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THE INFLUENCES OF AND RESPONSES TO THE LABOUR MARKET FOR CHEMICAL ENGINEERING SKILLS IN THE SOUTH AFRICAN PULP AND PAPER INDUSTRY

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of

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ABSTRACT

Modern day chemical engineers are largely responsible for the design, improvement and maintenance of processes that transform raw materials to products in an economical and sustainable manner. These individuals are highly paid and, due to the diversity of the field, the demand for individuals with the right level of training and experience is high. Despite the high demand and the attractiveness associated with an illustrious career however, the pulp and paper industry experiences a 15 to 20% labour turnover rate.

This research sets out to explore the influences of, and the responses to, the labour market for chemical engineering skills in the South African pulp and paper industry. An understanding of the labour markets would afford stakeholders the opportunity to curb the high turnover rates and allow for the ability to respond to changes in the labour market.

The research adopted a qualitative study which involved in-depth interviews with the stakeholders of the pulp and paper industry. A total of 18 stakeholders were interviewed. Due to distance and logistical constraints, some interviews were conducted telephonically. A semi structured interview guide line was used. Fine grained content analysis and descriptive statistics were used to extract key constructs from the data analysis obtained during the interview process.

The outcome of the research has resulted in a better understanding of the labour markets for chemical engineers in the industry. The findings provide key insights to factors that stakeholders consider as crucial in enhancing the effective use and retention of chemical engineers in the pulp and paper industry.

DECLARATION

I declare that the research project is my own work. It is submitted as partial fulfilment for the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

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Rakesh Singh (28592426)

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DEDICATION

For my parents Hemavati and Bansidhar Singh

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS

CHAPTER 1

1.1. Introduction to the Research Problem

1.1.1. Introduction

Chemical engineers are largely responsible for the design, improvement and maintenance of processes that transform raw materials to products on a large scale in a cost effective and sustainable manner. By training, chemical engineers possess a diverse skill set that allows for a high participation rate in modern day technology. Knowledge workers are classified as workers who possess high levels of skill and knowledge that is imparted to them by virtue of their diverse and rigorous training (Drucker 1994). As per Drucker's definition, chemical engineers can be classified as knowledge workers.

Just like any other processing industry, the South African Pulp and Paper industry acknowledges the value adding role of these individuals in terms of the impact they have on return on capital (Viviers, 2006).

1.1.2. The South African Education System

Higher education qualifications in South Africa are framed within the National Qualifications Framework (NQF) (National Commission for Higher Education (CHE), 1996; Commission for Higher Education (CHE), 2009). The NQF is a set of principles and guidelines by which records of learner achievements are recognised and registered in order to ensure an integrated and lifelong approach to learning. It forms an important aspect of redressing educational disparities that resulted from a historically structured inequity. The development and implementation of the NQF is overseen by the South African Qualifications Authority (SAQA), a statutory body

representing a number of stakeholders. It integrates education and training into a single qualifications framework and provides a quality assurance system through various bodies that are accountable either to the Department of Education or the Department of Labour. The NQF is made up of levels as described below in Table 1.2.

Table 1.1: South African NQF levels

Education Band	NQF Level	Skill Band	Qualification Type
Higher Education Training Band	8	High Skills	Doctorates
	7		Masters
	6		Bachelors Degree
	5		University of Technology Degrees and certificates

This report focuses on chemical engineers in the South African Pulp and Paper industry who are made up of degree and diploma receiving graduates. Graduates are classified as individuals that have a university degree whilst diplomats are classified as individuals who have technical diploma from a university of technology or technical college. In terms of the NQF, engineers, technologists and technicians are classified from NQF level 5 and higher as shown in Table 1.2.

Skills are the necessary competencies that can be expertly applied in a particular context for a particular purpose, and skills shortages (or 'scarce skills') occur when demand for a particular skills set outstrips supply (National Advisory Council on Innovation (NACI) and the Department of Science and Technology (DST), 2003).

South Africa's labour market is defined as structural. There is a considerable mismatch in the labour market between the type of labour available and that which is required for a country's sustainable economic growth (Pauw, Oosthuizen & Van der Westhuizen, 2008). The South African Labour market is characterised by the following features:

- High unemployment rates in the lower skills sector than that required by the economy;

- Shortage of skills sets in the more sophisticated technological and professional sector.

Over the last decade, labour turnover of chemical engineers in the pulp and paper industry has been high and the industry has experienced labour turnover rates of 15 to 20% per annum (Nice, 2008). In an industry that is continuously challenged to improve efficiencies and compete globally, continuity and knowledge transfer in project execution and completion is a key component for economic growth. Attracting and retaining a highly skilled workforce that is independent, internationally marketable and highly mobile, is a critical feature of globalisation (Paul, 2000). One way to improve return on capital is to increase the skills base. Increasing of the skills base would increase economic growth. Organisations that employ a highly skilled workforce often posses a competitive advantage in an environment where processes and systems are often standardised across all participants (Templer & Cawsey, 1999). For the reasons stated above, it is imperative that the pulp and paper industry has a thorough understanding of the labour market so that the industry is able to respond appropriately to changes in the labour market for chemical engineers in the pulp and paper industry. The impact of past policies in terms of education and

training has been an impeding factor and has acted as a brake on economic growth (Fallon & Lucas, 2009).

1.1.3. The South African Pulp and Paper Industry

Apart from some pulp and paper production in Swaziland, South Africa is the only major producer of pulp and paper on the African continent. Production data is presented in Table 1.3. South Africa has a rich source of raw material through forests in Mpumalanga and KwaZulu-Natal, which are augmented by the warm equatorial climate. In economic terms, the industry is classified as an oligopoly dominated by two major players, namely Sappi and Mondi. The South African Pulp and Paper industry is now a player in the global market and is required to produce high quality products at high efficiencies in order to remain competitive.

Table 1.2: Estimated production of pulp in the African continent adapted from (PAMSA, 2007)

Grade	Estimated Production(ton per annum)
Mechanical wood pulp	238 000 tons
Semi chemical pulp	135 000 tons
Chemical wood pulp	1 489 000 tons
Dissolving pulp	543 000 tons
Tissue grades	195 000 tons
Printing and writing grades	1 132 000 tons
Packaging grades	1 400 000 tons

The South African paper, pulp and board industry has consistently increased exports of paper and board and maintained imports at similar levels for the past three years, despite facing a number of challenges. Pulp production and exports have steadily increased since 2007. Exports in 2008 amounted to 850 000 t, up from 671 000 t in 2007, and 2009 exports appear to have exceeded these figures, despite the recession (Seggie & Molony, 2010)

1.1.4. The Industry as an Employer

The pulp and paper industry is an employer of 63 000 people with an estimated 850 000 people dependant on the industry (PAMSA, 2006). This means that the industry is an employer of people from both the structured and unstructured labour market. The industry is labour intensive with a high number of employees coming from the unstructured sector of the labour market, which is comprised of the low skilled labour market.

1.1.5. Issues Facing the Industry

The impact of globalisation, as well as the ongoing increase in energy costs in South Africa and the impact of improved environmental sustainability, have impacted many South African industries. The global marketplace for the pulp and paper industry is changing immensely and the South African Pulp and Paper industry is not immune to these impacts. Competitive issues arise as a result of the following factors:

- Low cost competition in the form of product dumping from Asia and South America;
- High investor expectations;
- Industry consolidation in the form of mergers and acquisitions;
- Increased demand by customers for high value product;

- Environmental sustainability.

In an attempt to avert these threats, the industry has to embark on various optimisations and efficiency improvement projects in the productivity, energy, skills competencies and sustainability sectors of the business. In an attempt to obtain these levels of skill competencies for competitive advantage, an understanding of the supply and demand side issues of the labour market and the industry's ability to react to these factors is crucial.

1.2. Scope and Purpose

The purpose of this research is to gain a deeper understanding of the labour markets and the mechanisms that play a significant role in the proper development of chemical engineers for the pulp and paper industry. The scope of this research is limited to stakeholders in the South African Pulp and Paper industry and is described by the definitions of the following relevant terms:

- **Employers** – These are made up of companies that are employers of engineers and comprise Sappi, Mondi, Nampak and Kimberly Clarke, which can be considered the big four players in the industry. On the employer side the scope will be limited to Human Resources, Training Managers and Technical Managers.

- **Academic Institutions** - The supply of chemical engineers and engineering technologists come from universities and universities of technology. These institutions are situated across the country. Most of the curricula offered by the universities and universities of technology are accredited by the Engineering Council of South Africa (ECSA).

- **Industry Associations** – The Engineering Council of South Africa (ECSA), the South African Institution (SAIChe), the Papermakers Association of South Africa (PAMSA) and the Forest Industry Sector Education and Training Authority (FIETA), which is an affiliate of the Industry Sector Education and Training Authority (SETA).

- **Employee**s – These are highly qualified, highly paid graduates and diplomats that are employed in the industry.

1.2.1. Objectives of the Research

An adequate supply of well trained professionals are of paramount importance to any industry. An understanding of the mechanics of labour markets is an important part of a strategic element in most organisations as it allows for the following benefits:

- A faster response to changes in supply and demand to ensure sustainability and continuity in the execution of projects;

- Ability to plan manpower budgets and improve labour attrition rates;

- Ability to forecast skills requirements.

Having stated the benefits, it is imperative that stakeholders understand the impacts of the influences of the labour market on skills development and retention. An understanding of labour market factors is crucial in preparing a response to changes in the market.

1.2.2. Research Motivation and Aims

The motivation behind this research stems from the impact of the current skills shortage that the industry faces in terms of sustainability and low return on capital, poor project implementation and continuity and knowledge transfer. The aim of the research is to gain a deeper understanding in the following areas:

- Establishing and understanding the supply factors and constraints within this environment;
- Establishing and understanding the demand factors and the constraints within this environment;
- Understanding and developing a framework to respond to the labour market supply and demand dynamics.

CHAPTER 2: Literature Review

2.1. Introduction

The literature review set out below provides insight into labour market theory on a generic level and encompasses issues at a contextual level. The review begins with a broad overview of labour market economics by providing the fundamental economic framework and mechanisms of supply and demand for labour in order to provide sufficient understanding of the micro and macro-economic principles. It further seeks to narrow down specific issues that influence the supply and demand for chemical engineering skills in the South African Pulp and Paper Industry.

The literature also focuses on the South African economy in terms of globalisation and sets the scene to understand the need for highly skilled engineers and professionals if South Africa wants to compete globally. Further, the literature provides an understanding of supply side factors and the role played by Higher Education and Training. Demand side issues like under-professionalization and under-utilisation are also explored. In conclusion, retention and talent management is also explored.

The majority of the literature review is current and reveals that the current context of labour markets for engineers is well defined, however very little is detailed on labour markets for chemical engineers in the pulp and paper industry. This identifies a gap in the literature review and this research intends to provide sufficient information to address the gap.

2.2. Economic Theory of the Labour Markets

2.2.1. Labour Market Defined

The labour market is an imaginary marketplace where labour is bought and sold. Although the market is characterised by the same economic principles of supply and demand of a product, the labour market is unique in the sense that it cannot be treated as a product due to factors like equality, justice and humaneness. The principles of equality, justice and humaneness are essential elements of the labour market. In addition to humaneness and fairness, the labour market has other unique characteristics, like diversity, personality and the complexity of the price of labour. In the labour market the price is determined not only by the employment package, but also by inflation, taxation, standard of living and provision of health and safety (Barker, 2003). A schematic representation of the functioning mechanisms of the labour market is shown in Figure 2.1. These mechanisms demonstrate the 'circular flow' of the economy. The circular flow model is defined as the flow of resources from households to firms and of products to firms from households (Kaufman & Hotchkiss, 2006). These flows are accompanied by reverse flows of money from firms to households and from households to firms. The circular flow is comprised of the resource market, households, product market, businesses and the government. Households interact with business firms in two distinct ways:

(1) Households supply economic resources, such as labour, to businesses in exchange for income; this interaction occurs in markets for resources.

(2) Households use their incomes to buy goods and services produced and sold by business firms. This second type of interaction occurs in markets for products (Kaufman & Hotchkiss, 2006).

Boeri & van Ours (2008) (2008) have a simplified definition of a labour market as an institution where services or specified tasks rendered by human beings is exchanged for a price. This price is termed a wage or salary.

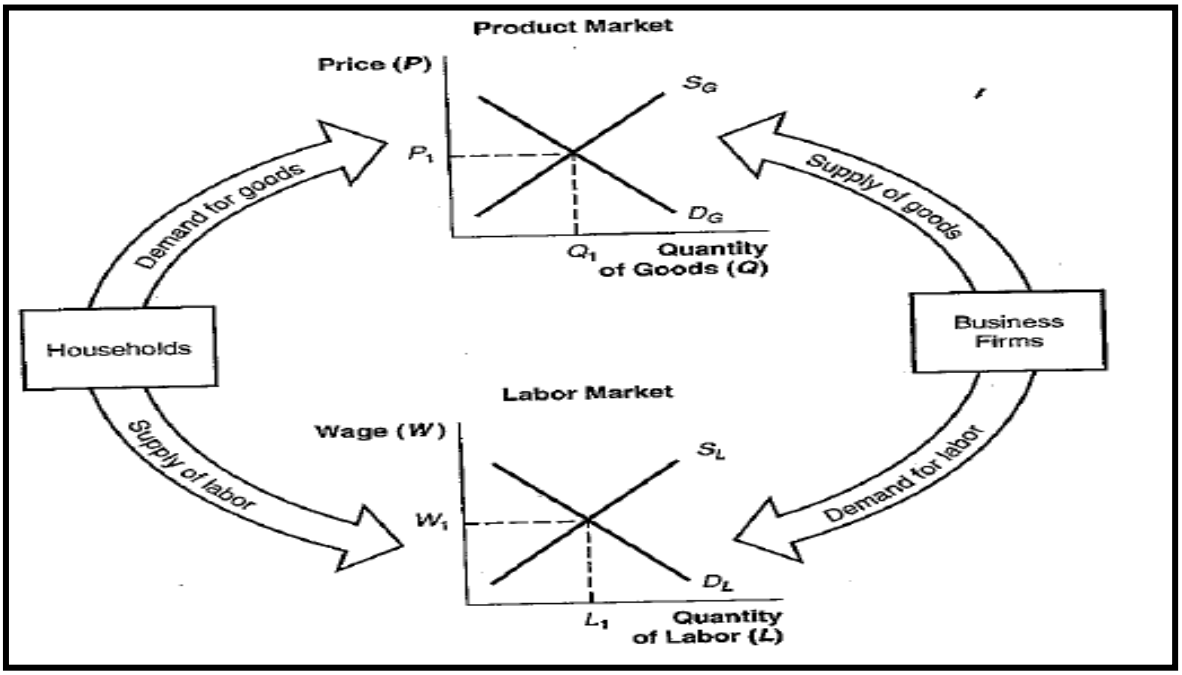

Figure 2.1: Circular flow model of the economy (Kaufman and Hotchkiss, 2006)

2.3. Composition of the Labour Market

Kraak (2008) postulated that the labour markets of most advanced and developing economies comprise of three distinct configurations.

- **Internal labour market:** This market is located within the workplace and jobs are allocated to persons from within the workplace. Jobs of this nature are filled by means of internal promotion and the skill set is normally developed by on the job training and experience. Inclusion or appointment is based on skill, age, sex, race, social class and family background. Qualifications are not used as criteria for appointment.

- **Unstructured labour market:** This market is located externally and is made up of persons that seek employment independently of state or employer support during development. Most persons in this market do not follow a predefined structure in the acquiring of skill and knowledge, hence they form part of the low skilled labour market. This sector must not be confused with the unskilled sector as these individuals struggle to find employment as manual labourers.

- **Structured labour:** This market is located externally and is a segment that comprises of persons that have followed a structured, predefined pathway in terms of education and training that is normally offered at an institution. Persons from this sector enter the workforce as candidate professionals and are promoted up to professionals through a structured process. Persons that fall into this category are engineers, doctors, social workers and accountants.

2.4. Functions of Labour Markets

Barker (2003) postulates that a labour market has two economic functions, in that the market distributes:

- Human resources among alternate users; i.e. amongst sectors, enterprises, locations and occupations.

- Income in the form of wages or salaries as incentives or rewards to workers (International Labour Organisation (ILO), 1993).

In essence, labour markets, by their functioning, should contribute to:

- Efficiency – highest possible output and income.

- Growth - increase in employment in the future and the contribution to higher productivity and income.

- Equity – equality of opportunity for all to access jobs, training, rewards and fairness in the workplace.

- Social justice – society's influence to minimise negative effects of the labour market on employees' welfare.

2.5. The Supply and Demand of Labour

The basis for practically all economic analyses is the interaction of supply and demand (Barker, 2003). The labour market is imperfect, however in understanding the determinants of the labour market, the market is assumed to be a perfectly competitive market. In a perfectly competitive labour market, workers and firms are fully informed about wages and services offered by other firms and there are no frictions or costs involved in matching of workers and vacancies (Boeri & van Ours, 2008). These assumptions rarely exist. In a perfectly competitive labour market, equilibrium (supply equals demand) is reached through the wage mechanism.

2.6. Labour Market Policies

Until the 1980s, labour policies of many governments and policy makers relied on macroeconomic policy to stimulate and generate employment. Policy encompasses an instrument like the unemployment insurance fund to counteract the effects of unemployment. Like any other policy, these policies had drawbacks and often did not achieve the desired outcomes. To address the issues of unemployment, specific attention was paid to labour market policies. These policies are termed active labour market policies, and as defined by (Barker, 2003), these policies aim to improve the operation and results of labour markets and include policies to enrich supply, enhance demand and improve processes.

