 8*

  Here the performance of the product released for sale is evaluated from an overall business perspective.

Looking at various steps, or phases, of the NPD process, it is imperative to understand that a large business process such as this indeed requires a quality management framework to support its operational effectiveness. This entailed about the necessity of investigating a question that was posed this way: "Which universal effective quality management approach can be used to successfully manage an NPD process?" In support of this view, there are many

questions that need to be posed and addressed prior to designing products (Foster, 2001:177). This means that quality of NPD planning should occur *prior* to designing products. These are questions such as the following:

- What are the functions the customer wants?
- What are the capabilities of current products?
- What are the limitations of the materials selected for the product?
- Are there better materials available?
- How much will the product cost to make?
- How much must the product cost to be enticing in the market place?
- What does it mean to design products for *quality*?

Last but not least, although it is rather impossible to foresee whether or not a given process is favourable for every NPD process in the business, the organisation can execute improvements based on the experience gained from previous NPD projects (Rundquist & Chibba, 2004: 41).

3.2.3 NPD management

Kahn, Barczak, and Moss (2006) present their view of the best practices framework for NPD management based on the PDMA's six NPD management dimensions (strategy, portfolio management, process, market research, people and performance evaluation). They describe each dimension across four levels of sophistication with each level corresponding to a particular set of characteristics describing poor or rudimentary practice (level 1), better practice (level 2), good practice (level 3) and best practice (level 4). A company can characterise itself on each of the six dimensions according to the four general states, thus identifying key areas for improvement.

Sanongpong (2009b) explained that like any other business process, the process approach should be a guiding principle for the monitoring of the NPD process. McCracken (2011:3) further explained that there are a number of factors involved in the conceptualisation, development and marketing of a new product. These factors are listed below:

- a successful launch;

- effective NPD management;
- product superiority;
- a favourable market environment;
- good use of communication;
- effective ID systems;
- an NPD-friendly corporate culture;
- the use of a formal NPD process;
- legislation;
- distribution of the product;
- the marketing budget; and
- the timing of product release.

Having noted the description, phases and factors affecting the NPD process, it seems that all inputs and/or outputs of various processes impacting the realisation of the NPD process should be holistically managed in order to obtain expected results. With this study in mind, it is in fact imperative that a universal approach be identified to effectively manage the quality of an NPD process.

3.3 KEY FACTORS AFFECTING NPD PROCESSES

It cannot be over-emphasised that successful firms today *must* learn lessons related to the dynamics of consumers, competitors and technologies, all of which require companies to review and reconstitute the products and services they offer to the market (Subramaniyam, Srinivasan & Prabaharn, 2011:166). They further explain that while there are several many factors associated with successful NPD, the fact is, processes and structures which are customer-focused recur.

The key factors spearheading market success include the capacity to develop the right products for the right customers using the right processes with shorter development life cycles than competitors, knowing that customers demand products of higher quality, lower price, and better performance in an ever-shorter delivery time (Rejeb *et al*., 2011:217). Competition in the marketplace for new products is compelling changes in the way product designers and manufacturing engineers develop products (Xu, Li, Li & Tang, 2007:2029).

Manufacturers are facing increasing challenges of better product quality with tighter delivery requirements for customers and more profitability shareholders. A review of literature identifies some key factors affecting NPD process as, but not limited to, the following:

- leadership;
- voice of the customer;
- globalisation; and
- innovation.

3.3.1 Leadership

It is said that as much as management commitment is necessary but it is actually not enough. To encourage achievement within a company, the most important element is management leadership on quality, with verification to prove it Gryna (2001:225). Leadership is a key strategic variable for quality management. A leader organises, plans, controls, communicates, teaches, advises and delegates. Where there is a leader, there is also a follower (Foster, 2001:99). According to Tallqvist (2009:18), leadership is a person or group of persons who lead others, emphasising the leader's set of ways to make others follow; he further explains that leadership influences others to do the management. According to Harmancioglu *et al.* (2007:409), senior management plays a leading role in idea generation and decision making during the NPD process. As a result, and as a rule, there shouldn't be any project that enters development not including a product definition, agreed to by the project team and signed off by top management (Cooper, 1996: 470). During the NPD process, top managers are there to operate as gate keepers: as leadership's accountability is to make the right in opposition to wrong decisions and assess the performance of the NPD teams using visible metrics at the end of each stage (Harmancioglu *et al*., 2007:417).

Research conducted with UK SMEs demonstrated that one of the reasons of problematic implementation of NPD is due to low priority given to NPD programmes, unrealistic expectations, short-term vision, lack of strategic thinking, risk averseness, and the incapability to learn from past failures were seen as major rationale for product development delay (Owens, 2007:241). He

further explained that most respondents indicated that the aforementioned challenges were a reflection of senior management's attitudes toward innovation and NPD in general. For that reason, top management will know how to play a major role in setting the climate for important innovative NPD programmes (Owens, 2007:242).

In a research conducted by Song and Noh (2006:274), interviews revealed that the first key success factor of NPD was the determination and enthusiasm of the top management to drive innovation. Other significant keys of success of NPD were interest, commitment and support of management (Sanongpong, 2009a). According to Kumar *et al.* (2009:72), the NPD stages review, and approval team is comprised of senior managers as they embrace the following responsibilities:

- profit and loss responsibility for the affected product lines;
- responsibility for defining the business plan and overall product development strategy; and
- the authority to commit resources to the projects.

According to Harmancioglu *et al.* (2007: 413), organisational leaders should not only be involved in decision-making at NPD gates and business case groundwork, but also in idea generation. The titles of the gate keepers will vary from organisation to organisation but could be the vice president in a smaller company or director of business units in a larger company (Kumar et *al.,* 2009:72). The success of design reviews, then, largely depend on the degree to which management supports the programme by insisting that the best specialists be made available for design review work (Gryna, 2001:362).

Sanongpong (2009b) is of the opinion that when monitoring the NPD process, management is supposed to review the process metrics in order to control the whole process to deliver the desired output. According to Collins, Yassine and Borgatti (2008:1), functional managers and process architects can evaluate whether tasks like stage-gates and design reviews are acting as effective information flow regulators in the product development process. Leadership should therefore be completely reliable and reasonable in gaining and earning

trust; if they are not, the potential for quality improvement will be reduced (Foster, 2001: 101). Therefore, management need to develop a better understanding of how they can possibly enhance and reconfigure resources to remain competitive (Acur, Kandemir, Weerd-Nederhof & Song, 2009).

Opinions pertaining to leadership demonstrate that no matter how 'excellent' a model, improvement programme, or management system requirement is, if there is no interest, commitment, dedication, eagerness, enthusiasm and support from company leadership, such 'excellence' is still regarded as failure. This confirms that even if the study identifies an effective quality management approach that could be implemented to manage the NPD process of Cape Pak (Pty) Ltd, in order to resolve the problem statement, noted as: "Lack of an effective approach to quality management practices within the NPD process result in poor product quality and customer dissatisfaction", the leaders of the company *must* be committed to quality management of the effectiveness of the NPD process.

3.3.2 Voice of the Customer

On average, more than one-third of the organisation's revenue comes from products that did not exist five years ago, and as a result, subjects such as the voice of the customer and lead user brought fresh ideas to NPD (Nambisan, 2003:3). When developing new products, it is imperative for design teams to comprehend customer perceptions of consumer products: the accomplishment of such products is greatly reliant upon associated customer satisfaction levels (Kwong, Wong, & Chan, 2009:11262). According to Gryna (2001:333), organisations striving to knock the competitors off their pedestals, should have one goal in mind—studying customer needs in detail and translating them in a structured way into product features and design parameters because, in spite of everything, a customer's keenness to pay a certain price for a product depends on his perception of the prospective worth derived from buying the product (Murthy *et al.,* 2009: 1595).

Research conducted with UK SMEs found that problematic implementation of NPD is often due to poor understanding of customer requirements and

insufficient knowledge of a product's technology and market forces such as competition, suppliers and distributors. The lack of understanding necessitates frequent changes in the product development and marketing plans (Owens, 2007:240). Competition from emerging countries, increased costs of raw materials, variability of requests and inconsiderate economic crisis have combined to the point where the customer is no longer just a king, but essentially a determinant of a company's future (Rejeb *et al.,* 2011:217). Sofianti, Suryadi, Govindaraju, and Prinhartono (2010) contend that maintaining existing customers is far more effortless and economical than grabbing a new customer; they further provide awareness that as the relationship with the customer occurs in long term, the influence of the customer perception and knowledge in expressing the idea into a design should not be abandoned.

Kumar *et al.* (2009:73) agree, explaining that organisations should not assume that they know customers' desires without asking them what they want in a product, as customers' versions may be drastically different from the supplier's vision. Hung *et al.* (2008:340) stated emphatically: "As we know very well, the customer requirement is the most important consideration for NPD". Sofianti *et al.* (2010) understand the value of customer satisfaction, they further provide awareness that, customers today have more preference of products and services than ever before, but they seem dissatisfied, therefore, companies should invest in greater product variety as customers are not able to differentiate themselves. customer satisfaction models play an important role in identifying customer perceptions of consumer products (Kwong *et al.,* 2009:11262).

Rejeb *et al.* (2011:217) suggested that the key factors spearheading market success include the capacity to develop the right products for the right customers using the right processes with shorter development life cycles than competitors. Murthy *et al.* (2009: 1593) argued that from the customer's point of view, unreliability reduces availability and increases maintenance costs over the useful life of the product. So then, to satisfy customers, manufacturers must choose to invest in product reliability from an overall business viewpoint. The problem statement of this study identified that lack of quality management in

NPD process of Cape Pak (Ltd) resulted in (at minimum), frequent customer dissatisfaction, Likewise, Addo-Tenkorang (2011) noted that it is crucial to improve customer satisfaction and identify the associated design attributes to ensure sustained customer loyalty and competitiveness for the firm.

Additionally, Hung *et al.* (2008:340) indicated that the customer requirement is the most important consideration for the organisation, as it is the most important consideration for NPD. They further suggest that it is crucial to improve customer satisfaction and identify the associated design attributes that would ensure sustained customer loyalty and competitiveness for the organisation. Research shows that by managing the knowledge of their customer, organisations are more likely to sense emerging market opportunities earlier than their competitors, to constructively challenge the established wisdom of 'doing things around here', and to more rapidly create economic value for the organisation, its shareholders, and last, but not least, its customer (Sofianti *et al.,* 2010).

The scholarly opinions related to this study, though, demonstrate that the clear cut to competitiveness begins with how customers perceive the services and products supplied to them. The unfortunate part of this is the reality that a new product can be considered a success if, and only if, it satisfies customer requirements (Kumar *et al*., 2009:73). This is one of the reasons that for Cape Pak to stand out from and outshine its competitors, leaders of this company should, at a minimum, practically demonstrate their commitment to achieving and exceeding customer requirements. This must be achieved by driving a culture of customer focus throughout the entire company.

3.3.3 Globalisation

Organisations today form part of a global market economy characterised by constant change and an increasingly intense level of competition (McCracken, 2011:1). McCracken contends that NPD has been recognised as an avenue for organisations to remain relevant and competitive in this continually changing global market. The reality is that global advancement is focusing on amending the entire structure of final products. In this global evolution, product structures

are adjusted as new product improvements inherit some quality characteristics of old products, and reject some quality characteristics not meeting customers' needs (Tang & Yun, 2007:169). Tang and Yun state that global optimisation includes a variety of actions:

- setting up a new product structure;
- keeping some old features in the initial product; and
- developing new sub-systems or new interfaces to replace old sub-systems or interfaces.

But participating in the global economy does not in itself guarantee sustainable income growth, as this depends significantly on how the organisation is placed in the global production networks (Kaplinsky *et al.,* 2001: 24). This is one of the reasons why in recent years, NPD has become competitive and globalised with a planning phase that is tremendously significant to the success of NPD projects (Hung *et al.,* 2007:338).

Chin, Tang, Yang, Wong and Wang (2009:9882) are of the opinion that in order to deal with the unsympathetic economic changes, an organisation's NPD department should actively adopt a global development policy, incorporating diverse disciplines in a collaborative and boundary-free manner. For instance, in order for Africa to take advantage of the continent's potential, global brands are being forced to stretch beyond the products and services that have been successful in more developed economies (Nyaundi, 2011: 5). One of the reasons for this is that, global NPD has recently attracted substantial attention through the increase in international collaboration (Ma, Lin, Riedel and Pawar (2009).

Global competition is increasing with pressure on prices, smaller orders, short life cycles, more suppliers, and more governmental regulations (Ming, Yan, Wang, Li, Lu Peng, & Ma*,* 2008:154). To contend with these globalisation factors, a cross-functional team formation is necessary, as this brings the advantage of integrating different product requirements (Hsu *et al.,* 2009:305). That is why, where possible, in international NPD, managers must coordinate activities between parent company and overseas units (Lee & Wong, 2008:31).

Globalisation tends to produce a new industrial revolution related to production, product, and services distribution without precedent. All countries and economical regions, even the emerging ones, are affected; the competition is becoming very harsh indeed (Kifor, Oprean & Banciu, 2008). The authors further explained that there is a powerful development of knowledge-based economies, with radical effect on markets, society and technology. This determines a new approach on production, based on high added value and knowledge involvement at all levels. This scenario demonstrates that powerful global competition, rapid technology change and shifting patterns of world market opportunities force organisations to continually invest in NPD (Owens, 2007:335). Murthy *et al*. (2009:1593) argued that modern industrial societies are characterised by new products appearing on the market at an ever increasing pace, for a variety of reasons:

- rapid advances in technology;
- increasing consumer expectations; and
- global competition.

According to various opinions around globalisation, it is a given fact that competing globally is advantageous to any company that engages in global business and/or partnerships. Again, various scholars, as referenced in the Literature Review of this study, enlightened that as much as participating on a global scale is undoubtedly beneficial, the global market is *not* sympathetic or even compassionate to its players. Factors such as economic stability, innovation, technology, price, speed, and most importantly, quality are major winners and qualifiers of this dynamic game. In the case of Cape Pak (Pty), the majority of its customers are in the international market. As much as this is beneficial to Cape Pak (Pty), it can also be very risky if the company has no proper control over its processes, especially including the NPD process. Challenges such as product recalls, defect containments, reworks and warranties are costly, especially when dealt with outside the particular product's country of origin.

3.3.4 Innovation

According to Matsui, Filippini, Kitanaka and Sato (2007:16), the development and introduction of innovative new products is one of the most significant challenges for manufacturing companies engaged in competitive business environments. Although general perceptions view innovation as related to products only, innovation can be practiced in any form. Innovation is much broader than just a physical product as it could include a product-related service, or happen as a part of the value chain from order-to-deliver to use-to scrap, or it can entertain new raw materials, new methods for manufacturing, or new forms of industrial organisation (Tallqvist, 2009:19). According to Acur *et al.* (2009), the priorities for innovative organisations are to identify and exploit new product market opportunities, and to pursue really new and fundamental innovations which require state of the art technology. They further say that developing an innovative NPD climate increases NPD speed through the development of technological competence.

Design innovation by means of NPD process has been well-studied over the last forty years. The conceptualisation, design, engineering implementation, and commercialisation of products have been studied across a broad range of industries (Marion, 2009). This is because, although innovation is a costly process (Nyaundi, 2011: 2), it is a necessary process for introducing a novelty into a system. This process involves several successive phases, beginning with creativity and the search for innovative ideas, and ending with the launch of a product or service into the market (Rejeb *et al*., 2011: 216-217).

Sun, Zhao and Yau (2009:580) suggested that the improvement of existing products through the addition of new features, the design of more user-friendly operations or even the reduction of redundant parts can create more new products. These new products, then, can be upgraded again into yet more new products according to market demand. Then again, Ebrahim, Ahmed and Taha (2009:1) suggested that innovation is becoming *the* most important key factor for any organisation's success in the 21st century. They further suggested that it is a well-known fact that innovation is better achieved by working in team. Also,

one of the best ways of encouraging innovation is to make certain that individuals and organisations gain from the results of their innovation efforts. Further, the quality and efficiency of the methods and tools a company uses to commercialise products and create innovations will lead to value for those involved (Miguel, 2007:617-618).

The need for NPD and innovation is a must in this world for upgrading in every aspect; thus, organisations should have an innovation process to match customer needs (Miguel, 2007:617). Rejeb *et al.* (2011:220) concur that it is necessary to define a conceptual model of the innovation process, as according to them, several different models have been proposed for the innovation process, starting with the idea of screening and ending with the commercial launch.

Nicholas *et al.* (2011:227-228) also agreed that organisations must innovate in order to expand into new markets, to arrest margin erosion and to protect their current market share as excellence in NPD is vital for new product success; hence, a business's culture should be assessed to ascertain whether or not it is supportive to innovation, change, and ultimately NPD (Owens, 2007:248). The ability to bring new products to market quickly is fundamental to any successful customer-driven company (Miguel, 2007:617); however, today's highly competitive environment makes this task more challenging than ever, as apparently customers not only demand higher levels of quality in new products, but also demand the latest innovations.

It is clear that it is quite easy for companies to render similar services and/or produce same products. This is because companies can always replicate or benchmark from one another. Nonetheless, business becomes quite risky when more and more companies render the same services and/or produce the same products, because then it is easy for customers to get such services or products anytime, anywhere, with other companies. Consequently, competition comes to the forefront. On the one hand, to outshine competition, companies have to constantly endeavour to do things differently than the rest to acquire a bigger portion of the market share. This is where innovation comes into play. According to previous studies, innovation is one of the ways in which a

company will have a long stay in the market. Subsequently, companies engaging in NPD process have a surer footing because if the NPD process is properly managed, they will have the opportunity to design these products at minimal costs, with new or enhanced features, reliability and durability concepts and user-friendliness in mind. However, this can only be achieved if the NPD process is properly controlled where quality management is concerned.

3.4 THE MAIN QUALITY DETERMINANTS OF NPD PROCESS

According to Cooper (1996: 473), a high quality new product process clearly pays off. In the quest to set NPD goals that will lead to controls and improvements, the NPD process performance is measured to pledge an adequate level of performance through the establishment of product, process and programme performance metrics (Sanongpong, 2009b). Quality determination revolves around four factors, factors which can be applied to the assessment of the current status of the product development process with respect to quality (Gryna, 2001:366). These factors include cost of poor quality, standing in the marketplace, quality culture and assessment of current quality activities.

According to Tang and Yun (2007:167), quality management in NPD process is in existence to ensure flawless quality integration in product life cycle process by putting much focus on the following:

- information generated in all phases of the product life cycle;
- relevant human resources: engineers, managers, technicians; and
- suppliers and customers.

The control of process-based NPD is performed through design reviews including verifications and validations (Sanongpong, 2009b). These NPD quality determinants are practiced to guarantee desired results in terms of both effectiveness and efficiency. De Mozota (2006) explained that with the awareness that design creates value, designers and design managers also appreciate that one cannot manage what is not measured. So measuring the impact of design value is a key success factor for designers who want to

successfully execute their design strategy, and for design managers who want to present design as an instrument for value management.

Competitions in global product market are shown in the ways of time, quality, cost, service and environment, and in which quality is the key factor (Tang & Yun, 2007:167). Then again, the management of quality-related activities in design (as in all functional activities) should embrace a measurement condition (Gryna, 2001:366). With clearing quality concept, product quality assurance has been extended in product process, from manufacture forward to design and afterward to after-service, and covers the whole product life cycle (Tang & Yun, 2007:167). Therefore, quality of execution of key tasks and activities throughout the new product process is emphasised in top performing firms (Cooper, 1996: 471).

During the design and development planning, the organisation shall determine the review, verification and validation that are appropriate to each design and development stage (ISO9001, 2008: 7.3.1). Products and processes should be designed, verified and validated in a manner that is well-suited to the industrial requirements (Maropoulos & Ceglarek, 2010:1). Design reviews, verifications and validations are formal reviews performed throughout the development process to guarantee that the metrics, requirements, concept, and product or process satisfies the requirements of that stage or development, the issues are understood, the risks are being managed, and there is a excellent business case for development; hence, the NPD is controlled to help assure the desired results in terms of both effectiveness and efficiency (Sanongpong, 2009a). These controls are in the form of design reviews including verifications and validations as part of the review (Sanongpong, 2009b). It can therefore be concluded that the main quality determinants of NPD process are NPD reviews, verifications and validations.

3.4.1 NPD Process Review

Because issues of continuous quality improvement and product elimination are important elements in the NPD process, Tomkovick and Miller (2000:414) contend that to fulfil diverse product requirements, the NPD process should be frequently reviewed. The design review is a formal, documented,

comprehensive, and systematic assessment of a design to assess the design requirements, to assess the ability of the design to meet these requirements, and to discover problems and propose solutions (Gryna, 2001:362). Design and development verification as part of the review should ensure that the design and development outputs have met the design and development input requirements (Sanongpong, 2009a). Hence, design reviews should be performed by a pertinent and competent multidisciplinary team (often referred to as 'specialists') that is not directly associated with the development of the design (Gryna, 2001:362). Gryna further explains that the team should be experienced, reputable and objective.

3.4.2 NPD Process Verification

Maropoulos and Ceglarek, (2010:2) believed that, in general terms, verification is a quality control process used to evaluate whether or not a product, service or system complies. These authors suggested that validation, in particular, is a quality assurance process of determining evidence to provide a high degree of assurance that a product, service, or system has achieved its intended use requirements. Verification is confirmation, through the provision of objective evidence, that specified requirements *have been fulfilled.* Tang and Yun (2007:169) enlightened that in the middle of the product cycle, quality assurance is enacted to verify conformance of products according to quality manuals and product design specifications, and to control six factors affecting quality: man, machines, material, methods, environments and measurements.

Tang and Yun further stress that verification is performed to monitor the actions and processes, to analyse the states and conditions, and to make decisions and solve quality problems. Design verification is testing to assure that the design outputs meet design input requirements. Design verification may include activities such as design reviews, performing alternate calculations, understanding and performing tests and demonstrations, and reviewing design documents before releasing (Sanongpong, 2009a). In recent years, a great amount of verification equipment and new techniques were developed to address several aspects of verification using different methods (Lissel and Gerlach, 2007).

3.4.3 NPD Process Validation

Validation is confirmation through the provision of objective evidence that the requirements for a specific *intended use* or *application* have been fulfilled (ISO9000, 2005). According to Sanongpong (2009b), design and development validation is performed in accordance with customer requirements including programme timing; he said that the validation normally includes an analysis of field reports for similar products. According to Maropoulos and Ceglarek (2010:1), validation is the industrial requirement that drives research and development. There are numerous benefits for an organisation to develop a viable validation process:

- bad results would be reduced;
- lead times achieved;
- fewer failures; and
- better product quality as perceived by customers.

During the validation process, designs are prototyped to validate for fit, function and fabrication (Krishnan & Ulrich, 2001:10). The validation is authoritatively complete when the relevant data, submitted to customer, is approved (Sanongpong, 2009b). According to Maropoulos and Ceglarek (2010:2), verification and validation are the means used to substantiate that a product, service, or system meets its respective specifications and fulfils its intended purpose.

According to previous studies as reviewed above, at a minimum there are three quality determinants of NPD process: 1) NPD process reviews; 2) verification; and most importantly 3) validations. The study had identified that the NPD process is comprised of many steps or phases. This presents a risk due to their interrelation if these stages are not properly controlled. This means that if in Phase One quality was not determined following NPD stage review, verification and validation; there is a high probability that any undetected non-conformance will negatively affect the final stage. When a huge risk such as this occurs, the company will experience losses that are not limited to re-scoping the NPD project, including the need for more human resources, the need for product and/or manufacturing process redesign, the need to discard verification or

checking fixtures due to their insufficiency, the need to review and where necessary, the need to amend and control documents. However, the biggest risk in this is that the entire NPD project will delay, causing what has been stated as a research problem: 'Dissatisfied Customer'. Then again, the concept of 'first to market' is an advantage over competition. In industries like the Automotive, validation becomes a very imperative stage of quality determination of the NPD process. The industry follows an NPD quality control method that is called Production Parts Approval Process (PPAP). At minimal, the PPAP will identify controls necessary for product and input components drawings and other critical documents, the identification and control of input component suppliers, the process taken for incoming inspection of input components, the control of the manufacturing and shipping process etc. All of this comes down to the fact that quality determination in NPD process is imperative. It is very important that each NPD step is reviewed, verified and validated. These quality determinants should be approved for adequacy prior to proceeding to the next NPD step.

3.5 BASIC REQUIREMENTS OF INTEGRATING QM INTO NPD PROCESS

Through their research, the following authors: (Song & Noh, 2006; Owens, 2007; Hsu *et al.,* 2009; Sofianti *et al*., 2010; Kumar *et al.,* 2009; de Mozota, 2006; Sudarsan; Fenves, Sriram & Wang 2005, Taylor & Vanek 2011; Rautiainen, von Schantz & Vähäniitty 2011; Ebert 2007; Ebrahim *et al.,* 2009; and Filho *et al*. 2007) have identified the following as the basic requirements for effective quality management into NPD process:

- NPD strategy;
- skills and resources;
- competence;
- product quality;
- multidisciplinary teams; and
- risk management.

3.5.1 NPD Strategy

As a result of highly sophisticated product technologies and competition based on core competencies, organisations have been forced to ensure tighter relations between their NPD projects and business strategy, and to adopt a rational company-wide NPD strategy (Nambisan, 2003:4). Rundquist and Chibba (2004: 40) identified that new product strategy is a strategy for deciding which new products are to be developed. They also suggested that, a clear and well-communicated new product strategy is a significant performance driver that can easily separate good performers from the rest. In the quest to characterise an organisation's practical strategic ability to cope with competition pressures and to generate the best NPD performance, Acur *et al.* (2009) identified strategic dimensions for dynamic NPD capabilities as follows:

- Technological competence increases the organisation's speed and NPD programme performance; as a result, the better the technological alignment of a firm, the greater the technological competence development.
- Positive innovative climate increases the organisation's technological competence development as well as NPD speed.

Similarly, Nambisan (2003:4) is of the opinion that due to innovative product technologies and tight competition, organisations are now focused on applying diverse concepts of NPD strategy:

- strategic product planning;
- technology planning;
- portfolio management;
- product platform strategy; and
- technology alliances.

A good NPD strategy is reflected in how good NPD financial performance indicators are. Or in other words, NPD strategy determines how poor or how good the organisation will perform financially (Matsui *et al.,* 2007:16). According to Liu, Chen, and Tsai (2005: 637), an NPD strategy is an important activity that facilitates the organisation's survival and ability to make continuous improvements; this is one of the reasons why many organisations have

adopted new product development strategy. In his research, Cooper (1984:152) identified four variables concerning a new product development strategy:

- **Orientating the enterprise to a new product:** This includes creating a new product, developing a better product for meeting the customer's demand than that of competitors, and product concentration and differentiation.
- **Market characteristic adopted by the new product:** This includes the characteristics for a new market, customers, competitors and new sales channels.
- **The enterprise's technological orientation and commitment:** This includes the percentage of R&D orientation.
- **Technological characteristics adopted by the new product:** This includes more advanced and complicated technologies, closely matched with a company's R&D resources, technical maturity and concentration.

In order to survive, organisations should focus on new product development strategy implementation (Liu *et al.,* 2005: 637) as NPD strategy demonstrates a positive effect on NPD performance. Consequently, the NPD strategy should be reflected in the business case, which gets evaluated and updated during project implementation and where senior management sets the broad strategic goals for the NPD process and projects as well as dedicating teams with independence and empowerment to meet these goals (Harmancioglu *et al.* (2007:409).

According to Cooper (1996: 467), a company's clear and well-communicated new product strategy will have the following characteristics:

- The goals and/or objectives for the company's total new product effort (i.e. sales and profits that the new product would contribute to the company goals).
- The role of new products in achieving the company's goals is clearly communicated to all.

- The clearly defined specified areas of strategic focus such as products, markets, or technologies, to give direction to the business' total new product effort.
- The new product efforts have a long-term thrust and focus, including sustainable long-term projects (as opposed to short-term, incremental projects).

NPD strategy is in place, at a minimum, to determine new product costs, quality, speed, and targeted sales. It is evident that there needs to be a clear direction put forward for any business activity. The NPD process clearly is no exception to this rule. A strategy that will focus on new product qualification into the market is significant for any NPD project. This strategy should be determined from the highest company leadership goals and objectives, cascaded down to each relevant NPD project team member. When there is an established NPD strategy, team members will have a heightened capability to deliver against set targets.

3.5.2 Skills and Resources

With a successful NPD strategy in place, the next significant step is to guarantee that a quality NPD process is being applied, encompassing high-quality market research and launch activities, carried out by a competent cross-functional team (Nicholas *et al.,* 2011:241). Management should dedicate appropriate resources to assure the company unit's new product objectives (Cooper, 1996: 467).

According to Owens (2007:244), respondents of the research conducted with UK SMEs claimed that their businesses needed more experienced personnel in NPD. Design knowledge is generally acquired in the course of 'do to learn' processes of implementing design projects to attain design context (Hsu *et al.,* 2009:305). It is said that there are three categories of factors contributing to NPD success: project environments, skills and resources, and strategy (Song & Noh, 2006:63).

Ebert (2007:850) explains that winning products depend on the skills and competence of the product manager. In Song and Noh's research (2006:272), respondents concurred that marketing, technology; general resources, competitive predictability, market predictability and technological predictability are the most crucial skills and resources for a successful NPD process. Lee &Wong (2008:31) agreed with this awareness, suggesting that successful new products surface from a combination of the organisation's existing capacity, skills and resources, and a competence consisting of marketing and technology synergy.

Hsu *et al.* (2009:304) are of the opinion that most successful design solutions require several kinds of expertise. Consequently, it is necessary to accrue a network for the interchange of knowledge which incorporates knowledge supporters and demanders to form a framework of knowledge work. Mishra and Mishra (2009:282) suggested that in the software community, for instance, the economy of merging diverse development skills and domain expertise is very much appreciated; as processes become more sophisticated (e.g. communication media) the cost and technology pushes more companies toward global software development. Proficiency is one of the important focuses in executing NPD processes as it determines the degree to which businesses can meet or exceed demand, and thus succeed (Harmancioglu *et al.,* 2007: 400). Lee and Wong (2008:32) refers to this NPD proficiency as screening preliminary market and technical assessments, market research, product development, test marketing, and market launch. Therefore, organisations competing around the world must access new knowledge and absorb technical information from foreign countries to develop the technical knowledge, skills and technologies (Murthy *et al.,* 2009:1593).