2.6.1. Enriching Labour Supply

Active labour market policies enhance and improve labour quality and quantity, or influence the distribution across occupations or locations.

The following factors contribute to enriching labour supply (Barker, 2003):

- Provision of training and retraining to reduce skill mismatches between supply and demand.
- Assistance with social services like child care, housing and other fringe benefits that allow for the targeted group to secure and keep their employment.
- Geographic labour mobility provision to allow for mobility assistance in areas where jobs are available.
- Improvement in work related and inter-enterprise mobility.
- Actions to influence the size of the labour force.

2.6.2. Enriching Labour Demand

Policies which are generated to enrich labour demand are aimed at influencing structure, composition or the levels of demand, and include the following (Altman 2005):

- Provision of subsidies and incentives for employers.
- Provision of incentives and subsidies for individuals.
- Promoting self employment and supporting of small projects by making funding and training available for these ventures.
- Vocational based training schemes.
- Job search training and counselling.
- Labour market information and statistics.

2.7. Overview of the South African Economy

It is imperative that one considers the economic climate as part of the context in which this research was conducted, as a lack of understanding of the economic context may obscure and render skewness in judgement of the labour market in South Africa and the need for skills.

2.7.1. Growth Rate

South Africa's GDP has been growing at almost 5% per annum for the past few years, as depicted in Figure 2.2. The service sector contributes to GDP with a share of 67%, followed by industry (30%), and agriculture (2.5%). South Africa has maintained its position as the world's leading producer of platinum, gold and chromium. There is a relatively strong relationship between a country's growth rate and activity on the labour market. An increase in GDP is associated with an increase

in demand for labour (Aranki, Friberg, & Sjödin, 2010). As depicted in Figure 2.2, the South African growth rate has been stagnating over the last ten years. This is of concern as the unemployment rate continues to rise and the economic activities within the country are unable to absorb the unemployed. No country has achieved a reduction in unemployment without an increase in economic growth (OECD, 2008).

Figure 2.2: South Africa's annual GDP growth rate
(http://www.tradingeconomics.com/south-africa/indicators/)

2.7.2. Unemployment

South Africa's unemployment rate is the highest amongst the 62 countries that are tracked by Bloomberg. Despite various efforts and pledges made by the president to cut the unemployment rate by 14% and the interjections by the South African Reserve Bank to cut interest rates to help offset the impacts of the declining employment, unemployment rates still remain high (Bloomberg, 2010).

Although unemployment rates have been on the decline over the last eight years as depicted in Figure 2.3 below, they are relatively high for an economy like South Africa's. South Africa's unemployment rose sharply in the late 1990s as a result of a

surge in supply of unskilled labour and the failure of labour demand to keep up with the supply. Structural reforms to labour markets and education, together with supportive macroeconomic activities, are the key to unemployment rate reduction (OECD, 2008)

Figure 2.3: South Africa's Unemployment Rate

(http://www.tradingeconomics.com/south-africa/indicators/**)**

2.8. South Africa in the Global Competitiveness Ranking

The Global Competitiveness Report (World Economic Forum (WEF), 2009) ranked South Africa only 45th out of 133 nations, but as the highest in Sub-Saharan Africa. Table 2.1 shows some of the key metrics that may aptly provide insight into this research. The items in bold script in table 2.1 are issues that refer to labour markets and have an impact on this research.

Table 2.1: Key Metric Ranking

Metric	Rank/133
Financing through local equity market	4
Financial market sophistication	6
Efficiency of legal framework in challenging regulations	22
University-industry collaboration in R&D	25
Quality of scientific research institutions	29
Ease of access to loans	31
Venture capital availability	33
Availability of latest technologies	37
Judicial independence	38
Cooperation in labour-employer relations	**121**
Flexibility of wage determination	**123**
Availability of scientists and engineers	**123**
Hiring and firing practices	**125**
Business costs of crime and violence	**133**
Quality of mathematics and science education	**133**

What is of significance for the purpose of this research is that South Africa ranks last in the category, 'quality of mathematics and science education'. The democratic government of 1994 has made major efforts to increase access to education and the enrolment rate has increased, however the quality remains an issue. Since the 1990s, South African results in maths and science have deteriorated. In these crucial areas, the government's goals for pass rates were too optimistic and are not being met. Problems within the education system include amongst others, lack of teacher

training, shortage of infrastructure in terms of teaching facilities, shortage of teaching aids and teacher management (OECD, 2008).

Mathematics is a major inhibitor for entry into any engineering discipline, and reasons cited for poor mathematics in South African schools are the exclusion of mental exercises from the syllabus, the introduction of the outcomes based education that does not develop competency, mathematics being perceived as a non learning subject and the obsession of schools to achieve high pass rates which encourage students to take mathematics on the standard grade (Lawless, 2005). A lack of labour market flexibility in terms of the unemployment insurance fund which was introduced in 2001 after an increase in unemployment rates, coupled with employment protection policies, make the labour market highly regulated and can be considered as factors for high unemployment rates (OEDC, 2008)

2.9. Snapshot of the South African Labour Market

Since the birth of democracy the South African Government introduced many policies to augment the economic growth of the country. Amongst others, policies of economic reform based on sound fiscal constructs, trade reform and deregulation and market friendly economics were introduced. These measures augured well for economic growth, however they also created problems in the arena of labour markets (Bhorat & Cassim, 2004).

Due to economic changes, the liberalisation of trade reform and deregulation, the South African economy is now competing globally. Globalisation intensifies domestic competition and when competition increases, emphasis is placed on productivity and efficiencies to achieve profitability. Improvement in efficiencies and

productivity is normally achieved by adoption of new technologies, which require a highly skilled labour force. There are a number of features of the South African labour market that are unusual for a country at its present stage of economic development (Fallan & Lucas, 1998).

- The level of urbanisation is relatively high, and agriculture accounts for a low share of the labour force;
- Formal wage employment is by far the largest source of productive labour absorption;
- The urban informal sector is a relatively small employer;
- Unemployment is relatively high.

South Africa's labour market is defined as structural. There is a considerable mismatch in the labour market between the type of labour available and that which is required for a country's sustainable economic growth (Pauw, Oosthuizen & Van der Westhuizen, 2008). The South African Labour market is characterised by the following features:

- High unemployment rates in the lower skills sector than those required by the economy;
- Shortage of skill sets in the more sophisticated technological and professional sector.

"Skills shortages in particular remain a serious constraint in South Africa, although increasing amounts of public and private sector resources are being committed to address the problem. Private capital will be sought for infrastructure projects, especially energy" (Economist Intelligence Unit, 2008).

2.9.1. Impacts of the Changing Economy on the South African Labour Market

The ability or the lack thereof of the domestic economy to generate a sufficient supply of participants of the desired quality has come under constant pressure, and the ability to respond to the changes in the dynamics of the labour market needs to be well understood. One such dynamic is influenced by the education system. Since 1994, the global demand has put the education system, more so the higher education system, under severe pressure and scrutiny. The education system is expected to become more responsive to the needs and expectations of industry (Delanty (2000) in Kruss, 2004).

Only 1.6% of the total population of the country was enrolled in public higher education institutions in 2007. The higher education participation rate compares the total number of people enrolled with the total number of people aged between 20 and 24 in the country. In South Africa, the rate was 15.88% in 2007, declining from 16.34% in 2004. This compares poorly internationally where the rates range from 25% in East Asia to 70% in North America and Western Europe. Over the period 2004-2007, graduations in higher education institutions increased by 8.6% and enrolments by 2.6%. Participation rates and performance levels at institutions of higher learning are still clearly demarcated along race lines, with Africans faring worst, marking continuing inequality. There are more graduates in the fields of human and social sciences than in business, management, science engineering and technology. The number of students graduating with post graduate qualifications is declining (CHE, 2009).

The Accelerated and Shared Growth Initiative for South Africa (ASGISA, 2006) has identified skills shortage as a key to the growth of the South African economy, hence a highly developed work force has become the priority of policy makers (http://www.southafrica.info/business/economy/policies/asgi-sa.htm). It must also be noted that much progress has been made in producing graduates from universities and universities of technology, however as demonstrated by Pauw *et al*, 2008, the concern lies in the type of graduates produced. This is an issue of skills mismatch which can only be solved by the labour market's ability to respond by changing the labour supply to the requirements of labour demand.

2.10. Point of Entry

The aim of the research report was to gain a deeper understanding on the influences of, and responses to, the labour market with regard to chemical engineering skills in the South African Pulp and Paper Industry. Various studies have attempted to gain an understanding of these issues in other disciplines of engineering, but little or no work has been done thus far in this arena, hence from this point forward much of the literature review will be centred on the engineering discipline. For the purpose of this research focus is placed on the structured labour sector, as the skill set required for technological advancement and overall productivity and efficiency improvement is highly associated with people from the structured labour market, comprising of diplomats and university graduates. In terms of the National Qualifications Framework (NQF), persons in possession of a university of technology degree (NQF 5) and above form the population of relevance in this research (Kraak, 2008).

2.11. The South African Pulp and Paper Industry

The South African Pulp and Paper industry is not immune to the challenges of intense competition created by globalisation. In the past decade, exports have grown progressively as indicated in Figure 2.4. This is a clear indication that the industry is trading globally and has to conform to quality and efficiencies to remain profitable. The South African Pulp and Paper Industry is an employer of 63 000 people with an estimated 850 000 people dependant on the industry (Hunt, 2006). To remain competitive the industry has to harness the following:

- The rich reserves of forestry that are augmented by the warm equatorial climate. This climate increases the growth rate and the tree to pulp conversion rate is almost double when compared to other Northern hemisphere producers;
- Intensify capital spending on technological improvements to improve efficiencies;
- Build up human capital to respond to the technological improvements;
- Improve innovation and reduce the carbon footprint to become environmentally sustainable. (Pulp and Paper in South Africa, Mnbendi Information Services [Internet])

The pulp and paper industry has experienced significant brain drain over the last decade. Reasons cited for this brain drain were amongst others, socio-political changes, safety and security. The industry experiences an iteration rate of 15% to 20% of technical people, and does not have a sufficient pipeline to supply skilled

personnel. Without the availability of a pipeline of trained technical people, the industry has to import the necessary skills from abroad or stagnate (Nice, 2008).

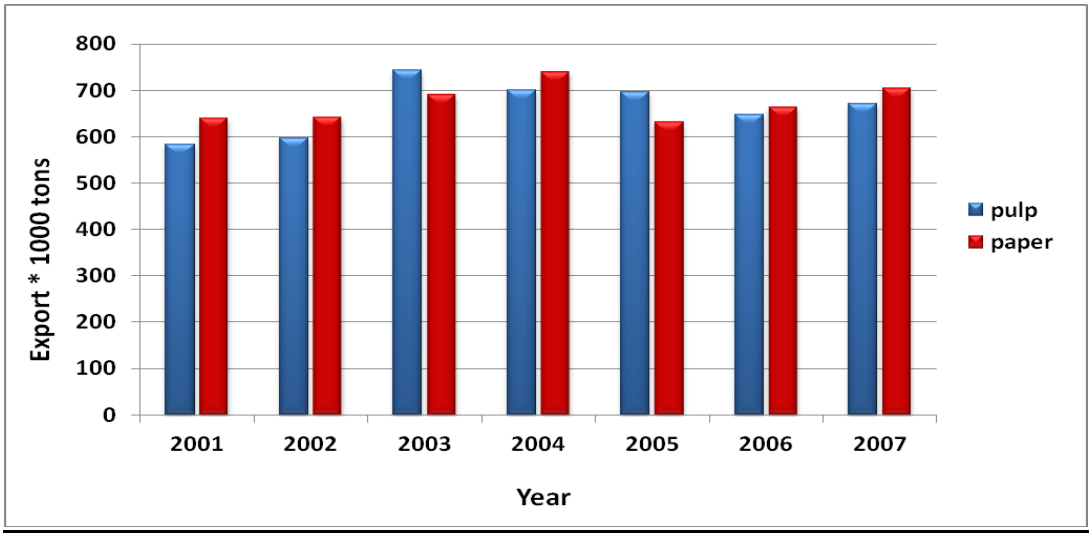

Figure 2.4: Progressive growth of Pulp and Paper exports per 1000 tons

(Adapted from the Paper Manufacturers Association of South Africa (PAMSA) (2010) [Internet] Available from http://www.pamsa.co.za/ (Accessed 19/08/2010))

2.12. Supply Side

Shortfalls in education and training are key contributors to skill mismatches. Table 2.2 gives an indication of the levels of unemployment as a correlation to the number of years of education. The probability of being employed is closely correlated with years of education and is typical of many developing and developed countries, however the unique feature in the South African context is that South Africa as a country has failed to improve education and training sufficiently to allow for the skilled labour force to keep up with the increasing demand. Studies conducted by Clark *et al* (2005) in Daniels in 2007 and the Human Sciences Research Council indicate that there is an excess demand for highly skilled occupations. The one area

of concern is the drop in the matric pass rate from 73.3% in 2003 to 60.6% in 2009, with low pass rates in mathematics and physical science (OECD, 2010).

Table 2.2: Percentage Unemployment by Level of Education (SSA, 2008)

	2003	2004	2005	2006	2007	2008
All population	27.1	24.7	23.8	22.6	22.3	22.9
Higher	9.8	7.6	7.4	8.0	7.2	7.7

2.12.1. The Role of Higher Education in Labour Supply

Global economic changes, coupled with the ability to be flexible, adapt and innovate, are enablers of competitiveness. These constructs place new demands on education and training (Kruss, 2004).

Employer institutions are regarded as institutions that create a demand for labour. Evidence from employer representatives suggest that academic preparations of undergraduates are inadequate for the needs of modern technologically advanced industries, as the graduates lack business techniques or the commercial and managerial understanding required by the employers of the modern day (Barrie, 1994; Bueret & Webb, 1983; Spurling, (1992) in Bryn, Scott., Bolton, Bramley & Manske. (2000)).

Engineering graduates are often described as being ill prepared by academic institutions, as their inability to contribute to economic growth is very much evident upon employment. The graduates also tend to respond very slowly to technological change and to adopt new, so-called core, skills. There is also a belief that

engineering faculties have not expanded their curricula to adopt the changing environment as other disciplines have (Jones *et a*l, 1983).

Further, research and investigations by Kruss (2004) indicate that the expectation of private sector leaders is that higher education institutions must have the ability to directly prepare graduates with the skills to become employable. Sentiments that academic institutions were not supplying the right number of graduates in the fields required and that the institutions were producing generalists rather than specialists with specialised skill sets to meet the needs of defined groups were also echoed.

Most companies regard the degrees offered by institutions as an indicator of potential and have indicated that institutions lack the ability to prepare graduates for skills in the areas of problem solving, communication, entrepreneurship, good citizenship, managerial skills and leadership skills. Many leaders have indicated that their organisations are burdened by the need to provide training skills that should be part of the curricula (Kruss, 2004).

The National Commission on Higher Education (NCHE) formulated the 'White Paper on Education and Training 3 (WPET) (Government Gazette, 1997), which postulated that the resultant economic and technological changes that affect the economy create an agenda for the role of higher education in reconstruction and development to provide the following:

- **Human Resource Development:** the mobilisation of human talent and potential through lifelong learning to contribute to the social, economic, cultural and intellectual life of a rapidly changing society.

- **High-level skills and training**: the training and provision of person power to strengthen the country's enterprises, services and infrastructure. This requires the development of professionals and knowledge workers with globally equivalent skills, but who are socially responsible and conscious of their role in contributing to the national development effort and social transformation.

- **Production, acquisition and application of new knowledge:** national growth and competitiveness is dependent on continuous technological improvement and innovation, driven by a well organised, vibrant research and development system which integrates the research and training capacity of higher education with the needs of industry and social reconstruction.

Despite the publication of the white paper in 1996 and the significant amounts of efforts made by policy makers, society, government, industry and academic institutions, the country still fails to produce high calibre graduates to meet the requirements of modern day industry. South Africa requires a large number of graduates that are of high calibre. There still exists a need to review the bottle necks and develop a strategy to maximise the outputs from tertiary institutions (Lawless, 2005). Following significant studies in the civil engineering industry by Lawless in 2005, the author has postulated the following points that would ensure tertiary institutions provide a consistent feed of high calibre graduates to industry:

- High entrance requirements – this would mean that the entrant has the ability to complete the field of study.
- A curricula that is conducive to add value to industry – implying that the curricula is devised in conjunction with the industry Government Gazette (1997) .

- Experiential training opportunities.
- Sufficient employment opportunities.
- Improvement in the quality of lecturing staff, a plausible lecture student ratio to derive maximum benefits and a remuneration package that encourages lecturing as a profession.

2.12.2. Financial constraints influencing supply

Given the history of South Africa and the level of poverty, funding is often an issue in terms of students wanting to continue with their studies after completing secondary school. Very few students from disadvantaged backgrounds can afford tertiary education and bursaries are essential. Generally bursaries are awarded after matric examination results. The award process is time consuming and funding becomes available by the end of the first university term. During this process students need to secure a residence, tuition and book deposits, and many students can ill afford this and drop out of academic institutions (Lawless, 2005).

It is expected that the number of university students in South Africa will grow by 53 000 to reach 837 000 in 2011. Government has taken a proactive initiative by increasing spending in this arena. In 2009, the South African minister of finance provided the student financial aid scheme with a R330 million boost to enable previously disadvantaged students to secure financial aid on entering university.

2.13. Demand Side

South Africa's biggest problems lie on the demand side of the labour market. Low employment rates have been accompanied by high levels of involuntary unemployment. It must be emphasised that insufficient labour demand has been the major cause of low employment. Poor demand can be attributed to weak economic

growth which hinders labour absorption. South Africa's economic growth has been relatively weak over the last several decades whilst the labour force has been growing rapidly. South Africa's per capita growth has been in the region of 2% over the last several decades as depicted in Figure 2.5. This is lower than that of other emerging economies (OECD, 2010).

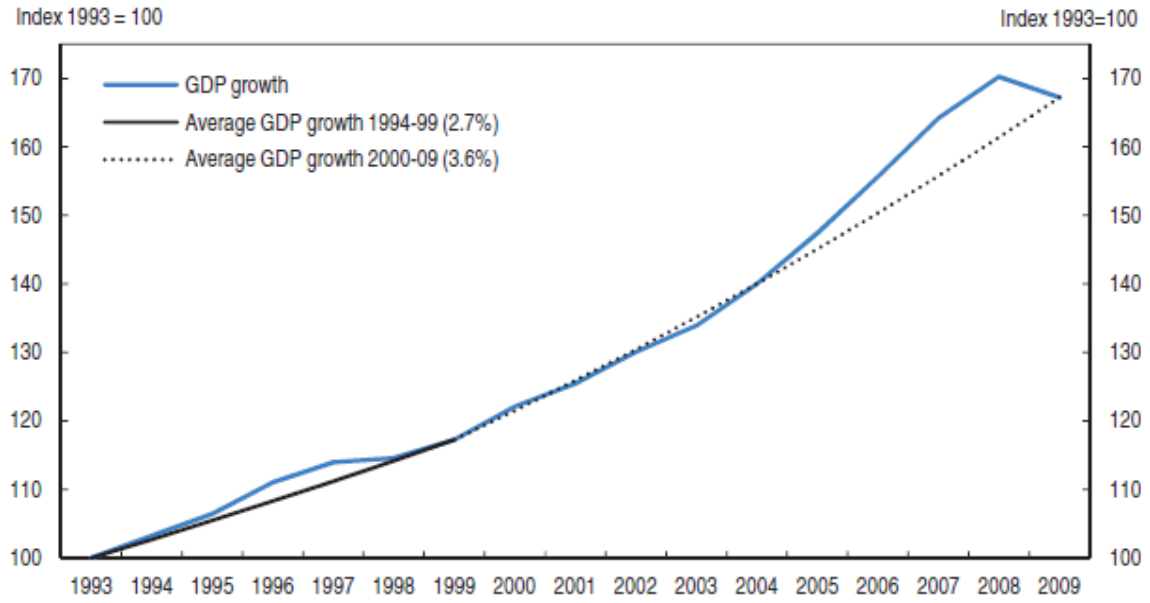

Figure 2.5: South Africa's per capita growth from 1993-2009 (OECD, 2010)

2.13.1. The under professionalization factor

Generally, the engineering discipline suffers from a lack of social status. In Britain an anti-engineering, anti-industrial culture denies engineers a social status when compared to other professions like doctors, lawyers and accountants. This factor marginalises engineers' influence and the economic role they play (Jones *et al*, 1983).

In the South African context, there has been considerable growth in the number of engineering professionals, but many of these are working in the financial and business services sectors where they are unlikely to be using their technical skills.

Table 2.3 shows that there was an annual average growth rate of 18.7% in the employment of engineering professionals in the financial sector, compared with very small growth in the transport, storage and communication sectors (1.2%) and community, social and personal services sectors (1.7%), and only slightly better growth in mining and quarrying (3.4%), electricity, gas and water supply (3.6%) and wholesale and retail (3.7%) (Quantec, 2007).

Table 2.3: Engineering employment by economic sector in 1996 and 2005 (Quantec 2007).

NUMBER of ENGINEERS, TECHNOLOGISTS, and TECHNICIANS PER ECONOMIC SECTOR	1996	2005	% AVERAGE ANNUAL GROWTH
Mining and quarrying	1852	2510	3.4
Manufacturing	8792	18266	8.5
Electricity, Gas and Water Supply	4243	5806	3.6
Construction	6859	9779	4.0
Wholesale and Retail Trade	4423	6155	3.7
Transport, Construction and Communication	8988	9999	1.2
Finance	4180	19576	18.7
Community, Social and Personal Services	5921	6861	1.7
Total	45258	78952	6.4

2.13.2. The Under Utilisation Factor

Organisations are often guilty of not supporting high level professionals and allocating menial administrative tasks to them. These factors result in professionals undertaking tasks that are beneath their technical and intellectual capability, which

minimises their influence within the firm and discourages continuing careers in engineering (Jones *et al*, 1983).

Fundamental problems in the pulp and paper industry exist at the operational level. Significant levels of capital investment have been made in new equipment, technology and levels of automation, without up-skilling the workforce. This has led to chemical engineers adopting supervisory roles to enhance process and production efficiencies (Nice, 2008).

2.13.3. Attracting and Developing Young Talent

Globally, engineering has an image problem and the issues around this need to be addressed. South Africa is not immune to the image problem faced amongst engineers. Concerted efforts have been made by various organisations to deal with this situation. Some organisations have adopted a collaborative approach by involving schools, colleges and universities, including developing skills in mathematics. The industry needs to build and maintain a pipeline or talent pool to ensure continuity and skills replenishment. It is well documented that the engineering discipline faces competition from various other disciplines that provide more fashionable and prestigious outlooks on certain careers (Hall & Sandelands, 2009).

2.14. Labour Turnover

Mitigating labour turnover is one of the biggest challenges facing human asset management (Fitz-enz & Phillips, 1998) and the pulp and paper industry is not immune to this phenomena. Labour turnover is often classified into two categories (Sutherland & Jordaan, 2004):

- Voluntary turnover – whereby an individual leaves an organisation in search of

better employment conditions, job prospects or job satisfaction,

- Involuntary turnover – whereby an individual leaves an organisation as a result of dismissal, retrenchment or performance related issues.

Turnover is a manageable issue in the workplace; however an understanding of the causes of turnover is crucial in turnover management (Sutherland & Jordaan, 2004). A wide array of literature exists on the various competing variables that help predict turnover (Morrell, Loan-Clarke & Wilkinson, 2001). Turnover can be grouped into two categories as postulated by Morrell *et al*. (2001):

- The economic school – encapsulates the labour market theory and supply and demand issues. In this model they explore job search theory and techniques and objective opportunities.
- "The Psychological School" - encapsulates individual decision making, job satisfaction and organisational commitments.

In terms of supply and demand issues, these factors are external to the organisation, and although organisations may argue that they do not have much control over external factors, it is imperative that, in order to respond, they understand the labour market dynamics so that their responses are appropriate in terms of economic shocks when budgeting for manpower Government Gazette (1997).

2.14.1. Types of Turnover

Turnover can be classified as functional or dysfunctional (Sutherland & Jordaan, 2004). Functional and dysfunctional turnover is associated with attributes as stipulated in Table 2.4.

Table 2.4: Characteristics of Turnover (Adapted from Sutherland & Jordaan, 2004)

Functional Turnover	Dysfunctional Turnover
High performing individuals remain in and organisation	High performing individuals leave the organisation
Underperforming individuals leave the organisation	Under or poor performing individuals remain in the organisation

Functional turnover is generally not a problem as no organisation wants to keep 'deadwood'. This mobility is beneficial as it can lead to new idea generation, promotion and mobility of existing staff within the organisation, organisational and cultural rejuvenation and prevention of complacency (Van As, 2001).Dysfunctional turnover is of great concern as it has the following impacts on organisations:

- Financial loss – loss of a highly skilled knowledge worker costs an organisation 22% of the individual's annual salary (Sutherland & Jordaan, 2004)
- Loss of knowledge and knowledge transfer (KPMG, 1998)
- Productivity impacts (Michaud, 2000)
- Loss of momentum and continuity (Van As, 2001)
- Loss of morale in existing employees (Tziner & Birati, 1996)
- Customer dissatisfaction (Koys, 2001)

2.15. Retention

The retention of skilled, talented people is crucial to the profitability and sustainability of a business (Koetser, 2008). The inability of an organisation to retain talent is a key contributor to skills shortage in an organisation (Howitz, 2007). Retention becomes a crucial factor in a skill sector where demand outstrips supply. Although many organisations spend a fair amount of time in attracting people, it is equally important to spend time in retaining skilled talent. Chambers *et al*. (1998) postulated that most large organisations face three challenges in retention of highly skilled people, namely:

- Multi dimensional cultural diversity
- Technological literacy
- Entrepreneurial skills

With this in mind, it is imperative that modern day organisations embrace the challenges that are associated with skills retention. Global market expansion has enhanced mobility and organisations need to guard against the ease of mobility of highly skilled individuals to ensure return on investment in skills development, continuity, sustainability, and growth (Koetser, 2008).

2.16. Conclusion

In order to understand the relationship between the literature discussed and the core fundamentals of labour markets, it is necessary to have an understanding of the labour market for chemical engineers in the pulp and paper industry in South Africa.

Chemical engineers have a vital role to play in the industry and it is important that the industry understands the impacts of the labour markets so that responses to changes are managed and understood. An understanding of labour markets would result in increased productivity, growth and sustainability. The literature review provides a sufficient basis to study the drivers within the labour market. In view of the literature discussed, it is clear that the problem is complex and the research outcomes may not provide clear outcomes of drivers in the current economic climate.

CHAPTER 3: Research Questions

The research aims to clarify the factors that influence the labour market for chemical engineers in the pulp and paper industry. The research questions have been identified and constructed through critical analysis of the literature review. The questions are set out below and answers to the questions will be sought using a qualitative exploratory approach as detailed in Chapter 4.

Research Question 1

Is demand for chemical engineers in the pulp and paper industry exceeding the supply?

Sufficient evidence cited in the literature review indicates that the industrial sector has grown over the last decade. The growth rate is compounded by advanced levels of technology, automation and the continuous need to reduce carbon footprints in terms of sustainability and the environment. This level of growth and technological advancement requires more engineers than before.

Research Question 2

What are the factors that hinder and promote the supply of chemical engineers into the pulp and paper industry?

The objective of the research report is to establish the supply factors for chemical engineering skills in the South African Pulp and Paper Industry. Adequate supplies of well trained professionals are of paramount importance to the industry. A vast array of research cited in the literature review provides a significant amount of insight that indicates that South African universities and universities of technology do not equip graduates with education and skills of the ‘modern industry’.

Recent studies have also provided insight that engineering graduates lack skill sets that:

- Provide sufficient quality to contribute to economic success;
- Have the ability to adopt new, so-called core, skills;
- Have ability to respond to the speed of technological change.

Some studies have indicated that the engineering faculties have stagnated in terms of curriculum design to suit the modern day industry when compared to other faculties like commerce. The literature cited has outlined the factors for an effective technical workforce as:

- High quality mathematics and science education at school level;
- High quality chemical engineering education;
- Structured training programmes;
- Re-definition of training approaches and techniques.

Research Question 3

What are the demand factors that promote and hinder the entrance of chemical engineers into the pulp and paper industry?

On the demand side it is envisaged that the research would provide sufficient insights, as cited in the literature review in the areas of:

- Placement and job creation at the desired skill level;
- Sponsorship and funding for higher level;
- Talent attraction;
- Skills development.

Research Question 4

Is the quality and quantity of chemical engineers entering the industry in line with employer expectations?

The literature cited provides sufficient evidence that indicates that the private sector believes that tertiary institutions are not preparing graduates with the necessary skills to make them readily employable. Sentiments that academic institutions are not supplying the right number of graduates in the fields required and that the institutions are producing generalists rather than specialists with specialised skill sets to meet the needs of defined groups, were also echoed. Many leaders are of the opinion that the workplace is burdened with training that should have been done at tertiary institutions.

Research Question 5

What are the reasons for chemical engineers leaving the pulp and paper industry?

Although much research has been conducted in this area and various initiatives have been undertaken by the industry in South Africa, many chemical engineers exit the industry for the following reasons amongst others:

- Lack of growth;
- Competition from other industries;
- Emigration;
- Under utilisation;
- Under professionalisation;
- Socio-political factors;
- Safety and security.

CHAPTER 4: Research Methodology

4.1. Research Method and Design

The study aimed to explore and delve into the underlying factors that influence the labour market of chemical engineering in the South African Pulp and Paper Industry with an attempt to prepare a framework of responses to the dynamics that play in the labour market. Qualitative research has multiple views and constructs as described in Table 4.1 and cannot be objectified (Creswell, 1994; Daft, 1993). These methods can be successfully used in the study of groups, small communities and organisations, as well as cases which do not fit into sets of particular theories (Welman & Kruger, 2001).

This research involved conducting qualitative exploratory in-depth interviews in a semi-structured manner to uncover and understand the important factors that influence the supply and demand of labour within the chemical engineering labour market of the pulp and paper industry.

Table 4.1: Reasons for qualitative construct as postulated by Welman and Kruger (2001)

No	Reasons for a Qualitative Construct
1	Qualitative research deals with subjective information/data and is produced by respondents
2	Qualitative research is based on flexible and exploratory methods to gain a deeper understanding on the subject at hand
3	Investigates the day to day events
4	Attempts to ascertain an insider's view in a subjective manner
5	Deals with the dynamic and changeable nature of reality

6	Uses a holistic approach in data collection – a wide variety
7	Focuses on validity
8	Utilises a small sample and adopts an in-depth approach

4.2. Population

A population refers to the entire group of people, events, or things of interest that the researcher wishes to investigate (Sekaran, 2000). In human research, a population is a larger group of all the people of interest (Graziano & Raulin, 2004). The target population or population of relevance is defined as the specific, complete group relevant to the research project (Zikmund, 2003). The population of relevance for this study is shown in Table 4.2, and consists of the stakeholders that have an influential role in the labour market for chemical engineers in the South African Pulp and Paper industry.

Table 4.2: Population of relevance

Population of Relevance
1. Universities with Chemical Engineering Faculties
2. Universities of Technology with Chemical Engineering Faculties
3. Forest Industry Education and Training Authority (FIETA)
4. Employers
5. Paper Manufacturer's Association of South Africa - PAMSA
6. Engineering Council of South Africa
7. South African Institute of Chemical Engineers - SAIChe
8. Employees

4.3. Sampling Strategy

A sample is a subset of population. It comprises of some members selected from the population, i.e. some but not all elements from the population would form the sample (Sekaran, 2000). The study focused on the influence and responses to the labour market of chemical engineering skills in the South African Pulp and Paper Industry. The sample size is drawn out of the population which is made up of stakeholders that play an influential role in the industry (Trochim, 2001). The specific unit of analysis is the perception of stakeholders regarding the supply and demand factors that influence the responses to the development of chemical engineers in the South African Pulp and Paper industry. Given the nature and scope of the research, 25 experts (educated individuals with relevant experience in their fields) representing the various stakeholders were interviewed as shown in Table 4.3 below.

Table 4.3: Sample distribution of stakeholders

Population	Sample Distribution	Total
Chemical Engineering Faculties at Universities	4 Representatives per region	4
Chemical Engineering Faculties at Universities of Technology	4 Representatives per region	4
Director of the FIETA	1 Representative	1
HR Managers in the Pulp and Paper Industry	1 Representative per company	4
Technical Managers in the Pulp and Paper Industry	1 Representative per company	4
Engineers leaving the Industry	5 Representatives	5
Professional Body - PAMSA	1 Representative	1
South African Institute of Chemical	1 Representative	1

Engineers		
Engineering Council of South Africa – ECSA	1 Representative	1
Total		25

Given the nature of the study, a judgment or purposive sampling technique was adopted as the sampling strategy. Purposive or judgmental sampling is a non-probability sampling technique which enables the researchers to use their own judgment to select sample members that will best enable one to answer and meet the objective of the research question**.** The logic on which the researcher bases the strategy for selecting the cases for a purposive sample will be dependent on the research questions and objectives (Saunders *et al*, 2003).

4.4. Data Collection and Methodology

Data was obtained in the form of semi-structured interviews with experts as detailed in Table 4.3 that have a stakeholder interest in the supply and demand factors for chemical engineers in the pulp and paper industry. The methodology adopted is detailed in section 4.4.1.

4.4.1. Questionnaire Construction

Primary data was obtained by a process of conducting semi-structured qualitative in-depth interviews with stakeholders by means of well designed and thought out open ended questions to ensure consistency and relevance (Phillips & Stawarski, 2008). Semi-structured interviews are interviews where the interviewer has a list of themes and questions as detailed in Appendix 2. The themes of questions and order may vary from interview to interview depending on the flow of the conversation. Data was

recorded by note taking (Saunders *et al*, 2003). A list of the participants that participated in this research is detailed in Appendix 3.

The confidentiality process was explained prior to the interview. In addition, an agreement between interviewer (researcher) and participant was reached by signing a letter of informed consent as detailed in Appendix 4. Names of participants and stakeholder groups are not disclosed in the final research paper. In doing so the researcher aims to provide sufficient comfort and thus allow the respondents to make open disclosures of in-depth tacit knowledge pertaining to the research questions. Interviews were conducted at the respondents' place of convenience (Phillips & Stawarski, 2008). Data collection during the interview process was accomplished by the interviewer taking detailed notes of the conversation. It was envisaged that the face-to-face interaction during the interview process enhanced the following attributes:

- Elaboration and discussions on the subject matter;
- Control of time;
- Probing for substantial reasoning due to the complexity of the subject;
- Enhanced participation rate.

Demographic and educational information on engineers exiting the industry was obtained by means of a ratio scale questionnaire. It is envisaged that the adopted approach will allow for sound realisation to answers posed by the research questions.

The participation matrix provided in Table 4.4 gives an indication of the various stakeholder involvements per question.