3.5.3 Technological Competence

According to Acur *et al.* (2009), technological competences is a set of activities and behaviours implemented to detect and shape opportunities and threats, seize opportunities, and maintain competitiveness through enhancing, combining, protecting and, where necessary, reconfiguring firms' tangible and

intangible resources. In their research, Acur *et al.* (2009) found that a business' innovative climate and technological alignment are positively associated with technological competence development, and technological competence development has positive effects on speed. Research shows that technological competence can be found in universities or through consultancy firms (Rundquist & Chibba, 2004: 48). Technological competence development is one of the organisation's most important dynamic capabilities (Acur *et al.,* 2009).

Due to its rigorousness, knowledge, skill and suitable behaviours have become critical parts of the NPD process. Multidisciplinary team members must be competent in their various backgrounds in order to minimise risks in the NPD process. There are various outputs of other processes that become inputs to the NPD process. Competence, for example, becomes a guiding principle to NPD process decision-making and technology advancement, including realising quality determinants such as NPD process reviews, verifications and validations. This means that company leaders should ensure that personnel taking part in NPD process are competent. Training needs should be assessed, training provided, and finally, competence assessed in order to ensure that each and every team member is well aware of what is expected, is knowledgeable, and is highly capable of delivering such demands.

3.5.4 Product Quality

The most significant factor required for a new product to do well is product superiority (Nyaundi, 2011:1). One of the top success factors, then, is delivering a differentiated product with unique customer benefits and superior value for the user (Cooper, 1996: 474). Products are supposed to be managed vigilantly so that products that meet customer needs are continually delivered to customers (Addor-Tenkorang, 2011). Addor-Tenkorang noted that when this is achieved, organisations continue to maintain a cash flow that covers the business costs and delivers a profit. Due to customers' ever-changing requirements, products have to be gradually acclimated to the customers' needs (Tang & Yun, 2007:167). And so product reliability is attributed to the decisions taken throughout the design and manufacturing of the product and in

turn, customers then select products based on such attributes (Murthy *et al.,* 2009: 1593).

Therefore, it can be concluded that product attributes define customer perceptions. Lamratanakul, Patanakul and Milosevic (2008: 177) agreed that product quality is related to the superiority of a product, customer requirements, vigorousness and reliability. As life cycles for products decrease, a focus shift onto quality in the product design process is necessary to remain competitive (Foster, 2001:204). Product quality, characterised by qualities such as user friendliness, ease of cleaning and solid feel, plays a major role in both market share and price that customers are willing to pay.

This study included the dynamics of globalisation; then again Hung *et al.* (2008: 338) suggested that in this highly competitive global market, developing a set of successful and profitable products is 'key' to success for organisations. However, this comes at a cost as product life cycle costs will normally amount to the total cost of owning, operating, maintaining, and finally discarding (Murthy *et al.,* 2009: 1597). Furthermore, as a result of the complex multi-disciplinary design discourses, the demand for top-quality products necessitates the availability and involvement of more designers (Saridakis & Dentsoras, 2007: 205).

Quality data related to product and its processes should be generated throughout the product's life. These data are scattered in different stages, individual departments and processes in various formats such as figures, reports, tables, files and data sets. They reflect all aspects of quality state in product's life cycle (Tang & Yun, 2007:167). Tang and Yun explain that quality data are the most important basis for decision-making in product quality control, quality management and quality improvement, and the most crucial resources in improving organisational business.

The success of new products depends, for the most part, on the NPD process (Kumar *et al.,* 2009: 71). NPD best practice can be defined as NPD practices that promote greater success in developing and launching new products and services (Nicholas *et al*., 2011:228). Organisations that want to outshine

competition can only do this if they accomplish one important condition: a steady stream of high quality products efficiently delivered to the customer. To meet this challenge, companies endeavour to apply innovative practices to NPD (Miguel, 2007:617). According to Kwong *et al. (*2009:11262), high quality products are identified by measuring associated customer satisfaction levels. Recognition of this has transformed most industries from production-centralised to customer-driven. Kwong *et al.* (2009:11262) suggest that market analysis is an effective means to understand customer perception towards new consumer products.

As incorporated into the research problem, lack of an effective approach to quality management practices within the NPD process results in poor product quality and customer dissatisfaction. Then again, product quality is highly correlated to customer satisfaction. It is said that customers who consistently receive products that exceed expectations are naturally very happy customers. Another significant aspect of this is the fact that happy customers do not keep their satisfaction to themselves but rather spread the news to other partners (e.g. colleagues, suppliers, professional bodies), referring such products to other potential customers. This in turn greatly strengthens the competitive edge of the company. It can then be concluded that producing superior new products will guarantee that the company retains its customers for longer, acquires and retains more new customers, and remain in profitable business for longer (i.e. enhanced sustainability).

3.5.5 Multidisciplinary Teams

Effective product development depends on the integration of a variety of specialised capabilities, strong functional groups with interdisciplinary teams and multiple progressive pressures (Hung *et al.,* 2008:338). Most successful design solutions require several kinds of expertise. Therefore, it is essential to build a network for the interchange of knowledge which integrates with knowledge supporters and demanders from a framework of knowledge work (Hsu *et al.,* 2009:304). Project's stakeholders are persons or groups having an interest in the NPD project. According to Surbier, Alpan and Blanco (2009), there are three major stakeholders during production launch—those in the

R&D, production and purchasing departments. Other stakeholders that also take part in an NPD project, but to a lesser degree, include departments such as procurement, quality or factory management.

Personnel such as designers, manufacturers, suppliers, marketers and so forth can participate in the product development process with mutual communication at the same time (Tang & Yun, 2007:169). No matter the restriction of the geographical position, even the relevant personnel from different places, through a product development network, can be linked to execute and modify product design in accord with the consumer requirements. According to Sun *et al.* (2009: 579), collaborative design is a manner of collaboration which involves all relevant people. Many organisations have formed some development teams under the Concurrent Engineering (CE) approach to implement their ideas and to convert research to company profit, getting very good results over the past few years. The essential obligation of using a cross-functional team in NPD is that collaboration of functional diversity enhances the amount and variety of information accessible to team members (Song & Noh, 2006: 267).

Again, Addo-Tenkorang (2011) suggested that NPD management processes such as Concurrent Engineering (CE) depend on having a very well-defined multidisciplinary team consisting of numerous departments: marketing, product engineering, manufacturing engineering, production engineering, finance, quality, logistics control, systems engineering, services and external consultancy or support teams as well as the customers and brokers. He further explained that NPD / CE Multidisciplinary teams are categorised as follows:

- **Functional Team:** This type of multidisciplinary team very much relates to the orthodox over-the-wall way of a functional department. This team type should be avoided.
- **Lightweight Team:** This type of multidisciplinary CE team is mainly formed with members from the same department.
- **Heavyweight Team:** This type of multidisciplinary CE team is a classical cross-functional CE team. Members work part-time aside their original departmental duties.
- **Autonomy Team:** This type of multidisciplinary CE team is also a classical cross-functional team where members work full-time from their

own offices and also use the departmental resources. With this type of CE team, regular meetings take place among the CE team members.

- **Collocated Autonomy Team:** This type of multidisciplinary CE is much like the autonomy team type of CE, that to enhance total dedication to the project as well as the integration of the team, members are brought together in the same working environment with the requisite resources to carry on their activities.
- **The Virtual Team:** This type of multidisciplinary CE team is geographically distributed, thus employing information technologies (i.e. internet/intranet, telephone conferences and videoconferences) for communication amongst members (Addo-Tenkorang, 2011).

Functional diversity in NPD increases the amount and variety of information available to team members. Quality of execution of technical actions leads to more time-efficient projects (Lee and Wong, 2008:34). Therefore, it can be concluded that a cross-functional group of permanent members responsible for NPD would likely be a fruitful approach to the NPD process (Rehnquist & Chibba, 2004: 9). Nambisan (2003:3), agreed with these opinions by also concluding that, NPD is an interdisciplinary, applied field with a clearly defined research focus and agenda; also, the NPD process could be described as a system encompassing an active interaction between internal and external factors.

It is clear that the NPD process is not a ‘one-man-show’. Due to its intensity and numerous stages, the NPD process shall be realised by a diverse and competent team. The NPD team should comprise clearly defined goals, objectives, responsibilities, authorities and accountabilities so that they can easily achieve, perhaps even exceed, their stated measurements against targets.

3.5.6 Risk Management

Risk is an inherent part of business and public life (Chin *et al.,* 2009:9880). According to Chin *et al.* (2009:9881), NPD project risks could be defined as the

likelihood that the NPD project cannot be accomplished within the expected time. Certain aspects are categorised as ‘critical’ in an NPD project selection:

- market fitness;
- technical competence;
- financial issues; and
- operational uncertainties.

It is an undisputable fact that NPD makes a critical contribution to the success of manufacturing organisations; however, the development of new products continues to be a risky venture (Bradfield, Gao, & Soltan, 2007:519). The NPD project risk is defined as an uncertain event or condition which could result in a negative effect on NPD technical project's objectives. Choi *et al.* (2009:45), determining the variety of risk types in product development processes, had classified risks into the following nine categories:

- human resources;
- management/senior leadership support;
- business or organisational impacts;
- technology;
- vendor and scope;
- schedule and budge; and
- project linkages.

A risk factor such as lack of skilled technicians or engineers is an example of human resource type risks. This comes down to the fact that the NPD multidisciplinary team must be competent in various inputs that they offer to the NPD process. NPD Risk may be found right through different stages of NPD (Chin *et al.,* 2009:9881). NPD risks could be associated with raw material suppliers as well, in situations where the supplier is not able to deliver quality raw materials or components within the expected schedule (Chin *et al.,* 2009:9889).

For custom-build products, both the manufacturer and customer face different forms of risks. From the reliability point of view, the risk to the manufacturer is the redesigning of the product (that is if contract has reliability improvement

clauses) and the associated costs and penalties (Murthy *et al.,* 2009:1598). For the customer, the risk is the impact of unreliability (such as increased likelihood of breakdowns, reduced availability, higher maintenance costs) on the product or business performance (Chin *et al.,* 2009:9880).

Research suggests that product development process and its outcome depend on the perceived level of uncertainty concerning the state of the external environment (Song &Noh, 2006: 266). As a result of this, NPD is unfortunately often poorly or inadequately performed (Huynh & Nakamori, 2007:923). One of the well-known factors of product development is that the level of improbability in the commencement of the process is very high, decreasing over time (Filho *et al.,* 2007:2). According to Chin *et al.* (2009:9882), there are four major nodes of NPD risks:

- research and development risk;
- supply risk;
- production risk; and
- product reliability.

Addo-Tenkorang (2011) believed that new products and services are the lifeblood of all industrial and organisational businesses. Investing in their development is not an optional extra - it is, rather, crucial to business growth and profitability. However, embarking on the development process is risky, requiring considerable planning and organisation. According to Murthy *et al.* (2009:1597), product development involves design, detailed engineering, building prototype and testing to assess whether the product meets some defined performance targets. The outcome of any development process is uncertain and as such, it can involve several iterations before achieving the target values. Several researchers have found that risk handling in NPD projects in many organisations is often done by using informal and unsystematic methods that are based largely on management perceptions (Chin *et al.,* 2009:9879). This is one of the reasons why one of the objectives of this study was to identify a universal approach that could be used to effectively manage quality of an NPD process, while minimising risk.

Murthy *et al.* (2009:1598) suggested that an organisation should perform a risk analysis in order to deal with assessing all perceived NPD associated risk and the probabilities of their occurrences as part of the investment strategy.

What is clear is that business process risks (including the NPD process) should be well understood in order that they are capably managed. In order to know business process risks, there needs to be a systematic control method that a company applies for risk analysis. Risk analysis is therefore a proactive approach whereby the NPD multidisciplinary team sits, studies, and scrutinises each NPD phase with the intention of identifying actions that are prone to risk factors. Risk analysis could be conducted during the NPD stage review. A systematic risk analysis includes, but is not limited to, proactively evaluating risks based on NPD process costs, quality, speed, people, environment and safety. Risks could be evaluated according to a scale of 'high', 'medium' and 'low' whereby more focus should then be directed to risks that rate 'high' for instance. Companies can make use of a risk analysis tool such as a Failure Mode Effects Analysis (FMEA) to evaluate NPD process risks.

3.6 BENEFITS OF QM IN NPD PROCESS

An NPD management model suggests that environment, skills, resources, leadership, strategic fit, proficiency of NPD process and effective product positioning strategies are all associated with project success (Song &Noh, 2006:262). Therefore, a successful and structured NPD process, speedy NPD process (Time-to-Market), and competitive advantage could be regarded as distinct benefits of an effective Quality Management Approach into NPD process.

3.6.1 Successful and Structured NPD process

Cooper (1994:5) defines a formal NPD-process as a formal blueprint, roadmap, and template or thought process for driving a new product project from idea stage to market launch and beyond. Organisations began to adopt structured NPD process management models to bring about thoroughness and stability to NPD processes, noting that these models present an overall process structure

and metrics to manage the different phases of product development (Nambisan, 2003:5). It is common for organisations to formally document NPD. This trend has been evident since the 1990s as a method to control costs, time and quality of the NPD process (Rundquist & Chibba, 2004: 37).

According to Rundquist and Chibba (2004: 39), in order to confidently state that an NPD process is formal, it should be documented in some recognised format and be put into practice to acknowledge the relevant business function (e.g. Management, NPD-department and other departments actively involved in new product development). Nevertheless, a formal NPD-process does not necessarily have to be firm and inflexible (Rundquist & Chibba, 2004: 39). One of the attributes of a formal NPD process is that it controls and measure the results produced in the process and in turn, offers senior management an opportunity to evaluate and compare projects (Rundquist & Chibba, 2004: 48). According to Lamratanakul *et al.* (2008: 188), factors affecting success of product development clearly act as internal drivers for product development performance. In the competitive global market, developing a set of successful and profitable products is the key to success for organisations. Effective product development depends on the integration of a variety of specialised capabilities, strong functional groups with interdisciplinary teams and multiple progressive pressures (Hung *et al.,* 2008:338).

According to Nicholas *et al.* (2011:237), high success in NPD is made possible by best practice frameworks that usually reflect formalisation, structure and repeatable processes. According to Rundquist and Chibba (2004: 44), the use of a formal NPD process has proved to be the difference between success and failure at project level as organisations that practice a formal NPD process have a more documented strategy for product line aspects and for continuous improvements in the NPD process. Having noted this, a study by Griffin (1997:429) generated evidence that more than one third of the organisations partaking in the study did not use a formal process for managing NPD; unsurprisingly, their NPD process was not well-controlled.

3.6.2 Speedy NPD process (Time-to-Market)

Irregular introduction of new products can negatively influence sales growth and profitability improvement, leading to an unstable financial base for future growth of the business (Matsui *et al.,* 2007:16). According to Choi *et al.* (2009:44), nowadays product lifecycles have tended to become shorter, and as a result, new products should be introduced to their respective markets at regular intervals. To achieve this, a well-defined product development process is critical for any determined business. Modern organisations are facing ever-increasing challenges of shorter product lifecycles, increased outsourcing, mass customisation demands, more complex products, geographically dispersed design teams, inventories subject to rapid depreciation, and rapid fulfilment needs (Ming *et al.,* 2008:154). In order to effectively tackle these challenges in our modern collaborative business environment, and obtain competitive advantages, new industrial capabilities are required.

Owens (2007:236) supports these opinions by suggesting that effortless processes influence the successful implementation of NPD. If NPD processes are concurrently accustomed to follow market requirements, shorter product development time can then be expected. Despite this, a number of organisations not only want to accelerate their NPD efforts but they also like to be a 'first to market' business. Organisations cannot muddle through market requirements, as knowledge dynamics are imperative for organisation to develop new products faster. Organisations that undergo NPD processes operate under unstable circumstances as competition is often very severe, and on top of this, new and sometimes even disturbing technological doubts materialise. Challenges like these are often confronted by speed and flexibility, both of which are key success factors of NPD (Kettunen, 2008:541).

Product Development is becoming important for attaining, and sustaining, competitive advantage in the current industrial market. With shortening product life cycles, there is increasing pressure to reduce product development time *and* cost while still maintaining high product quality (Wang & Lin, 2009:460). According to Ebrahim *et al.* (2009:213), for organisations dealing with short product life cycles, it is imperative to quickly and safely develop new products

and new product platforms that satisfy realistic demands on quality, performance, and cost. Research demonstrated that duration (time-to-market), schedule obedience, and handover quality improve with strengthening of a coherent product management role (Ebert, 2007:860).

According to Miguel (2007:617), the ability to bring new products to market quickly is fundamental to any successful customer-driven company. However, today's highly competitive environment makes this task more challenging than ever. Customers not only demand higher levels of quality in new products, but also demand the latest innovations. With the purpose to improve the speed and effectiveness of their NPD process, companies experiment with different best practices (Dooley, Subra & Anderson, 2002:85). Speedy product development time is related to how quickly firms receive economic returns from the development team efforts and firms' responsiveness to competitive forces (Lamratanakul *et al.,* 2008: 177). Organisations should therefore be eager to develop products faster because time-to-market is related to increased sales, beating the competition to the market and being responsive to changing markets, styles, and technologies (Lamratanakul *et al.,* 2008: 177).

According to research interviews conducted, participants noted the effect that customer expectation has on product development: "competitors, primarily overseas, are taking our business away from us". "The fast changing nature of our society is something we are still struggling to come to grips with". "We are finding more and more often people don't want something that will last for five years, never mind twenty, they want change more often and we are finding we have to respond to that and quickly" (Owens, 2007:236). This bears down on the fact that rapid and efficient commercialisation of new products is now a top priority in many organisations.

3.6.3 Competitive Advantage

Competition has stimulated rapid changes in manufacturing industries, causing a significant shift to how products are designed, manufactured, and delivered, (Xu*et al.,* 2007:2029). It is evident that NPD processes are continually advancing, and in so doing, the process is also very much refined. However,

this continual advancement presents a major risk to organisations that cannot keep up with the newest NPD practices, as these organisations will suffer an increasingly marked competitive disadvantage (Griffin, 1997: 429).

According to Acur *et al.* (2009), there is an excessive competitive pressure currently experienced across diverse industries; because of this, there is a critical need for businesses to maintain long-term competitiveness. Evans, Pei, and Campbell (2009) agree, adding that in a progressively more competitive commercial environment, organisations are under constant pressure to operate at optimum efficiency. This is due to the global and dynamic environment into which companies have been thrust. In these times, Product Development Process is an important factor to gain competitive advantage (Martin & de Carvalho, 2006). De Mozota (2006) is of the opinion that the external market-based advantage is derived from the design-based differentiation of organisations' products or services. In the competitive environment, it is necessary for organisations to assemble a variety of capabilities and services with the intention of outshining the competition (Ebrahim *et al*., 2009:1).

In the face of growing competition, firms increasingly have to re-evaluate their organisation and their processes (Martin, Détienne, & Lavigne, 2000). There are many paths by which a competitive advantage can be built, and the same variety applies to design-driven values (de Mozota, 2006: 47). One of the indicators of a company's competitiveness is its capability of developing new products (Sofianti *et al.,* 2010). Sanongpong (2009a) agrees and links the competitive advantage of a company to two key factors:

- the ability to generate new intellectual property that offers superior value to customers; and
- the ability to capitalise on it quickly.

Therefore, an organisation's competitiveness is measured against its NPD performance improvement related to products portfolios, internal climate and more importantly, its strategic alignment (Acur *et al.,* 2009).

One of the primary objectives of this study was to identify a universal approach for effectively managing quality of an NPD process. The study underscores this

objective by demonstrating that integrating a quality management approach into an NPD process can certainly benefit the company. And the benefits are not limited to a successful and structured NPD process, but also include a speedy NPD process and most importantly, the competitive edge.

3.7 UNIVERSAL QM APPROACHES IN NPD PROCESS

During recent decades, a number of methods have become widely available to support NPD. An early, but still an important review of product development methods, can be found in the literature (Miguel, 2007:618). The trend in organisational structures for high performance product development has moved toward integrated models (Sanongpong, 2009). A 'model' is an abstract demonstration of reality that is built, verified, analysed, and manipulated to amplify understanding of that reality. Models can be inherent in the mind (mental models) or be codified. It is said that all models are wrong, but some are useful (Browning, Fricke & Negele, 2005:104). These authors further explained that a useful model is supportive for making forecasts and testing hypotheses about the effects of contemplated actions in the real world, where such actions would be too disorderly or costly to try. Mazur (2010:1) believed that quality approaches to NPD as a channel for commercialisation has been growing in recent years; he further stated that there are methods which have been supporting organisations to structure their NPD processes, methods such as the following:

- Stage-gate;
- Design for Six Sigma; and
- Design for Lean Sigma.

There is an increasing need to develop a systematic and effective method for assessing the NPD project technical risks and the early design stage which helps designers make critical decisions among alternative designs from project risk point of view (Chin *et al.,* 2009:9879). According to Kester, Hultink and Lauche (2009:327), the project selection literature in the NPD domain has primarily focused on the development and investigation of sophisticated quantitative modelling methods to facilitate NPD selection decisions and hence, the establishment of the following models:

- NPD Management Model;
- Collaborative NPD (CNPD) Framework;
- Critical Path Methodology;
- Methodology: Project Plan;
- NPD Conceptual Framework;
- Paf Model for Projects;
- Product Lifecycle Management (PLM) Model;
- Product Management Model;
- Reference Model;
- Stage-gate Conceptual Model; and
- Value Design Management Model.

3.7.1 NPD Management Model

According to Yan and Makinde (2011:2220), companies generally promote the process of Continuous Improvement (CI) in their quality improvement initiatives. Yan and Makinde believed that CI has not been fully embraced in the NPD environment.

Figure 3.1: NPD Management Model
(Yan & Makinde: 2011)

Accordingly, for a company to be innovative and competitive, it needs to encompass CI in its NPD initiatives as well (Yan & Makinde, 2011:2220). Yan

and Makinde have consequently proposed a NPD management model in order for companies to manage the NPD process and obtain a better understanding of methods of realising a successful product development through well-performed tasks in the process. Above is their proposed NPD Management Model (refer to Figure 3.1). The cornerstones of the model are listed below:

- management commitment;
- employee involvement;
- product strategy (resource availability, NPD capability, market research, suppliers and continuous improvement);
- quality assurance;
- customer satisfaction; and
- feedback from new product launching.

3.7.2 Product Management Model

Ebert (2007: 880) defined product management as the discipline and role which controls a product (or solution or service) from its initiation to the market/customer delivery in order to generate major potential value to the business. He further explained that in order to achieve business success, product managers should focus on several proportions such as creating a winning product and business case, conquering markets and growing market share and delivering value to customers, as depicted in Figure 3.2.

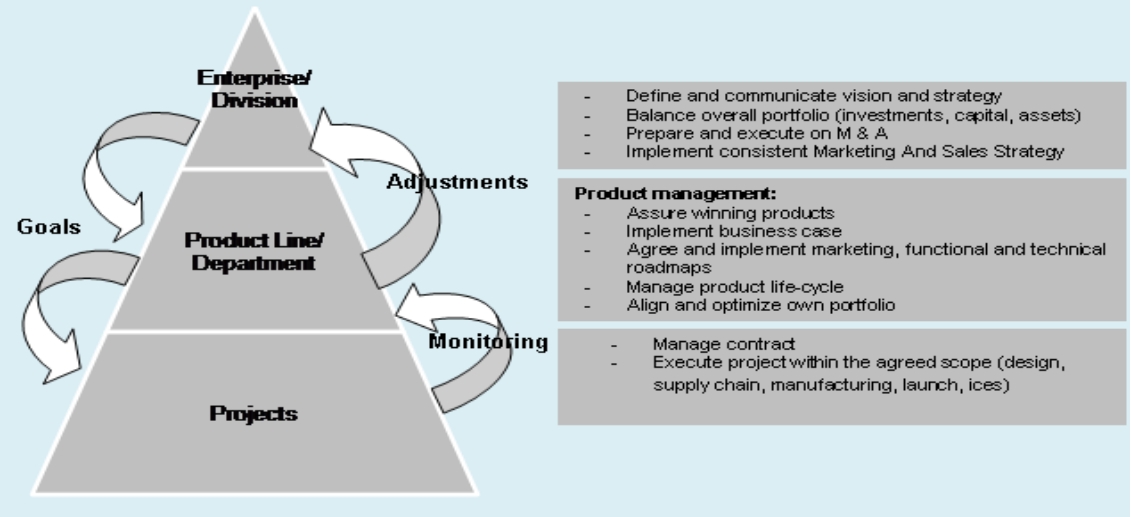


Figure 3.2: Product management model
(Ebert, 2007: 880)

From his best practices from day-to-day work using project management in his research, Ebert (2007:856-859) learnt that goals which are defined and measured *will* be achieved; hence, the model encourages that the project manager should set objectives and then achieve them. Secondly, the project manager should balance value and requirements by properly expressing requirements to form a high-level concept of the functional and non-functional behaviour of the product. Thirdly, in project management, risks and uncertainty should be carefully managed. Lastly, leadership and teamwork are significant in product management.

3.7.3 Collaborative NPD Model

The Collaborative NPD (CNPD) process is a dynamic, vibrant and flexible process that could be applied to maintain an organisation's competitiveness for sustainable development (Hsu *et al*., 2009:304-306). Organisations, therefore, cooperate with others in a collaborative way to sustain their business and competitive ability. Ming *et al.* (2008:154) agreed, explaining that challenges in NPD which are the new business drivers make manufactures pursue more competitive business modes, such as collaborative manufacturing, to more closely collaborate with their customers, suppliers, manufacturers and partner for the most advanced competitiveness by leveraging core competences throughout the entire product life cycle.

According to Hsu *et al. (*2009:306), CNPD can facilitate interconnected and cross-domain personnel to concurrently carry out design, communication and audit for multiple projects, accomplishing NPD as scheduled. Ming *et al*. (2008: 156) are of the opinion that in the quest to embark upon new challenges in modern collaborative business environment there needs to be a new collaborative business resolution to facilitate a number of important things:

- Changing the way the world brings products to market by leveraging the power of product collaboration across global value chains of trusted partners, employees, suppliers, and customers.
- Delivering product collaboration solutions for successful value chains that are specially designed to speed product development manage programmes effectively and enable strategic sourcing.

- Reducing development costs, increasing product innovation, dramatically speeding time to market and strategically impacting revenue by early strategic supplier, customer and partner involvement in collaborative product and supply chain processes.

The benefit of these collaborations is development ability as well as operation efficiency, largely reducing expense cost and enhancing growth benefit for the organisation (Hsu *et al.,* 2009:304). Hsu *et al*. further identified the following as key benefits of CNPD:

- collaborative cooperation with others to sustain their business and competitive ability.
- improved research and development ability; and
- efficient operation that largely reduces cost and enhances growth to benefit the organisation.

According to Hsu *et al.* (2009:306), the CNPD process consists of four main stages:

- product planning stage;
- product design stage;
- engineering test stage; and
- production and marketing stage.

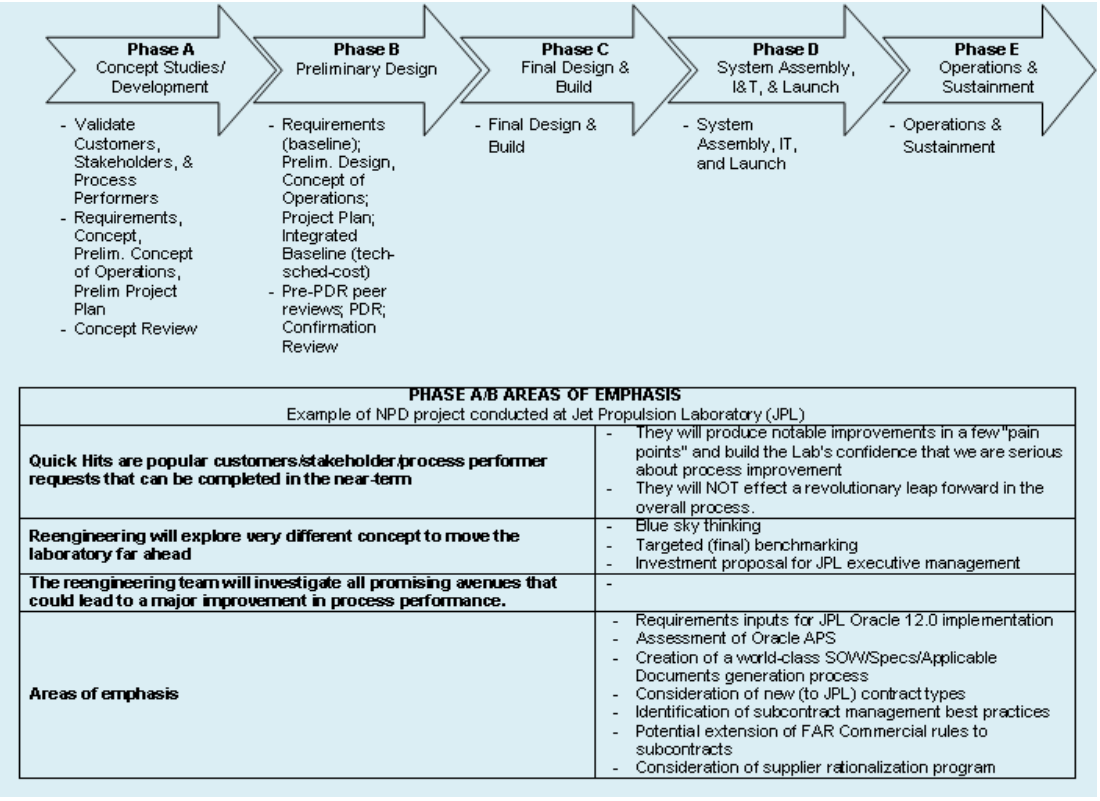
3.7.4 Critical Path Methodology (CPM)

The Critical Path Methodology (CPM) is a commercial project management software package and a first choice, or perhaps the only one, for project schedule analysis (Yang, 2007:26). The CPM has stood the test of time as its existence is traced back to the 1950s. However, it is also recognised that organisations do not actively pursue the CPM. According to Chiang, Trappey and Chen (2008:153), the CPM is adopted to calculate the expected value and variance of the NPD completion time and the probability of meeting the specified project deadline. Traditional CPM does not consider in advance the resource constraints in planning, thus making the produced schedule irrational (Yang, 2007:26).

Research shows that organisations that take time to become familiar with and then implement the methodology will passively migrate towards critical path activities and methods in order to achieve efficient and effective outcomes (Marion, 2009:6). Yang (2007:26) agreed with this statement, saying that CPM has some pitfalls in actual practice in that it is an unrealistic activity that combines proper duration and redundant safety time.

3.7.5 Methodology: Project Plan Model

In their quest to capture customer requirements as the basis for proposing a concept (and subsequent design) that meets the requirements in a verifiable manner, Taylor and Vanek (2011) consequently developed a Methodology Project Plan Model, as depicted in Figure 3.3. The expectation of their model was to effectively manage the NPD process.



PHASE A/B AREAS OF EMPHASIS Example of NPD project conducted at Jet Propulsion Laboratory (JPL)	
Quick Hits are popular customers/stakeholder/process performer requests that can be completed in the near-term	- They will produce notable improvements in a few "pain points" and build the Lab's confidence that we are serious about process improvement - They will NOT effect a revolutionary leap forward in the overall process.
Reengineering will explore very different concept to move the laboratory far ahead	- Blue sky thinking - Targeted (final) benchmarking - Investment proposal for JPL executive management
The reengineering team will investigate all promising avenues that could lead to a major improvement in process performance.	-
Areas of emphasis	- Requirements inputs for JPL Oracle 12.0 implementation - Assessment of Oracle APS - Creation of a world-class SOW/Specs/Applicable Documents generation process - Consideration of new (to JPL) contract types - Identification of subcontract management best practices - Potential extension of FAR Commercial rules to subcontracts - Consideration of supplier rationalization program

Figure 3.3: The Methodology Project Plan Model
(Taylor & Vanek, 2011)

According to Liu, Zeng, Maletz, and Brisso (2009:1), PPM is a systematic concept for the integrated management of all product-related information and processes across the extended enterprise through the entire life cycle, from

concept and design, to production, distribution, maintenance, and retirement. They further explained that organisations which have adopted the PPM gain many benefits, including but not limited to the following:

- mass customisation;
- high quality;
- reduced project failure rates;
- increased and quick innovation;
- quicker delivery;
- higher plant uptimes;
- effective management and use of corporate intellectual capital;
- effective communication among different groups at dispersed locations;
- minimised manufacturing costs; and
- less industrial and commercial waste throughout every phase of the product life cycle.

Today, PPM is widely recognised as a business necessity as it enables companies to leverage their investments in product-related intellectual and physical assets and is the vehicle to reduce cost, provide solid return on investment and enable product and process innovation (Liu *et al.,* 2009: 2).

3.7.6 Conceptual Development Model

Another NPD model, widely recognised and accepted, is a Conceptual Development Model (refer to Figure 3.4). The model was established by Song and Noh (2006:262-278).

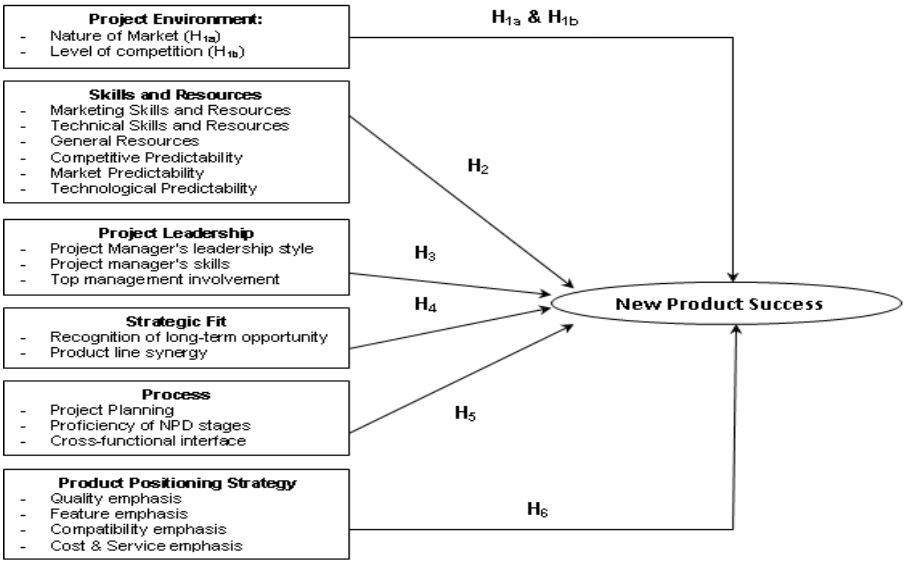


Figure 3.4: A conceptual development model.
(Song & Noh, 2006)

This model was established to facilitate new product success. According to Song and Noh (2006: 262), the framework suggests that environment, skills, resources, leadership, strategic fit, and proficiency of NPD process, and effective product positioning strategies are associated with project success. The conceptual model introduces three NPD streams:

- product development as a rational plan;
- product development as a communication web; and
- product development as disciplined problem-solving.

The conceptual model focuses on six main contributors of a successful NPD process:

- the conduciveness of the NPD project environment;
- NPD applicable skills and resources;
- leadership involved in an NPD project;
- the NPD strategic fit;
- the NPD processes; and lastly
- product positioning strategy.

However, Song and Noh, as originators of the Conceptual Development Model, focused primarily on product development as a rational plan since their objective was to uncover the Korean best practices in NPD (Song & Noh, 2006:262-263).

3.7.7 Portfolio Management for NPD

NPD portfolio management is the process of accomplishing balanced resource allocation in terms of value maximisation, strategic alignment, risk levels, and the number of on-going projects (Rautiainen *et al.,* 2011). According to Acur *et al.* (2009), portfolio management completely influences technological competence development, speed and NPD programme performance. They further said that manager's experience reduces NPD speed when they favour portfolio management in their technological competence development process.

According to Kester *et al. (*2009:328), portfolio management is not an isolated or stand-alone business process; however, it is interconnected to decision-making processes that are in existence to improve and execute any organisation's strategic goals by assigning available resources. Rautiainen *et al. (*2011) recognised that portfolio management could be applied using various models and one of those models is the Paf Model for Projects (Pamp), as depicted in Figure 3.5.

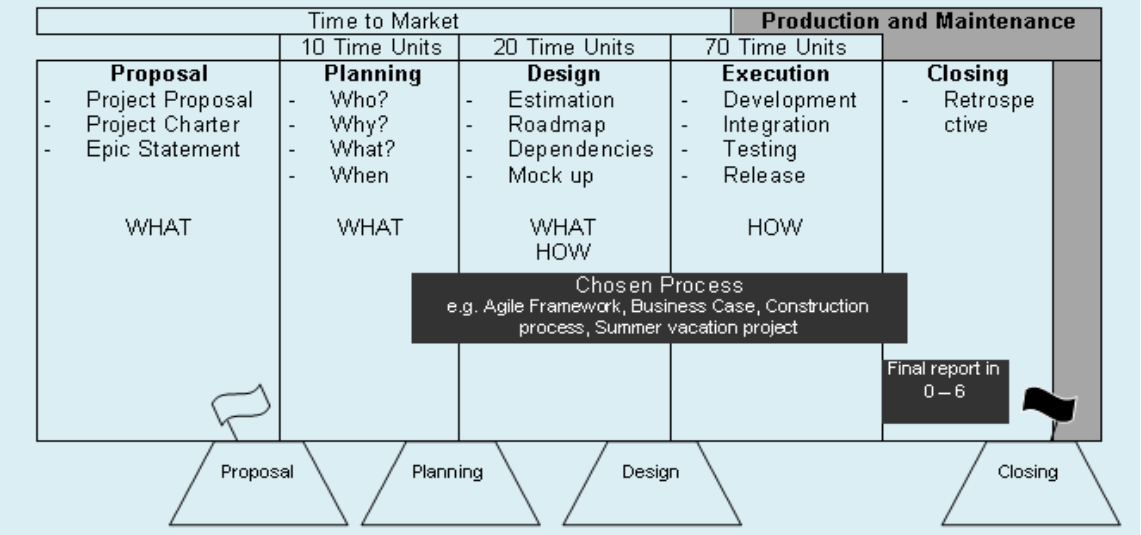


Figure 3.5: Paf Model for Projects (PAMP)
(Kester, Hultink & Lauche, 2009)

According to Rautiainen *et al.* (2011), the Paf, founded in 1966, is a public association that operates activities on the autonomous Aland Islands. The model is used more in gaming industry-related NPD processes (Rautiainen *et al.,* 2011). The successful portfolio management is about accomplishing stability between four potentially conflicting goals:

- maximising the financial value of the portfolio;
- linking the portfolio to strategy;
- balancing it on relevant dimensions; and
- ensuring that the total number of on-going activities is feasible.

Kumar *et al.* (2009:75) are of the opinion that there are reviews in between the stages of the Portfolio Management as follows:

- The first part of the gate review process in the model is to assess whether the project should continue based on its own merits.
- The second step (and key component of effective portfolio management) is to assess whether the project has high enough priority relative to other projects to justify continuity.

The downfall of portfolio management is that when decisions to portfolio management are poor, the organisation could easily lose its returns. (Kester *et al.*,2009:327). As a result, portfolio management challenges that organisations' experiences should never be taken too lightly, as they can result in detrimental consequences for an organisation's long-term competitive position (Kester *et al.,* 2009:327). The authors further explained that portfolio management is a multifaceted structure of interconnected and recursive decision-making processes for which the main objective of the portfolio management system is to explain the business strategy as a dynamic set of NPD projects and products that adhere to the following:

- they have not yet started and are subject to project selection decisions;
- they are in development and subject to project continuation or termination decisions; and
- they are launched into the market and subject to product continuation or deletion decisions.

3.7.8 Product Lifecycle Management (PLM) Model

According to Sudarsan *et al.* (2005:1399), Product Lifecycle Management (PLM) is a strategic business approach for the effective management and use of corporate intellectual capital. They further enlightened that PLM systems are gaining recognition managing all information about an organisation's products throughout the products' full life cycle, as depicted in Figure 3.6. Global competition is one of the keys driving many organisations to adopt the PLM concept and implement PLM systems. PLM has the potential to enormously improve organisation's ability to innovate, get products to market faster, and reduce errors (Sudarsan *et al.,* 2005:1399).

Addor-Tenkorang (2011) explained that the product life cycle process is the system through which products are managed from commencement to withdrawal; apparently, the product life cycle does not have to stop as it can easily be prolonged by a range of marketing and production innovations.

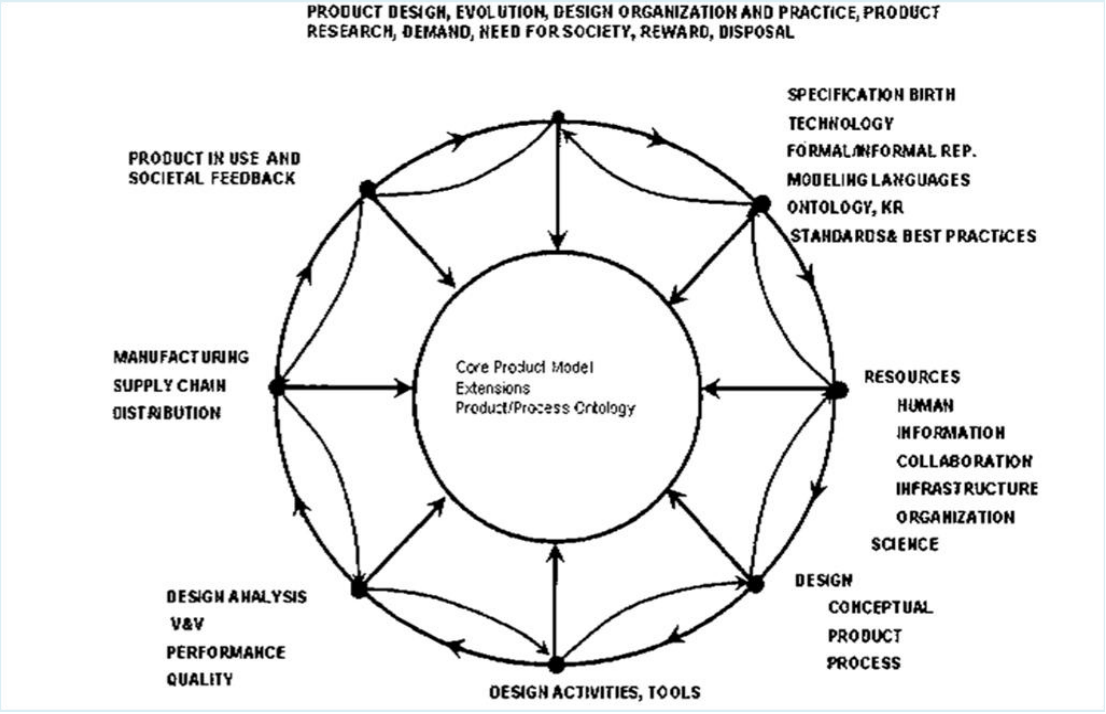


Figure 3.6: Product Life cycle Management Model
(Sudarsan*et al*., 2005)

Addor-Tenkorang (2011) indicated that the classic product life cycle has five stages including development, growth, maturity, decline and withdrawal. Addor-Tenkorang (2011) further provided awareness that the product life cycle of some products may last for hundreds of years while for others the life cycle may be only a few months. He explained that once a product is on the market, it may be essential to regularly introduce 'new life' into it. This can be done in quite a few ways such as product improvement, extension of product range, and improved promotion.

3.7.9 Reference Model for NPD

Reference model defines the scope of product development through the NPD process; this model is also known as standard process (Filho *et al.,* 2009:355). According to Filho *et al. (*2009:355), the use of a reference model for NPD may contribute to the standardisation of some practices, the use of a common language, the repeatability of projects and to its quality, thereby increasing the probability of making successful products (as shown in Figure 3.7). Such a reference model is inclusive of the following phases:

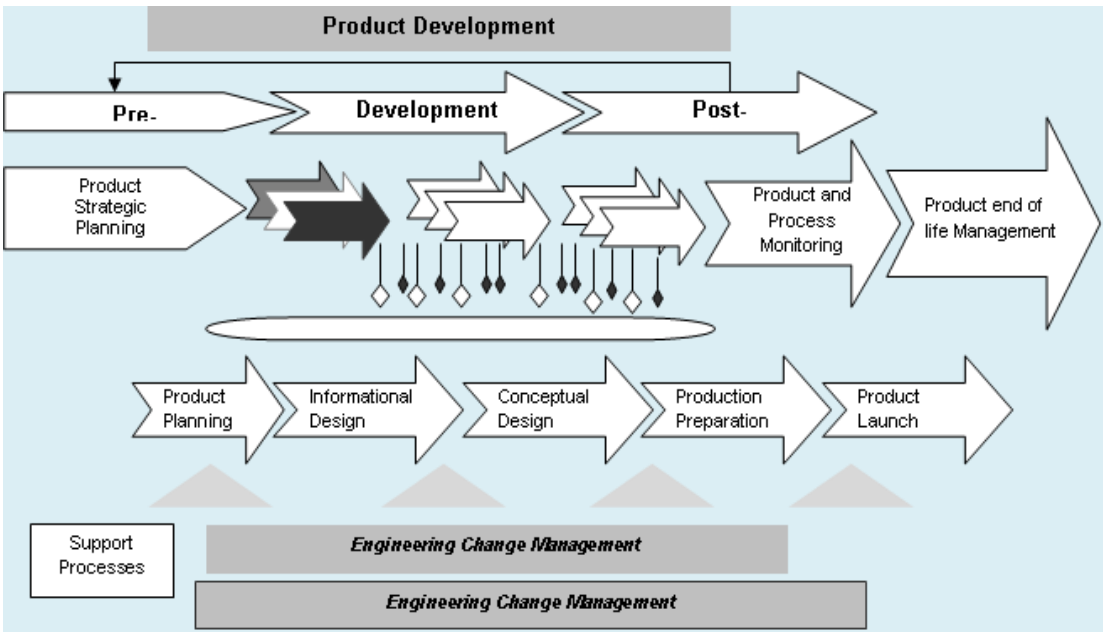


Figure 3.7: Reference model for NPD
(Filho *et al*., 2009)

3.7.10 Stage-Gate Process Model for NPD

According to Mazur (2010:7) Stage-Gate is a process for doing projects right and doing the right projects, which Cooper (the originator) defines as building in the voice of the customer. There are several versions of generic stage-gate as well as numerous tailored approaches which are understandingly kept confidential by the companies using them. The stage-gate process is a method of managing the NPD process to increase the probability of launching new products quickly and successfully (Ebrahim *et al.,* 2009:214). The process provides a blueprint to move projects through the various stages of development:

- idea generation;
- preliminary investigation;
- business case preparation;
- product development;
- product testing; and
- product introduction.

The stage-gate approach, by Dr Robert Cooper, has been acknowledged as one of the successful and reproducible ways of structuring the NPD process (Mazur, 2010:7). Mazur further declared that the stage-gate (Figure 3.8) is now used extensively both as a customer-tailored approach by Cooper's own specialists and in the more generic phase-gate approach by organisations endeavouring self-improvement. According to Mazur (2012:8), Cooper explained eight factors that make a stage-gate process successful:

- quality processes;
- risk managed with stages gates decision;
- gates are central to weeding out bad projects, assuring homework is done, and setting up following stages;
- parallel activities to improve speed to market;
- cross-functional team with authority;
- market-driven and customer-focused;
- pre-development homework; and
- superior differentiation and customer value.

According to Bradfield *et al.* (2007:519), a cross-functional stage-gate model is a common model in the United States, used by over 60% of all organisations. They further explained that the stage-gate model divides the NPD process into discrete stages, each of which is followed by a review gate. Each stage and review gate involves project team members from different functional departments within the organisation.

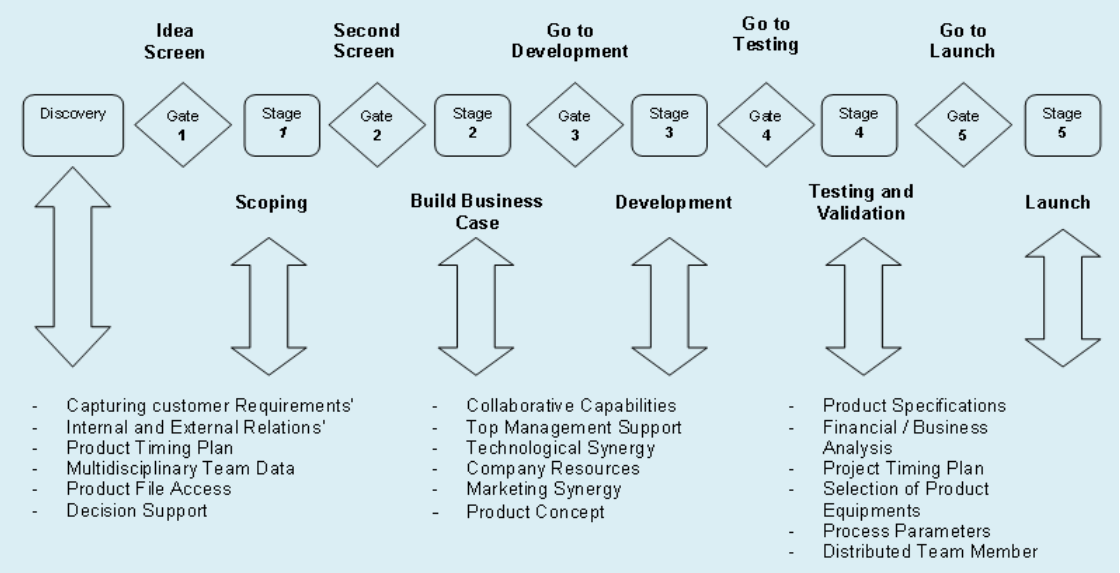


Figure 3.8: the Stage-gate process for NPD
(Ebrahim, Ahmed & Taha, 2009)

Decision-making value at NPD gates is defined as the proficiency with which NPD managers use predefined performance criteria and assess usefulness of information generated by NPD activities when determining likelihood of new product success over NPD process (Jespersen, 2011). The efficiency of NPD gate decision processes is subjected to NPD managers' experience and NPD competences (Jespersen, 2011). Jespersen further said that an analysis should be done on how mangers, NPD experiences and NPD competencies influence the decision criteria and information used on the product reviews at NPD gates.

The gate review criteria involve a set of tasks that the team is expected to execute in the previous phase of the project. It is helpful to define the development process to include the tasks that should be performed in each phase of the project as per the task plans. This process provides consistent guidance for the teams pertaining to key activities in each phase that form the

foundation to fulfilling the gate criteria (Kumar *et al.,* 2009:74). Although a cross-functional team structure could be in place, the NPD stages are led by specific functions or people (Harmancioglu *et al.,* 2007: 413). With the aim of reducing the cycle time thereby improving new product success rates, companies are redesigning and streamlining their new product processes, increasingly looking to stage-gate systems to manage, direct, and control their product innovation efforts (Cooper, 1996; 475).

3.7.11 Value Model for Design Management

From her research concerning design-oriented European SMEs, de Mozota (2006:45) established a value model for design (i.e. the four powers of design) as shown in Figure 3.9. This model identifies design as a differentiator, integrator, transformer, and as good business. The model intended to describe to design professionals a research-based value model for design management and to express to them how this model can be implemented using Robert Kaplan's and David Norton's Balanced Score Card (de Mozota, 2006:45).

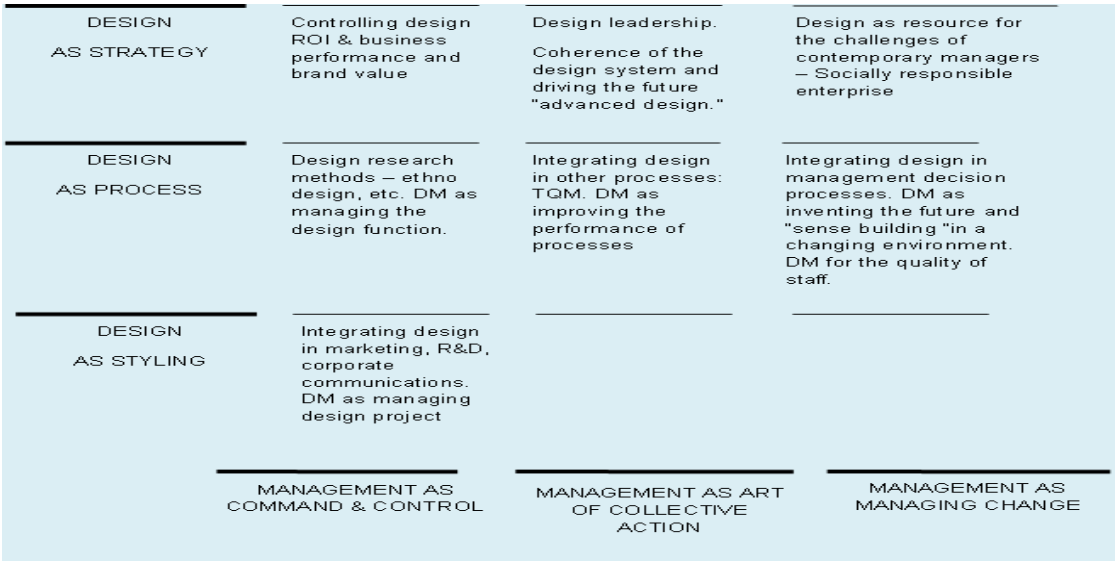


Figure 3.9: A value model for design
(de Mozota, 2006)

3.7.12 The Four Powers of Design

Since value in management science takes place by accomplishing a result better than that of the competition, de Mozota (2006) argued that design is

comprehensible when integrated into the value management model; hence the identification of the four powers of design:

Design as a differentiator: de Mozota (2006) viewed design as a foundation for competitive advantage on the market through the following:

- brand equity;
- customer loyalty;
- price premium; or
- customer orientation.

Design as integrator: She further identified design as a resource that improves NPD processes by means of the following:

- time-to-market;
- building consensus in teams using visualisation skills;
- design as a process that favours a modular and platform architecture of product lines;
- user-oriented innovation models; and
- fuzzy front-end project management.

Design as transformer**:** Design is also an engine for the following:

- creating new business opportunities;
- improving the company's ability to cope with change; or
- expertise to better interpret the company and the marketplace.

Design as good business: last but not least, de Mozota (2006) interpreted design as a basis for the following:

- increased sales and better margins;
- more brand value;
- greater market share;
- better return on investment (ROI);
- design as a resource for society at large (inclusive design, sustainable design).

This study is inclusive of 11 studied models that could possibly be used to manage the quality of an NPD process. There is *NPD Management Model*

that is inclusive of continuous improvement and innovation principles deemed to be a competitive advantage to any company that engages in NPD process. A *Product Management Model* is directed towards setting NPD objectives, and even more importantly, achieving them. There is also a *Collaborative NPD Model*. This particular model facilitates the NPD multidisciplinary team in simultaneously performing design and so forth. Additionally, a *Critical Path Methodology (CPM)* was also studied in this research. One of its objectives is to calculate the expected value and variance of the NPD completion time. This means that CPM is therefore focusing more on NPD speed (i.e. time-to-market). Another of the studied models was *Methodology: Project Plan Model,* a model which holistically manages the overall and effectiveness of the NPD process, whereas the *Conceptual Development Model* facilitates new product success with a main focus on skills, resources, leadership, strategic fit and the overall proficiency of NPD process. Similarly, the *Portfolio Management* for NPD influences technological competence development, speed and NPD programme performance. There is also a *Product Lifecycle Management (PLM) Model* which has a potential of improving the company's ability to innovate, the NPD Speed and the reduction of errors. A reference model for NPD will define the scope of product development through the NPD process. On the other hand, the value model for design identifies design as a differentiator, integrator, transformer and good business. Last but not least, a *Stage-Gate Process Model* for NPD was investigated, as this model manages the NPD process to increase the probability of launching new products quickly and successfully.

Having investigated different models, it is reassuring that one of the objectives of this study (i.e. identifying a universal approach that could effectively manage quality of an NPD process) could be easily achieved by selecting the most favourable, most suitable model for managing the quality of Cape Pak (Pty)'s NPD process.

3.8 CONCLUSION

In the quest to master the NPD process, organisations are urged to introduce new products with more frequency; more focus should be directed to NPD's final phase, the production launch (Surbier *et al.,* 2009). NPD is a vital process for retaining an organisation's competitiveness (Chin *et al.,* 2009: 9879).

In this chapter, the researcher visited, studied and came to an understanding of literature that is appropriated to resolving the problem statement and the objectives of this research. The subject and the relationship between NPD and Quality Management were thoroughly investigated based on available literature. The investigation began by comprehensively defining NPD as a process. Literature demonstrated that an NPD process is a risky process that should be performed in a tightly managed and structured environment. NPD process requires committed leadership and amongst other factors, competence to realise the process. It also appeared that the use of multidisciplinary teams is very important for the success and speed-up of the NPD process. As derived from the literature review, customers and their requirements seemed to play a major role in NPD process.

Furthermore, it was discovered that the NPD process ought to be a formal and structured process in order for the organisation that engages in product design to fully benefit in terms of competitiveness in this unsympathetic global market. Hence, this research investigated internationally tested models that could facilitate in formalising and structuring the NPD process so as to determine quality in this process.

Most importantly, throughout the literature review, it became clear that a structured NPD process can successfully resolve the research problem that is identified as: 'lack of effective approach to quality management practices in NPD process result in poor product quality and customer dissatisfaction', as literature confirmed the importance of product quality and customer focus. Murthy *et al.* (2009 1599) are of the opinion that there are a number of models developed for modelling elements of Product Lifecycle; however, the construction and involvement of the models differ from simple to complex. They

further realise that it is not easy to select an appropriate model because this requires a trade-off between complexity and reality, which needs to be taken into account.

CHAPTER 4: RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

Research design is the complete strategy of attack on the central research problem, providing the overall structure for the procedures that the research follows, the data that the researcher collects, and the data analyses that the researcher conducts (Leedy & Ormrod, 2001:91). Simply put, research design is planning. Likewise, a research design is a plan or blueprint of how one intends to conduct the research, whilst research methodology focuses on the research process and the kind of tools and procedures to be used (Mouton, 2001:55-56). Accordingly, Leedy and Ormrod (2001:14) describe 'research methodology' as the general approach the researcher takes in performing a research project; to a degree, this approach prescribes the particular tools that the researcher selects.

This research followed an action research methodology, qualitative and quantitative approach was adopted to investigate a possible effective quality management approach that will facilitate the control of Cape Pak (Pty) NPD process. Chapter 4 explains the following in detail:

- action research, the research method chosen for this study;
- the quantitative approach;
- survey design method; and
- questionnaires in the form of Nominal and Likert Scale for collecting data.

4.2 RESEARCH TYPE

This study made use of action research methodology with the aim of bringing about change in the workplace: in this case, a change and improvement of the NPD process of Cape Pak (Pty). According to Reason and Bradbury (2001:1), action research is a participatory, democratic process concerned with developing practical knowing in the pursuit of worth-while human purposes, grounded in a participatory worldview which we believe is emerging at this historical moment. They further explain that action research seeks to bring

together action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions to issues of pressing concern to people, and more generally the flourishing of individual personas and their communities. Reason and Bradbury (2001:2) identified action research characteristics as in figure 4.1:

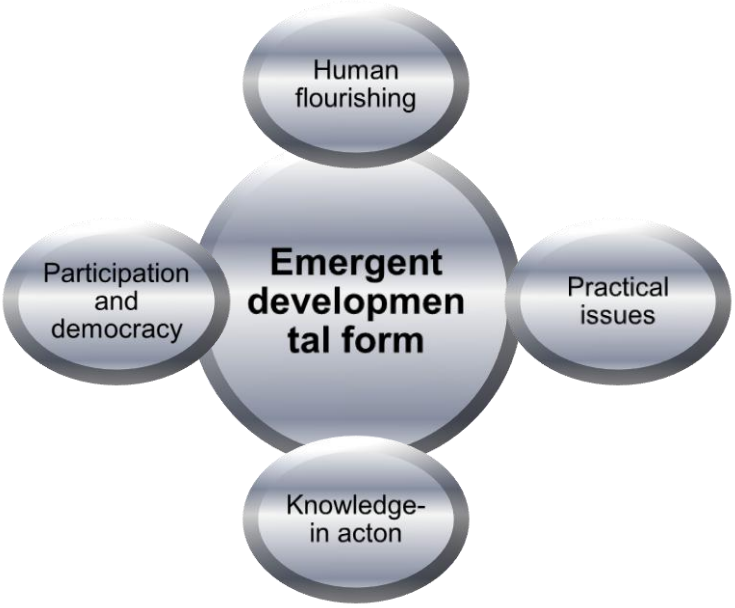


Figure 4.1: Action Research Characteristics
(Source: Reason and Bradbury, 2001)

4.3 RESEARCH APPROACH

The research followed a combination of both quantitative and qualitative approaches.