Table 4.4: Participation Matrix of Stakeholders

	Training Institutions	Employers	Associations	Engineers that have exited industry
RQ1. Is the demand for chemical engineers in the pulp and paper industry exceeding the supply?	☒	☒	☒	☒
RQ2. What are the factors that promote and hinder the supply of chemical engineers in the pulp and paper industry?	☒	☒	☒	☒
RQ3. What are the demand factors that promote and hinder the entrance of chemical engineers to the pulp and paper industry?	☒	☒	☒	☒
RQ4. Is the quality and quantity of chemical engineers entering the pulp and paper industry in line with industry expectations?	☒	☒	☒	☒
RQ5. What are the reasons for chemical engineers leaving the pulp and paper industry?	☒	☒	☒	☒

4.5 Interview Schedule

The researcher's intention to approach the stakeholders was to extract information as detailed in the predefined questionnaire (Appendix 2). In addition there were interventions by the stakeholders that led to further insights, and hence the engagement was not limited to the set of predefined questions. In conducting the research, the researcher took the following factors into consideration:

- Venue;
- Seating arrangements;
- Time.

4.6. Data Analysis

Data analysis and interpretation forms an imperative component of the research process (Eisenhardt, 1989). Since this research was qualitative, data collection took place through semi-structured exploratory interviews. Qualitative data analysis can be likened to a metamorphosis, where the researcher applies analytical methods that finally emerge with findings; the process is highly intuitive and often subjective (Merriam, 1998).

The method of analysis used in this study will be a combination of narrative analysis, constant comparative analysis, content analysis and descriptive statistics. The envisaged approach will thus entail breaking the data in manageable themes, patterns, trends and relationships. Welman *et al* (2001) described the content analysis method to analyse collected data. This method involves the collected data being examined systematically to record the frequency of themes and of the ways these themes are portrayed.

The volume of information obtained from the interviews in the current research was large, and as such the data was collated in terms of the research questions posed so as to organise the raw data (Koetser, 2008). This categorisation of data assisted in the identification of themes prior to editing the raw data (Holliday, 2002). The process through which the researcher obtained the data from the interview process and analysis to writing is mapped out in Figure 4.1. The 'corpus of raw data' (Figure 4.1 a) is the actual raw data that is used in this research. This encompasses sections of the original, complex, 'messy' information the researcher obtained from the interviewees, which was beyond the scope of the researcher to interpret completely. The data at this stage was still raw and had to be analysed and subsequently organised according to the given research questions (Figure 4.1 b). A common method of organisation was used that involved taking data from all parts of the corpus and arranging it under thematic headings (Holliday, 2002).

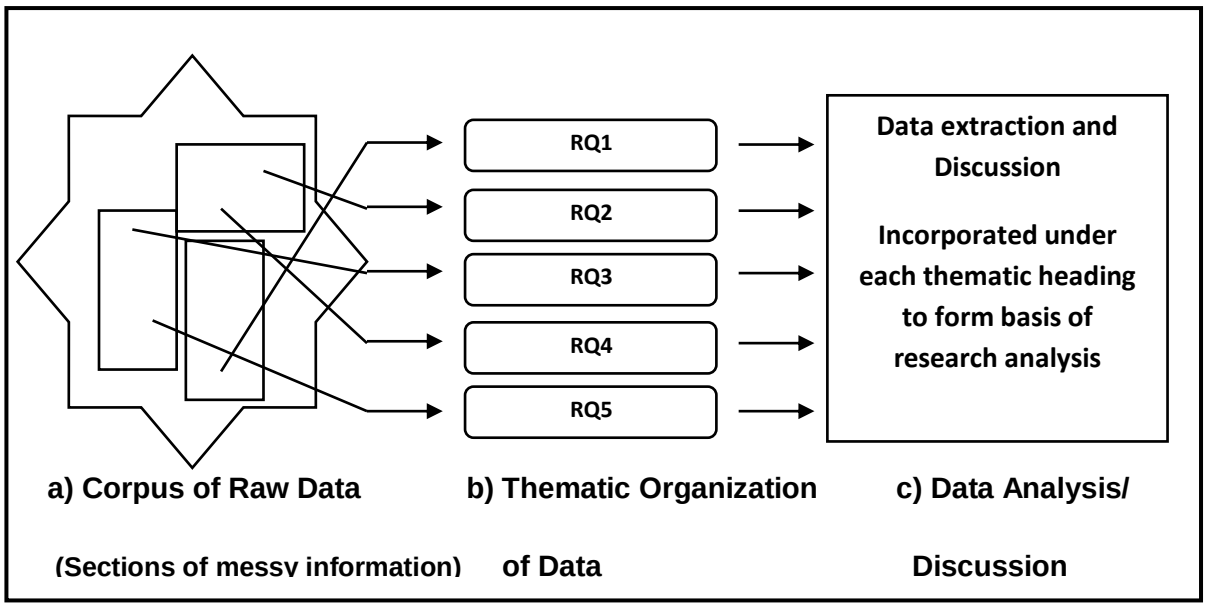

Figure 4.1: Data Collection, organisation and analysis (Adapted from Holliday (2002))

These themed headings (Figure 4.1 b) then became the basis for data analysis. Under each thematic heading extracts of data were taken from the corpus and put together with the discussion (Figure 4.1 c) so as to answer the research questions.

4.7. Research Limitations

The researcher was not formally trained to conduct face-to-face interviews as recommended by Welman and Kruger (2001). In addition, the sampling techniques fell under the non-probability methods and thus the extent to which the sample represented the population cannot be claimed with assurance. Time and cost constraints were the limiting and determinant factor for access to interviewees. The qualitative analysis process can produce systematic errors in terms of interviewer and response biases into the analysis and interpretation of the results of the study (Zikmund, 2003). The respondents were chosen by the researcher and a key selection criterion was the researcher's accessibility to the respondents as well as the researcher's judgement of the respondents' skill as subject matter experts. The combination of a convenience and judgement sampling methodology in a qualitative non-probabilistic approach lends itself to results that cannot be generalised to a population with any degree of confidence (Zikmund, 2003)

CHAPTER 5: Results

5.1 Introduction

This section presents the results of qualitative exploratory in-depth interviews that were conducted to establish the influencing factors of the supply and demand of labour within the chemical engineering labour market of the pulp and paper industry. All interviews were carried out in a semi-structured manner. Raw data was analysed using content analysis in a systematic manner to allow for an objective transcription of the emerging themes and patterns. A total of 18 respondents participated from the defined stakeholders as detailed in Table 4.3 of Chapter 4.

5.1.1 Sample Description

Figure 5.1 provides a graphical overview of the number of stakeholders in the industry to be sampled and the actual participating stakeholder response. A total of 26 interviews were planned to be conducted with various stakeholders in the industry. A total of 18 interviewees participated in the process, which equals 69% of the response rate (based on actual number of participants interviewed). Industry associations like ECSA, SAIChe and FIETA were not keen on participating in the interview. ECSA and SAIChe representatives indicated that they do not have sufficient information on the labour market of the pulp and paper industry but rather have a general overview of the chemical engineering environment as a whole. Attempts to engage with FIETA were unsuccessful. Both the technical manager and human resources manager from one company did not participate. In most cases institutions did not respond to the researcher's attempt to make contact. Despite these limitations, a 69% participation rate was achieved. This is a good

representation considering the geographical location of the various stakeholders and the diverse nature of the industry.

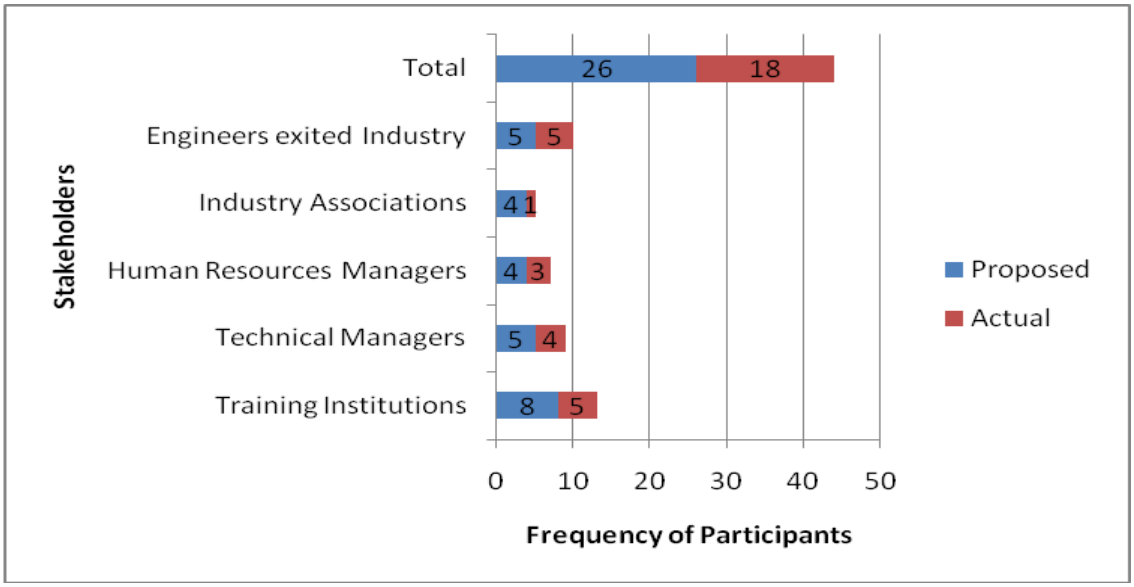

Figure 5.1: Stakeholder representation and participation rates

5.2. Chapter Layout

The data recorded during interviews with the relevant stakeholders was analysed for common themes across the interviews. The analysis was performed by collecting the raw data in a table form to facilitate ease of viewing and extraction of common themes. All raw data from the interviews was analysed and captured into themes. Content analysis was done to determine the frequency of themes emanating from the raw data. The frequency of the themes were quantified and presented in a graphical format. Further justification to the themes was validated by direct quotation of stakeholder responses. It must be noted that although there were 18 respondents, often participants provided more than one response to the questions posed to them. This was accepted by the researcher as it provided greater insight into the

underlying issues, provided an indication as to the complexity of the problem at hand and added to the richness of the research.

5.3 Research Question One: *Is the demand for chemical engineers in the pulp and paper industry exceeding the supply?*

The purpose of Research Question One was to establish the stakeholders' view of the supply and demand of chemical engineers in the pulp and paper industry. The question was made up of four parts:

- Part 1: attempted to ascertain whether there is an imbalance in supply and demand
- Part 2: attempted to ascertain evidence supporting the stakeholders' view of the imbalance in supply and demand
- Part 3: attempted to gain an understanding of the stakeholders' views on the reasons of the imbalance in supply and demand
- Part 4: attempted to gain an understanding of the stakeholders' views on solutions to remedy the imbalance in supply and demand.

Part 1

This was a Likert scale question that attempted to determine whether demand exceeded supply. The questionnaire was constructed to ascertain whether the stakeholders agreed or disagreed with the statement of demand exceeding supply. The responses were quantified and reported in a descriptive form. Figure 5.2 illustrates the response of the frequency of agreements and disagreements amongst the stakeholders regarding if the demand for chemical engineers in the pulp and paper industry exceeds the supply. Of the 18 respondents, 14 believe that the

demand for chemical engineers is not exceeding the supply, thus disagreeing with the aforementioned question. The only respondent from an industry association and one from one respondent from the company agree that demand for chemical engineers exceeds the supply. Two respondents from engineers exiting the industry took a neutral stance to this question.

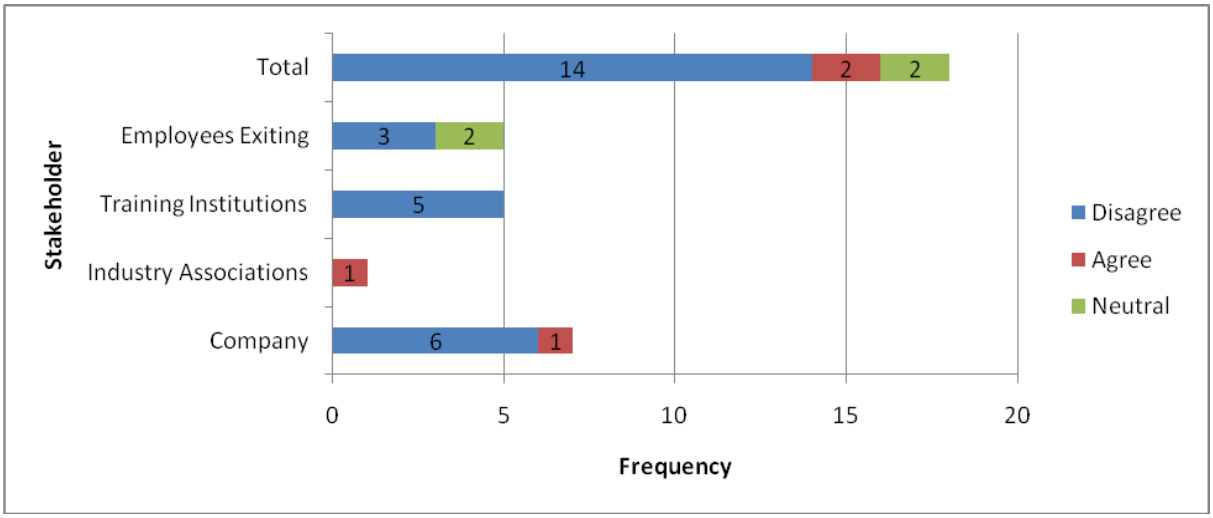

Figure 5.2: Stakeholder view of supply and demand

Part 2

Part two attempted to extract supporting evidence to the response of the first part of the question. The researcher was of the opinion that supporting evidence would provide a deeper understanding of the stakeholders' views and would provide insight into the way the industry measures the supply and demand for chemical engineers. The yardstick used to determine excess supply was to measure the inability of graduates to find jobs or to be placed in structured employment after graduation. Sufficient evidence was obtained during the interview process to support this. On the demand side, sufficient evidence was provided in terms of the number of applications received after a job is advertised. Engineers often make a choice in

terms of what they want to do, and if not utilised in an efficient manner, they often leave for alternate vacancies.

The supporting evidence was presented by the themed responses depicted in Figure 5.3. The frequencies of the most prevalent themes are:

- Graduates fail to find employment/placement - this signifies the inability for chemical engineering graduates to find employment.
- Ease in replacing engineers – this signifies the ease with which companies replace engineers when they leave.
- Engineer utilisation - this signifies the actual role the engineer plays in the industry.

These emergent themes validated the research question of excess supply.

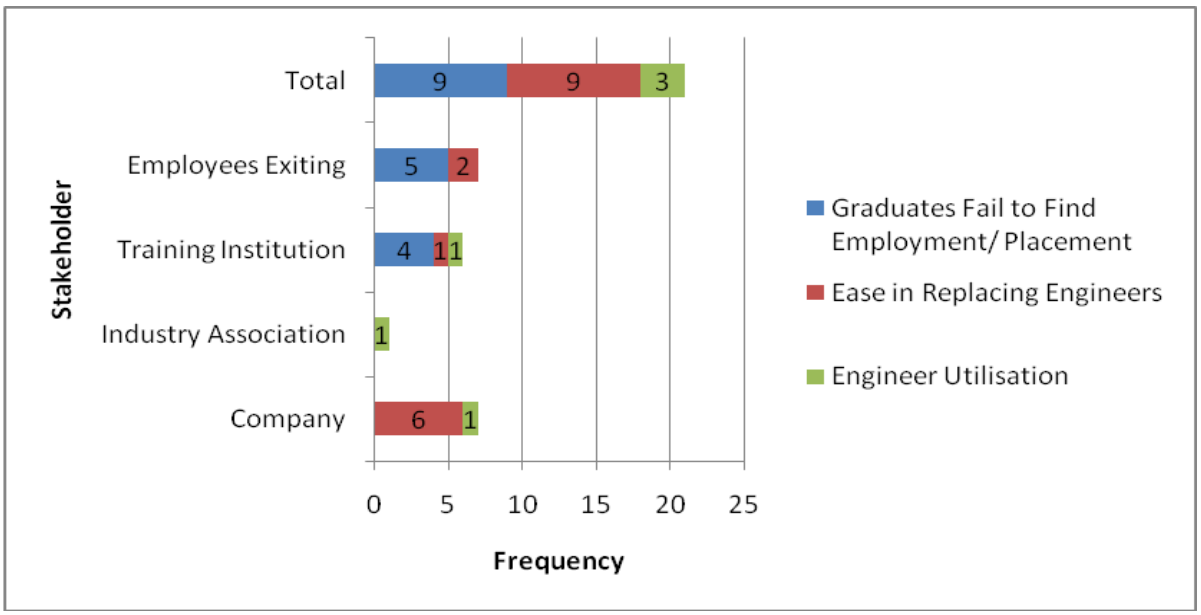

Figure 5.3: Evidence supporting excess supply

5.3.1 Stakeholder Evidence In Support Of Excess Supply

Theme 1: Graduates Fail To Find Employment/Placement

Training institutions indicated that not all graduates were absorbed into the chemical engineering/pulp and paper industry, and remained unemployed or joined different sectors. One training institution provided evidence by a means of a survey they undertook at the 2010 graduation ceremonies to determine if the graduates were employed. The respondent revealed: "...*20 percent of the graduates were unemployed at that point in time...".* Another training institution indicated that they had reduced student intake in the 2010 academic year due to the fact that graduates were not finding employment. This was an effort to curb the supply.