4.3.1 Qualitative Research Approach

According to Bless and Higson-Smith (2000:157), qualitative research is research that is conducted using a range of methods which use qualifying words and descriptions to record and investigate aspects of social reality. In order to obtain the opinions and perceptions on the management of NPD process, a number of interviews were conducted during the course of this research.

According to Kumar (2011:144), an interview is a commonly used method of collecting information from people, a verbal interchange, often face-to-face, though the telephone may be used, in which an interviewer tries to elicit

information, beliefs or opinions from another person. Furthermore, the interview method of collecting data involves presentation of oral/verbal stimuli and replies in terms of oral-verbal responses (Kothari, 2004: 97). In addition, an interview is where a researcher asks questions for the purpose of seeking information directly related to the research (Bailey, 2007:95). The interview method was subsequently applied in this investigation as one of the means of acquiring accurate factual information about the NPD department.

In this research, semi-structured interviews were conducted whereby the researcher used an interview guide with specific questions organised according to topic but not necessarily asked in a specific order (Bailey, 2007:100). This technique focuses on the soft and natural flow of the interview, rather than the order as a structured guide, to determine when and how a question is asked.

4.3.2 Quantitative Research Approach

The quantitative research approach was a secondary research approach used for this study. Quantitative research is a form of conclusive research involving large representative samples and fairly structured data collection procedures (Struwig & Stead, 2001:4). Quantitative research is used to answer questions about interactions amongst measured variables with the objective of explaining, predicting, and controlling phenomena *(*Leedy & Ormrod, 2001:101). They further enlighten that, quantitative approach is sometimes called the *traditional, experimental,* or *positivist approach.*

With this research in mind, descriptive quantitative research was investigated involving exploring the possible correlation among two or more phenomena (Leedy & Ormrod, 2001:191). Descriptive research examines a situation as it is. According to Walliman (2005:304), descriptive statistics provide a method of quantifying the characteristic of the data, where their centre is, how broadly they spread and how one aspect of the data relates to another aspect of the same data. Additionally, descriptive statistics provide statistical summaries of data; its purpose is to provide an overall, coherent and straightforward picture of a large amount of data (Struwig & Stead, 2001:158).

4.4 RESEARCH POPULATION

Cape Pak (Pty)'s South African plant has 60 permanent employees, including about 20 temporal employees which are general production personnel. The Operations Division has the most employees. In total, the Operations Division is capacitated with 40 direct and support services employees. Out of the 40 direct and support services employees of the Operations Division, 24 of these employees have direct inputs to the NPD Process of Cape Pak (Pty). Additionally to the NPD process (from other divisions) includes the following:

- the Managing Director;
- the Commercial Manager; and
- the Cost and Management Accountant who prepares new product prototype BOMs.

4.5 TARGETED GROUP

The group that was targeted for this research was Cape Pak (Pty)'s Operations Division. At the time of this research, Operations division contained five departments: New Product Development, Technical Sales, Quality, Production and Supply Chain (including Logistics, Purchasing and Production Planning). These departments have an internal supplier-customer relationship with each other. It is assumed that on 'formal' bases, Cape Pak (Pty) Management will select an NPD multidisciplinary team from this group. The sample size of the study was purposely selected from Cape Pak (Pty) personnel deemed to have direct inputs to the NPD process (see Table 4.1).

Table 4.1: Research Targeted Group

BUSINESS FUNCTION	NPD PROCESS RELATIONSHIP	QTY
Managing Director (Salesman)	Company major shareholder and primary contact to international customers.	**1**
General Manager	Leads the Operations Division in which NPD and Quality Department's reports to.	**1**
NPD Projects Manager	Cape Pak (Pty)'s products knowledge specialist that is currently heading the NPD function.	**1**
Quality and NPD Manager	Manages both quality and NPD departments	**1**
Technical Sales Managers	Does marketing and sales of Cape Pak (Pty) products	**2**
Trainee Graduates	Assists in Supply Chain Department	**2**

BUSINESS FUNCTION	NPD PROCESS RELATIONSHIP	QTY
	(Logistics)	
Production Manager	NPD handovers commercial run to production foreman	**1**
Purchasing coordinator	Explores relevant suppliers in order to procure new products' raw materials	**2**
Production Planner	Plans prototypes production	**1**
NPD Prototype Operators	Produces prototypes	**2**
Quality Technicians	Quality control of prototypes	**2**
Sales Admin Coordinators	Export prototypes and liaise with customers around lead times and delivery dates.	**2**
Cost Management Accountant	Prepares prototypes Bill of Materials (BOMs)	**1**
Supply Chain Supervisor	Manages: Supplier Development Coordinator, Planner and Logistics Trainee Graduate	**1**
Production Supervisors	Get involved in NPD during production launch/Commercial Run of the NPD	**5**
Production Administrator	Prepares internal Manufacturing Orders including NPD Prototypes	**1**
Commercial Manager	Cape Pak (Pty) Business Processes Co-ordinator and Manages the Sales Business Function	**1**
SAMPLE SIZE TOTAL		**27**

4.6 SAMPLE DESIGN AND METHOD

A sample design is defined as a plan for obtaining a sample from a given population (Kothari, 2004: 55).

4.6.1 Non-Probability Sampling

This research was made possible by use of non-probability sampling, an umbrella of sampling procedures such as deliberate sampling, purposive sampling and judgement sampling. According to Leedy and Ormrod (2001:228), in non-probability sampling the researcher has no way of projecting or assuring that each element of the population will be represented in the sample. Furthermore, some members of the population have little or no chance of being sampled. In accordance with this, in this type of sampling, items for the sample are selected deliberately by the researcher whereby the researcher's preference remains the best (Kothari, 2004:57).

4.6.2 Purposive sampling

As per the indication here above, purposive sampling falls under the category of non-probability sampling. In purposive sampling, a sample is chosen, as the name implies, for a particular purpose (Leedy & Ormrod, 2001:228). This is the reason why in this particular research, the sample was purposely selected from Cape Pak (Pty)'s business functions that are deemed to have inputs directly impacting on the NPD process of that company.

4.6.3 Sample size

The sample size is a list or record of population from which all the sampling units are drawn (Watkins, 2008:54). The size of the purposive sample is made up of twenty seven (27) relevant Cape Pak (Pty) employees.

Out of 40 Operations Division employees, 24 of these employees have direct input into the NPD process. These employees comprise about 60% of the Operations Division. In addition to the 24 employees of the Operations Division, there are three more employees from other Cape Pak (Pty) divisions (i.e. Managing Director, Commercial Manager and Cost and Management Accountant) that also partake in the NPD process.

Consequently, the sample size is calculated as follows:

Operations Division	=	*40 ÷ 100 = 0.4*
	=	*0.4 x 60%*
	=	*24 employees*
Add: from other divisions	=	*3 employees*
Total sample size	**=**	***27 employees***

4.7 SURVEY RESEARCH

A survey research is conducted in this study. Survey research typically employs a face-to-face interview, a telephone interview, or a written questionnaire, as it aims at solving problems through the interpretation of data that have been gathered (Leedy & Ormrod, 2001). All the questions were

appropriately formulated to answer the investigative research questions. The questionnaire responses were analysed and summarised to reveal percentages, frequency counts, p-values, correlations and Cronbach's Alpha. Conclusions were drawn based on the results of such responses.

4.8 DATA COLLECTION DESIGN AND METHODOLOGY

According to Mouton (2001:104-105), there are variety of data collection methods, ranging but not limited to observing, interviewing, testing, selecting and analysing content. The data were collected through a number of interviews and a self-administered questionnaire (refer to Appendices 4 and 5). These data included both primary data and secondary data. In terms of research methodology, a combination of both qualitative and quantitative research approaches was utilised.

The self-administered questionnaire (i.e. rating scale) followed the 5-point Likert Scale style, which rated from 1 (strongly disagree) to 5 (strongly agree). According to Leedy and Ormrod (2001:197), Likert scales were developed by Rensis Likert in the 1930s to assess people's attitudes. They further explain that, a rating scale is constructive when a behaviour, attitude, or other phenomenon of interest needs to be evaluated on a variety of, for instance, 'inadequate' to 'excellent', 'never' to 'always', or 'strongly disapprove' to 'strongly approve'. The questionnaire was designed based on respondents' demographical data (Part 1) and a rating scale where some 28 statements significant to research questions, objectives and literature review were drawn and sent to the targeted group (Part 2) (refer to Appendix 4). This method of data collection is quite popular, particularly in case of big enquiries (Kothari, 2004:100).

PART 1: Part 1 required individual data and data from the organisation under investigation. Respondents were required to select or answer questions based on their options, including gender, job title within the organisation, years in current position, years of work experience, level of education, the impact of work position on NPD, and quality processes.

PART 2: Part 2 of the questionnaire was in a form of a Likert Scale where respondents were asked to respond to each of the statements by selecting 1 through 5 possible scales.

For the purposes of illustrating and trending data for analysis, all variables based on respondents' demographical and rating scale data was coded. To enable the analysis takes place via SPSS, all the statements from the questionnaire were coded as A-Codes (A1 & A2) and assigned to the demographical data, whilst all B-codes (from B1 to B28) were assigned to the rating scale, shown in Table 4.2.

Table 4.2: Demographic Data and Likert Scale Coded Variables

Variables	Code
Number of years in current position	A1
Work experience in years	A2
Management commitment and strategy For NPD process	
Management plays a major role in setting the climate for important innovative NPD programmes	B1
Management's interest, commitment and support are the most significant keys of success of our NPD process.	B2
A quality strategy for NPD process is in place	B3
A clear NPD strategy is defined by top management.	B4
The NPD Strategy is communicated to the NPD team.	B5
Risk management in NPD process	
NPD is a risky process that is recognised by our company.	B6
We plan and organise our NPD process carefully in order to reduce risk.	B7
Voice of the Customer	
Customer's voice is well recognised as one of the key factors in our NPD process.	B8
Customer's keenness of buying our products is seriously considered during our NPD process.	B9
I have a good understanding of customer requirements on a particular product to be developed.	B10
Customer requirements, uniqueness, reliability and durability as the main aspects of quality strategy are well conformed in our NPD process.	B11
Globalisation gives us pressures on prices, smaller orders, short life cycles, more suppliers and governmental regulations.	B12
Our Business' competitiveness is improved by our NPD process.	B13
Continuous improvement has been adopted to improve the quality of our NPD process.	B14
Innovation is recognised as one of the key success factors for our NPD process.	B15
Best practices are used to promote greater success in developing and launching new products.	B16
Our company has adequate knowledge skills to generate a suitable product solution in the time-competitive environment.	B17
Our company has sufficient knowledge of product technology and market forces.	B18

Variables	Code
Management has necessary skills for marketing, technical, resources, and company's competitiveness	B19
NPD team members have sufficient NPD technological competence (skills, knowledge, and work experience).	B20
Management provides necessary training programmes to NPD team members.	B21
Our NPD process has diverse inputs on the integration of a variety of specialised capabilities and strong interdisciplinary business functions.	B22
R&D, production and purchasing functions are in place to ensure the success of NPD process.	B23
Design reviews, verifications and validations were performed throughout the NPD process to ensure the quality of new product.	B24
Quality control is performed in each stage of our NPD process	B25
Quality management is in place to ensure the quality of products and integration of NPD process.	B26
Product development time is shortened since we concurrently followed our structured NPD process.	B27
Shortening product life cycles increasingly pressurise us to reduce our NPD time and cost in order to maintain product quality.	B28

4.9 STATISTICAL METHODS TO ANALYSE DATA

According to Mouton (2001:108), data analysis entails breaking up the data into convenient themes, patterns, trends and relationships. Since the collection of quantitative data was conducted using questionnaires, this part of the research focused on discussing statistical meaning of the questionnaire results as received from respondents. The interpretation of data for this research was made possible by the use of statistics. According to Leedy and Ormrod (2001:259), the major functions of statistics are as follows:

- Some statistics describe what the data look like.
- Where their centre or midpoint is?
- How broadly they are spread?
- How closely are different variables within the data correlated with one another?

The statistical method examines a few variables in a large number of cases (i.e. respondents) (Struwig & Stead, 2001:8-9). In this research, data was interpreted using descriptive statistics. Descriptive statistics *describe* a body of data (Leedy & Ormrod, 2001:264). The descriptive statistics enlighten on how to statistically determine information the researchers might want to know about a data set:

- points of central tendency;

- amount of variation; and
- the extent to which different variables are related to one another.

SPSS was used to organise data and demonstrate collected data trends of the research. The data analysis and interpretation of this research is in the form of four phases: data reliability, validity testing, data organisation, and statistic description/interpretation. Below are data analysis phases as applied in this research:

PHASE 1: Data Validity Testing—in this phase, measuring instrument validity was tested and the data obtained from the questionnaires was captured on SPSS.

PHASE 2: Data Reliability Testing—a reliability test was conducted prior to organising data.

PHASE3: Data Organisation—subsequent to data capturing and performance of the reliability test, data was organised using tables and graphs.

PHASE 4: Statistic Description/Interpretation—in this phase, collected data trends are described, as demonstrated by the tables and graphs.

Validity refers to whether a measuring instrument measures what it claims to measure (Jackson, 2008: 71). The author explains that there are several types of validity (such as content, criterion and construct validity) and that validity is measured by the use of correlation coefficients. Leedy and Ormrod (2001:31) agree with this description, adding that the validity of a measurement instrument is the extent to which the instrument measures what it is supposed to measure, especially when insubstantial phenomena is measured. Accordingly, validity takes different forms, each of which is important in different situations. The validity used for this research was content validity.

According to Leedy and Ormrod (2001:98), content validity is the extent to which a measurement instrument is a representative sample of the content area (domain) being measured. Jackson (2008:72) agrees with this description and further explains that content validity is a systematic examination of the test

content to determine whether it covers a representative sample of the domain of behaviours to be measured, and to assess content validity. In authenticating the validity of this research questionnaires (as the measurement tool used in this particular research), the researcher consulted comprehensively with her supervisor on the matter of the accuracy of the questionnaires prior to distribution to a targeted group. The questionnaire was only distributed after the supervisor and the researcher confidently agreed that the measuring tool was authentic (i.e. the questionnaire represents information relevant to the research problem, questions, objectives and reviewed literature).Statistical information (as given on descriptive part of this research) is explained as s follows:

4.9.1 Range

One of the ways of measuring variation in this report was the use of a 'range'. According to Jackson (2008: 197), the range is a simplest measure of variation, described as the difference between the lowest and the highest scores in a distribution. She further enlightens that in order to determine the range one simply subtracts the lowest score from the highest score. Leedy and Ormrod (2001:268) entirely agree with this description; their own description of the range is as indicating the spread of the data from lowest to highest value. The formula is as presented: Range = Highest score – Lowest score.

Correspondingly to the mode (as a measure of central tendency) the range has limited usefulness as a measure of distribution and may even be misleading if the extreme upper or lower limits are abnormal more than other values in the series. The range provides information concerning the difference in the spreads of the distributions (Jackson, 2008: 197).

4.9.2 Standard Deviation

Data analysis of this research also made use of standard deviation as data variation measurement. According to Jackson (2008:198), standard deviation can mean the following: 'Standard' = average, normal, and or usual, whilst 'Deviation' = diverge, move away from or digress. She then concludes that the standard deviation is the average movement *away* from something which is, in

this case, the centre of the distribution (i.e. the mean). In strong agreement with this description of standard deviation, Leedy and Ormrod (2001:269-270) define standard deviation as the standard measure of variability in most statistical operations; it is also the most accepted index of spreading in modern statistical practice.

The range is somewhat limited in its use because in the range, only the highest and lowest scores enter the calculation and all other scores are ignored (Jackson, 2008:197). In addition to the range, in this study, the standard deviation was also applied as a measure of variation. The beauty of the standard deviation is that all of the scores in the distribution are measured, and this in turn is advantageous to the researcher as accuracy of data around variation will be secured.

4.9.3 Data Skewed Distributions

According to Struwig and Stead (2001: 159), the shape of the distribution of scores is important to consider when doing data analysis. A normal or symmetrical distribution of scores is required. According to Jackson (2008:202), research data can be skewed in positive or negative distribution. She further explains this trend as follows:

Most distributions do not approximate a normal or bell-shaped curve instead; they are skewed, or lopsided. In a skewed distribution, scores tend to cluster at one end or the other of the x-axis, with the tail of the distribution extending in the opposite direction where the peak is to the left of the centre point and the tail extends toward the right. This situation could happen when data entails extremely high scores that pull the distribution in that direction.

This is a distribution in which the peak is to the right of the centre point and the tail extends toward the left, or in the negative direction (Jackson, 2008:203). In negatively skewed distribution, explains Jackson, the mean is pulled toward the left by the few extremely low scores in the distribution.

4.9.4 Kurtosis

According to Jackson (2008:202), Kurtosis refers to how flat or peaked a normal distribution is. In other words, kurtosis refers to the degree of dispersion among the scores, that is, whether the distribution is tall and skinny or short and fat. The author further shares about positive and negatively skewed distributions as explained below.

4.9.5 Interval Scale of Measurement

According to Jackson (2008:60), in an interval scale, the units of measurement (intervals) between the numbers on the scale are all equal in size. Successively, in Part 2 of the questionnaire (i.e. the Likert Scale), respondents' data was measured using an interval scale of measurement. According to Leedy and Ormrod (2001:29), the interval scale of measurement is characterised by two features:

- it has equal units of measurement; and
- its zero point has been established arbitrarily.

Interval scales of measurement permit statistical analyses that are not feasible with nominal or ordinal data; this is because an interval scale reproduces equal distance among adjacent points. Furthermore, the interval scales are useful in any statistics that are calculated using addition or subtraction such as means, standard deviations, and correlations.

4.9.6 Points of central tendency

Points of central tendency are the central points around which the data revolves (i.e. the midpoint around which the mass of data is equally distributed) (Leedy & Ormrod, 2001:264). Jackson agrees saying a measure of central tendency is a representative number that characterises the 'middleness' of an entire set of data (Jackson, 2008:190). Leedy and Ormrod (2001:264) further explain that there are techniques of finding such a point for any given variable these techniques are *measures of central tendency*. Measures of central tendency consist of the mode, median, and mean where the mode is the most

frequently occurring score, the median is the score that has an equal number of scores above and below it, and the mean is the average score (Struwig & Stead, 2001:158)

However, in this investigation, the mean was the only applied point of central tendency. Leedy and Ormrod, (2001:264**)** further described the mean as a measure of central tendency:

Mean: Mean could be seen as support-aid point for a set of data. This is because the mean balances the weights of all the scores. The mean indicates the point where the weight of the total statistical mass is in levelness around the centre of its own magnitude. Consequently, the mean is the arithmetic average of the scores within the data set. Leedy and Ormrod instruct that to find the mean, one need to calculate the sum of all the scores (adding each score every time it occurs) and then divide by the total number of scores. Jackson (2008:190) agrees with these authors by explaining that the mean is the most commonly used measure of central tendency as it is the arithmetic average of a group of scores. The mean indicates the midpoint where the weight of the scores on one side of the mean exactly balances the weight of the scores on the other side of the mean. Seemingly, the mean is the measure of central tendency that researchers and statisticians most commonly use.

4.9.7 Correlation Measurement

Correlation is another word to describe the measure of association or the relationships between two phenomena (Walliman, 2005: 116). Data analysis and interpretation of this research made use of correlation measurements where one function of statistics describes or indicates the strength of data relationships. According to Leedy and Ormrod (2001:193), a correlation study examines the extent to which differences in one characteristic or variable are related to differences in one or more *other* characteristics or variables. Correlations vary in their magnitude (i.e. the strength of the relationship) as sometimes there is no relationship between variables, or the relationship may be weak (Jackson, 2008:109).

Leedy and Ormrod (2001: 193) agree and further suggest that a correlation exists if, when one variable increases, another variable either increases or decreases in a somewhat predictable fashion. Substantial correlations between two characteristics can be evident only when both characteristics with a reasonable degree of validity and reliability are measured. Therefore, correlation measurement is the art of seeking to know how two or more variable are interrelated.

According to Leedy and Ormrod (2001:271), correlation coefficient is a number between -1 and +1. It is said that a number close to either +1 or -1 (e.g., +0.89 or -0.76) indicates a strong correlation whilst, a number close to 0 (e.g., -0.15 or -0.22) indicates a weak correlation. Leedy and Ormrod also say that most correlation coefficients are decimals (either positive or negative) somewhere between these two extremes. A correlation coefficient for two variables simultaneously puts in the picture two different things about the relationship between those variables. The direction of the relation is indicated by the sign of the correlation coefficient – in other words, by whether the number is positive or negative. A positive number indicates a positive correlation.

4.10 ETHICS APPLIED ON DATA COLLECTION

The organisation under investigation, including people partaking in the research, should consent to the research and be informed of the research process, their rights to privacy, anonymity, confidentiality and respect (Mouton, 2001: 243-244). Throughout the data collection process, respondents fully enjoyed the right of remaining anonymous (the questionnaire cover letter (refer to appendix 3) explained steps for keeping responses anonymous). Even whilst doing face-to-face interviews, respondents were provided confidence in protection of their names and identity numbers.

Respondents were not subjected to data collection by means of cameras, tape recorders and any other data gathering devices. The researcher declared protection of Cape Pak (Pty) and its employees' rights, interests, sensitivities, and gained material and information provided to this investigation on the basis of mutual trust. Respondents to this research had rights that included but were not limited to the following:

- A right to interview refusal.
- A right to questions answering refusal.
- A right to refuse to answer telephonic or e-mail questionnaires.
- A right to refuse to answer any questions.
- A right to not be interviewed at mealtimes.
- A right to not be interviewed at night.
- A right to long periods interview refusal.

Prior to the full-scale investigation, the researcher obtained a written approval for the research from top management of Cape Pak (Pty) (refer to Appendix 2) where Cape Peninsula University of Technology (CPUT) was acknowledged as the researcher's representative institution. Secondly, a questionnaire cover letter was distributed to the targeted group explaining what the research entailed, including the desired benefits of the research. In addition, the researcher reassured the respondents of their protection in order to obtain their consent to partake in the proposed research. This communication included the researcher's goals of the research and requested each respondent's permission to proceed. There were no identified risks of partaking.

Besides the questionnaire cover letter, the researcher explained that respondents may opt out at any stage should they feel like doing so; however, they will still obtain rewards (in the form of research report copy) for their help in the investigation. The personal information of all the respondents was assured to be kept strictly confidential.

4.11 CONCLUSION

The main objective of Chapter 4 was to comprehensively describe design and methods used in this research. The following subjects were extensively explained:

- action research method;
- qualitative and quantitative research approaches;
- research population;
- targeted group;

- sample design and method;
- data collection design and methodology;
- ethics applied on data collection; and
- statistical methods including,
- research applied ethics.

In the next chapter, collected data is analysed and interpreted to draw various conclusions from the survey.

CHAPTER 5: DATA ANALYSIS AND RESULTS INTERPRETATION

5.1 INTRODUCTION

Data are an expression of the reality (Leedy & Ormrod, 2001:100). Leedy and Ormrod explain that data are not the supreme reality – the pure, undisguised, naked truth that underlies all the phenomena researchers observe. This means that data is a relation between *absolute truth* and the researcher's inquiring mind. This chapter deals with data analysis that facilitated the researcher in interpreting and drawing meaningful conclusions. Walliman (2005: 301) identified quite a few reasons why researchers analyse data, such as to measure, make comparisons, examine relationships, forecast test hypotheses, construct concepts and theories, explore, control and explain.

This chapter presents comprehensive outcomes of research data analysis and most importantly, outcomes of both the qualitative and quantitative studies as embarked on in this research. On the qualitative approach, the respondents' interview outcome is explored and results stated. The same scenario goes for the quantitative study; this chapter entails comprehensive statistical results of the survey including demographical and rating scale data outcome. This chapter intended to determine the following:

- Whether Cape Pak (Pty)'s NPD process natural workgroup (i.e. respondents) is well-informed of the NPD process in general.
- Whether there will be correlation between collected data and the statement of the research problem.
- Whether there will be correlation between collected data, research questions and objectives.

5.2 SCALES OF MEASUREMENT

The measurement tool used for the qualitative study was an interview questionnaire (refer to Appendix 5) whilst for the quantitative study, the measurement tool used was a demographical and rating scale questionnaire

(refer to Appendix 4). Part 1 of the questionnaire dealt with respondents' demographical information and was measured with nominal scale of measurement, whereas Part 2 of the questionnaire was measured with a Likert Scale.

For ethical consideration, all 24 respondents and participants who completed the questionnaires and those that were selected for interview purposes, are coded from RES01 to RES24. The 12 participants involved in interviews were coded from PAR1 to PAR12.

5.3 QUALITATIVE DATA FORMAT

The qualitative data outcome is based on responses from a number of interviews, both group interviews and in-depth interview. There were two sessions of interviews that were performed in two different time slots. In the first session, respondents were targeted individually. The second interview session was held as Group Interview in a 'meeting' type of setup, whereby all Key Business Functions with direct inputs to the NPD process were interviewed collectively.

5.3.1 In-depth Interview: Session 1

The first session involved only key management personnel directly involved in the realisation of the NPD process. Session 1 was in a form of in-depth interview, an interview which has two characteristics. First, it involves face-to-face, repeated interaction between the researcher and respondent, and secondly, this type of interview seeks to understand the latter's perspectives (Kumar, 2011:160). For these in-depth interviews, only three participants were selected on the basis of their capacity to make strategic decisions within the business and their sufficient market, product and technological competence. The identity of these participants was coded as PAR2, PAR3 and PAR5 (one of them).

5.3.2 Focus Group Interview: Session 2

Session 2 of the interview took the form of a focus group interview where the former is undertaken with a group and the latter with an individual (Kumar, 2011:160). The second session included the 12 participants selected on the basis of their support and decision-making in the NPD process. It was unfortunate that six of these Business Functions could not attend the interview due to other business commitments taking priority at the time of the interview session.

5.3.3 Interview Questions

The interview questionnaire is a written list of questions, the answers to which are recorded by respondents (Kumar, 2011:145). The interview questions sufficed as a guide for research direction. As the NPD Team of Cape Pak (Pty) Ltd are colleagues who work together regularly, observe and experience similar challenges, successes, frustrations and improvements, it was easy for the researcher to use the interview as just a normal professional conversation with the intention of gathering facts around their experiences in the NPD process. However, as indicated, there were guiding questions that took a form of S-W-O-T Analysis for in-depth interview. The questions for the in-depth interview were as noted below:

- **Strengths and/or opportunities for NPD process:**
  In your opinion and experience, what are strengths and/or opportunities for our company's NPD process?
- **Weaknesses and/or threats for NPD process:**
  What are the weaknesses and/or threats or gaps in the Cape Pak (Pty) on NPD process?
- **Risk management in NPD process:**
  How does the company manage NPD process-related risks?

Only two questions were asked in the focus group interview:

- **Gaps in the NPD process**
  What gaps in the NPD process do you normally experience?

- **Possible improvements for NPD process**
  What kind of improvement (if any) does the company need to assume in order to bridge such gaps?

For more details on the interview questionnaire, please refer to Appendix 5 (i.e. the interview questionnaire).

5.4 OUTCOMES OF THE IN-DEPTH INTERVIEWS

The in-depth interview took place on the week of the 6th to the 10th of March 2012. The interviewees or participants were PAR1, PAR2, PAR3 and PAR5 (one of them). All the responses are summarised as the following:

5.4.1 Strengths and/or opportunities for NPD process

In your opinion and experience, what are the strengths and/or opportunities for our companies NPD process?

"Bulk of our manufacturing process is manual and that is our strength. There are only three 'automated' manufacturing processes. Despite that this could be perceived as Technology deficiency due to its labour intensiveness, it provides the company a competitive advantage over its competitors. This is due to the fact that, Cape Pak (Pty) is operating in a Niche Market where Liquid Liner business is concerned" (**PAR2**).

"The benefit of operating more with manual manufacturing processes is that, we are capable of designing and producing exactly what the customer requires at the time when they want it. Whereas the global technologically sophisticated or 'privileged' companies in this market can only service customers with what their manufacturing process is capacitated to provide". (**PAR2**).

Cape Pak (Pty) refers to this customisation as being 'Customer Centric', defining customer centricity as: "Creating a positive customer experience at the point of sale and post-sale.

"It used to be very difficult to manufacture NPD prototypes and this was because, our NPD manufacturing process highly depended on the availability of capacity from the Production manufacturing process". This resulted in the:

- *Delay of prototypes manufacturing*
- *Delayed delivery to customer, and*
- *Customer dissatisfaction* (**PAR3**).

"However, since the NPD manufacturing process was put in place and optimised, it is now effortless to manufacture NPD prototypes. What's more is that, the NPD process has its dedicated workforce and this, likewise, benefit where NPD manufacturing process is concerned". (**PAR3**).

"Our customer database is inclusive of customers that have been with the company for more than 10 years. This means that, through thick and thin, the company is managing to retain customers". (**PAR5**).

This participant suspects that this could be attributable to the company's greatness in uniqueness and / or customisation of products.

5.4.2 Weaknesses and / or threats for NPD process

What are the weaknesses and/or threats or gaps in the Cape Pak (Pty)'s NPD process?

"Speed and Quality are our huge challenge for our NPD process. It takes time to produce prototypes that could be delivered to the customer for testing in their Product filling processes." "When these prototypes eventually arrive at customer, there are usually many quality problems experienced by the customer. It even takes time for the company to properly and comprehensively investigate such problems for improvement purposes and to put customers at ease". (**PAR2**).

The participant further said delays associated with investigating NPD related customer complaints could be as a result of insufficient business resources where testing equipment, test methods and quality control plans are concerned

"The quality control of our NPD process is not fully carried out due to the fact that, the company lacks proper test equipment that could facilitate fully optimised in-process and external product testing. As a result of this insufficiency, the company cannot be entirely confident of the product in the market, that's why our company experiences customer dissatisfaction most of the time (**PAR3**).

"There is no system in place that directs the NPD process steps and the accountability thereof. When I, as a person responsible for initiating the first step towards designing or developing new products, I am expected to follow up with everyone with direct inputs to the NPD process, people do not want to take accountability, then the task at hand does not materialise and that causes delays in prototypes speed. It is really unfortunate that the Sales function is the initiator of the NPD process due to the fact that sales people are a primary Link between the Company and its customers. This frustrates a lot as customers put pressure on Sales people for quality and delivery requirements" (**PAR5**).

This comes down to the fact that, NPD process goals, objectives, responsibilities, accountabilities and authorities should be well stipulated in advance so that the NPD multidisciplinary team knows what is expected of them. For this to happen, as already identified in literature review, the NPD process should be implemented and managed just like any other business process.

5.4.3 Risk management in NPD process

How does the company manage NPD process related risks?

"I feel like our NPD process is a 'one-man-show', as this Business Function is not centrally controlled just like all the other Key Business Processes. The NPD process entirely depended on the NPD Projects Manager's planning, organisation and decision making. Many Business functions, for instance the Quality Function are not at all involved in 'Go' or 'No-go' of the NPD Prototypes. The Business Function that is responsible for the NPD process does everything alone. The risks to this setup are:

- *The company at large lacks crucial knowledge of the NPD process.*
- *Customer dissatisfaction is not rectified collectively.*
- *There are unaccounted-for costs related to the NPD process.*
- *There are no documented systems in place (e.g. Procedures, Process Descriptions, Test methods, quality control plans)"*.

"Due to these risks, the company does not measure the status of competence in the NPD Process. Besides, there is no 'Formal' NPD process dedicated team" (**PAR2**).

"I feel like, due to lack of proper product test equipment, there is a competency related risk that should be assessed by our company. This risk is related to the lack of test equipment, the fact that once these resources are available, there needs to be a training programme and competency assessments of relevant personnel, such as quality controllers including the development of testing methods and quality control plans for product verification and validation subsequent to product delivery to the customer" (**PAR3**).

"I'm of the opinion that, the main risks with the NPD process is that, in most cases, customers cannot truly express their needs and in that, the Technical Sales team ought to use their expertise and drive information out of the customer. There is obviously nothing wrong with this approach however, customers tend to not officially approve such specifications (i.e., sign and return back a signed copy of the Finished Product Specification for instance). What the customers do is to pressurise the company for products by ordering and demanding order delivery date, On-time and In-full" (**PAR5**).

"This is very risky as, if the products are not fit for purpose, the customer:

- *Would be very dissatisfied*
- *Could claim large sums of money due to their product damages or loss*
- *Could stop buying, but even worse*
- *The company image would be at a detriment"*.

"Furthermore, due to the reality that 'Product Knowledge' is seating with very few personnel within the business", it makes it very difficult for these individuals

to be efficient in their everyday activities but besides that, it puts the company at a very high risk because, should those individuals be 'out of scene' whether by choice or by natural causes, it would be very difficult for the company to continue and be sustainable" (**PAR5**).

5.4.4 In-depth Interview on measuring the success of NPD process

During October, 2012, the researcher conducted an in-depth interview in a form of a meeting with PAR1, whereby the researcher (as the newly appointed Manager of the NPD process) and PAR1 outlined the future of the NPD process at Cape Pak (Pty) by discussing and agreeing on performance measures and measurable targets of the NPD process going forward.

According to PAR1, to properly manage deficiencies in the NPD process of the company (such as those identified by the first three participants), project management effectiveness should be the main focus for realising an excellent NPD process within this company. It was further agreed that the performance measures for NPD project management should be OTIF project completion against plan, budget and new product sales, where measurable targets would be as follows:

- NPD high level documentation writing, implementation and control.
- Training and competency assessment of the NPD multidisciplinary team in all NPD processes.
- Measurement and reporting structure of the NPD process should be logged, trended and analysed.
- NPD process performance should be updated on daily basis so that all related Business Functions should be able to make informed NPD process decisions daily.
- New product sales against budget should be measured on actual versus plan basis.

According to PAR1, in general, customers are not satisfied with Cape Pak (Pty)'s products and services; however, according to some of the customers, the company's atmosphere of 'friendliness' makes the customer feel welcome.

However, the participant mentioned that global competition is becoming very tight and strict in such a way that a business cannot afford to be sustained merely by 'friendly' people, but also by product quality, delivery speed and cost-effectiveness.

5.5 RESPONSES FROM FOCUS GROUP INTERVIEW

Only two questions were posed to the focus group. Each Business Function was individually requested to answer these questions:

- *What gaps in the NPD process do you normally experience? And,*
- *What kind of improvement (if any) does the company need to assume in order for it to bridge such gaps?*

5.5.1 Gaps in the NPD process

These questions resulted in many significant and helpful responses, stated as follows:

On the 29 May 2012, a focus group interview was held with NPD process key Business Functions who have direct inputs to the NPD process. Out of 27 Business Functions directly involved in the NPD process, the key Business Functions comprised a total of 12 participants, coded as PAR1-9, PAR12-14, and PAR17.

Only about 70% of the participants could make it to the focus group interview. Three of these Business Functions were either absent from work or had to be excused due to other significant priority business commitments. Present in the focus group interview session were PAR02 to PAR09 and PAR13 and PAR14.

What gaps in the NPD process do you normally experience?

"Continuous ineffective communication from the team around NPD Samples (i.e. Prototypes) and the actual commercial run is frustrating. It results in non-operational Bill of Materials (BOMs). By the time in which a Commercial run needs to commence, there is tremendous pressure to update prices of

materials in order to update the BOMs and in most cases; insufficient and/or incorrect materials are purchased" (**PAR13**).

"If only NPD samples were planned by the production planner life would have been easier. The fact that the NPD projects manager directs NPD samples by himself creates problems on raw material and machinery capacity, including people requirements. The problem is that when NPD samples are produced, the NPD manufacturing team takes readily available materials that were not purchased for NPD process. Also, at the time whereby there was no dedicated NPD manufacturing process, NPD manufacturing process used to inconvenience and interrupt production facility by manufacturing 'urgent' NPD Samples whilst inconveniencing already firm orders. This sometimes resulted in people working unplanned overtime and that alone costs our business" (**PAR09**).

"The fact that NPD Samples do not have both the customer and/or Cape Pak (Pty) product codes (i.e. sometimes having just only one of), creates confusion on already determined product ID and traceability system. The outcome of this is that products are not booked accurately on the SYSPRO System. In most cases, NPD Samples validation is not taken off the SYSPRO system; as a result, during the commercial run there will be both sample codes on actual product information that in most cases confuses people working with that system. Such confusion creates wasteful activities around production planning and raw material purchasing" (**PAR09**).

"The Sales team pressurises everybody for NPD Samples to be made; on the other hand, the actual commercial run order from the customer can come as late as in two years' time. The obsolete BOMs gap as identified by PAR13 is due to the reality that, by the time some of the NPD Samples are approved for commercial run, the team had unintentionally overlooked or forgot to update manufacturing documentation such as BOMs, Manufacturing and Finished Product specifications for instance" (**PAR09**).

"We lack NPD process stages planning and review that could lead to sufficient new product verification and validation, thereby determining quality of our NPD

process. Respectively, a planning and review of this nature will result in effective communication to the team clarifying each Business Function's responsibilities in each NPD prototype and overall service" (**PAR04**).

"Our NPD process needs a formally authorised NPD multidisciplinary team that should be empowered with the right NPD competence, linked to Business Function's expertise and key performance indicators so that when there is a task at hand, it could be tackled with no major complications and frustrations. This means that there are various training resources (e.g. product knowledge, project management) that should take place in order to discover such competence. When a competence gap is closed, purchasing specific test equipment, developing accurate test methods and quality control plans would be an understood and graceful, successful daily activity" (**PAR04**).

"NPD speed and quality are Cape Pak (Pty)'s biggest challenge. It takes time to manufacture NPD Samples yet even once these are produced, there are dissatisfied customers that complain about product quality. Our NPD process is not a centrally controlled business process as it has no documented systems in place (i.e. procedures, process descriptions)" (**PAR02**).

"The NPD process does not really affect our Function. The only problem was that by the time that a commercial run needs to occur, there is no proper handover from the NPD function as a result, in most cases, our Function struggles a lot with the first time commercial run resulting in wasteful activities such as down time. I think it would be easier if the NPD team could dedicate time and mentor our Function during the first time of commercial run to eliminate wasteful activities such as extended setup time" (**PAR07**).

5.5.2 What kind of improvement (if any) does the company need to assume in order it to bridge such gaps?

The focus group interview session participants, collectively discussed, agreed and came up with the following group recommendations:

Managing NPD Risks:

One of the ways to manage NPD process-related risks is to ensure that there are no NPD Samples made without 'formal' written customer approval. When this happens, customers would be 'forced' to understand their requirements so that, if at any time when the Samples are not according to these requirements, the related cost risk is not one-way but owned by both the company and the customer. It was also said that Functions responsible for external customers (e.g. TSMs) would have to take time and teach customers about the functionality, reliability and product application. All NPD Samples should be captured on a structured system so that a responsible Business Function could trend and analyse on the basis of plan versus actual. When this happens, the NPD team will be able to keep track of these NPD products.

Production Plan:

To ensure an effective production plan and raw material, people requirements should be managed efficiently. Prototypes should only be produced if the Works Order is officially generated from customer order on the SYSPRO System. The Works Order should be forwarded to the Production Planner so that he can plan all requirements accordingly.

Sample Log Database:

Sales Coordinators (both local and export) should ensure that there is a Sample log database and number so that the Supply Chain and Production Functions could easily differentiate between a NPD Sample and 'normal' production.

NPD Gate Control System

The Quality and NPD Function should establish an uncomplicated 'NPD Gate Control System' so that the NPD process can only progress to the next stage when there has been formal approval from the previous stage.

The feedback from interview sessions positively correlates with literature review. This demonstrates that indeed, NPD process is a very imperative and huge business process that if not properly managed could lead to challenges related to process delays, people incompetency, customer dissatisfaction etc. This shows that, there was a need for Cape Pak (Pty) to formalise the way the company manages its NPD process.

5.6 DESCRIPTIVE STATISTICS

In total, 27 questionnaires were distributed to the targeted group (i.e. the research sample size). Most questionnaires were e-mailed, accompanied by a letter that explained the requirements of the study and instructions for completing the questionnaire (refer to Appendix 3). Out of 27 questionnaires distributed to the targeted group, the researcher received back 24 questionnaires, missing only three questionnaires.

As some employees are illiterate (i.e. the general workers) and could not fully understand the statements of the Rating Scale, the researcher sat with these employees and carefully explained the questionnaire, to those who were either illiterate or ignorant where NPD process is concerned.

For the purposes of illustrating and trending data for analysis, all variables based on respondents' demographical and rating scale data was coded.
A-codes were assigned to the demographical data whilst B-codes were assigned to the rating scale (*refer to Table 4.2 on page 92*).

The data analysis and interpretation of this research is in the form of four phases:

- data reliability testing;
- data validity testing;
- data organisation; and
- statistic description/interpretation.

Table: 5.1: Descriptive Statistics

Var.	N	R	Min.	Max.	Mean	SD.	Skew.	Kurt.
A1	24	4	1	5	2.5	1.251	0.654	-0.566
A2	24	4	1	5	3.88	1.329	-1.328	0.77
B1	24	4	1	5	4.25	1.032	-1.844	3.704
B2	23	4	1	5	4.22	0.998	-1.679	3.642
B3	24	4	1	5	3.42	1.381	-0.406	-0.961
B4	24	4	1	5	3.42	1.06	-0.24	-0.194
B5	23	4	1	5	3.35	1.265	-0.435	-0.362
B6	24	3	2	5	3.92	0.83	-0.833	0.854
B7	24	4	1	5	3.25	1.073	-0.316	-0.789
B8	24	2	3	5	4.25	0.676	-0.346	-0.666
B9	24	3	2	5	3.92	0.83	-0.334	-0.338
B10	24	4	1	5	3.79	1.179	-0.776	-0.209
B11	23	3	2	5	3.83	0.937	-0.352	-0.63
B12	23	2	3	5	4.3	0.765	-0.601	-0.974
B13	24	4	1	5	3.88	1.116	-0.964	0.509
B14	24	4	1	5	3.42	1.316	-0.365	-1.044
B15	24	4	1	5	3.83	1.129	-0.831	0.185
B16	24	3	2	5	3.75	0.944	-0.127	-0.879
B17	24	3	2	5	3.71	1.042	-0.359	-0.937
B18	24	3	2	5	3.67	1.09	-0.138	-1.258
B19	24	3	2	5	3.79	0.977	-0.461	-0.605
B20	24	3	2	5	3.71	0.908	-0.115	-0.69
B21	24	4	1	5	2.88	1.116	0.061	-0.256
B22	21	2	2	4	3.38	0.74	-0.774	-0.654
B23	23	3	2	5	3.39	0.988	0.021	-0.944
B24	24	4	1	5	3.38	1.173	-0.466	-0.341
B25	24	4	1	5	3.33	1.09	-0.081	-0.459
B26	24	4	1	5	3.75	1.073	-0.834	0.487
B27	24	4	1	5	3.13	1.076	0.189	-0.485
B28	24	3	2	5	3.38	0.97	0.073	-0.869

Var: *Variable*
R: *Range*
Min: *Minimum*
Max: *Maximum*
SD: *Standard Deviation*
Skew: *Skewness*

5.6.1 Interpretation of the Descriptive Statistic

Table 5.2 illustrates descriptive statistics applied in this research.

N (Sample)

Data demonstrates that out of 30 variables, 24 participants responded 100% to the questions whilst 7 participants skipped some of the variables. Given that, five rating scale variables (i.e. B5, B11, B12, B22, and B23) were affected. However, the two demographical data questions were responded to 100%.

Range

Number of years in current position

Data demonstrated that years in current position (of NPD team members) range between 10 and 15.

Work Experience in Years

Data demonstrated that the range of respondents' work experience in years is also between 10 and 15.

Rating Scale Choices

Data demonstrated that the range of 15 variables were respondents that agreed with the variables.

Furthermore, the range of 10 variables consisted of respondents that neither agreed nor disagreed to such variables.

At the same time, the range of 2 variables consisted of respondents that disagreed with such variables.

Mean & Standard Deviation

Data demonstrated that on average, the midpoint around which the mass of data is equally distributed is at 3.6 where standard deviation (i.e. the average movement away from the centre of the distribution - mean) is sitting at only 1.0 on average.

5.6.2 Correlation Matrix

Table 5.2 shows correlation data of the research:

Table 5.2: Correlation Matrix

	A1	A2	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20	B21	B22	B23	B24	B25	B26	B27
A1																													
A2	.519																												
B1	.056	.100																											
B2	.444	.422	.628																										
B3	.044	-.365	.111	.201																									
B4	.208	-.394	.082	.207	.693																								
B5	.201	-.264	.289	.305	.834	.742																							
B6	-.361	-.277	-.161	-.379	-.075	.326	-.080																						
B7	.129	-.310	-.061	-.064	.642	.659	.732	-.051																					
B8	-.118	-.604	-.375	-.395	.170	.274	.040	.012	.344																				
B9	-.052	-.309	.023	-.415	-.255	-.169	-.039	.106	.087	.193																			
B10	-.099	-.265	-.345	-.251	-.188	.084	-.020	.392	-.042	.189	.086																		
B11	-.260	-.534	-.537	-.387	.339	.473	.267	.417	.509	.580	-.065	.519																	
B12	.048	-.412	-.291	-.056	.084	.119	.022	.069	-.200	.221	.109	.562	.239																
B13	.164	.190	-.086	-.344	-.296	-.241	-.154	-.035	-.098	-.045	.507	-.130	-.301	-.253															
B14	.217	-.472	-.283	-.254	.447	.446	.478	.037	.444	.402	.467	.030	.319	.267	.270														
B15	-.128	-.400	-.021	-.119	.093	.020	.061	-.023	.064	.163	.582	-.117	-.020	.412	.064	.415													
B16	.200	-.323	-.251	-.202	.177	.197	.089	.160	-.039	.254	.395	.004	.138	.405	.239	.767	.548												
B17	.260	-.465	-.261	-.221	.165	.382	.265	.102	.085	.436	.179	.471	.324	.575	.149	.659	.072	.523											
B18	.067	-.626	.199	.157	.431	.475	.545	-.162	.241	.414	.239	.184	.196	.547	-.047	.543	.386	.321	.693										
B19	-.023	-.657	.084	-.095	.385	.463	.510	-.084	.264	.375	.185	.177	.188	.394	.141	.600	.206	.371	.778	.852									
B20	.158	-.396	.178	.188	.394	.502	.584	.005	.235	.166	.250	.276	.076	.437	.136	.611	.179	.399	.630	.725	.767								
B21	-.335	-.189	.021	-.045	.167	.203	.072	.346	-.126	-.141	-.044	-.191	.012	.200	.040	.107	.417	.287	.033	.156	.243	.229							
B22	-.086	-.158	.095	.100	-.037	.107	.140	.340	-.179	-.040	.195	.578	.293	.335	.181	.179	.043	.279	.368	.349	.271	.481	.179						
B23	.088	-.233	.172	.182	.189	.523	.259	.274	.421	.350	.154	.008	.464	-.035	-.164	.094	.192	.124	-.070	.199	-.009	.048	.057	.253					
B24	.261	-.147	-.066	.035	.300	.121	.405	-.400	.420	.359	.443	-.167	.158	-.078	.300	.668	.356	.419	.231	.415	.265	.263	-.281	.140	.221				
B25	.242	-.072	-.123	-.007	.178	-.018	.387	-.358	.185	.075	.253	.202	.215	.152	.283	.521	.121	.369	.451	.428	.414	.324	-.207	.464	-.017	.733			
B26	.235	-.445	-.381	-.211	.316	.316	.287	-.131	.281	.535	.082	.276	.428	.378	-.038	.657	.238	.613	.684	.472	.527	.280	-.227	.085	.027	.531	.576		
B27	-.176	-.479	-.108	-.241	.536	.515	.625	.114	.662	.348	.139	-.036	.576	-.222	.103	.543	-.031	.158	.251	.357	.454	.248	-.025	.142	.359	.555	.496	.384	
B28	-.115	-.444	-.016	-.017	.441	.683	.533	.428	.380	.187	-.263	.576	.531	.377	-.396	.081	-.227	-.188	.446	.424	.448	.436	.121	.236	.149	-.306	-.092	.142	.278

Observed Positive Correlation

*Data demonstrates that there is a positive correlation between the NPD strategy communicated to the NPD team (**B5**) and how Cape Pak (Pty) plans and organises its NPD process in order to reduce risks (**B7**).*

*Data demonstrates that there is a positive correlation between adopting continuous improvement to the quality of the NPD process (**B14**), with best practices used to promote greater success in developing and launching new products (**B16**).*

*A positive correlation was observed between the company having adequate knowledge and skills to generate a suitable product solution in the time-competitive environment (**B17**) and management having necessary skills for marketing, technical, resources and company competitiveness (**B19**).*
*Correspondently, there was a positive correlation observed between the company having sufficient knowledge of product technology and market forces (**B18**) with management having necessary skills for marketing, technical, resources and company competitiveness (**B19**).*

*Furthermore, it seems like there is a positive correlation between management having necessary skills for marketing, technical, resources and company competitiveness (**B19**) and NPD team members having sufficient NPD technological competence (skills, knowledge, and work experience) (**B20**).*

*Lastly, there was a positive correlation between design reviews, verifications and validations performed throughout the NPD process to ensure the quality of new product (**B24**) and quality control being performed in each stage of the NPD process (**B25**).*

<u>Observed Negative Correlation</u>

*A negative correlation was observed between management playing a major role in setting the climate for important innovative NPD programmes (**B1**) and innovation recognised as one of the key success factors for the company's NPD process (**B15**).*

*There is a negative correlation between management's interest, commitment and support being the significant keys of success of the company's NPD (**B2**) and NPD that is planned and organised carefully in order to reduce risks (**B7**).*

*Data demonstrates a negative correlation between management's interest, commitment and support being the significant keys of success of the company's NPD (**B2**) and quality control being performed in each stage of the NPD process (**B25**).*

*Another negative correlation was observed between customer requirements, uniqueness, reliability and durability as the main aspects of quality strategy being well-conformed in the company's NPD process (**B11**), and innovation recognised as one of the key success factors for the company's NPD process (**B15**).*

*Furthermore, data demonstrates a negative correlation between management having necessary skills for marketing, technical, resources, and company competiveness (**B19**) with R&D, production and purchasing functions being in place to ensure the success of NPD process (**B23**).*

*There is a negative correlation observed between R&D, production and purchasing functions being in place to ensure the success of NPD process (**B23**) and quality control performed in each stage of the company's NPD process (**B25**).*

*Lastly, a negative correlation was observed between quality control performed in each stage of the company's NPD process (**B25**) and shortening product life cycles increasingly pressurising the company to reduce its NPD time and cost in order to maintain product quality (**B28**).*

5.6.3 Data variation measurement

As stated by Leedy and Ormrod (2001:268), data variation measurement quantifies variation by measuring the worst odds. They further explain that, the distant the data are distributed from the central pivotal axis, the greater the margin of predictive error becomes. This means that, as data move away from the mean, they lose more and more of the quality that makes them *average*. It is for that reason that not only should the data be distributed centrally, but also their spread. Table 5.4 shows the results of ANOVA (One Way Analysis of Variance).

Table 5.3: One Way Analysis of Variance (ANOVA) Statistical data

Variable		Sum of Squares	df	Mean Square	F	Sig.
B1	Between Groups	5.133	4	1.283	1.259	.320
	Within Groups	19.367	19	1.019		
	Total	24.500	23			
B2	Between Groups	2.807	4	.702	.661	.627
	Within Groups	19.106	18	1.061		
	Total	21.913	22			
B3	Between Groups	6.183	4	1.546	.780	.552
	Within Groups	37.650	19	1.982		
	Total	43.833	23			
B4	Between Groups	3.633	4	.908	.777	.554
	Within Groups	22.200	19	1.168		
	Total	25.833	23			
B5	Between Groups	4.184	4	1.046	.607	.663
	Within Groups	31.033	18	1.724		
	Total	35.217	22			
B6	Between Groups	4.233	4	1.058	1.733	.184
	Within Groups	11.600	19	.611		
	Total	15.833	23			
B7	Between Groups	3.533	4	.883	.731	.582
	Within Groups	22.967	19	1.209		
	Total	26.500	23			
B8	Between Groups	2.033	4	.508	1.141	.367
	Within Groups	8.467	19	.446		
	Total	10.500	23			
B9	Between Groups	5.533	4	1.383	2.552	.073
	Within Groups	10.300	19	.542		
	Total	15.833	23			
B10	Between Groups	5.992	4	1.498	1.096	.387
	Within Groups	25.967	19	1.367		
	Total	31.958	23			
B11	Between Groups	2.904	4	.726	.797	.543
	Within Groups	16.400	18	.911		
	Total	19.304	22			
B12	Between Groups	1.770	4	.442	.717	.591
	Within Groups	11.100	18	.617		
	Total	12.870	22			
B13	Between Groups	3.675	4	.919	.700	.602
	Within Groups	24.950	19	1.313		
	Total	28.625	23			
B14	Between Groups	5.967	4	1.492	.837	.519
	Within Groups	33.867	19	1.782		
	Total	39.833	23			
B15	Between Groups	6.617	4	1.654	1.384	.277
	Within Groups	22.717	19	1.196		
	Total	29.333	23			
B16	Between Groups	.183	4	.046	.043	.996
	Within Groups	20.317	19	1.069		
	Total	20.500	23			
B17	Between Groups	2.592	4	.648	.550	.701

Variable		Sum of Squares	df	Mean Square	F	Sig.
	Within Groups	22.367	19	1.177		
	Total	24.958	23			
B18	Between Groups	5.283	4	1.321	1.138	.369
	Within Groups	22.050	19	1.161		
	Total	27.333	23			
B19	Between Groups	6.358	4	1.590	1.936	.146
	Within Groups	15.600	19	.821		
	Total	21.958	23			
B20	Between Groups	2.542	4	.635	.735	.579
	Within Groups	16.417	19	.864		
	Total	18.958	23			
B21	Between Groups	6.258	4	1.565	1.329	.295
	Within Groups	22.367	19	1.177		
	Total	28.625	23			
B22	Between Groups	.313	4	.078	.118	.974
	Within Groups	10.639	16	.665		
	Total	10.952	20			
B23	Between Groups	.545	4	.136	.117	.975
	Within Groups	20.933	18	1.163		
	Total	21.478	22			
B24	Between Groups	8.258	4	2.065	1.679	.196
	Within Groups	23.367	19	1.230		
	Total	31.625	23			
B25	Between Groups	3.367	4	.842	.667	.623
	Within Groups	23.967	19	1.261		
	Total	27.333	23			
B26	Between Groups	4.433	4	1.108	.954	.455
	Within Groups	22.067	19	1.161		
	Total	26.500	23			
B27	Between Groups	3.325	4	.831	.678	.616
	Within Groups	23.300	19	1.226		
	Total	26.625	23			
B28	Between Groups	5.158	4	1.290	1.488	.245
	Within Groups	16.467	19	.867		
	Total	21.625	23			

This above table shows the output of the ANOVA analysis and whether research data have a statistically significant difference between the group means. *Data demonstrates that approximately 50% of the variables' significance level is more than .05, where some are sitting as high as at 0.097 (p = .0.970). It can therefore be concluded that there is statistical significance between the fifteen conditions.*

However, data also shows there are 50% of the variables with a significance level less than .05. Therefore, there is a statistically significant difference in the mean between these research variables.

5.6.4 RELIABILITY TESTING

According to Leedy and Ormrod (2001: 32), reliability is the consistency with which a measuring instrument yields a certain result when the entity being measured has not changed. They suggest that researchers can measure something accurately only when they can also measure it consistently. Jackson (2008:67) agrees with them, similarly describing reliability as the consistency of stability of a measuring instrument. In other words, the measuring instrument must measure exactly the same way every time it is used. According to Blaikie (2003: 219), Cronbach's Alpha, is probably the most commonly used test for scale reliability where reliability refers to the capacity of a measure to produce consistent results. He further explains that Cronbach's Alpha coefficient ranges between 0 and 1, with a high value indicating a high level of consistency among the items.

The data reliability can be measured by using correlation coefficients. These are sets of scores which can vary between -1.00 and +1.00 (Jackson, 2008:68). Jackson (2008:69) further enlightens that the stronger the relationship between the variables, the closer the coefficient is to either -1.00 or +1.00. Leedy and Ormrod (2001:271) are in agreement with this description by also defining correlation coefficient as a number between -1 and +1. A number close to either +1 or -1 (e.g. +0.89 or -0.76) indicates a strong correlation, whilst a number close to 0 (e.g. -0.15 or -0.22) indicates a weak correlation. Correlation coefficients for two variables simultaneously demonstrate two different things about the relationship between those variables, and that is positive and/or negative correlation. Table 5.6 shows the results of data reliability by means of Cronbach's Alpha.

Table 5.4: Result of Cronbach's Alpha

SUMMARY OF CASES		
Cases	**N**	**Percentage**
Valid	18	75.0
Excluded	6	25.0
Total	24	100.0
RESULT OF CRONBACH'S ALPHA		
Cronbach's Alpha	**Cronbach's Alpha based on standardised items**	**N of Items**
.831	.847	30

The Cronbach's Alpha of the research data is at a high value of 0.831; this implies that there is a high level of consistency amongst the variables. Likewise, a result of this nature implies that all the variables are statistically consistent to each other. A reliability result of this nature provides confidence and assurance that appropriate conclusions could be drawn from this data.

5.6.5 Data organisation

In this research, there were two applications (frequency distributions and graphs) employed to organise data with the aim of drawing meaningful conclusions.

Frequency Distributions

Data tabulation is the first step in the process whereby raw data are converted into the 'list of required information' that could now be simply interpretable (Struwig & Stead, 2001:150). In this research, the researcher made use of frequency distribution; this is a table in which all of the scores are listed along with the frequency with which each occurs (i.e. relative frequency) in order to be able to draw meaningful conclusions by utilising statistical methods. The frequency distribution is a way of presenting data that makes their pattern easier to see (Jackson, 2008: 185). She further provides awareness that the frequency distribution is a way of presenting data that makes their pattern easier to distinguish.

Graphs

To further improve on visual aspects of the data provided by frequency distribution, and further demonstrate data results, additionally, graphs (i.e. Bar, Column and Pie graphs) were used. According to Jackson (2008:187), graphs naturally have two coordinate axes: the x-axis (the horizontal axis) and the y-axis (the vertical axis). The y-axis is a more often than not shorter than the x-axis.

Pie and Column graphs were used to demonstrate tendencies of Part 1 of the questionnaire (i.e. demographical data nominal scale). The graphs were used as a graphical representation of a frequency distribution in which vertical bars are centred above each category along the X-axis and are separated from each other by a space, indicating that the levels of the variable represent distinct, unrelated categories (Jackson, 2008: 187). Part 2 of the questionnaire's outcome was illustrated using a bar graph.

5.6.6 Data description/interpretation

The aim of this research phase was to trend organised data with the intention of meaningful interpretation of such data. As with many research projects, the researcher applied research measurement in order to understand what the research data entailed. Subsequently, measurement is restraining the data of any phenomenon – substantial or insubstantial – so that those data may be interpreted and eventually matched to an acceptable qualitative or quantitative standard (Leedy & Ormrod, 2001:24). It is for this reason that scales of measurement were used in this research (i.e. nominal and interval scale of measurements).

According to Leedy and Ormrod (2001:225), the purpose of research is to pursue the solution to a problem, taking into consideration the data that relate to the problem, it is said that data have many more meanings than most researchers discover (Leedy and Ormrod, 2001:290). According to Struwig and Stead (2001:168), it is imperative that when interpreting the data the researcher should focus on all the data and not only on those aspects that

appear interesting or statistically significant. They further warn that statistically non-significant findings must also be reported as often such findings can be revealing in that they may refute widely held beliefs in a field.

5.6.7 Demographical data analysis and interpretation

Demographic data was analysed and interpreted based on nominal scale of measurement using pie and column graphs for illustration. It is said that a researcher can measure data to some degree by assigning names to them (Leedy & Ormrod, 2001:28) and, for that reason the nominal scale was used to limit data by assigning a specific name to the respondent's demographical information (Appendix 4). According to the information provided by Leedy and Ormrod (2001:28), the word 'nominal' comes from the Latin 'nomen', meaning 'name'. In a nominal scale, objects or individuals are allocated to categories that have no numerical properties. Nominal scales have the characteristic of identity but lack the other properties (Jackson, 2008:59). In addition, variables measured on a nominal scale are often referred to as 'categorical variables' because the data are divided into categories. Therefore, measurement of Part 1 of the questionnaire made use of a nominal scale of measurement for respondent's demographic data categories such as gender, level within the organisation, number of years in current position, work experience gained in years and level of education was measured as respondents' demographical data.

Based on the results, there were no responses missed in all questions asked in Part 1 of the questionnaire (i.e. demographical information). Data analysis demonstrates that 100% of the respondents of 24 questionnaires responded 100% to demographical data.

Figure 5.1 indicates that the total number of females contributing in this research was 58% whilst contributing males were at 42%. It seems like the NPD process at Cape Pak (Pty) is capacitated with more females than males.