Human resource managers in companies echoed the sentiment that: *"there is an abundance of applications received when a position is advertised; however the quality and experience levels are of concern… ".* An engineer that exited the industry stated that "*Countless friends that I have who have completed University and have specialised in wood pulping and papermaking modules and cannot find jobs within the industry, whereas those that specialised in Oil and Minerals/Petrochemical modules are quickly snatched up by those companies within those industries."*

Theme 2: Ease in Replacing Engineers

At company level, some managers stated that the supply of engineers is not an issue. The general response was: *"...we are always able to fill in the positions, albeit that we may not get the right quality."*

Theme 3: Engineer Utilisation

A company expert explained that the engineering industry is a process industry and chemical engineers, if utilised appropriately, will put the supply under stress and hence believed that the supply of engineers is insufficient. This company expert stated that: "*Chemical engineers should be utilised in four spheres of the industry, there is place for them in the following spheres:*

1. *Operations*
2. *Process Optimisation*
3. *Project Engineers*
4. *Research and development*

This is the ideal pulp and paper plant and if the industry adopts engineer utilisation in this manner process engineers would be in short supply; the industry has to move in this direction to improve efficiencies…". Another industry expert indicated that: "*...industry does not know what to do with the engineers who are utilised at supervisory levels due to the fact that the skill of operational staff is lacking. This is of concern as in most organisations people are operating at the wrong levels… ".*

Part 3

This part of research question one aimed to ascertain the stakeholders' views of the reason for the excess supply of chemical engineers**.** Figure 5.4 illustrates four emerging themes from the phenomenon that sees an excess in the supply of engineers. The frequency of participants' responses were categorised into themes and the emergent themes were:

- Chemical engineering is a rewarding diverse industry - this refers to chemical engineering as a career which is rewarding with a diverse scope for job opportunities;
- Industry is buying technology – this refers to the fact that the industry outsources design and technology components to specialists;
- Utilisation rate of engineers in industry is low – this refers to engineers who are not utilised to perform engineering-related functions;
- High levels of intake – this refers to training institutions which allow for a large number of enrolments.

The response from the participants indicated that the excess of supply is related to the rewarding and diverse nature of chemical engineering as a career, which makes it attractive as a career choice. In addition, industry buys technology which does not allow for the absorption of chemical engineers into the industry's workforce, thus resulting in and allowing for an excess in supply. From this perspective the industry cannot afford to house design engineers for long periods of time, and the knowledge base still lies with German and Scandinavian companies. A third contributor to the excess in supply was attributed to the utilisation rate of engineers. The utilisation rate of engineers, in the South African Pulp and Paper industry, is regarded by industry experts as low. Participants indicated that tertiary institutions also contributed to the excess in supply due to the large number of student intakes and the minimal selection criteria.

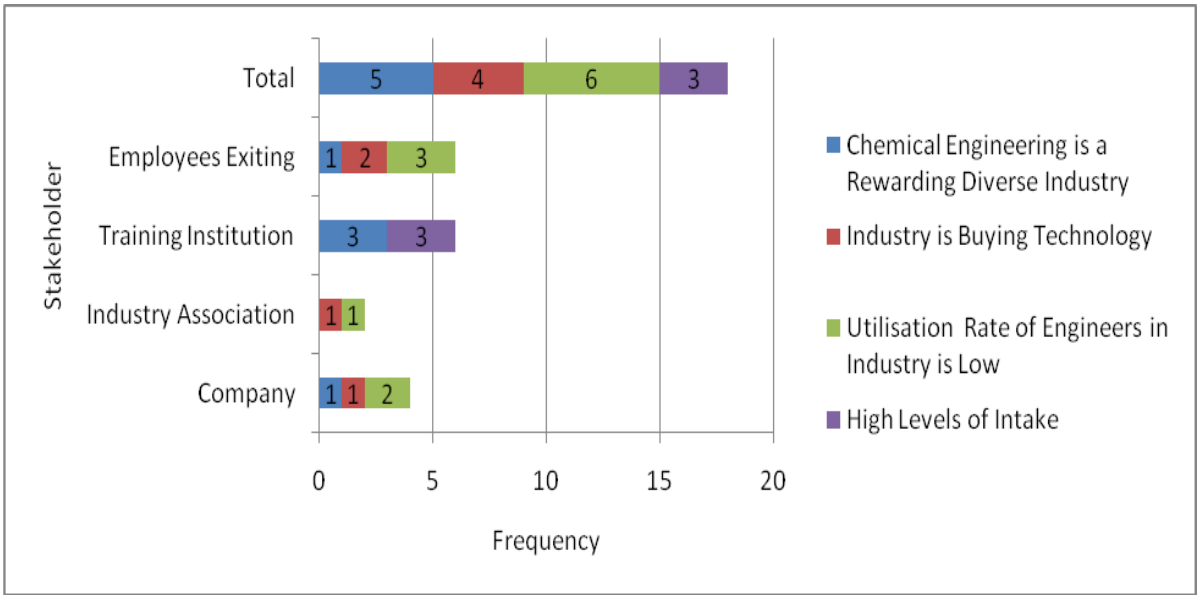

Figure 5.4: Factors contributing to excess supply

5.3.2 Stakeholder Evidence in Support of Factors Contributing To Excess Supply

<u>Theme 1: Chemical Engineering is a Rewarding, Diverse Industry</u>

Many respondents reiterated the sentiments that matriculants chose to study chemical engineering as it is a rewarding career. Respondents from training institutions confirmed this sentiment, and stated that: "*...the generic structure of the chemical engineering curriculum allows for graduates to find employment in any process industry, however the industrial sector is not growing fast enough*".

A second factor in training institutions contributing to the excess in supply of engineers was the level of intake. As one respondent mentioned: "*...it is impossible to predict demand and in my experience I can conclude that the demand is very cyclical, this coupled with the relaxation of intake requirements contributes to an oversupply".*

Theme 2: Industry is Buying Technology

Experts from the companies in the South African pulp and paper industry stated that they do buy in technology from abroad, simply because "...*most of the engineering houses for the pulp and paper industry resides in Europe and Scandinavia, we do not do detailed engineering in house as this becomes an expensive option...*"

Theme 3: Utilisation Rate of Engineers in Industry is Low

Another company expert stated that *"the industry is not developing fast enough in South Africa, the industry needs to use engineers to grow the industry as it faces numerous issues in terms of renewable energy, efficiency improvements and waste reduction and if these issues are addressed appropriately then the supply would come under serious pressure. Although many graduates are produced at undergraduate level, little or no effort is placed on the production of post graduates".*

Theme 4: High Levels of Intake

A training institution attributes the high levels of supply to the relaxation of entrance requirements, as if students don't get into university then they pursue a career in chemical engineering at a university of technology. A training institution that offers an elective in pulp and paper indicated that the faculty are very popular and the intake is limited to 30 engineers per year, however the industry is unable to absorb these graduates and some are placed at specialist research units like the Council for Scientific Research (CSIR).

Part 4

Part 4 of Research Question One attempted to establish the solutions recommended by the stakeholders in the industry to curb the excess in supply of chemical

engineers to the pulp and paper industry. The solutions proposed by the participating stakeholders are represented in Figure 5.5. The frequency of participants' responses were categorised into themes and the emergent themes were:

- Restricting intake - refers to training institutions limiting the number of enrolments;
- Understanding the manpower needs – refers to companies having a good forecast for the number of engineers required;
- Engineer utilisation – refers to engineers performing engineering related functions;
- Improved image - refers to the attractiveness of the industry.

From the responses obtained it can be seen that more than 39 % of stakeholders came to the realisation that engineer utilisation should be encouraged in the industry. In addition, training institutions proposed restricting the intake of students to curb the excess supply of engineering graduates. An improvement of the industry's image was strongly recommended by employees exiting the engineering industry, as well as current employers.

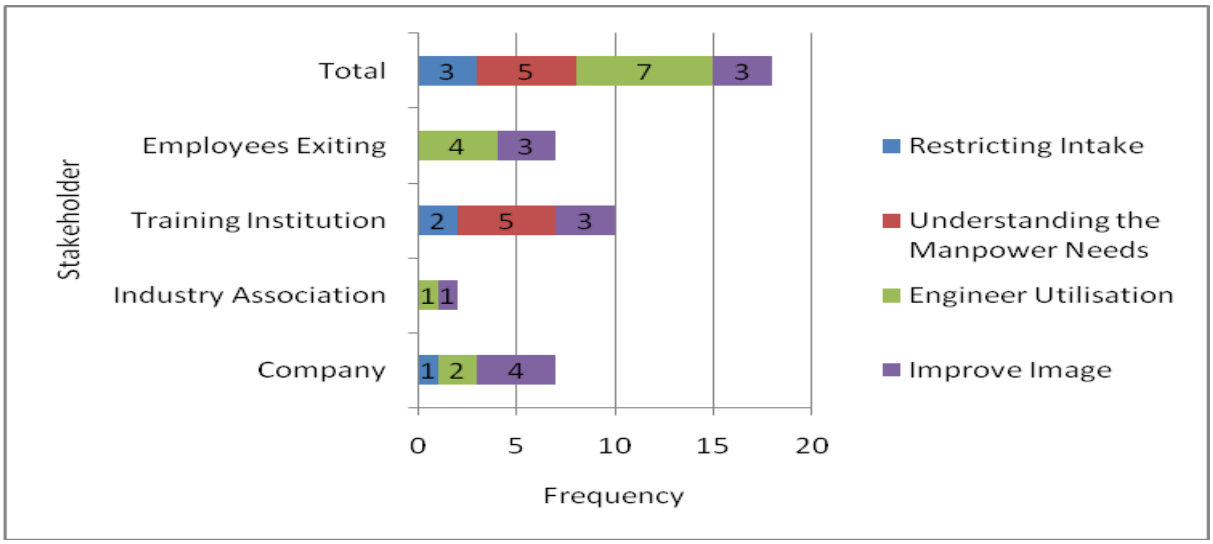

Figure 5.5: Proposed solutions to curb supply

5.3.3. Stakeholder Evidence in Support of Curbing Supply

Theme 1: Engineer Utilisation

Many respondents proposed that the industry should utilise engineers in key functional roles, as this would promote the demand for engineers. Most employees exiting the industry indicated that, *"Industry has a tendency to employ wood scientists, chemists and paper makers in engineer roles; this practice hampers engineer development and utilisation…".* One company expert pointed out that *"...the industry has scope to employ engineers in three distinctive roles of optimisation, operations and projects. An increase of engineer employment in these functions would increase demand….".*

Theme 2: Improve Image

Companies are of the opinion that a multitude of factors are responsible for the excess supply of engineers and many echoed the sentiments of the industry's poor image. A company representative indicated that "*the image of the industry can hardly be considered as a pull factor; currently there is no fertile ground for engineer breeding…".*

5.4. Research Question Two*: What are the factors that hinder and promote the supply of chemical engineers in the pulp and paper industry?*

The purpose of Research Question Two was to establish from the various stakeholders the factors that promote or hinder the supply of chemical engineers in the industry. The question is made up of three parts:

- Part 1: attempts to gain stakeholder understanding of factors that hinder the supply of chemical engineers in the pulp and paper industry;

- Part 2: attempts to gain stakeholder understanding of factors that promote the supply of chemical engineers in the pulp and paper industry;
- Part 3: attempts to gain understanding of the proposed solutions stakeholders have to remedy the issues of hindrance and promotion of supply of chemical engineers to the pulp and paper industry.

Part 1

This part of the question attempted to gain stakeholder understanding of the factors that hinder the supply of chemical engineers in the pulp and paper industry. Figure 5.6 represents the factors that industry stakeholders believe hinder the supply of chemical engineers. The frequency of participants' responses were categorised into themes and the emergent themes were:

- Level of Maths and Science – refers to the incumbents' proficiency levels in cognitive subjects as measured in mathematics and sciences;
- Industry awareness – refers to the engineers' familiarity with the industry;
- Finance – refers to the ability of the incumbent to secure financial resources to enter the field of study;
- Engineer utilisation – refers to engineers performing engineering related functions.

From the graph it can be seen that the poor levels of maths and science are of concern at the training institutions. Industry awareness ranks the highest and accounts for approximately 30% of the hindering factors and is of great concern amongst the exiting employees, companies and training institutions. 24% of all stakeholders felt that utilisation of engineers was a hindering factor to the supply.

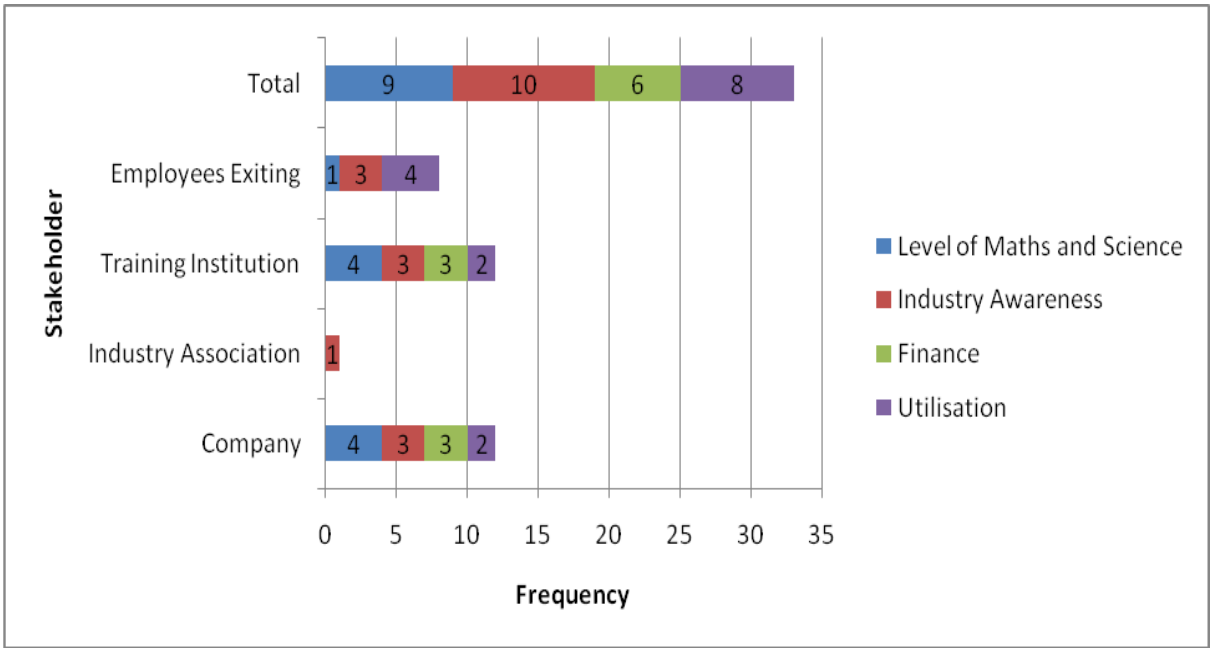

Figure 5.6: Factors that hinder chemical engineering supply

5.4.1 Stakeholder Evidence in Support of Hindrance to Supply

Theme 1: Level of Maths and Science

The secondary school level of education was of great concern amongst the training institutions. Maths and Science competency at secondary school level is relatively poor and this is considered a large contributor to the hindrance of the supply of chemical engineers, since school leavers do not meet tertiary level requirements. A training institution expert explained that the *"...mathematics and physics pass rate results for the first semester students for 2010 has been the lowest in many years and can be attributed to the Outcomes Based Education system that has been introduced at schools recently…".*

Another training institution has created a foundation programme to improve the mathematics and science levels of students entering the engineering faculty. In addition, one industry institution has started a programme to enhance mathematics

and science levels at school level. A human resources director at another industry institution indicated that he is willing to start a similar initiative at his company.

Theme 2: Industry Awareness

The initiatives by the above mentioned industry companies are twofold as their intention is also to create industry awareness. Training institutions believe that the industry plays a very passive role in attracting engineers to the industry. The engineering industry is virtually unheard of and very few people have an understanding and appreciation of the industry. As one training institution expert indicated, *"we are the only educational institute that offers pulp and paper as an elective. This unit is capacity constrained as it can accommodate a maximum of thirty students..."*. One industry association has only recently secured funding from the employers and has embarked on a project to finance post graduate students at university.

Theme 3: Finance

Finance is also a factor that hinders the supply of chemical engineers. Many students often study on student loans. A training institution indicated that *"75 % of students study on student loans…"*. Another training institution indicated that "*at final year level as much as 60% of the students manage to secure some sort of funding; the financial burden is high given the historical income disparity…"*.

Part 2

The second part of Research Question Two attempted to establish the stakeholders' views on factors that promote the supply of chemical engineers in the pulp and paper industry. Figure 5.7 gives an indication of the factors that industry stakeholders

believe promote the supply of chemical engineers. The frequency of participants' responses were categorised into themes and the emergent themes were:

- Competitive packages – refers to the salaries and fringe benefits offered by companies;
- Role and utilisation – refers to the position, tasks and functions engineers perform;
- Industry profile and image – refers to the type of unit operations within the companies and the overall positioning of the company in the context of other process related companies.