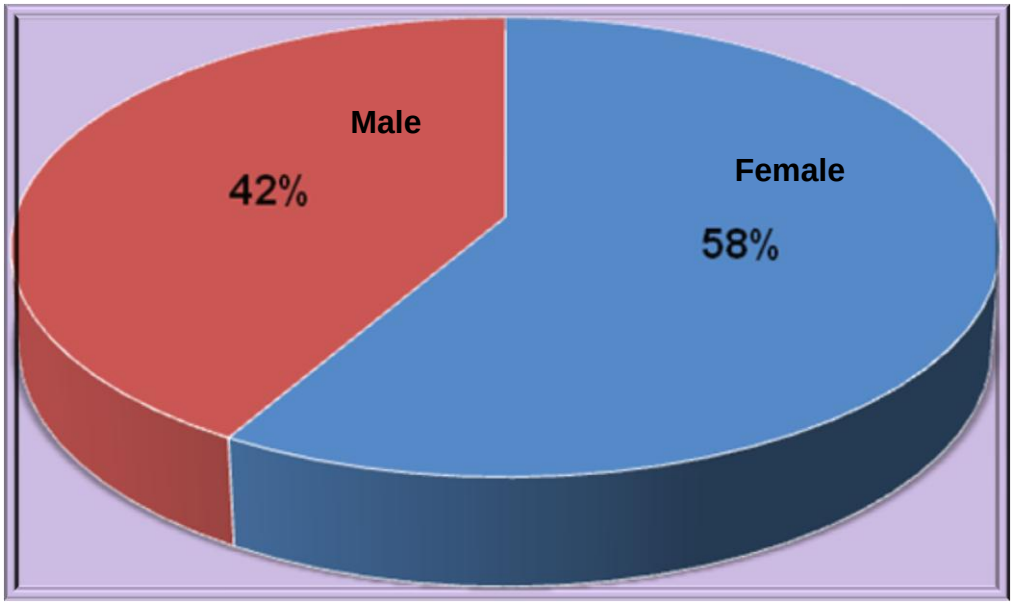


Figure 5.1: Respondents' gender

According to Figure 5.2, most of the respondents were Business Functions within administrative level of the organisations. These individuals are seating at 29.2% whilst 20.8% of the respondents are middle management. 16.7% of the respondents are at Supervisory levels. The remaining 33% of the respondents are in between the Executive, Junior Management and General Working levels.

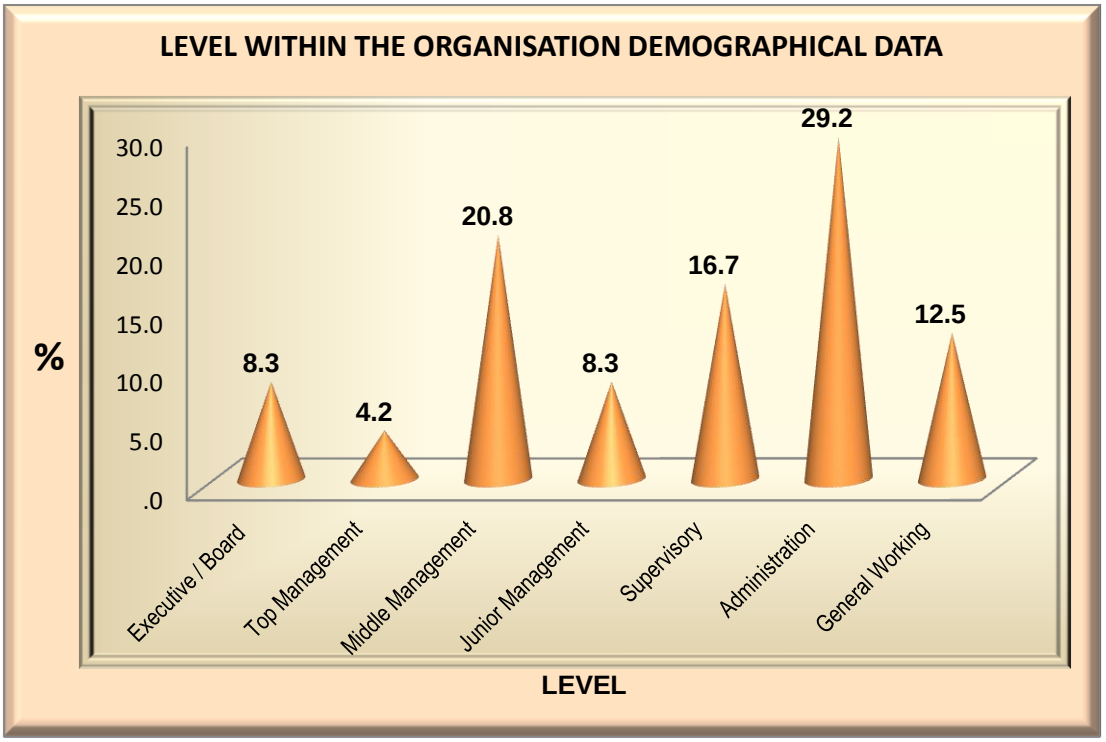


Figure 5.2: Level within the organisation

Figure 5.3 shows that the greater percentage of the respondents has been employed in their current position for between 2 to 5 years. These Business Functions amount to 42%, whilst the secondary group are individuals that have been in their current position less than 2 years. Approximately 29% of the respondents have been working for Cape Pak (Pty) for between 5 to 15 years.

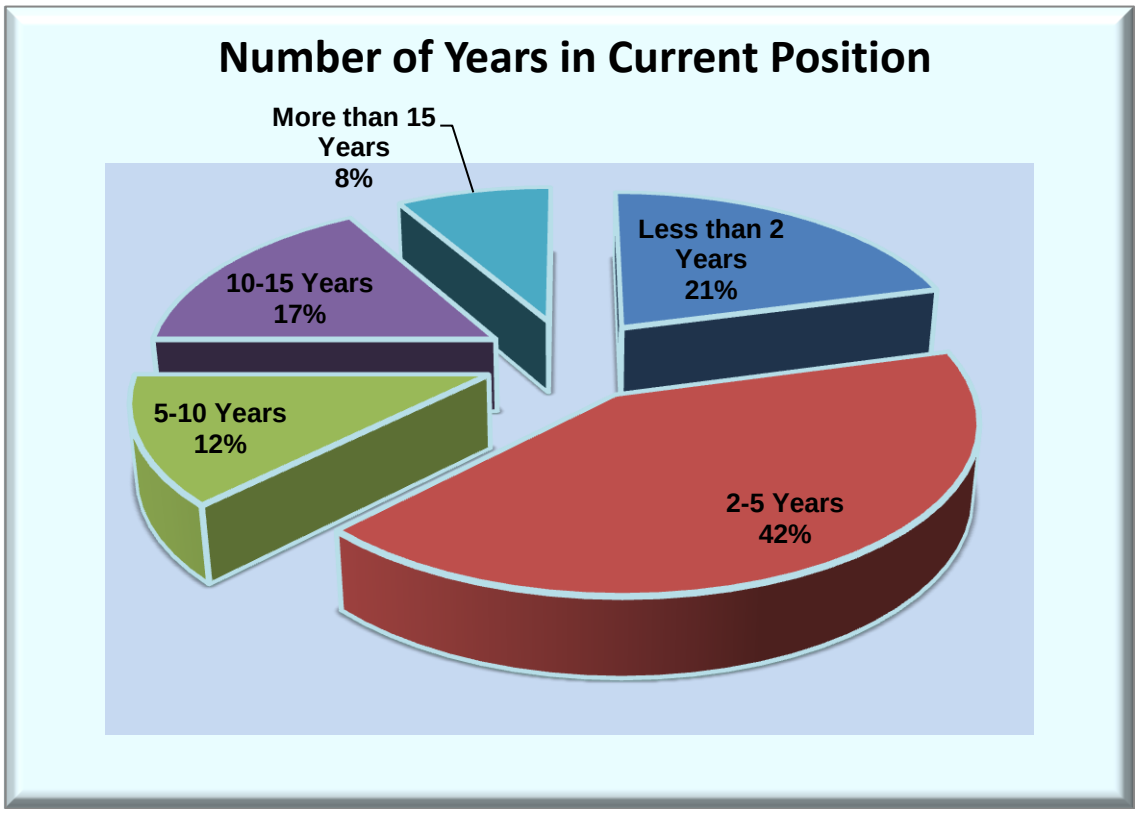


Figure 5.3: Number of years in current position

According to Figure 5.4, up to 79% of the respondents have between 10 to more than 15 years working experience, whilst 21% of the respondents have between less than 2 years to 10 years' experience only.

Figure 5.4: Work experience in years

As shown in Figure 5.5, the survey demonstrated that the majority of the NPD team of Cape Pak (Pty) are people with secondary education. These individuals amount to 42% of the entire team. 25% of the NPD team hold a Bachelor's degree whilst 29% of these individuals have College Certificate, National Diploma, Doctorate or another level of qualification.

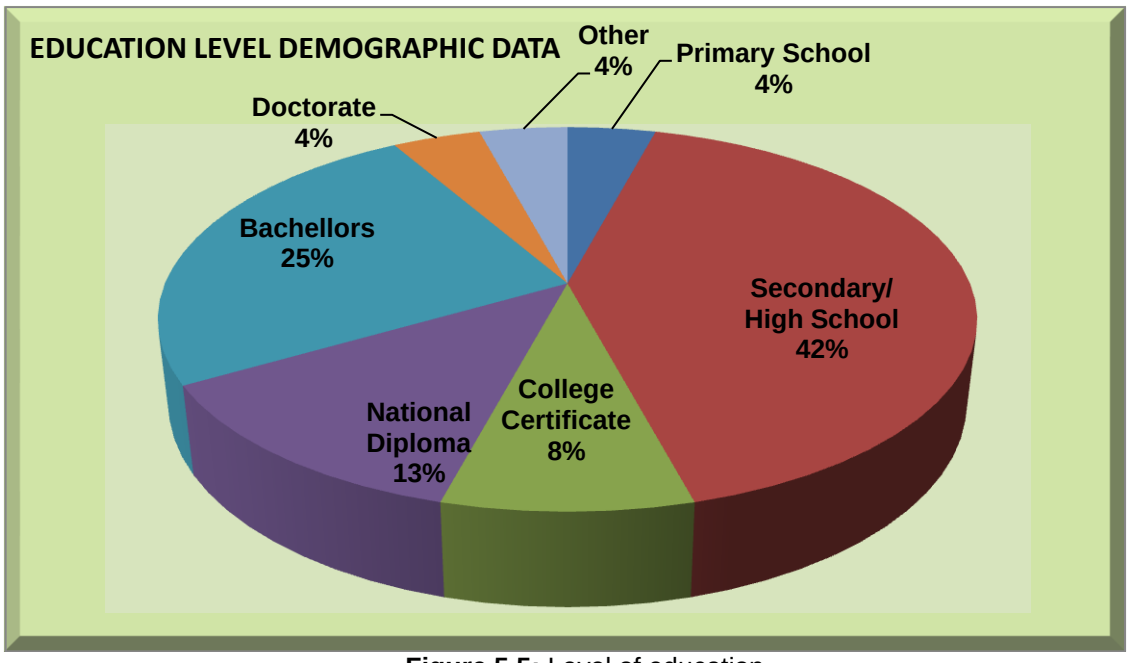


Figure 5.5: Level of education

Table 5.5 shows a comparison between data received for years in current position and work experience of the targeted group, people who have direct input into the NPD process of Cape Park (Pty).

Table 5.5: Comparison between years in work experience and in current position

NO.	YEARS IN CURRENT POSITION	WORK EXPERIENCE
1.	10 people are in current position between 2-5 years.	9 people have more than 15 years experience
2.	10 people are in current position between 5-10 years.	10 people have 10-15 years work experience
3.	5 people have been in current position less than 2 years.	3 people have less than 2 years work experience

5.6.8 Results regarding the impact of work position on NPD and quality

The results regarding the impact of work position on NPD and quality process are shown in Table 5.7, as respondents were asked the following questions from the questionnaire:

- How does your position have an impact in the NPD process?
- How does your position have an impact in the Quality Process?

Table 5.6: Responses regarding impact of work position on NPD and quality process

RES	RESPONSES TO NPD related question	RESPONSES TO Quality related question
1	No response	No response
2	Strategic Assessment, type of product to be developed, resource availability	Aligning business capability with customer and strategic requirements
4	I need to process the works order before the bags can be manufactured	Documentation I send through should be accurate so that the finish product is according to the customer specification.
6	I have to enter an accurate Bill of Material into our Production system once the product is manufactured to calculate an accurate cost of goods	No response
7	I do have a big impact, to make sure the product that they are making is the correct, and that the correct product is developed according to the customer needs.	To ensure before the customer gets its products that all the necessary quality checks has been done
8	People produce quality products and services I assist the organisation to find, develop and	Our function ensures a quality process with documentation to ensure there are no problems

RES	RESPONSES TO NPD related question	RESPONSES TO Quality related question
	retain high performing individuals who can deliver our short and long term requirements.	or penalties with customs
9	There is a big impact because if the customer approves the product design, quality, etc, the product specifications must be documented into the utilisation model for future planning purposes.	Our function is very critical because it triggers purchasing to buy raw material on time so that quality team can perform incoming inspection also on time, in that way we avoid using quality unapproved material in production which can have a negative impact to the end customer.
11	New material arriving	Raw material inspection notification
12	Feedback form market re requirements / product performance	Feedback from market re requirements/ product performance
13	I arrange the shipping / dispatch of the product to the customer's and ensures that it gets delivered on time and in full	When the product gets shipped, cargo needs to securely pack and ship and needs to arrive intact – no damages to the product.
14	None	None
15	After the NPD Process is complete and order is place production will then start to run the product.	Everything in production has an impact on the quality process.
16	I do NPD Samples	Quality Control
17	To ensure that the customer is satisfied with the product, quality and purpose	To ensure that the final product is according to finish product specifications.
17	I need to ensure that the product that is needed by NPD is purchased correctly. I also need to ensure that all raw materials that are required by NPD to produce are issued. I also need to ensure that the finish product is despatched.	I need to ensure that Quality is given fare notice of raw materials arriving on our premises for incoming purposes. I need to ensure that whatever raw materials are issued to the factory, that it has been quality inspected and in a clean condition. I need to ensure that if any raw material that are going to be used outside of our normal BOM that a deviation is issued to quality for record purposes. I need to ensure that all deviations and CARs are

RES	RESPONSES TO NPD related question	RESPONSES TO Quality related question
		closed out.
18	My position does not currently have an impact on NPD. I think that there is however an opportunity for all to identify certain needs / application in our market or for our products and if it may happen that a graduate trainee may see such a new opportunity, there is a chance that the graduate trainee could trigger a new development within the NPD Process.	Again, as mentioned in the previous answer, a graduate trainee may identify certain new opportunities with regards to quality, and in this manner influence the quality process.
19	It is my job to constantly challenge NPD on new commodities that will benefit our industry without a negative impact on the quality of our product.	Same as in the first question.
20	Member of executive committee to define NPD strategy and ensure that it communicated to Stakeholders. Setting project priorities and objectives, authorising project expense, ensuring suitably qualified resources are made available. Ensure team is held accountable to cost, project objectives, deadlines and KPI's etc.	Ensure quality related decisions are upheld and supported by team. Hold quality team accountable for effective systemic development, implementation and regular audits are undertaken to ensure compliance leading to improved standards.
21	To ensure that if a product was produced by the NPD department my team and I have to ensure that the details of the product have to be followed and manufactured.	To ensure that all quality related issues is met example: COA, First-off, rejecting of contaminated raw material etc.
22	I meet with customers and communicate their expectations	No response

Based on the results, most of the respondents knew their impact in the NPD and quality processes. However, there were four instances where there was no response to either question 6 or question 7. This might be an indication that respondents are not clear about the following:

- If their inputs are valuable in either NPD or quality process.
- How their inputs are utilised in either NPD or quality process.
- What the NPD or quality processes are about within the company.

Questionnaire Part 2 data analysis might be able to reveal the origin of this problem.

5.7 RATING SCALE INTERPRETATION

Data was interpreted based on the sum of highest scales between agree to strongly agree (i.e. agree percentage added to the strongly agree percentage). It was then taken down to neither agree nor disagree and then to disagree to strongly disagree. Finally, research statements were grouped according to their uniformity and uniqueness. This means that the data interpretation was performed in a group of statements and not necessarily individual statements. Figure 5.6 below is an illustration of the Likert scale results.

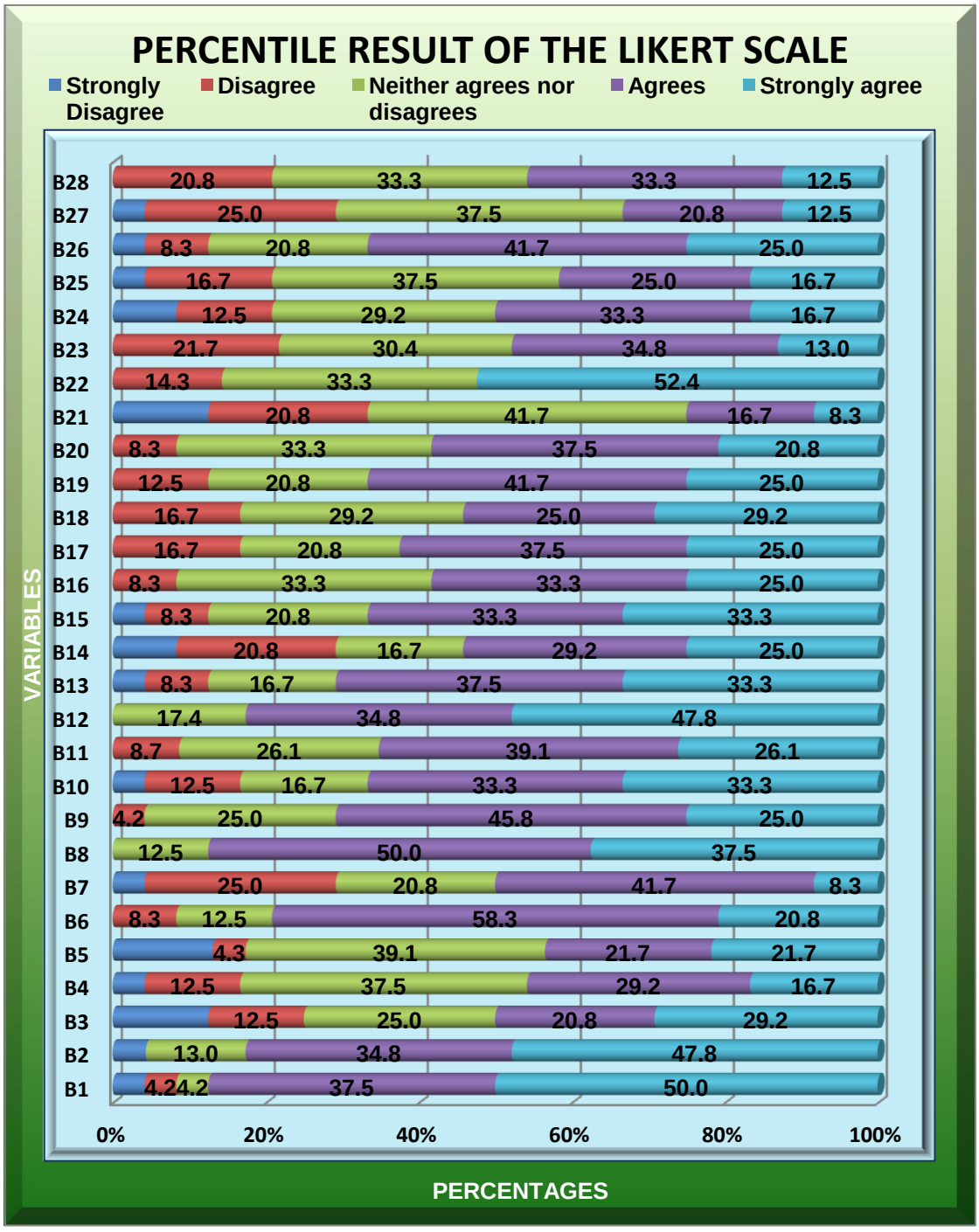


Figure 5.6: Results of the Likert Scale

5.7.1 Management Role

87.5% of respondents agree to strongly agree that Management plays a major role in setting the climate for important innovative NPD programmes (**B1**).

Likewise, 82.6% of the same scale is in favour of the statement: "Management's interest, commitment and support are the most significant keys of success of NPD process" (**B2**).

5.7.2 Quality and NPD Strategies

50% of the respondents agree to strongly agree that a quality strategy for NPD process is in place at Cape Pak (Pty,) whereas 25% of the respondents could not agree nor disagree (**B3**).

As well, 45.9% of the respondents agreed to strongly agree that Cape Pak (Pty) has a clear NPD strategy defined by management, whilst 37.5% could not agree nor disagree with this statement (**B4**).

It is also noted that 43.4% of the respondents agreed to strongly agree that the NPD strategy was not only defined by management but was also well-communicated to all concerned, whereas 39.1% could neither agree nor disagree (**B5**).

5.7.3 NPD Risk Management

A total of 79.1% respondents agree to strongly agree that the NPD process is indeed a risky process and that Cape Pak (Pty) recognises this as one of the key factors in its NPD process (**B6**).

Exactly 50% of the respondents agree to strongly agree that the company plans and organises its NPD process carefully in order to reduce risk. 20.8% could neither agree nor disagree whilst 25% disagreed (**B7**).

5.7.4 Customer Focus

*87.5% respondents agree to strongly agree that customer voice is well recognised as one of the key factors in Cape Pak (Pty)'s NPD process (**B8**).*

*70.8% agree to strongly agree that customer keenness to buy Cape Pak (Pty)'s products were seriously considered during the company's NPD process, whilst 25% could not agree nor disagree (**B9**).*

*Only 66.6% of respondents agree to strongly agree that they had a good understanding of customer requirements on particular products to be developed. 16.7% could not agree nor disagree, whilst only 12.5% disagreed (**B10**).*

*65.2% agree to strongly agree that customer requirements, uniqueness, reliability and durability, as the main aspects of quality strategy, are well conformed in Cape Pak (Pty)'s NPD process. However, 26% of the respondents could not agree nor disagree (**B11**).*

5.7.5 Globalisation

*82.6% respondents agree to strongly agree that globalisation gives Cape Pak (Pty) pressure on prices, smaller orders, short life cycles, more suppliers and governmental regulations. Only 17.4% of the respondents could neither agree nor disagree (**B12**).*

5.7.6 Competitiveness

*70.8% of the respondents agree to strongly agree that Cape Pak (Pty)'s business competitiveness is improved by the NPD process. However, 16.7% could neither agree nor disagree (**B13**).*

5.7.7 Innovation and continuous Improvement

Only 54.2% of the respondents agree to strongly agree that continuous improvement (B14-B16) has been adopted to improve the quality of Cape Pak

*(Pty)'s NPD process. 20.8% of the respondents disagree with this statement (**B14**).*

*Furthermore, 66.6% of respondents are of the opinion that innovation is recognised as one of the key success factors for Cape Pak (Pty)'s NPD process, whilst 20.8% neither agreed nor disagreed to the statement (**B15**).*

*58.3% of respondents agree to strongly agree that best practices are used to promote greater success in developing and launching new products at Cape Pak (Pty), whereas 33.3% could neither agree nor disagree with this statement (**B16**).*

5.7.8 NPD Competence

*62.5% respondents agree to strongly agree that Cape Pak (Pty) has adequate knowledge and skills to generate a suitable product solution in the time-competitive environment; however, 20.8% neither agree nor disagree (**B17**).*

*Correspondingly, 54.4% of the respondents agree to disagree that Cape Pak (Pty) has sufficient knowledge of product technology and market forces; however, 29.2% could neither agree nor disagree (**B18**).*

*66.7% agree to strongly agree that management has necessary skills for marketing, technical, resources, and company competitiveness, whilst 20.8% could neither agree nor disagree (**B19**).*

*58.3% agree to strongly agree that NPD team members of Cape Pak (Pty) have sufficient technological competence (skills, knowledge, and work experience), whilst 33.3% could neither agree nor disagree (**B20**).*

*Only 25% of respondents agree to strongly agree that management provides necessary training programmes to NPD team members; 41.7% could neither agree nor disagree and 20.8% disagreed with this statement (**B21**).*

5.7.9 Multidisciplinary Efforts

*52.4% of respondents agree to strongly agree that Cape Pak (Pty)'s NPD process has diverse inputs on the integration of a variety of specialised capabilities and strong interdisciplinary business functions; however, 33.3% neither agree nor disagree (**B22**).*

*In addition, only 47.8% of respondents agree to strongly agree that R&D, production and purchasing functions are in place to ensure the success of NPD process, whilst 21.7% of respondents disagreed with this statement (**B23**).*

5.7.10 Quality Determinants

*50% of the respondents agree to disagree that design review, verifications and validations were performed throughout the NPD process to ensure the quality of new product. However, 29.2% could neither agree nor disagree whilst only 12.5% disagreed (**B24**).*

*Furthermore, only 41.7% of respondents agree to strongly agree that quality control is performed in each stage of the NPD process, whilst 37.5% could not agree or disagree (**B25**).*

*66.7% respondents agree to strongly agree that quality management is in place to ensure the quality of products and integration of NPD process; however, 20.8% could not agree nor disagree (**B26**).*

5.7.11 NPD Speed

*33.3% of the respondents agree to strongly agree that product development time is shortened since Cape Pak (Pty) concurrently followed a structured NPD process; however, 37.5% of respondents could neither agree nor disagree, whilst 25% disagreed with this statement (**B27**).*

Correspondingly, 45.8% of the respondents agree to strongly agree that shortening product life cycles increasingly pressurise Cape Pak (Pty) to reduce its NPD time and cost in order to maintain product quality; however, 33.3% of

*the respondents could not neither agree nor disagree, whilst 20.8% respondents disagreed with this statement **(B28)**.*

5.8 FINDINGS AND DISCUSSION

Below are the findings and discussion around interpreted data.

5.8.1 Demographic Data

Through data analysis and interpretation, it was observed that there is sufficient representation of Cape Pak (Pty) management in this organisation's NPD process. In total, ten people that impact the NPD process are managers (two are at executive level and eight ranged from top, middle and junior management level).

The other important aspect that data revealed was the reality that about 50% of the NPD team are people with 2-5 years in their current positions; however, work-experience wise, Cape Pak (Pty) is armed with NPD team members that have between 10 and over 15 years work experience. It was also discovered that whilst the NPD team have many years of work experience, most of the people impacting this process are people who have only attained high school or secondary school education. These people amounted close to 50% in statistics.

One of the findings from data analysis was that some respondents did not respond to how their positions impact on the NPD and/or quality processes of Cape Pak (Pty). This could be a warning sign that some members of the NPD team do not know how their input impacts the NPD or quality processes. This finding was backed by the many instances in rating scale data analysis where respondents could not rate statements accordingly (i.e. take a stand); they mostly rated "neither agree nor disagree". Only 50% of respondents agree that NPD is a multidisciplinary process. Close to 30% of the people could not appropriately rate statements related to multidisciplinary team efforts.

5.8.2 Management Commitment and Strategy

On average, 84% of the Cape Pak (Pty) NPD team agree to strongly agree that management plays a major role in setting the climate for important innovative NPD programmes in the organisation and that management's interest, commitment and support are the most significant keys for success of the NPD process. It also appears that on average, 33.3% of the members of the NPD team could not agree nor disagree that management had implemented or defined and communicated both the NPD and quality strategies. On average, about 45% of the respondents agree to recognising these strategies, and 25% were in disagreement that these strategies are in place.

5.8.3 Training Skills and Resources

On statement 21 reading, "Management provides necessary training programmes to NPD team members", 33.3% respondents disagreed whilst 41.7% were undecided. The question remains: does Cape Pak (Pty) management provide necessary competence to the NPD team members? In an attempt to answer this question, only 50% of the respondents agree that Cape Pak (Pty) has adequate knowledge skills to generate a suitable product solution in the time-competitive environment, 29.2% were in disagreement, whilst 20.8% could not take a stand.

Nonetheless, 87.5% respondents agree to strongly agree that Cape Pak (Pty) have sufficient competence where product technology is concerned. 67.7% respondents agree to strongly agree that management has necessary skills for marketing, technical, resources, and company competitiveness to ensure the success of NPD process, whilst 58.3% agree that NPD team members have sufficient NPD technological competence (skills, knowledge, and work experience). These results are a bit disconcerting when compared to the 41.7% of respondents who could not rate either agree or disagree, and the 33.3% in disagreement with the statement about management providing necessary training programmes to NPD team members.

5.8.4 Risk Management

79.1% of the respondents agree that NPD process is truly a risky process; however, 29.2% of these respondents disagreed and are of the opinion that as risky as NPD process might be, the organisation does not plan this process properly. It was encouraging, however, that on average (i.e. 71.7%) the respondents agree to strongly agree that customer voice plays a huge role in Cape Pak (Pty)'s NPD process.

5.8.5 Globalisation, Competitiveness and Innovation

It was reassuring that on average about 80% of the respondents recognised that globalisation increasingly gives Cape Pak (Pty) pressure on prices, smaller orders, short life cycles, adding more suppliers and governmental regulations, and that this organisation's business competitiveness is improved by the NPD process. However, it appears that there is no much recognition of the relationship between the NPD process and innovation, as on average, only 59.7% of respondents agree to strongly agree on innovation statements.

5.8.6 NPD Quality Management

About 66.7% of respondents agree that there is a quality management in place at Cape Pak (Pty). This could be as a result of ISO9001 that this organisation has been certified on for more than 10 years; consequently, respondents knew that ISO9001 certification means that there is a Quality Management System within the organisation. Having noted this, only 50% respondents agree that there is quality control happening at each stage of the NPD process. 20.8% are in disagreement whilst 29.2% of respondents could not take a stand. Also, where NPD process reviews, verifications and validations are concerned, only 41.7% agree to these quality determinants implemented at Cape Pak (Pty), 37.5% of the respondents were undecided, whilst 20.9% disagreed that these quality determinants happen in Cape Pak (Pty)'s NPD process.

5.8.7 NPD Speed (Time-to-Market)

It seems as if the respondents did not know that NPD speed is imperative for boosting the competitiveness of the organisation as about 70.8% of the respondents rated 'neither agree nor disagree' on the last two statements of the rating scale that dealt with NPD speed, whilst 58% of the respondents disagree with these last two statements.

5.9 CONCLUSION

Chapter 5 dealt with collected data analysis and interpretation. The data validity and reliability were tested and data was tidied up in a form of frequency tables and graphs. Data was measured using nominal and interval scales where descriptive statistics were used to determine data frequencies and descriptives. Subsequent to analysis, data were interpreted and conclusions drawn.

CHAPTER 6: CONCLUSION AND RECOMENDATIONS

6.1 INTRODUCTION

The main focus of this chapter was to answer the research question posed in Chapter 1. The answer to the research question is centred on both the qualitative and quantitative study outcome that was achieved from research interview participants, including demographical and rating scale responses. Moreover, some of the information used to conclude and make recommendations from the research was attained from reviewed literature, where different authors' relevant opinions were taken into consideration with the intention of adding value to this current research. Correspondingly, Chapter 6 tests statistics as investigative questions are answered with reference to the research outcomes. This chapter is inclusive of the contribution of the dissertation to Cape Pak (Pty), the main limitations & solutions of the study, important research contributions of the dissertation, the implications of the study and finally, the research conclusion.

6.2 RESEARCH QUESTION CONCLUSIONS AND STATISTIC TESTING

These conclusions were established from the research investigative questions that were posed in the first chapter as follows:

- What are the key factors that impact the NPD process?
- What are the main quality determinants in NPD process?
- What are the basic requirements of effective quality management into NPD process?
- What are the benefits of an effective quality management into an NPD process?
- Which universal effective quality management approach can be used to manage an NPD process?

6.2.1 Conclusions related to the role of management

For all tried and tested business improvement initiatives (i.e. international management system standards, excellence models, lean manufacturing practices for example etc) success depends in large part on top management commitment. The research revealed that management plays a major role in setting the climate for important innovative NPD programmes. It was well demonstrated that the majority of respondents believed that management's interest, commitment and support are the most significant keys to NPD process success.

6.2.2 Conclusions related to Business Strategy around NPD and Quality

Business strategies are determined and implemented as direction to company future, including efficient business management. This is one of the reasons why the NPD and quality strategies form a crucial role in improving the NPD process of any manufacturing business. Consequently, the study suggests that management should implement quality and NPD strategies to better manage, monitor and measure the effectiveness of the NPD process.

6.2.3 Conclusions based on NPD Process Risk Management

It is an undisputable fact that NPD makes a critical contribution to the success of manufacturing organisations; however, the development of new products continues to be a risky venture (Bradfield, Gao, & Soltan, 2007:519). This demonstrates that, NPD is indeed a high risk process. It is therefore imperative that the organisation implement control methods to assess the risk impact of each NPD project. In addition, identified risks should be reviewed or re-assessed regularly whilst the project is in progress.

6.2.4 Conclusions based on Customer Focus

The problem statement of this research was identified as follows: "Lack of effective approach to quality management practices in NPD process result in poor product quality and customer dissatisfaction". In an attempt to resolve this problem, the study revealed that Cape Pak (Pty) customers are indeed not

entirely satisfied with the quality of NPD products. Correspondingly, the study demonstrated that business sustainability or continuity is highly dependent on how well customers perceive quality of their suppliers. Customer perception of the company, in fact, determines customer loyalty and satisfaction.

6.2.5 Conclusions that are based on Globalisation

According to the research data, globalisation directly affects the company's competitiveness as there are many aspects which an organisation competing internationally should consider, and strategies must be put in place to manage such aspects. In NPD environment, these aspects include the following:

- prices;
- smaller orders;
- short product life cycles;
- more suppliers; and most importantly
- well-monitored statutory and/or regulatory requirements.

6.2.6 Conclusions that are based on NPD Competitiveness

Competition strikes each company in a very tough manner. Nowadays, business sustainability and continuity requires not just hard work, but excellence. This is why companies must constantly focus on being the 'first' to research and develop unique products or solutions, and be the 'first' to market and sell such innovative products.

6.2.7 Conclusions that are based on Innovation and Continuous Improvement

Tying up with conclusions based on globalisation and competitiveness, this study had demonstrated that, innovation does not have to focus on designing and developing 'new' products only, but occasionally innovation should also be directed to improve 'what we already have'. Innovation needs to be an acceptable culture within the organisation where each business function is stimulated and even encouraged to suggest improvement initiatives. To encourage commitment, thereby making innovation process 'alive' and enjoyable, management should furthermore determine ways of incentivising champions of such improvement, showing appreciation of such ideas for

improvement whilst encouraging a never-ending chain of innovations, competitiveness and excellence.

6.2.8 Conclusions that are based on NPD Competence

Successful companies ensure that competence (i.e. knowledge, skills and behaviour) is continually assessed in order to retain an empowered work force which does things right the first time. Such approach facilitates the elimination of wasteful activities within the company. The scenario is parallel for Cape Pak (Pty). For this company to harvest ripe fruits from its NPD process, it has to make resources available for attaining NPD-related competence by provision of appropriate training.

6.2.9 Conclusions that are based on NPD Multidisciplinary Efforts

Subsequently, due to its multifaceted activities, a successful NPD process is made possible by diverse business functions within the organisation. The study demonstrated that each of these business functions is equally important in the realisation of the NPD process. Furthermore, the study also suggests that ineffective communication or ignorance within the NPD team results in poor quality products or services rendered. An empowered NPD multidisciplinary team brings about ‘change’ in this process by continually sharing fresh innovative ideas as well as vibrant synergy amongst team members.

6.2.10 Conclusions that are based on NPD Quality Determinants

In resolving customer satisfaction issues as identified in the research problem statement, companies should warrant superior quality of NPD products and realise excellent services provision. Based on the research outcome, it is apparent then that, the main elements of determining quality of the NPD process include NPD reviews, NPD verification and validation. The above monitoring and measurement of NPD unfortunately does not occur in a resourceful manner at Cape Pak (Pty) and this could be the cause of delayed NPD process and the inferior quality of NPD products.

6.2.11 Conclusions that are based on NPD Speed

In today's market, global competition exerts pressure, thereby forcing companies to decrease the shelf life of products. A problem such as this is attributable to technological innovations introduced into the market on daily basis. Frequently and constantly, new and superior products are introduced to the market. In view of that, a delayed NPD process makes it tough for the company to compete in the fast and prompt global market.

6.3 GENERAL CONCLUSIONS AND RECOMMENDATIONS

6.3.1 Conclusions

Although NPD is a risky and costly process, the research findings revealed that when an NPD process is structurally managed, it becomes an advanced process that would provide any company with competitive edge over its competitors. Some aspects that the research identified as key factors of NPD process success included leadership commitment, customer focus, globalisation and innovation. Additionally, the main quality determinants of the NPD process were identified as NPD reviews, verifications and validations. Correspondingly, for the NPD process to be successful, companies should focus on increasing proficiencies for realising the basic requirements of effective quality management into the NPD process. These requirements range, but are not limited to, the development of the NPD strategy, availability of skills and resources including NPD competence, product quality, empowered multidisciplinary teams and effective risk management.

The research comprehensively expressed the benefits of an effective quality management in an NPD process as the following: a successful and structured NPD process, NPD speed, and most importantly, competitive advantage. According to both the qualitative and quantitative results, all the positive aspects of the NPD process were noted. Management of the company under investigation should address the following NPD process areas for improvement:

- customer dissatisfaction;
- NPD speed and quality;

- problems experienced by customers around the NPD process (what makes matters worse are delays around solving NPD related customer complaints);
- NPD as a multifaceted process (it is not 'formally' realised by a multidisciplinary team. Management need to officially establish and train the NPD team where appropriate NPD performance indicators would be communicated, and performance measured against each NPD team member);
- documented systems for managing the NPD process.
- a system for directing the NPD process steps and the accountability thereof (no system appears to be in place);
- product and technological knowledge in the 'heads' of only a few individuals;
- proper product testing facilities, as without this, quality determinants (i.e. NPD verifications and validations) as explained in this research are not entirely performed;
- insufficient and improper product testing competence;
- communication improvement, including proper handover of new products for a commercial run;
- improved proper NPD process planning;
- lack of necessary and appropriate training programmes to the NPD team members as provided by management; and
- risks of the NPD process which should be continuously assessed to guide improvement initiatives.

6.3.2 Recommendations

Based on the research findings, the recommendations of this research should focus on the areas of customer dissatisfaction, product quality, and prototype planning within the company.

Customer Dissatisfaction

In response to the acknowledged customer dissatisfaction problem, the study suggests that product requirements should be understood 100% by both the supplier and the customer. There should be effective communication between the supplier and customers. Cape Pak (Pty) management should focus on developing mutually beneficial suppliers – to this end, customer Service Level Agreements could be reviewed and improved by both parties on a quarterly basis, for instance. Similarly, Cape Pak (Pty) management should focus on monitoring and measuring customer satisfaction. Management should be responding promptly and actively to customer concerns. This means that various business functions that participate in the NPD process should be held accountable for delivering NPD process expectations.

Product Quality

The study suggests that an appropriate product testing facility be investigated and implemented, and that training be provided to all key and relevant personnel (e.g. quality controllers).

Prototypes Planning

The NPD process should not be isolated from the entire business management system. NPD prototypes should be planned traditionally just like any other product planning within the organisation. Central planning of the NPD prototypes will ensure that there are sufficient raw materials, manufacturing capacities and people requirements.

6.4 IMPLICATIONS OF THE RESEARCH STUDY

6.4.1 NPD Gate Control System

This study provides a valuable suggestion that the company should establish a NPD gate control system in order to manage quality of its NPD process more effectively and more importantly, amongst other ideas, the qualitative study (i.e. the focus group interview recommendations) outcome suggested that Cape

Pak (Pty)'s Quality and NPD function should establish a user-friendly and practical NPD gate control system so that the NPD process can progress to the next stage *only* when there is approval from the previous stage. Correspondingly, with the intention of fulfilling a research objective that entailed "identifying a universal approach that could be used to effectively manage quality of a NPD process", the study recommends that an NPD gate control system such as the stage– gate approach be implemented. This approach has been acknowledged as one of the successful and reproducible way of structuring the NPD process (Mazur, 2010:7). Mazur explains that the stage-gate is now extensively used both as a customer-tailored approach, and in the more generic phase-gate approach, by organisations endeavouring self-improvement. According to Mazur (2012:8), Cooper (i.e. the originator of the stage-gate model) delineated eight factors that make a stage-gate process successful:

- quality process;
- manages risk with stage-gates decisions;
- gates are central to weeding out bad projects, assuring homework is done, and setting up the remaining stages;
- parallel activities improve speed to market;
- cross-functional team with authority;
- market-driven and customer-focused;
- pre-development homework; and
- superior differentiation and customer value.

Amongst models studied in this research, literature revealed that the stage-gate model has been, for decades now, a globally acknowledged and practiced model. To manage product development successfully, managers are recommended to use stepwise approaches such as stage-gate processes (Harmancioglu *et al.,* 2007: 400). Furthermore, Griffin (1997: 429) found that more than half of the respondents use a cross-functional stage-gate process for NPD, and this proved to work in such organisations. The study also suggests that Cape Pak (Pty)'s NPD process documentation be determined and implemented based on the NPD stage-gate model.

6.4.2 Implementing the stage-gate approach

According to Cooper (1996: 480), in the stage-gate approach, a task force (i.e. the multidisciplinary NPD team) should be assigned actions appropriate to their business functions as follows:

- a process audit to identify strengths and weaknesses of the current process;
- a retrospective analysis of past new product projects, again seeking areas needing improvement;
- benchmarking other companies and their processes;
- a review of the literature;
- establishing specifications and requirements for the new process;
- the design of a skeleton of the process;
- seeking feedback from potential users in the company;
- the detailed design of the process, spelling out stages, activities, gates, deliverables, criteria, methods, and procedures (with constant feedback from in-company users); and
- the design of a roll-out plan.

6.4.3 Contribution of the Dissertation to Cape Pak (Pty)

This is a comprehensive research report prepared purely by Cape Pak (Pty) personnel for Cape Pak (Pty). Due to the anonymity, confidentiality and ethical principles applied during the research process, the information contained in this document is uncontaminated; research integrity was maintained throughout the entire research process. The majority of the dissertation (especially Chapters 4 and 5) came directly from the employees of the company in just about all departments that have direct input to the NPD process. The participants willingly identified the strengths of the Cape Pak (Pty) NPD process; as a result, this is clearly an area where shareholders and management should focus on innovation with the intention of driving business excellence.

Having highlighted this, the respondents also identified areas for improvement (i.e. weaknesses or threats) that Cape Pak (Pty) appeared to be facing at the

time of this research. An example of this would be a lack of training. Referring to data analysis, it was evident that respondents did not perceive that Cape Pak (Pty) was providing sufficient training to its employees; thus, o*n statement 21 of the questionnaire that read, "Management provides necessary training programmes to NPD team members", 33.3% respondents disagreed whilst 41.7% were undecided.* According to these results, 75% of the sample size could not agree that Cape Pak (Pty) provides training. This was also highlighted during in-depth interview sessions where one of the participants admitted: *"I feel like, due to lack of proper product test equipment, there is a competency related risk that should be assessed by our company. This risk is related to the lack of test equipment, the fact that once these resources are available, there needs to be a training programme and competency assessments of relevant personnel, such as quality controllers including the development of testing methods and quality control plans for product verification and validation subsequent to product delivery to the customer"* (PAR3).

In light of this finding, according to Ebrahim *et al.* (2009:211), the reassurance is that specialised skills and talents required for the development of new products are often available within an organisation. One of the research participants had identified that *"due to the reality that 'Product Knowledge' is seating with very few personnel within the business", it makes it very difficult for these individuals to be efficient in their everyday activities but besides that, it puts the company at a very high risk because, should those individuals be 'out of scene' whether by choice or by natural causes, it would be very difficult for the company to continue and be sustainable"* (PAR5). These identified risks highlight that training is a major input to competence as competent personnel reduce mistakes that can lead to customer dissatisfaction.

From this, the researcher suggests that Cape Pak (Pty) management thoroughly review all challenges identified through the research in order to claim a bigger fraction of the market share. Last but not least, the research report will help Cape Pak (Pty) and related companies (e.g. its suppliers), learn from specific programmes and processes that are functional, enabling strategies to develop manufacturing frameworks appropriate for enhanced

quality and advancement in the design and delivery of new and existing products.

6.4.4 Main Limitations & Solution of the Study

Although the nature of the research (i.e. quality management correlated to NPD process) is essential and favourable for most industries that manufacture products, for all evident reasons this research was limited solely to Cape Pak (Pty), a packaging and load securing company. It is apparent that this is an area that calls for advanced research. Future research is therefore proposed for the benefit of various manufacturing industries.

6.4.5 Important Research Contributions of the Dissertation

The most important research contributions of this research are the following:

- This research provides a timely and critical view of quality management in NPD process for the manufacturing industry. This view is fundamental for the building of a strong manufacturing system within any company that engages in NPD process.
- This research is inclusive of comprehensive information related to numerous models that any company involved in NPD process can practise with the intention of quality management of their NPD process.
- The research outcome could be applied and successfully implemented in *any* manufacturing company no matter the size or location, as problems related to product quality and reliability make business complex for companies involved in product improvements and developments. It is difficult to ensure that the processes are efficient, minimising waste and reducing recalls.
- The academia fraternity of scholars internationally will benefit from valuable information related to the advantages of quality management correlated to the NPD process and thereby activate future research in this area of study.

- Accordingly, this research report will serve as valuable reference material for subsequent studies on related subject areas.

6.5 CONCLUSION

In this chapter, research outcomes were discussed where findings are explained based on both the qualitative and quantitative studies. The research problem, questions and objectives were revisited and conclusions drawn from the study. Recommendations and implications of the research study were successfully provided. The NPD process is very important because it results in either the survival or the fading-out of manufacturers in the market. Whilst the product generally has its own life with respect to market share in order to ensure sustainable competitiveness, innovative, till the time when product life is over (Kumar *et al*., 2009: 71). It is therefore suggested that the recommendations of this study be considered with great seriousness and implemented in order for Cape Pak (Pty) to 'claim' a greater market share and competitive edge in the global market.

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APPENDICES

APPENDIX 1: M Tech: Quality study consent letter

Faculty of Engineering
Department of Industrial Systems & Engineering
Cape Peninsula University of Technology
P. O. Box 1906
Bellville
7535

The General Manager
Cape Pak (Pty) (Pty) Ltd
P. O. Box 45581
OTTERY
South Africa
7808

Date: 13 January 2012

MTECH: QUALITY STUDY CONSENT LETTER

Principal Investigator:	Mrs. Bongiwe Mali-Swelindawo
Co-investigator:	Dr. Bingwen Yan (Research supervisor, CPUT)
Physical Address:	Faculty of Engineering Cape Peninsula University of Technology, Bellville Campus Symphony Way, 7535

We seek permission to conduct a research for the dissertation as identified above which is being conducted by Mrs. Bongiwe Mali-Swelindawo and Dr. Bingwen Yan (research supervisor) from the Department of Industrial and Systems Engineering, in the Engineering Faculty, Cape Peninsula University of Technology. The title of the research is: “An effective quality management approach for new product development process”. The dissertation will be submitted in fulfilment of the requirements for the Master of Technology Degree in Quality by Bongiwe Mali-Swelindawo.

Purpose of the Research

The purpose of this research is to formalise and put a structure to the NPD Process by identifying key factors that impact on NPD process, the main quality determinants in NPD process, basic requirements of an effective quality management into a NPD process, benefits of an effective quality management into an NPD process and importantly, a universal approach that could be used to effectively manage quality of an NPD process.

Participants to the Proposed Research

The proposal is to conduct this research at Cape Pak (Pty) (Pty) focusing on all Business Functions that have direct or indirect inputs to the NPD process. We request that you allow us (the investigators) to contact appropriate people with the goal of exploring their experiences and perceptions on NPD process management at Cape Pak (Pty) (Pty).

Benefits of participating

The outcome of the proposed research will support Cape Pak (Pty) (Pty) in integrating quality management in this organisation's NPD process. The benefits of this are: there will be clear key performance indicators and expectations of the NPD multidisciplinary team and, the research will empower the NPD multidisciplinary team to take sound decisions where NPD process is concerned. This will result in innovative and quality products that are a major input to customer satisfaction.

Ethics

The Investigators are committed to respecting all participants' right to privacy. Confidentiality will be upheld on data collected from all participants and any Cape Pak (Pty) information used to fulfil the requirements of this research. Findings reporting integrity will be upheld by the Investigators.

APPENDIX 2: Consent form of the research project

APPENDIX 2

Cape Peninsula University of Technology

Faculty of Engineering
Department of Industrial Systems & Engineering
Cape Peninsula University of Technology
P. O. Box 1906
Bellville
7535

CONSENT FORM FOR THE RESEARCH PROJECT

"An Effective Quality Management Approach for Stopak (Pty) Ltd's New Product Development Process"

DECLARATION BY PARTICIPANT:

From: The General Manager

I proclaim that:

I am aware of the research project that will be conducted as described in CPUT's consent letter, the copy that I currently have. I am pleased to approve the research to be conducted in our organisation.

I also approve that my information may be (tick-in the box):

- Used and kept for future research studies ☐
- Used and discarded ☐

Signed at (*place*) ..... on (*date*) ..03 Feb..... 2012

Print Name: Brett Potter

Signature of participant:

STOPAK INTERNATIONAL (PTY) LTD
P.O. BOX 45581
OTTERY, 7808
TEL. 021 703 9393 FAX. 021 704 1349

APPENDIX 2

DECLARATION BY THE INVESTIGATOR

I, *Bongiwe Mali Swelindawo* declare that I explained the information in this document to *(Brett Potter; the General Manager of Stopak (Pty) Ltd)*.

I encouraged him to ask questions and took adequate time to answer them.

I am satisfied that he adequately understand all aspects of the research, as discussed above

Signed at (*place*) Otery on (*date*) 03/02/2012

Signature of Investigator: _____

Contact Information

Please do not hesitate to contact the investigator should you need more information with regards to the proposed research:

Bongiwe Mali-Swelindawo

Cell: +27 (0) 83 412 0681
Tel: +27 (0) 21 704 9316 (W)
E-mail: bongi@stopak.com

APPENDIX 3: Quantitative study research questionnaire cover letter

Bongiwe Mali-Swelindawo
Faculty of Engineering
Department of Industrial Systems & Engineering
Cape Peninsula University of Technology
P. O. Box 1906
Bellville
7535

June 2012

Dear Colleague,

Research Questionnaire:
Quality management approach for new product development process

I am currently busy with M-Tech: Quality at the Cape Peninsula University of Technology (CPUT), in the department of Mechanical Engineering. I am conducting a research project aiming at identifying an effective quality management approach for new product development process for our organisation.

New Product Development is a very risky, costly and complicated process, yet, when performed with greater care control; it becomes the ultimate solution to product quality, customer satisfaction and more importantly, the process support in efficiently competing in the global market. Identifying a universal approach to formally perform and integrate quality management in our NPD process can only benefit our organisation.

The objective of this research questionnaire is to collect data from all the Business Functions that have direct inputs to the NPD process in the form of providing answers to the questionnaire.

This questionnaire is divided into two sections, please see clarification below:

Section 1
This section is made out of individual and our organisation's Information where respondents are urged to select (✓) appropriate answers and / or answer questions.

Section 2
Section 2 is in a form of a *Likert Scale ,* here, the respondent is requested to rate statements on the basis of, 1-Strongly Disagree, 2-Disagree, 3-Neither agrees nor disagrees, 4.-Agree, 5-Strongly Agree.

Please note that, for accuracy and truthfulness of this research, respondents are asked not to focus on whether the answer is 'right' or 'wrong' but, rather focus on personal perceptions OR experiences on the given questions and / or statements.

I would like to take this opportunity and thank you for your contribution in this research project. Your involvement is much valued.

Sincerely,

Bongiwe Mali-Swelindawo
The Researcher

APPENDIX 4: Quantitative study questionnaire

SECTION 1: Individual and Company's Information

Please select an option appropriate to yourself:

1.1 Gender:

Lady	
Gentleman	

1.2 Your Level within the organisation:

Executive / Board	
Top Management	
Middle Management	
Junior Management	
Supervisory	
Administration	
General Working	

1.3 Number of Years in Current Position

Less than 2 Years	
2-5 Years	
5-10 Years	
10-15 Years	
More than 15 Years	

1.4 Work Experience in years:

Less than 2 Years	
2-5 Years	
5-10 Years	
10-15 Years	
More than 15 Years	

1.5 Level of Education:

School:	
Primary School	
Secondary/ High School	
College Certificate	
University:	
National Diploma	
Higher Diploma	
Bachelors	
Masters	
Doctorate	
Other (Please indicate)	

1.6 How does your position have an impact in the NPD Process?

_____

_____

_____

_____

_____

_____

1.7 How does your position have an impact in the Quality Process?

_____

_____

_____

_____

_____

_____

SECTION 2:

Please rate the following statements on the basis of:

1 — Strongly Disagree

2 — Disagree

3 — Neither agrees nor disagrees

4 — Agree

5 — Strongly Agree

ITEM #	STATEMENT	LIKERT SCALE				
		1	2	3	4	5
1.	Management plays a major role in setting the climate for important innovative NPD programmes in the organisation.					
2.	Management's interest, commitment and support are the most significant keys of success of our NPD process.					
3.	A quality strategy for NPD process is in place that includes customer requirements, uniqueness, reliability and durability of product.					
4.	A clear NPD strategy is defined by top management.					
5.	The NPD Strategy is communicated to the NPD team.					
6.	NPD is a risky process that is recognised by our company.					
7.	We plan and organise our NPD process carefully in order to reduce risk.					
8.	Customer's voice is well recognised as one of the key factors in our NPD process.					
9.	Customer’s keenness of buying our products is seriously considered during our NPD process.					
10.	I have a good understanding of customer requirements on a particular product to be developed.					
11.	Customer requirements, uniqueness, reliability and durability as the main aspects of quality strategy are well conformed in our NPD process.					
12.	Globalisation increasingly gives us pressures on prices, smaller orders, short life cycles, adding more suppliers and governmental regulations.					
13.	Our Business’ competitiveness is improved by our NPD process.					
14.	Continuous improvement has been adopted to improve the quality of our NPD process.					
15.	Innovation is recognised as one of the key success factors for our NPD process.					
16.	Best practices are used to promote greater success in developing and launching new					

ITEM #	STATEMENT	LIKERT SCALE				
		1	2	3	4	5
	products.					
17.	Our company has adequate knowledge skills to generate a suitable product solution in the time-competitive environment.					
18.	Our company has sufficient knowledge of product technology and market forces such as, competition, suppliers, market forces, distributors etc.					
19.	Management has necessary skills for marketing, technical, resources, and company's competitiveness to ensure the success of NPD process.					
20.	NPD team members have sufficient NPD technological competence (skills, knowledge, and work experience).					
21.	Management provides necessary training programmes to NPD team members.					
22.	Our NPD process has diverse inputs on the integration of a variety of specialised capabilities and strong interdisciplinary business functions.					
23.	R&D, production and purchasing functions are in place to ensure the success of NPD process.					
24.	Design reviews, verifications and validations were performed throughout the NPD process to ensure the quality of new product.					
25.	Quality control is performed in each stage of our NPD process					
26.	Quality management is in place to ensure the quality of products and integration of NPD process.					
27.	Product development time is shortened since we concurrently followed our structured NPD process.					
28.	Shortening product life cycles increasingly pressurise us to reduce our NPD time and cost in order to maintain product quality.					

Thank you very much for taking time to complete this questionnaire. Your input is much appreciated.

APPENDIX 5: Qualitative Study Interview Questionnaire

PARTICIPANT NUMBER: _____

INTERVIEW QUESTIONNAIRE		
No.	**In-depth Interview Questions**	**ANSWER**
1.	In your opinion and experience, what are the strengths and/opportunities for our companies NPD process?	
2.	What are the weaknesses and / or threats or Gaps in the Cape Pak (Pty) on NPD process?	
3.	How does the company manage NPD process related risks?	
Focus Group Interview Questions		
4.	What gaps in the NPD process do you normally experience?	
5.	What kind of improvement (if any) does the company need to assume in order it to bridge such gaps?	

APPENDIX 6: Frequency Table for Demographical Data

APPENDIX 6:
SPSS DATA Frequency Table for Demographical Data

Please select an option appropriate to yourself:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Lady	14	58.3	58.3	58.3
	Gentleman	10	41.7	41.7	100.0
	Total	24	100.0	100.0	

Level within the organisation

	Level within the organisation	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Executive / Board	2	8.3	8.3	8.3
	Top Management	1	4.2	4.2	12.5
	Middle Management	5	20.8	20.8	33.3
	Junior Management	2	8.3	8.3	41.7
	Supervisory	4	16.7	16.7	58.3
	Administration	7	29.2	29.2	87.5
	General Working	3	12.5	12.5	100.0
	Total	24	100.0	100.0	

Number of years in current position

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 2 Years	5	20.8	20.8	20.8
	2-5 Years	10	41.7	41.7	62.5
	5-10 Years	3	12.5	12.5	75.0
	10-15 Years	4	16.7	16.7	91.7
	More than 15 Years	2	8.3	8.3	100.0
	Total	24	100.0	100.0	

Work experience in years

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 2 Years	3	12.5	12.5	12.5
	2-5 Years	1	4.2	4.2	16.7
	5-10 Years	1	4.2	4.2	20.8
	10-15 Years	10	41.7	41.7	62.5
	More than 15 Years	9	37.5	37.5	100.0
	Total	24	100.0	100.0	

Level of Education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Primary School	1	4.2	4.2	4.2
	Secondary/High School	10	41.7	41.7	45.8
	College Certificate	2	8.3	8.3	54.2
	National Diploma	3	12.5	12.5	66.7
	Bachelors	6	25.0	25.0	91.7
	Doctorate	1	4.2	4.2	95.8
	Other	1	4.2	4.2	100.0
	Total	24	100.0	100.0	

APPENDIX 7: SPSS DATA: Frequency Table for Likert Scale Data

Management plays a major role in setting the climate for important innovative NPD programmes.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	4.2	4.2	4.2
	Disagree	1	4.2	4.2	8.3
	Neither agrees nor disagrees	1	4.2	4.2	12.5
	Agrees	9	37.5	37.5	50.0
	Strongly agree	12	50.0	50.0	100.0
	Total	24	100.0	100.0	

Management's interest, commitment and support are the most significant keys of success of our NPD process.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	4.2	4.3	4.3
	Neither agrees nor disagrees	3	12.5	13.0	17.4
	Agrees	8	33.3	34.8	52.2
	Strongly Agree	11	45.8	47.8	100.0
	Total	23	95.8	100.0	
Missing	System	1	4.2		
Total		24	100.0		

A quality strategy for NPD process is in place.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	3	12.5	12.5	12.5
	Disagree	3	12.5	12.5	25.0
	Neither agrees nor disagrees	6	25.0	25.0	50.0
	Agree	5	20.8	20.8	70.8
	Strongly agree	7	29.2	29.2	100.0
	Total	24	100.0	100.0	

A clear NPD strategy is defined by top management.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	4.2	4.2	4.2
	Disagree	3	12.5	12.5	16.7
	Neither agrees nor disagrees	9	37.5	37.5	54.2
	Agrees	7	29.2	29.2	83.3
	Strongly agree	4	16.7	16.7	100.0
	Total	24	100.0	100.0	

The NPD Strategy is communicated to the NPD team.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	3	12.5	13.0	13.0
	Disagree	1	4.2	4.3	17.4
	Neither agrees nor disagrees	9	37.5	39.1	56.5
	Agree	5	20.8	21.7	78.3
	Strongly agree	5	20.8	21.7	100.0
	Total	23	95.8	100.0	
Missing	System	1	4.2		
Total		24	100.0		

NPD is a risky process that is recognised by our company.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	2	8.3	8.3	8.3
	Neither agrees nor disagree	3	12.5	12.5	20.8
	Agree	14	58.3	58.3	79.2
	Strongly Agree	5	20.8	20.8	100.0
	Total	24	100.0	100.0	

We plan and organise our NPD process carefully in order to reduce risk.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	4.2	4.2	4.2
	Disagree	6	25.0	25.0	29.2
	Neither agree nor disagree	5	20.8	20.8	50.0
	Agree	10	41.7	41.7	91.7
	Strongly Agree	2	8.3	8.3	100.0
	Total	24	100.0	100.0	

The Customer's voice is well-recognised as one of the key factors in our NPD process.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neither agrees nor disagrees	3	12.5	12.5	12.5
	Agree	12	50.0	50.0	62.5
	Strongly agree	9	37.5	37.5	100.0
	Total	24	100.0	100.0	

Customers' keenness of buying our products is seriously considered during our NPD process.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	4.2	4.2	4.2
	Neither agrees nor disagrees	6	25.0	25.0	29.2
	Agree	11	45.8	45.8	75.0
	Strongly agree	6	25.0	25.0	100.0
	Total	24	100.0	100.0	

I have a good understanding of customer requirements on a particular product to be developed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	4.2	4.2	4.2
	Disagree	3	12.5	12.5	16.7
	Neither agrees nor disagrees	4	16.7	16.7	33.3
	Agree	8	33.3	33.3	66.7
	Strongly agree	8	33.3	33.3	100.0
	Total	24	100.0	100.0	

Customer requirements, uniqueness, reliability and durability as the main aspects of quality strategy are well conformed in our NPD process.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	2	8.3	8.7	8.7
	Neither agrees nor disagree	6	25.0	26.1	34.8
	Agree	9	37.5	39.1	73.9
	Strongly agree	6	25.0	26.1	100.0
	Total	23	95.8	100.0	
Missing	System	1	4.2		
Total		24	100.0		

Globalisation gives us pressures on prices, smaller orders, short life cycles, more suppliers and governmental regulations.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neither agrees nor disagrees	4	16.7	17.4	17.4
	Agree	8	33.3	34.8	52.2
	Strongly agree	11	45.8	47.8	100.0
	Total	23	95.8	100.0	
Missing	System	1	4.2		
Total		24	100.0		

Our Business' competitiveness is improved by our NPD process.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	4.2	4.2	4.2
	Disagree	2	8.3	8.3	12.5
	Neither agrees nor disagrees	4	16.7	16.7	29.2
	Agree	9	37.5	37.5	66.7
	Strongly agree	8	33.3	33.3	100.0
	Total	24	100.0	100.0	

Continuous improvement has been adopted to improve the quality of our NPD process.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	2	8.3	8.3	8.3
	Disagree	5	20.8	20.8	29.2
	Neither agrees nor disagrees	4	16.7	16.7	45.8
	Agree	7	29.2	29.2	75.0
	Strongly agree	6	25.0	25.0	100.0
	Total	24	100.0	100.0	

Innovation is recognised as one of the key success factors for our NPD process.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	4.2	4.2	4.2
	Disagree	2	8.3	8.3	12.5
	Neither agrees nor disagrees	5	20.8	20.8	33.3
	Agree	8	33.3	33.3	66.7
	Strongly agree	8	33.3	33.3	100.0
	Total	24	100.0	100.0	

Best practices are used to promote greater success in developing and launching new products.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	2	8.3	8.3	8.3
	Neither agrees nor disagrees	8	33.3	33.3	41.7
	Agree	8	33.3	33.3	75.0
	Strongly agree	6	25.0	25.0	100.0
	Total	24	100.0	100.0	

Our company has adequate knowledge skills to generate a suitable product solution in the time-competitive environment.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	4	16.7	16.7	16.7
	Neither agrees nor disagree	5	20.8	20.8	37.5
	Agree	9	37.5	37.5	75.0
	Strongly agree	6	25.0	25.0	100.0
	Total	24	100.0	100.0	

Our company has sufficient knowledge of product technology and market forces.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	4	16.7	16.7	16.7
	Neither agree nor disagree	7	29.2	29.2	45.8
	Agree	6	25.0	25.0	70.8
	Strongly agree	7	29.2	29.2	100.0
	Total	24	100.0	100.0	

Management has necessary skills for marketing, technical, resources, and company's competitiveness.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	3	12.5	12.5	12.5
	Neither agrees nor disagree	5	20.8	20.8	33.3
	Agree	10	41.7	41.7	75.0
	Strongly agree	6	25.0	25.0	100.0
	Total	24	100.0	100.0	

NPD team members have sufficient NPD technological competence (skills, knowledge, and work experience).