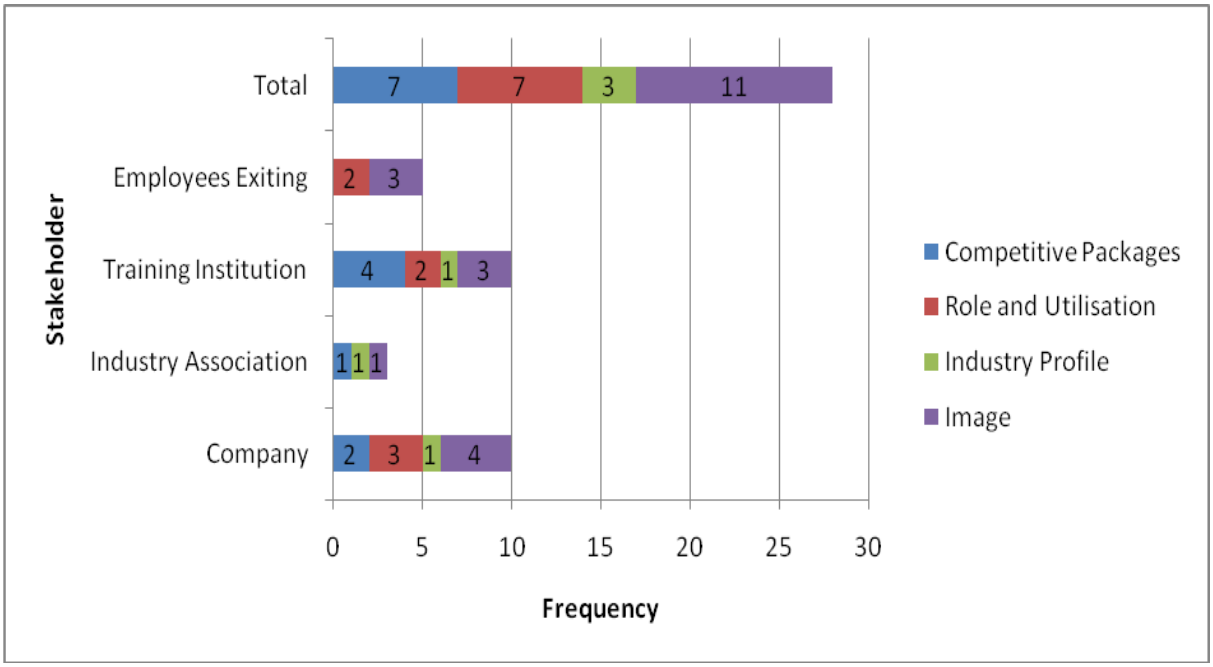

Figure 5.7: Factors that promote supply

The research results indicate that there is a high focus in terms of competitive packages followed by roles and utilisation and industry image, and stakeholders believe that remedying these factors may enhance supply.

There appears to be consensus amongst all stakeholder participants on the view that the industry does not offer competitive packages and if this issue is addressed then it may promote the supply of chemical engineers in the industry. The industry is competing for this scarce resource with the petrochemical companies who offer many fringe benefits coupled with an attractive salary.

One industry expert indicated that the chemical engineer *"is often used as the production manager's clerk, hence the under utilisation…"*.

The industry experts, academics and associations believe that the industry does not profile itself as a key user of chemical engineers, and the old adage of the industry being a production entity needs to change as its very nature consists of processes.

Part 3

The third part of Research Question Two attempted to ascertain the solutions that stakeholders propose to improve the supply of chemical engineers to the pulp and paper industry. Figure 5.8 provides insight into solutions that stakeholders believe would help improve the supply of chemical engineers in the industry.

Four promising themes were found to be likely solutions that may be implemented to improve the supply of chemical engineers to the pulp and paper industry. The themes are:

- Engage with academia – refers to the contact and involvement of the industry with academic institutions;
- Promote image – refers to the industry's ability to market itself in the context of other process related industries;

- Harness and adopt students early in the life cycle – refers to the companies' ability to engage with students when students enter training institutions;
- Provide study assistance and orientation – refers to the industry's ability to sponsor students and provide vacation work.

The frequency distribution is indicated by in Figure 5.8. Harnessing and adopting students early in the life cycle and industry image promotion were the two most popular solutions given by stakeholders.

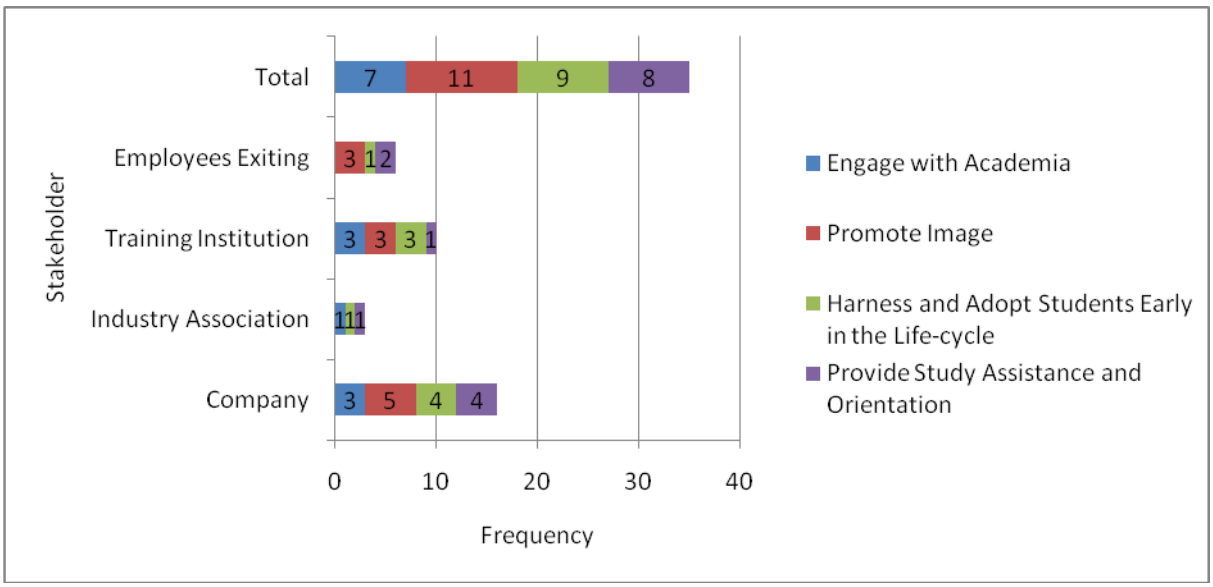

Figure 5.8: Proposed solutions to enhance supply

5.4.2. Stakeholder Evidence in Support of Enhancing Supply

Theme 1: Promote Image

The data in Figure 5.8 provides a consensus that the chemical engineering industry suffers from an image problem. One industry association expert indicated that "*the industry must go out on a massive public relations exercise in terms of creating awareness. The industry needs a dedicated public relations department…".*

In an attempt to promote their image, one company expert indicated that *"the big players need to collaborate in creating an image for the industry and it cannot work if the role players work in silos…".*

Theme 2: Harness and adopt students early in the life cycle

Engineers that have exited the industry believe that it should recruit future engineers from university graduates. In addition, the industry should provide study assistance in the form of bursaries and provide an engineering orientation programme to future candidates to platform the prospects for chemical engineers in the industry. An engineer that has left the industry indicated that *"companies must make themselves highly visible at tertiary institutes and offer incentives, bursary schemes etc. to get students excited about going into the industry…".*

Theme 3: Engage with Academia

Training institutions also indicated that there is a need to open the channels of communication and foster a relationship. A training institution expert indicated that, *"if industry plays an active role in academia and is prepared to adopt real life industrial problems in the curriculum, this will be a good promotional exercise as students invariably start asking questions about the industry…".*

5.5 Research Question Three: *What are the demand factors that promote and hinder the entrance of chemical engineers into the pulp and paper industry?*

The purpose of this question was to establish from stakeholders the factors that promote and hinder the demand for chemical engineers in the industry. The intention

was to establish whether the stakeholders share the same view on the demand side issues. Research question three is made up of three parts:

- Part 1: attempts to gain stakeholder understanding of factors that promote the demand of chemical engineers in the pulp and paper industry;
- Part 2: attempts to gain stakeholder understanding of factors that hinder the demand of chemical engineers in the pulp and paper industry;
- Part 3: attempts to gain understanding of the proposed solutions stakeholders have to remedy the issues of hindrance and promotion of demand of chemical engineers in the pulp and paper industry.

Part 1

This part of the question attempted to gain stakeholder understanding of the factors that promote the demand of chemical engineers in the pulp and paper industry. Figure 5.9 depicts the prevalent themes that promote demand of chemical engineers in the pulp and paper industry:

- Competitiveness - refers to the salaries and fringe benefits offered by companies;
- Improved working environment - refers to working conditions and the flexibility to harness potential relative to other industries;
- Understanding the demand – refers to the industry's ability to forecast the demand for chemical engineers;
- Training and development – refers to the ability of companies to provide industry specific training needs to generalists.

The above mentioned factors were found to be likely contributors in the enhancement of the demand for chemical engineers in the pulp and paper industry. The frequency distribution is shown in Figure 5.9.

Competitiveness and an improved working environment dominate demand by more than 54%. Competitiveness in terms of salaries and benefits, coupled with the level of professionalism and job satisfaction, were found to play an important role in demand promotion by stakeholders.

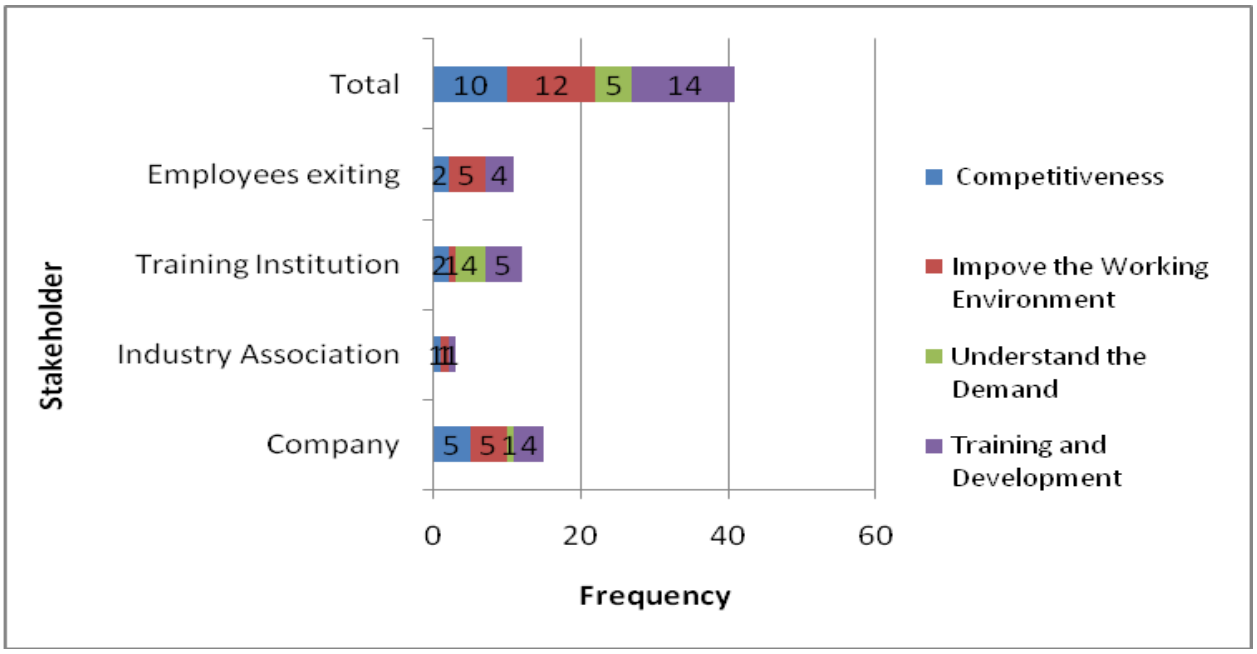

Figure 5.9: Factors promoting demand

5.5.1 Stakeholder Evidence in Support of Demand Promotion

Company representatives indicated that a proper, structured training programme is crucial for engineer attraction and retention. One company representative indicated that "*engineers have often played a supportive role to production and are tasked with menial tasks, this must change and we must create an attractive environment for competition, innovation and development…".*

Engineers that have exited the industry indicated that their reasons for leaving centred around pay, job responsibilities and other opportunities. Another interesting factor was that many graduates who completed their two year engineering degree in training programmes were not guaranteed employment and exited the industry for better and more stable jobs. Many training institution experts indicated that they do not have a clear indication of what the demands are and this often poses a problem as they are unable to control the intake. Planning at training institutions is done for the long term, however not knowing the demand for engineers creates imbalances in the labour market. They are often faced with too many applicants to study engineering.

Part 2

The second part of Research Question Three attempted to establish the stakeholders' views on factors that hinder the demand of chemical engineers in the pulp and paper industry. Figure 5.10 depicts the prevalent themes that hinder the demand for chemical engineers in the pulp and paper industry.

- Utilisation – refers to engineers performing engineering related functions;
- Knowledge of what engineers can do – refers to tasks that the engineer has been trained to perform;
- Emphasis of technical excellence – refers to the ability for the industry to focus on rational approaches in operation;
- Expansion and industry growth – refers to the capital spend to foster growth.

The above mentioned factors were found to be likely contributors that hinder the demand of chemical engineers in the pulp and paper industry. The frequency distribution is indicated in Figure 5.10. From Figure 5.10 it can be seen that the

utilisation factor and technical experience of engineers in the industry did not hinder demand substantially as compared to knowledge of what engineers can do.

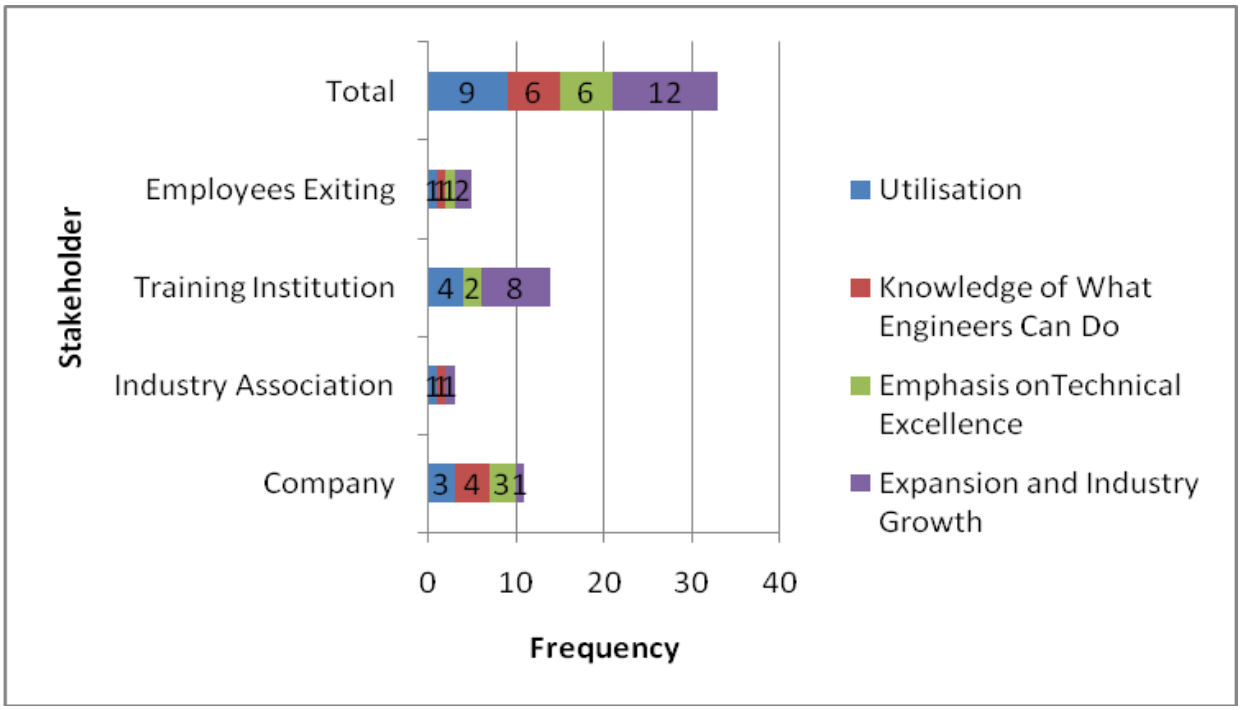

Figure 5.10: Factors hindering demand

5.5.2 Stakeholder Evidence to Support Factors Hindering Demand

Theme 1: Expansion and Industry Growth

The industry has stagnated over the last decade, with very few expansion projects. A lack of capital expenditure limits the engineer's potential to expand in the design environment. An company expert indicated that "...*due to cost constraints a lot of design work is outsourced to design companies and this limits the engineers' creativity, many of the engineers in industry perform the roles of optimisation and product development , hence the engineers' full potential is not harnessed* …".

Theme 2: Knowledge of What Engineers Can Do

Industry and industry associations echoed sentiments regarding the lack of knowledge in the industry of what the roles and responsibilities of chemical engineers are and how they should be utilised to add value. An association expert indicated that *"we don't know what to do with these guys, the industry is operating at a very low level, and it stems from the operational excellence we have, engineers are often playing a supervisory and supportive role…".*

Theme 3: Emphasis of Technical Excellence

On the same point, another company expert indicated that "*due to the lack of growth and the industry's continued drive to buy in technology, engineers are treated as a commodity rather than exercising them in a role of excellence and due to the positioning of the engineer in the organisation's structure most organisations meet their employment equity targets, this means that the appointment is not done in terms of excellence …"*

Part 3

The third part of Research Question Three attempted to ascertain the solutions that stakeholders propose to improve the demand of chemical engineers in the pulp and paper industry. Figure 5.11 provides insight into solutions that stakeholders believe would help improve the demand of chemical engineers in the industry. These responses were grouped into six themes:

- Good career shaping – refers to the companies' ability to train and develop engineers in careers that are rewarding and show growth potential;
- Career development opportunities – refers to the companies' ability to have programmes that allow for development;

- Competitive salaries - refers to the salaries and fringe benefits offered by companies;
- Improve utilisation - refers to engineers performing engineering related functions;
- Industry involvement in academia - refers to the contact and involvement of the industry with academic institutions;
- Demand determination - refers to the industry's ability to forecast the demand for chemical engineers.

The frequency distribution of the responses is depicted in Figure 5.11.