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	2	8.3	8.3	8.3
	Neither agrees nor disagree	8	33.3	33.3	41.7
	Agree	9	37.5	37.5	79.2
	Strongly agree	5	20.8	20.8	100.0
	Total	24	100.0	100.0	

Management provides necessary training programmes to NPD team members.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	3	12.5	12.5	12.5
	Disagree	5	20.8	20.8	33.3
	Neither agrees nor disagrees	10	41.7	41.7	75.0
	Agree	4	16.7	16.7	91.7
	Strongly agree	2	8.3	8.3	100.0
	Total	24	100.0	100.0	

Our NPD process has diverse inputs on the integration of a variety of specialised capabilities and strong interdisciplinary business functions.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	3	12.5	14.3	14.3
	Neither agrees nor disagree	7	29.2	33.3	47.6
	Agree	11	45.8	52.4	100.0
	Total	21	87.5	100.0	
Missing	System	3	12.5		
Total		24	100.0		

R&D, production and purchasing functions are in place to ensure the success of NPD process.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	5	20.8	21.7	21.7
	Neither agrees nor disagrees	7	29.2	30.4	52.2
	Agree	8	33.3	34.8	87.0
	Strongly agree	3	12.5	13.0	100.0
	Total	23	95.8	100.0	
Missing	System	1	4.2		
Total		24	100.0		

Design reviews, verifications and validations were performed throughout the NPD process to ensure the quality of new product.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	2	8.3	8.3	8.3
	Disagree	3	12.5	12.5	20.8
	Neither agrees nor disagrees	7	29.2	29.2	50.0
	Agree	8	33.3	33.3	83.3
	Strongly agree	4	16.7	16.7	100.0
	Total	24	100.0	100.0	

Quality control is performed in each stage of our NPD process.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	4.2	4.2	4.2
	Disagree	4	16.7	16.7	20.8
	Neither agrees nor disagrees	9	37.5	37.5	58.3
	Agree	6	25.0	25.0	83.3
	Strongly agree	4	16.7	16.7	100.0
	Total	24	100.0	100.0	

Quality management is in place to ensure the quality of products and integration of NPD process.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	1	4.2	4.2	4.2
	Disagree	2	8.3	8.3	12.5
	Neither agrees nor disagree	5	20.8	20.8	33.3
	Agree	10	41.7	41.7	75.0
	Strongly agree	6	25.0	25.0	100.0
	Total	24	100.0	100.0	

Product development time is shortened since we concurrently followed our structured NPD process.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	4.2	4.2	4.2
	Disagree	6	25.0	25.0	29.2
	Neither agrees nor disagree	9	37.5	37.5	66.7
	Agree	5	20.8	20.8	87.5
	Strongly agree	3	12.5	12.5	100.0
	Total	24	100.0	100.0	

Shortening product life cycles increasingly pressurise us to reduce our NPD time and cost in order to maintain product quality.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	5	20.8	20.8	20.8
	Neither agrees nor disagrees	8	33.3	33.3	54.2
	Agree	8	33.3	33.3	87.5
	Strongly agree	3	12.5	12.5	100.0
	Total	24	100.0	100.0	

APPENDIX 8: SPSS DATA: Reliability Statistics

Appendix 8:
SPSS DATA: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.831	**.847**	**30**

APPENDIX 9: SPSS DATA on Inter-Item Correlation Matrix

	A1	A2	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20	B21	B22	B23	B24	B25	B26	B27	B28
A1	1.000	.519	.056	.444	.044	.208	-.361	.129	-.118	-.052	-.099	-.260	.048	.164	.217	-.128	.200	.260	.067	-.023	.158	-.335	-.086	.088	.261	.242	.235	-.176	-.115	-.115
A2	.519	1.000	.100	.422	-.365	-.394	-.277	-.310	-.604	-.309	-.265	-.534	-.412	.190	-.472	-.400	-.323	-.465	-.626	-.657	-.396	-.189	-.158	-.233	-.147	-.072	-.445	-.479	-.444	-.444
B1	.056	.100	1.000	.628	.111	.082	-.161	-.061	-.375	.023	-.345	-.537	-.291	-.086	-.283	-.021	-.251	-.261	.199	.084	.178	.021	.095	.172	-.066	-.123	-.381	-.108	-.016	-.016
B2	.444	.422	.628	1.000	.201	.207	-.379	-.064	-.395	-.415	-.251	-.387	-.056	-.344	-.254	-.119	-.202	-.221	.157	-.095	.188	-.045	.100	.182	.035	-.007	-.211	-.241	-.017	-.017
B3	.044	-.365	.111	.201	1.000	.693	-.075	.642	.170	-.255	-.188	.339	.084	-.296	.447	.093	.177	.165	.431	.385	.394	.167	-.037	.189	.300	.178	.316	.536	.441	.441
B4	.208	-.394	.082	.207	.693	1.000	.326	.659	.274	-.169	.084	.473	.119	-.241	.446	.020	.197	.382	.475	.463	.502	.203	.107	.523	.121	-.018	.316	.515	.683	.683
B5	.201	-.264	.289	.305	.834	.742	-.080	.732	.040	-.039	-.020	.267	.022	-.154	.478	.061	.089	.265	.545	.510	.584	.072	.140	.259	.405	.387	.287	.625	.533	.533
B6	-.361	-.277	-.161	-.379	-.075	.326	1.000	-.051	.012	.106	.392	.417	.069	-.035	.037	-.023	.160	.102	-.162	-.084	.005	.346	.340	.274	-.400	-.358	-.131	.114	.428	.428
B7	.129	-.310	-.061	-.064	.642	.659	-.051	1.000	.344	.087	-.042	.509	-.200	-.098	.444	.064	-.039	.085	.241	.264	.235	-.126	-.179	.421	.420	.185	.281	.662	.380	.380
B8	-.118	-.604	-.375	-.395	.170	.274	.012	.344	1.000	.193	.189	.580	.221	-.045	.402	.163	.254	.436	.414	.375	.166	-.141	-.040	.350	.359	.075	.535	.348	.187	.187
B9	-.052	-.309	.023	-.415	-.255	-.169	.106	.087	.193	1.000	.086	-.065	.109	.507	.467	.582	.395	.179	.239	.185	.250	-.044	.195	.154	.443	.253	.082	.139	-.263	-.263
B10	-.099	-.265	-.345	-.251	-.188	.084	.392	-.042	.189	.086	1.000	.519	.562	-.130	.030	-.117	.004	.471	.184	.177	.276	-.191	.578	.008	-.167	.202	.276	-.036	.576	.576
B11	-.260	-.534	-.537	-.387	.339	.473	.417	.509	.580	-.065	.519	1.000	.239	-.301	.319	-.020	.138	.324	.196	.188	.076	.012	.293	.464	.158	.215	.428	.576	.531	.531
B12	.048	-.412	-.291	-.056	.084	.119	.069	-.200	.221	.109	.562	.239	1.000	-.253	.267	.412	.405	.575	.547	.394	.437	.200	.335	-.035	-.078	.152	.378	-.222	.377	.377
B13	.164	.190	-.086	-.344	-.296	-.241	-.035	-.098	-.045	.507	-.130	-.301	-.253	1.000	.270	.064	.239	.149	-.047	.141	.136	.040	.181	-.164	.300	.283	-.038	.103	-.396	-.396
B14	.217	-.472	-.283	-.254	.447	.446	.037	.444	.402	.467	.030	.319	.267	.270	1.000	.415	.767	.659	.543	.600	.611	.107	.179	.094	.668	.521	.657	.543	.081	.081
B15	-.128	-.400	-.021	-.119	.093	.020	-.023	.064	.163	.582	-.117	-.020	.412	.064	.415	1.000	.548	.072	.386	.206	.179	.417	.043	.192	.356	.121	.238	-.031	-.227	-.227
B16	.200	-.323	-.251	-.202	.177	.197	.160	-.039	.254	.395	.004	.138	.405	.239	.767	.548	1.000	.523	.321	.371	.399	.287	.279	.124	.419	.369	.613	.158	-.188	-.188
B17	.260	-.465	-.261	-.221	.165	.382	.102	.085	.436	.179	.471	.324	.575	.149	.659	.072	.523	1.000	.693	.778	.630	.033	.368	-.070	.231	.451	.684	.251	.446	.446
B18	.067	-.626	.199	.157	.431	.475	-.162	.241	.414	.239	.184	.196	.547	-.047	.543	.386	.321	.693	1.000	.852	.725	.156	.349	.199	.415	.428	.472	.357	.424	.424
B19	-.023	-.657	.084	-.095	.385	.463	-.084	.264	.375	.185	.177	.188	.394	.141	.600	.206	.371	.778	.852	1.000	.767	.243	.271	-.009	.265	.414	.527	.454	.448	.448
B20	.158	-.396	.178	.188	.394	.502	.005	.235	.166	.250	.276	.076	.437	.136	.611	.179	.399	.630	.725	.767	1.000	.229	.481	.048	.263	.324	.280	.248	.436	.436
B21	-.335	-.189	.021	-.045	.167	.203	.346	-.126	-.141	-.044	-.191	.012	.200	.040	.107	.417	.287	.033	.156	.243	.229	1.000	.179	.057	-.281	-.207	-.227	-.025	.121	.121
B22	-.086	-.158	.095	.100	-.037	.107	.340	-.179	-.040	.195	.578	.293	.335	.181	.179	.043	.279	.368	.349	.271	.481	.179	1.000	.253	.140	.464	.085	.142	.236	.236
B23	.088	-.233	.172	.182	.189	.523	.274	.421	.350	.154	.008	.464	-.035	-.164	.094	.192	.124	-.070	.199	-.009	.048	.057	.253	1.000	.221	-.017	.027	.359	.149	.149
B24	.261	-.147	-.066	.035	.300	.121	-.400	.420	.359	.443	-.167	.158	-.078	.300	.668	.356	.419	.231	.415	.265	.263	-.281	.140	.221	1.000	.733	.531	.555	-.306	-.306
B25	.242	-.072	-.123	-.007	.178	-.018	-.358	.185	.075	.253	.202	.215	.152	.283	.521	.121	.369	.451	.428	.414	.324	-.207	.464	-.017	.733	1.000	.576	.496	-.092	-.092
B26	.235	-.445	-.381	-.211	.316	.316	-.131	.281	.535	.082	.276	.428	.378	-.038	.657	.238	.613	.684	.472	.527	.280	-.227	.085	.027	.531	.576	1.000	.384	.142	.142
B27	-.176	-.479	-.108	-.241	.536	.515	.114	.662	.348	.139	-.036	.576	-.222	.103	.543	-.031	.158	.251	.357	.454	.248	-.025	.142	.359	.555	.496	.384	1.000	.278	.278
B28	-.115	-.444	-.016	-.017	.441	.683	.428	.380	.187	-.263	.576	.531	.377	-.396	.081	-.227	-.188	.446	.424	.448	.436	.121	.236	.149	-.306	-.092	.142	.278	1.000	1.000

APPENDIX 10: SPSS DATA: Statistical Descriptives

		N	Mean	SD.	Std. Error	95% Conf. Lower Bound	Min.	Max.
B1	<2 Yrs	5	4.80	.447	.200	4.24	4	5
	2-5 Yrs	10	3.90	1.370	.433	2.92	1	5
	5-10 Yrs	3	3.67	.577	.333	2.23	3	4
	10-15 Yrs	4	4.50	.577	.289	3.58	4	5
	>15 Yrs	2	5.00	.000	.000	5.00	5	5
	Total	24	4.25	1.032	.211	3.81	1	5
B2	<2 Yrs	5	3.80	.837	.374	2.76	3	5
	2-5 Yrs	9	4.11	1.269	.423	3.14	1	5
	5-10 Yrs	3	4.67	.577	.333	3.23	4	5
	10-15 Yrs	4	4.25	.957	.479	2.73	3	5
	>15 Yrs	2	5.00	.000	.000	5.00	5	5
	Total	23	4.22	.998	.208	3.79	1	5
B3	<2 Yrs	5	4.00	1.732	.775	1.85	1	5
	2-5 Yrs	10	2.90	1.370	.433	1.92	1	5
	5-10 Yrs	3	4.00	1.000	.577	1.52	3	5
	10-15 Yrs	4	3.25	1.258	.629	1.25	2	5
	>15 Yrs	2	4.00	1.414	1.000	-8.71	3	5
	Total	24	3.42	1.381	.282	2.83	1	5
B4	<2 Yrs	5	3.60	1.517	.678	1.72	1	5
	2-5 Yrs	10	3.00	.667	.211	2.52	2	4
	5-10 Yrs	3	4.00	1.000	.577	1.52	3	5
	10-15 Yrs	4	3.50	1.291	.645	1.45	2	5
	>15 Yrs	2	4.00	1.414	1.000	-8.71	3	5
	Total	24	3.42	1.060	.216	2.97	1	5
B5	<2 Yrs	5	3.80	1.789	.800	1.58	1	5
	2-5 Yrs	10	2.90	1.197	.379	2.04	1	4
	5-10 Yrs	3	3.67	1.155	.667	.80	3	5
	10-15 Yrs	3	3.33	.577	.333	1.90	3	4
	>15 Yrs	2	4.00	1.414	1.000	-8.71	3	5
	Total	23	3.35	1.265	.264	2.80	1	5
B6	<2 Yrs	5	4.00	.707	.316	3.12	3	5
	2-5 Yrs	10	4.20	.632	.200	3.75	3	5
	5-10 Yrs	3	4.00	1.000	.577	1.52	3	5
	10-15 Yrs	4	3.00	1.155	.577	1.16	2	4
	>15 Yrs	2	4.00	.000	.000	4.00	4	4
	Total	24	3.92	.830	.169	3.57	2	5
B7	<2 Yrs	5	3.60	1.140	.510	2.18	2	5
	2-5 Yrs	10	3.20	1.229	.389	2.32	1	5
	5-10 Yrs	3	2.33	.577	.333	.90	2	3
	10-15 Yrs	4	3.50	1.000	.500	1.91	2	4
	>15 Yrs	2	3.50	.707	.500	-2.85	3	4
	Total	24	3.25	1.073	.219	2.80	1	5
B8	<2 Yrs	5	4.60	.548	.245	3.92	4	5
	2-5 Yrs	10	4.20	.632	.200	3.75	3	5
	5-10 Yrs	3	3.67	1.155	.667	.80	3	5
	10-15 Yrs	4	4.50	.577	.289	3.58	4	5
	>15 Yrs	2	4.00	.000	.000	4.00	4	4

		N	Mean	SD.	Std. Error	95% Conf. Lower Bound	Min.	Max.
	Total	24	4.25	.676	.138	3.96	3	5
B9	<2 Yrs	5	4.40	.548	.245	3.72	4	5
	2-5 Yrs	10	3.80	.789	.249	3.24	3	5
	5-10 Yrs	3	3.00	1.000	.577	.52	2	4
	10-15 Yrs	4	4.50	.577	.289	3.58	4	5
	>15 Yrs	2	3.50	.707	.500	-2.85	3	4
	Total	24	3.92	.830	.169	3.57	2	5
B10	<2 Yrs	5	3.60	1.140	.510	2.18	2	5
	2-5 Yrs	10	3.80	1.229	.389	2.92	1	5
	5-10 Yrs	3	4.67	.577	.333	3.23	4	5
	10-15 Yrs	4	4.00	1.414	.707	1.75	2	5
	>15 Yrs	2	2.50	.707	.500	-3.85	2	3
	Total	24	3.79	1.179	.241	3.29	1	5
B11	<2 Yrs	5	4.00	1.225	.548	2.48	2	5
	2-5 Yrs	10	4.10	.738	.233	3.57	3	5
	5-10 Yrs	2	3.50	.707	.500	-2.85	3	4
	10-15 Yrs	4	3.50	1.291	.645	1.45	2	5
	>15 Yrs	2	3.00	.000	.000	3.00	3	3
	Total	23	3.83	.937	.195	3.42	2	5
B12	<2 Yrs	5	4.00	1.000	.447	2.76	3	5
	2-5 Yrs	10	4.20	.789	.249	3.64	3	5
	5-10 Yrs	2	5.00	.000	.000	5.00	5	5
	10-15 Yrs	4	4.50	.577	.289	3.58	4	5
	>15 Yrs	2	4.50	.707	.500	-1.85	4	5
	Total	23	4.30	.765	.159	3.97	3	5
B13	<2 Yrs	5	4.20	1.304	.583	2.58	2	5
	2-5 Yrs	10	3.90	.738	.233	3.37	3	5
	5-10 Yrs	3	3.00	2.000	1.155	-1.97	1	5
	10-15 Yrs	4	4.25	.500	.250	3.45	4	5
	>15 Yrs	2	3.50	2.121	1.500	-15.56	2	5
	Total	24	3.88	1.116	.228	3.40	1	5
B14	<2 Yrs	5	3.80	1.643	.735	1.76	1	5
	2-5 Yrs	10	3.40	1.174	.371	2.56	2	5
	5-10 Yrs	3	2.33	.577	.333	.90	2	3
	10-15 Yrs	4	4.00	.816	.408	2.70	3	5
	>15 Yrs	2	3.00	2.828	2.000	-22.41	1	5
	Total	24	3.42	1.316	.269	2.86	1	5
B15	<2 Yrs	5	4.40	.894	.400	3.29	3	5
	2-5 Yrs	10	3.80	.919	.291	3.14	2	5
	5-10 Yrs	3	2.67	.577	.333	1.23	2	3
	10-15 Yrs	4	3.75	1.893	.946	.74	1	5
	>15 Yrs	2	4.50	.707	.500	-1.85	4	5
	Total	24	3.83	1.129	.231	3.36	1	5
B16	<2 Yrs	5	3.80	1.095	.490	2.44	2	5
	2-5 Yrs	10	3.70	.949	.300	3.02	2	5
	5-10 Yrs	3	3.67	1.155	.667	.80	3	5
	10-15 Yrs	4	3.75	.957	.479	2.23	3	5
	>15 Yrs	2	4.00	1.414	1.000	-8.71	3	5
	Total	24	3.75	.944	.193	3.35	2	5

		N	Mean	SD.	Std. Error	95% Conf. Lower Bound	Min.	Max.
B17	<2 Yrs	5	3.80	1.095	.490	2.44	2	5
	2-5 Yrs	10	3.40	1.075	.340	2.63	2	5
	5-10 Yrs	3	4.33	.577	.333	2.90	4	5
	10-15 Yrs	4	4.00	1.414	.707	1.75	2	5
	>15 Yrs	2	3.50	.707	.500	-2.85	3	4
	Total	24	3.71	1.042	.213	3.27	2	5
B18	<2 Yrs	5	4.40	1.342	.600	2.73	2	5
	2-5 Yrs	10	3.20	1.033	.327	2.46	2	5
	5-10 Yrs	3	4.00	1.000	.577	1.52	3	5
	10-15 Yrs	4	3.75	.957	.479	2.23	3	5
	>15 Yrs	2	3.50	.707	.500	-2.85	3	4
	Total	24	3.67	1.090	.223	3.21	2	5
B19	<2 Yrs	5	4.60	.894	.400	3.49	3	5
	2-5 Yrs	10	3.40	.966	.306	2.71	2	5
	5-10 Yrs	3	4.00	.000	.000	4.00	4	4
	10-15 Yrs	4	4.00	.816	.408	2.70	3	5
	>15 Yrs	2	3.00	1.414	1.000	-9.71	2	4
	Total	24	3.79	.977	.199	3.38	2	5
B20	<2 Yrs	5	4.00	1.225	.548	2.48	2	5
	2-5 Yrs	10	3.50	.850	.269	2.89	2	5
	5-10 Yrs	3	3.33	.577	.333	1.90	3	4
	10-15 Yrs	4	4.25	.957	.479	2.73	3	5
	>15 Yrs	2	3.50	.707	.500	-2.85	3	4
	Total	24	3.71	.908	.185	3.32	2	5
B21	<2 Yrs	5	3.60	.894	.400	2.49	3	5
	2-5 Yrs	10	3.00	1.155	.365	2.17	1	5
	5-10 Yrs	3	2.67	.577	.333	1.23	2	3
	10-15 Yrs	4	2.00	.816	.408	.70	1	3
	>15 Yrs	2	2.50	2.121	1.500	-16.56	1	4
	Total	24	2.88	1.116	.228	2.40	1	5
B22	<2 Yrs	4	3.25	.957	.479	1.73	2	4
	2-5 Yrs	9	3.44	.527	.176	3.04	3	4
	5-10 Yrs	3	3.33	1.155	.667	.46	2	4
	10-15 Yrs	4	3.50	1.000	.500	1.91	2	4
	>15 Yrs	1	3.00	.	.	.	3	3
	Total	21	3.38	.740	.161	3.04	2	4
B23	<2 Yrs	5	3.60	1.140	.510	2.18	2	5
	2-5 Yrs	10	3.40	.843	.267	2.80	2	5
	5-10 Yrs	3	3.33	1.528	.882	-.46	2	5
	10-15 Yrs	3	3.33	1.155	.667	.46	2	4
	>15 Yrs	2	3.00	1.414	1.000	-9.71	2	4
	Total	23	3.39	.988	.206	2.96	2	5
B24	<2 Yrs	5	3.20	.837	.374	2.16	2	4
	2-5 Yrs	10	3.10	1.101	.348	2.31	1	5
	5-10 Yrs	3	2.67	2.082	1.202	-2.50	1	5
	10-15 Yrs	4	4.50	.577	.289	3.58	4	5
	>15 Yrs	2	4.00	.000	.000	4.00	4	4
	Total	24	3.38	1.173	.239	2.88	1	5
B25	<2 Yrs	5	3.40	1.140	.510	1.98	2	5

		N	Mean	SD.	Std. Error	95% Conf. Lower Bound	Min.	Max.
	2-5 Yrs	10	3.20	1.135	.359	2.39	1	5
	5-10 Yrs	3	3.33	1.528	.882	-.46	2	5
	10-15 Yrs	4	4.00	.816	.408	2.70	3	5
	>15 Yrs	2	2.50	.707	.500	-3.85	2	3
	Total	24	3.33	1.090	.223	2.87	1	5
B26	<2 Yrs	5	3.80	1.095	.490	2.44	2	5
	2-5 Yrs	10	3.70	.949	.300	3.02	2	5
	5-10 Yrs	3	4.33	1.155	.667	1.46	3	5
	10-15 Yrs	4	4.00	.816	.408	2.70	3	5
	>15 Yrs	2	2.50	2.121	1.500	-16.56	1	4
	Total	24	3.75	1.073	.219	3.30	1	5
B27	<2 Yrs	5	3.80	1.095	.490	2.44	2	5
	2-5 Yrs	10	3.00	1.054	.333	2.25	1	5
	5-10 Yrs	3	3.00	1.732	1.000	-1.30	2	5
	10-15 Yrs	4	3.00	.816	.408	1.70	2	4
	>15 Yrs	2	2.50	.707	.500	-3.85	2	3
	Total	24	3.13	1.076	.220	2.67	1	5
B28	<2 Yrs	5	3.60	1.140	.510	2.18	2	5
	2-5 Yrs	10	3.30	.823	.260	2.71	2	5
	5-10 Yrs	3	4.33	.577	.333	2.90	4	5
	10-15 Yrs	4	3.00	1.155	.577	1.16	2	4
	>15 Yrs	2	2.50	.707	.500	-3.85	2	3
	Total	24	3.38	.970	.198	2.97	2	5

APPENDIX 11: SPSS DATA: One Way Analysis of Variance (ANOVA)

Var.		Sum of Squares	df	Mean Square	F	Sig.
B1	Between Groups	5.133	4	1.283	1.259	.320
	Within Groups	19.367	19	1.019		
	Total	24.500	23			
B2	Between Groups	2.807	4	.702	.661	.627
	Within Groups	19.106	18	1.061		
	Total	21.913	22			
B3	Between Groups	6.183	4	1.546	.780	.552
	Within Groups	37.650	19	1.982		
	Total	43.833	23			
B4	Between Groups	3.633	4	.908	.777	.554
	Within Groups	22.200	19	1.168		
	Total	25.833	23			
B5	Between Groups	4.184	4	1.046	.607	.663
	Within Groups	31.033	18	1.724		
	Total	35.217	22			
B6	Between Groups	4.233	4	1.058	1.733	.184
	Within Groups	11.600	19	.611		
	Total	15.833	23			
B7	Between Groups	3.533	4	.883	.731	.582
	Within Groups	22.967	19	1.209		
	Total	26.500	23			
B8	Between Groups	2.033	4	.508	1.141	.367
	Within Groups	8.467	19	.446		
	Total	10.500	23			
B9	Between Groups	5.533	4	1.383	2.552	.073
	Within Groups	10.300	19	.542		
	Total	15.833	23			
B10	Between Groups	5.992	4	1.498	1.096	.387
	Within Groups	25.967	19	1.367		
	Total	31.958	23			
B11	Between Groups	2.904	4	.726	.797	.543
	Within Groups	16.400	18	.911		
	Total	19.304	22			
B12	Between Groups	1.770	4	.442	.717	.591
	Within Groups	11.100	18	.617		
	Total	12.870	22			
B13	Between Groups	3.675	4	.919	.700	.602
	Within Groups	24.950	19	1.313		
	Total	28.625	23			
B14	Between Groups	5.967	4	1.492	.837	.519
	Within Groups	33.867	19	1.782		
	Total	39.833	23			
B15	Between Groups	6.617	4	1.654	1.384	.277
	Within Groups	22.717	19	1.196		
	Total	29.333	23			
B16	Between Groups	.183	4	.046	.043	.996
	Within Groups	20.317	19	1.069		
	Total	20.500	23			

B17	Between Groups	2.592	4	.648	.550	.701
	Within Groups	22.367	19	1.177		
	Total	24.958	23			
B18	Between Groups	5.283	4	1.321	1.138	.369
	Within Groups	22.050	19	1.161		
	Total	27.333	23			
B19	Between Groups	6.358	4	1.590	1.936	.146
	Within Groups	15.600	19	.821		
	Total	21.958	23			
B20	Between Groups	2.542	4	.635	.735	.579
	Within Groups	16.417	19	.864		
	Total	18.958	23			
B21	Between Groups	6.258	4	1.565	1.329	.295
	Within Groups	22.367	19	1.177		
	Total	28.625	23			
B22	Between Groups	.313	4	.078	.118	.974
	Within Groups	10.639	16	.665		
	Total	10.952	20			
B23	Between Groups	.545	4	.136	.117	.975
	Within Groups	20.933	18	1.163		
	Total	21.478	22			
B24	Between Groups	8.258	4	2.065	1.679	.196
	Within Groups	23.367	19	1.230		
	Total	31.625	23			
B25	Between Groups	3.367	4	.842	.667	.623
	Within Groups	23.967	19	1.261		
	Total	27.333	23			
B26	Between Groups	4.433	4	1.108	.954	.455
	Within Groups	22.067	19	1.161		
	Total	26.500	23			
B27	Between Groups	3.325	4	.831	.678	.616
	Within Groups	23.300	19	1.226		
	Total	26.625	23			
B28	Between Groups	5.158	4	1.290	1.488	.245
	Within Groups	16.467	19	.867		
	Total	21.625	23			