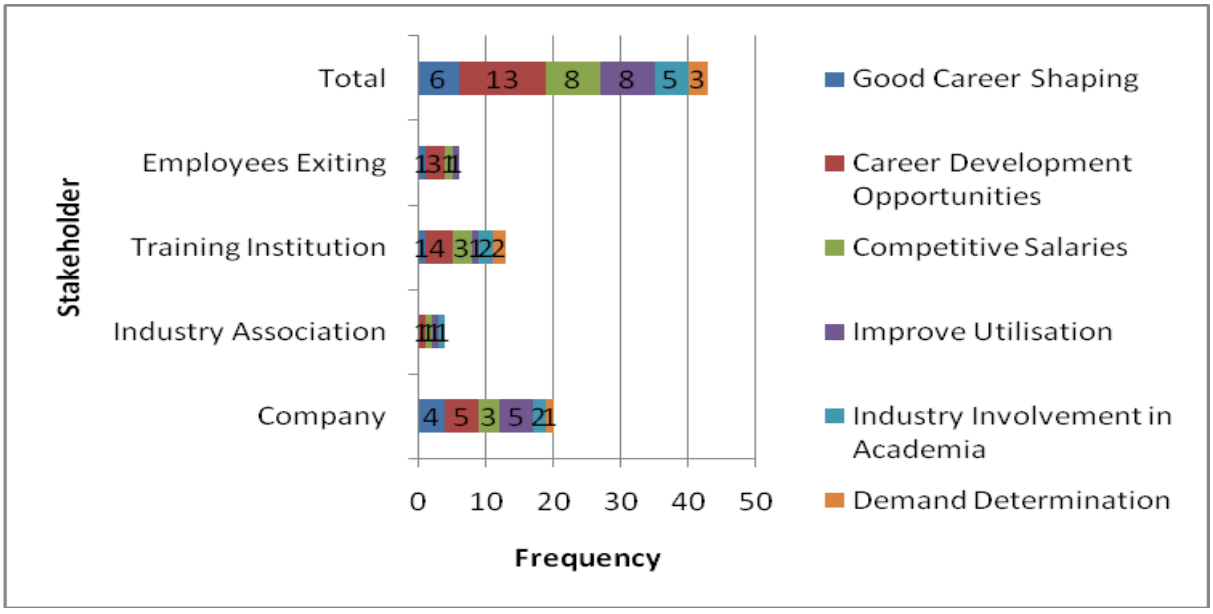

Figure 5.11: Stakeholder proposals to improve demand

Career development opportunities and good career shaping had the highest scales and were the most important solutions recommended by stakeholder employers and employees exiting the industry. Training institutions do not rate career development highly as a solution as they are probably not aware of career opportunities that are available within the industry. Entry level tuition at training institutions has been a cause for concern by company experts. They believe that this is a crucial element to

acquaint graduates with the industry, thus improving demand. Training institutions echoed the sentiments on industry involvement and the need to understand the demand so that a pipeline of well developed engineers is sustained in the value chain. Training institutions also indicated the need for industry involvement in influencing the undergraduate curriculum so that the student is aligned to the industry upon completion of their studies. In addition, sentiments towards industry involvement in research and development and real life problems were suggested by training institutions to enhance practicality within the curriculum.

5.6 Research Question Four: Is *the quality of chemical engineers entering the pulp and paper industry in line with employer expectations?*

The purpose of Research Question Four was to ascertain the stakeholders' views on the quality of chemical engineers entering the industry and whether they meet employer expectations. The question was made up of four parts:

- Part 1: attempted to ascertain whether the quality of chemical engineers entering the industry meets employer expectations;
- Part 2: attempted to gain an understanding of what factors should be considered to meet employer expectations;
- Part 3: attempted to establish if a mismatch existed between vocational training at training institutions and what industry expects;
- Part 4: attempted to gain an understanding of what needs to be done to align training institutions with employer requirements.

Part 1

In this part of research question four an attempt was made to gain an understanding of what the stakeholders' view was on the quality of engineers entering the industry. Respondents were asked to agree or disagree to the statement. "*Is the quality of engineers entering the industry of an acceptable level?"* Figure 5.12 shows the perception from the various stakeholders in industry of the quality of entry level engineers in industry. From the results obtained it can be seen that 83% of stakeholders agree that the quality of engineers exiting training institutions are of an acceptable level. 17% of stakeholders disagree that the quality of engineers entering the industry are of an acceptable level and do not meet their expectations.

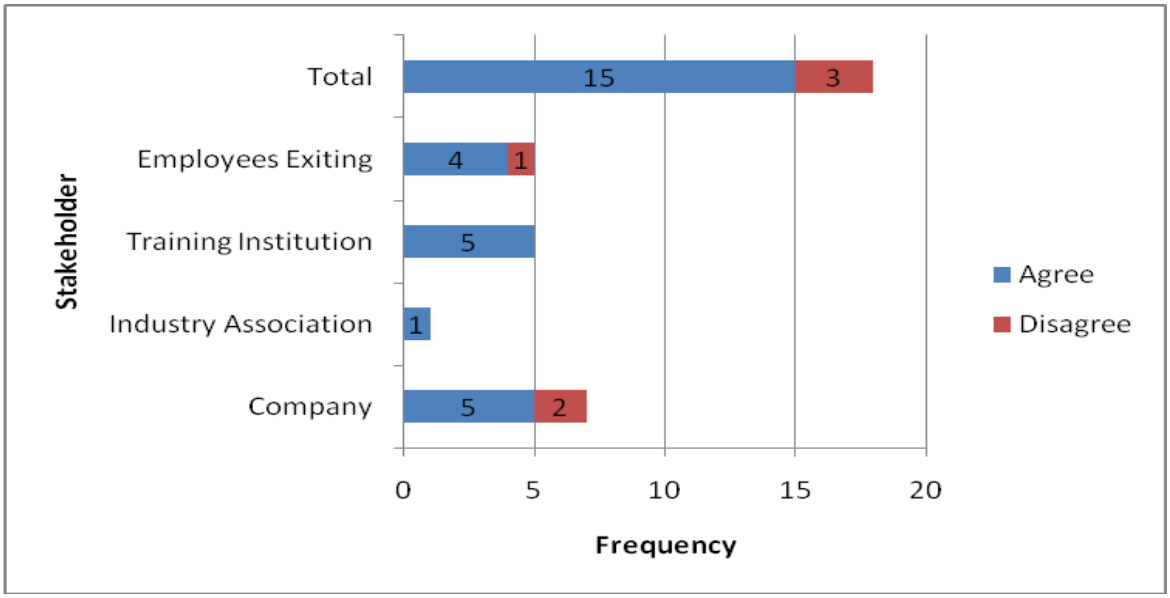

Figure 5.12: Stakeholder view on quality of engineers entering industry

5.6.1 Stakeholder Evidence in Support of the Quality of Engineers Entering the Industry

The interview process revealed that associations or industry institutions were not sure of the industry's expectations, hence the negative perception of the quality of

engineers which is often deemed to be a mismatch between companies' expectations and academic institutions. One engineer who exited a company indicated that: "*Based on my personal experiences, my degree, which offered papermaking and wood pulping as electives, was more than sufficient; however, graduates need a greater understanding of the people skills required in a large organisation. Furthermore, practical work experience is invaluable and vacation work with meaningful projects would be beneficial…".*

Some stakeholders believe that due to the lack of manpower, planning and the feed stock of engineers, companies tends to get poor quality engineers as the selection and placement criteria is hurried. One company employer expert pointed out that: "*Again, if one waits until the bitter end, one can get "bad" engineers. Through bursary and vacation work programmes, one can mitigate against this…*". An industry association expert indicated that the engineering degree at academic institutions is a generalist course, and said that; "*... with the essential building blocks, it is up to companies to uplift incoming engineers to plant specific requirements."* Another industry expert indicated that he acknowledges that the engineering degree is a generalist course and an introductory course in pulp and paper would suffice to meet industry specific expectations.

Part 2

This part of research question four attempted to gain an understanding of the attributes that stakeholders consider important in meeting their expectations. Figure 5.13 depicts the responses given by the stakeholders with regards to the factors that should be considered to meet employer expectations. Three emergent themes were revealed:

- Engagement – refers to stakeholders' involvement with training institutions;
- Engineers must be practical and involved – refers to the engineers' ability to relate to practical situations at plant level;
- Proper recruitment and selection – refers to the ability of employers to employ new engineers who meet the requirements overall and not just academically.

The frequency distribution is depicted in figure 5.13. It can be seen from Figure 5.13 that engagement with training institutions and training was highly regarded equally by up to 36% of stakeholders and is a crucial factor in terms of aligning employers' expectations. In addition, some stakeholders (28%) believe that early proper utilisation may help in aligning employer expectations. Academic institutions stated that there is little interaction between companies and academia in shaping the curriculum. As one academic indicated, *"... Add high-level management from industry to University and departmental advisory boards…".*

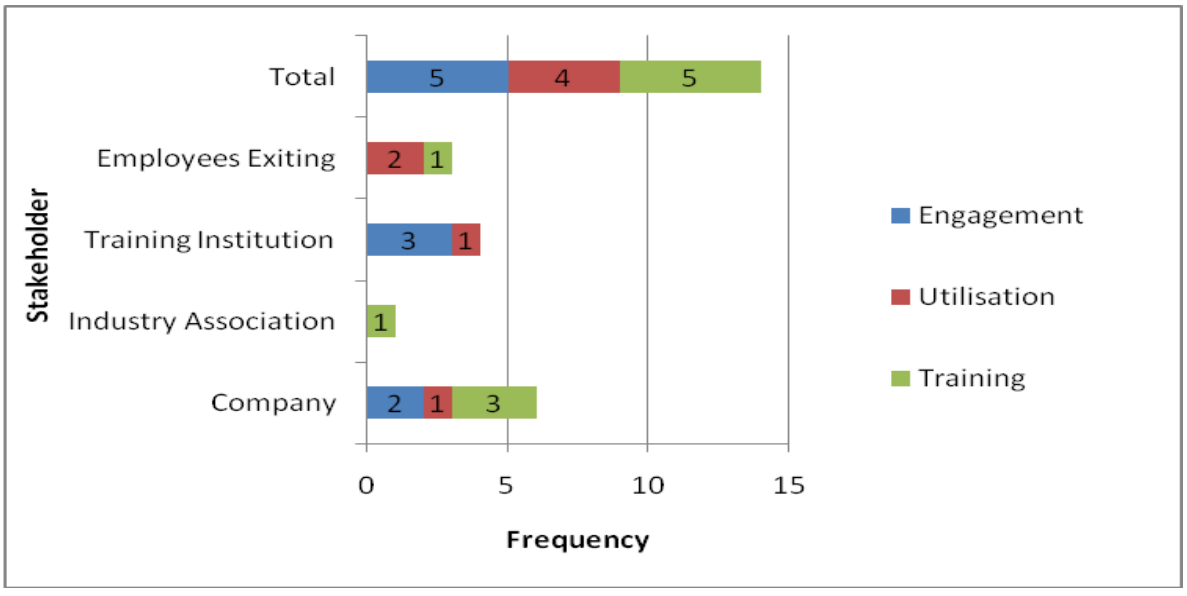

Figure 5.13: Stakeholder view of attributes required to meet employer expectations

Part 3

This part attempted to gain an understanding about whether there is a mismatch between the training provided to engineers at training institutions and company expectations.

Mismatch in this context refers to the adaptability of the training provided in terms of the industry requirements. Figure 5.14 represents the stakeholder response to the belief that there exists a mismatch between tertiary institutions and companies.

From the responses obtained it can clearly be seen that 75% of stakeholders believe that no mismatch exists between training provided by training institutions and industry requirements, whilst 25% believe that a mismatch exists.

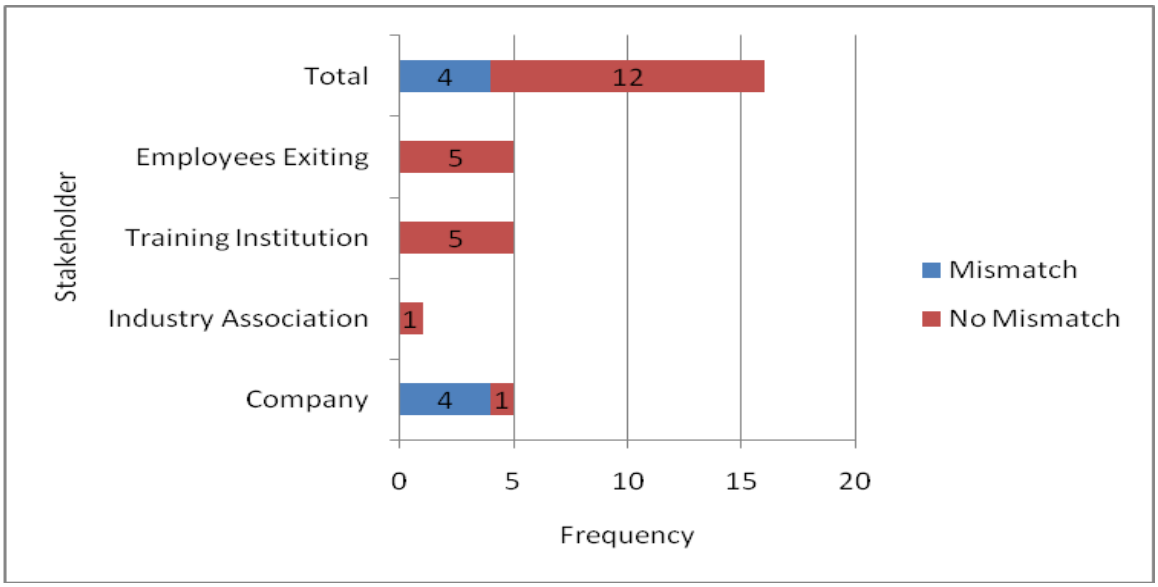

Figure 5.14: Stakeholders' response to mismatch between training and employer expectations

5.6.2 Stakeholder Evidence in Support of a Mismatch between Employer Expectations and Training

An engineer who has exited a company indicated that, "*I don't believe there is a mismatch – University covers the training required to equip students more than adequately to meet industry expectations. I think there is sufficient educational information relayed at University regarding the pulp and paper industry in terms of the Wood Pulping and Papermaking Modules, along with field trips etc…".*

Another engineer who exited the company indicated that, "*Based on my personal experiences, my degree, which offered papermaking and wood pulping as electives, was more than sufficient; however, graduates need a greater understanding of the people skills required in a large organisation. Furthermore, practical work experience is invaluable and vacation work with meaningful projects would be beneficial…".*

Training institutions believe that the engineering degree curriculum is designed in a generalist manner that equips engineers to apply the knowledge attained in a wide spectrum of fields, which allows graduates to identify and grow opportunities. One industry association expert indicated that the up and coming graduates are well equipped in the unit operations of various industries and adaptation to the pulp and paper industry is not difficult.

Part 4

This part of research question four attempted to gain an understanding of what stakeholders believed would be required to align industry expectations with that of the training institutions. The data as depicted in figure 5.15 indicates that stakeholder believe that engagement with academia , provision of in house skill and institutional use will help create better alignment between training institutions and companies.

- Engagement – refers to the relationship with training institutions and stakeholders
- Provision of in house skills – refers to the job specific training that needs to be provided by companies or employers
- Institutional use – refers to the use of training institutions for developmental work to improve industry awareness.

General perceptions were that the companies are very docile when it comes to engaging with academia. The suggestions given by various stakeholders are further highlighted below.

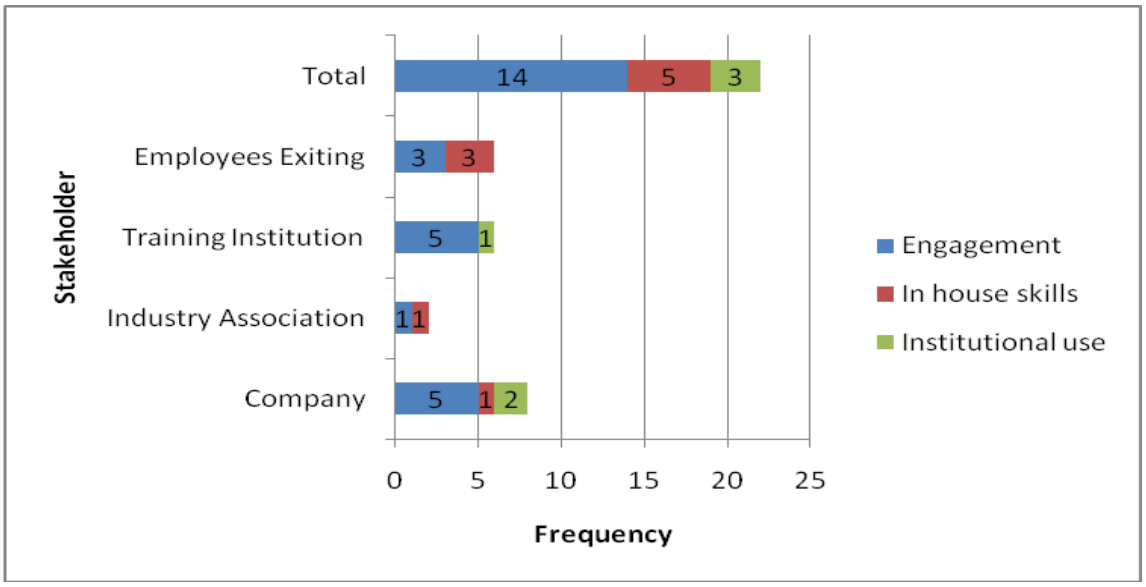

Figure 5.15: Stakeholders' response to view in improving alignment between training institutions and employers

5.6.3 Stakeholder Evidence to Support the Alignment between Industry and Training Institutions

Two academic institutions had their Engineering Council Accreditations but there was no representation from the pulp and paper industry in this forum. The Industry

Association has engaged in some developmental work for post graduate students, but at under graduate level very little engagement is taking place. Once this engagement takes place, the shaping of the curriculum becomes possible. "*Shaping the curriculum*" is a phrase that was echoed by most stakeholders.

Engineers exiting the industry indicated that more vacation work would not only align the engineer to the industry, but it would also provide insight and job fit. One engineer that has exited the industry indicated that, "*These pulp and paper modules are being offered and if the employer feels that there is a mismatch between their expectations and that of the training provided then there should be some sort of partnership between the relevant companies and the university to address this and facilitate a change. But on the whole I think companies within the industry need to first be clear of what their expectations and responsibilities of that job role is and they need to stick to that when the position is filled. It won't help by employing a Chemical Engineer and once placement is made expecting him/her to fill other job responsibilities e.g. production clerk…".*

5.7 Research Question 5: *What are the reasons for chemical engineers leaving the pulp and paper industry?*

The purpose of Research Question Five was to gain a deeper understanding of why chemical engineers leave the industry. The question was made up of three parts:

- Part 1: attempted to ascertain the demographic related questions and a profile of the interviewees. This was achieved by a questionnaire allowing the interviewee to tick blocks most applicable to the individual's profile. The sample selection was purposive in an attempt to ensure that the socio-economic factors of interviewees were similar;

- Part 2: attempted to gain an understanding of the positions that engineers occupied after leaving the industry;
- Part 3: attempted to establish the reasons why engineers left the industry;
- Part 4: attempted to gain an understanding of positive aspects that engineers enjoyed whilst working in the industry.

Part 1

Part 1 establishes the demographics of the five participants as depicted in figure 5.16. From the results obtained it can be seen that the majority of the participants (80%) belonged to the Asian population, with 20% belonging to the White population. It should be noted that there was a 0% representation from the Black population. The participants fell in the age groups of between 26 to 35 yrs, with 60% of participants being male and remaining 40% being female. It should also be noted that 60% of the participants had more than three years of working engineering experience, with the remaining 40% having between one to three years working experience.

Part 2

Part 2 of Research Question Five attempted to gain an understanding of the positions that engineers occupied after leaving the industry. Four interviewees left their positions as process engineers and moved sideways to positions in other industries as process engineers. One interviewee moved into a managerial position.

Part 3

Part 3 of Research Question Five attempted to gain an understanding of the reasons why chemical engineers left the pulp and paper industry. The most prevalent themes were:

- Competitive salaries - refers to the salaries and fringe benefits offered by companies;
- Career growth – refers to progression in the engineer's career within the industry.

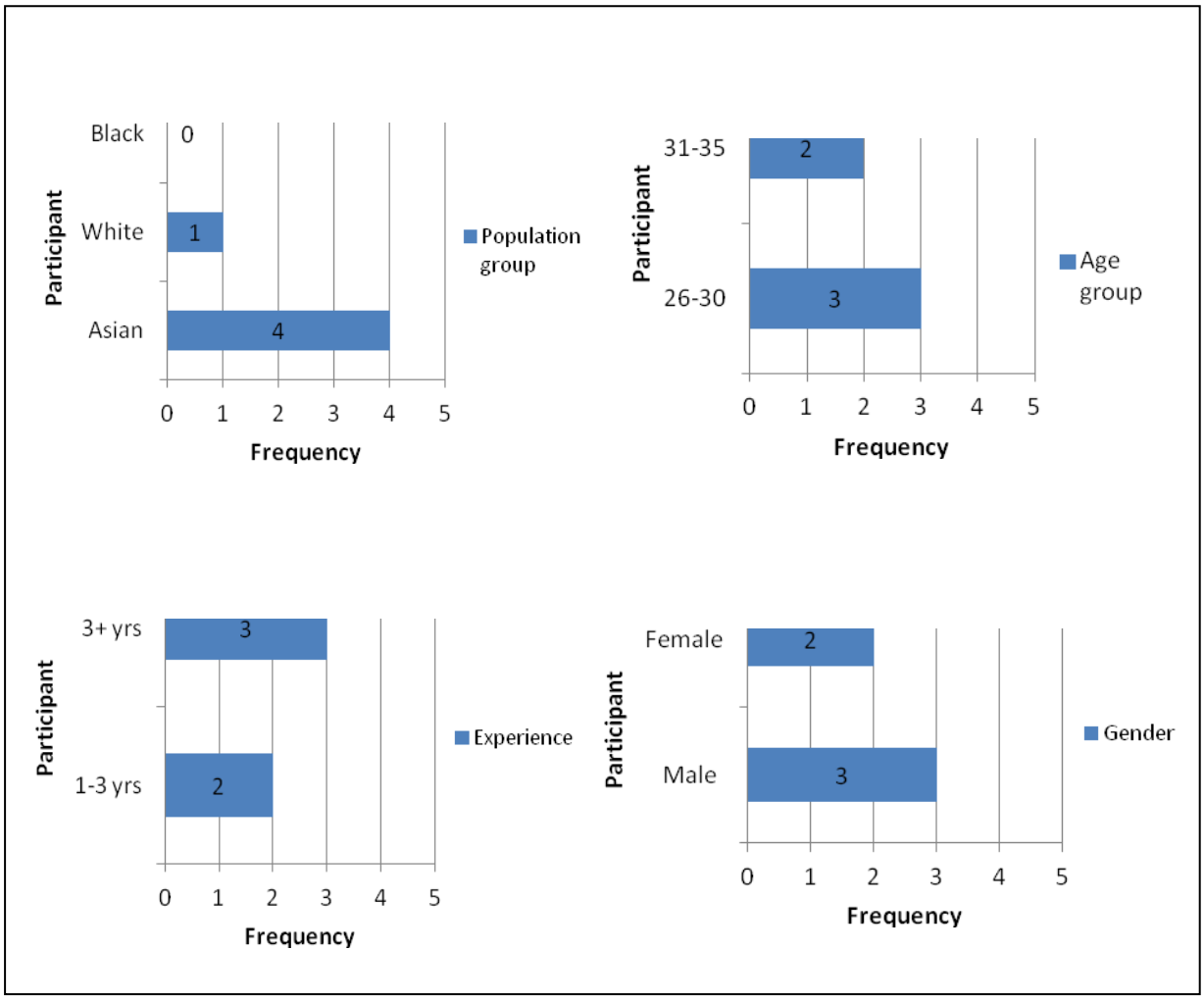

Figure 5.16: Demographics of five engineers

Figure 5.17 depicts the frequency distribution of the themes. Salaries were the main reason why all participants left the industry. It was also noted that the pulp and paper industry competes with the mining and petrochemical industries and thus competitiveness is crucial.

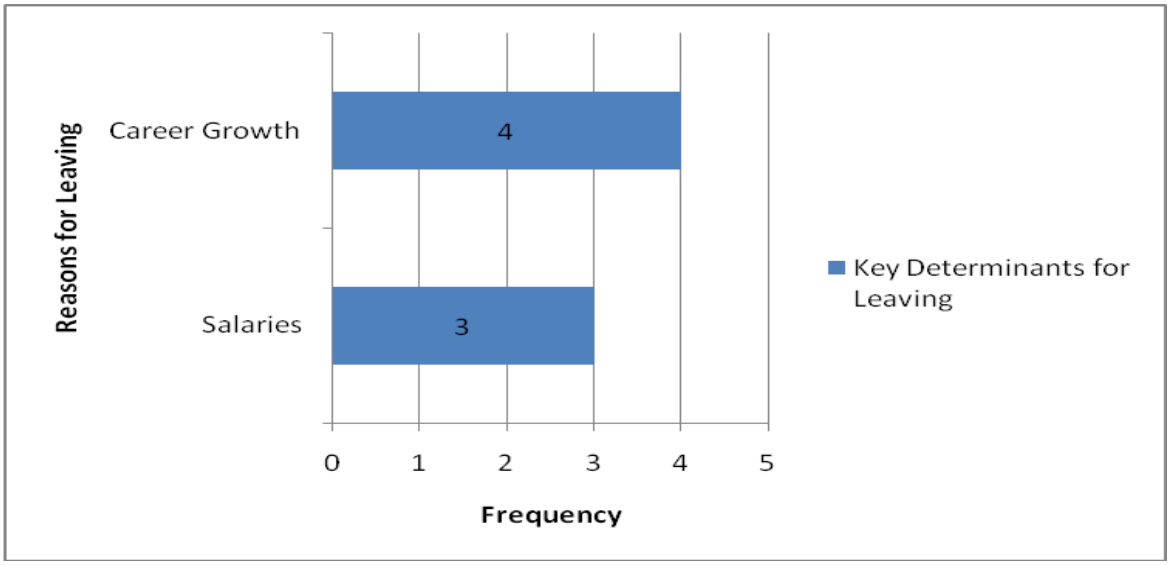

Figure 5.17: Reasons for engineers leaving the pulp and paper industry

Part 4

Part 4 of Research Question Five attempted to gain an understanding of the positive aspects of working in the pulp and paper industry. From Figure 5.18, the most prevalent 'enjoyable' theme emerging from the data is that of the diverse nature of the industry and the ability for engineers to apply their skills. Some interviewees also indicated that the industry provides good training and development.

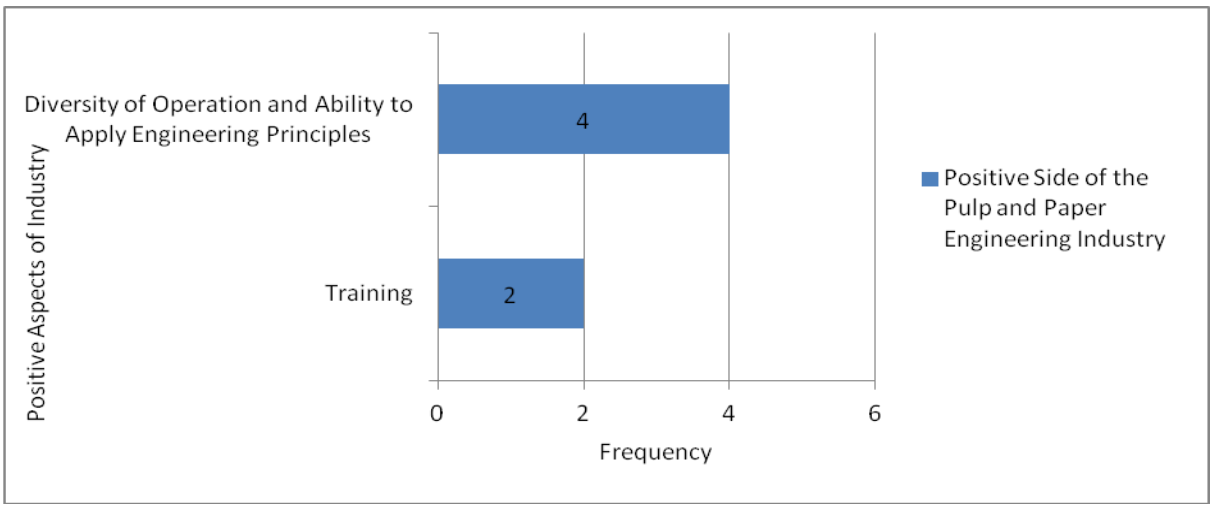

Figure 5.18: Positive aspects of working as an engineer in the pulp and paper industry

5.7.1 Evidence to Support the Positive Aspects of working as an engineer in the pulp and paper industry

An engineer who exited the industry stated that "*I like that the industry is ever competitive and that keeps thing "on the go" all the time. I like the fact that the industry is always trying to better the environment and constantly doing positive things to ensure sustainability of our environment. It's changing the perception in people's minds that it's an industry that cares…".*

Another engineer that exited the industry stated that "*As a chemical engineer, I admired that the industry constantly embraced new technology during the manufacturing process. Large sums of capital were spent on technological advancements that allowed for detailed problem solving, with an aim to operate each unit as efficiently as possible. Not many industries invest so heavily in technology as they aim to keep conversion costs low, but during my time at Mondi, the company adopted a phased approach towards improving the technology of the facility…".*

5.8. Conclusion

The results from the five research questions support the findings in the existing literature and contribute to new knowledge. Chapter Six discusses the results in more detail within the context of the existing literature.

CHAPTER 6: Discussion

6.1 Introduction

The aim of the research was to provide the stakeholders of the South African Pulp and Paper Industry with an understanding of the labour markets for chemical engineers in the industry. By understanding the influences of labour markets, stakeholders would have a better perspective on their responses to changes in the labour markets for chemical engineers in the pulp and paper industry. Chapter Six discusses the insight to the findings of each research question in terms of the existing theory base.

6.2 Discussion of the results for Research Question One: *Is the demand for chemical engineers in the pulp and paper industry exceeding the supply?*

The question was broken down into four constructs that sought to determine:

- The demand and supply imbalance;
- Evidence supporting the imbalance;
- Reasons for the imbalance;
- Proposed solutions to counteract the imbalance.

6.2.1. The demand and supply imbalance

As depicted by figure 5.2, there is an almost unanimous agreement by stakeholders that there is an excess supply of chemical engineers in the pulp and paper industry. An industry association expert and one company expert were of the view that the demand is greater that the supply, however these experts viewed the industry from the perspective of how a modern day process plant should operate.

6.2.2 Evidence supporting an excess in supply

The supporting evidence was presented by the themed responses depicted in Figure 5.3. The frequencies of the most prevalent themes that emerged from the data gathering process are:

- Engineer utilisation - signifying the actual role the engineer plays in the industry;
- Ease in replacing engineers – signifying the ease with which companies replace engineers when they leave;
- Graduates fail to find employment/placement - signifying the inability for chemical engineering graduates to find employment.

The themes, engineer utilisation, graduates fail to find employment and ease in replacing engineers, are also interrelated as depicted in figure 6.1. It is often noticed that engineers, more so those that graduate from universities of technology, often take on jobs at an operational level. This is a prevalent theme amongst engineers that have exited the industry. Training institutions have also echoed the same sentiment. Companies have also found that graduates from universities of technology go into operational positions rather than technical jobs. They attribute this to:

- A higher salary earned in the production environment;
- The lack of opportunities in the technical environment.

In summary, when supply is in excess, then chemical engineers, by the diverse nature of their training, are able to slot into various process related functions, from operations to supervisory roles in a process industry. This often results in the under utilisation of the engineer and results in individuals exiting the industry.

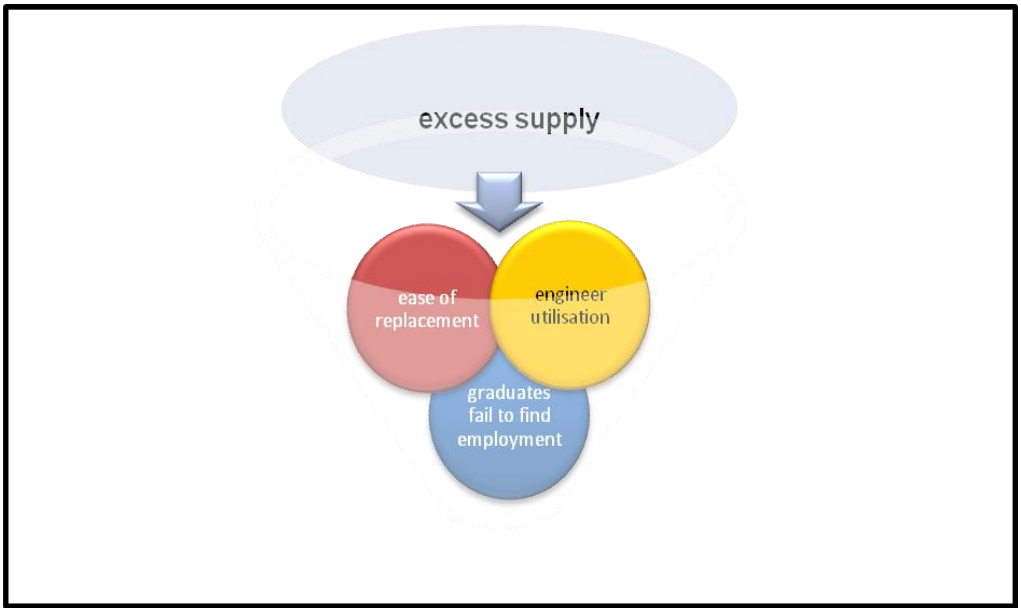

Figure 6.1: Interrelated relationship – graduate fail to find employment vs. engineer utilisation vs. ease of replacement.

6.2.3. Factors contributing to excess supply

Figure 5.4 gives an indication of the factors that stakeholders consider as contributors to the excess in supply. The factors are:

- Chemical engineering is a rewarding, diverse industry - refers to chemical engineering as a career as being rewarding and a diverse scope for job opportunities;
- Industry is buying technology – refers to industry outsourcing the design and technology component to specialists;
- Utilisation rate of engineers in industry is low – refers to engineers not being utilised to perform engineering related functions;
- High levels of intake – refers to training institutions allowing for a large number of enrolments.

6.2.3.1. Chemical engineering industry is a rewarding diverse industry

Chemical engineering is perceived by school leavers as a rewarding career as the nature of the study and curriculum allows for a diverse skill set, hence the scope for job opportunities are diverse. This is acknowledged by all stakeholders of the pulp and paper industry. The diverse nature of the study allows for engineers to be flexible and generalists rather than specialists, so job opportunities in process and chemical fields become easily accessible with little industry specific training. The drive by policy makers to improve the skills shortage in the country (ASGISA, 2006), coupled with South Africa's positioning as the world's leading producer of platinum, gold, and chromium and the industrial sectors' 30% contribution to GDP, has made chemical engineering a lucrative career, hence the influx of people choosing it as a career. However the industry growth rate and the country's GDP has stagnated over the last ten years resulting in an excess of supply. The South African services sector contributes to 67% of South Africa's GDP. This has led to an increase in engineering graduates finding employment in the services sector. There has been an 18.7% growth rate in the employment of engineering professionals in the financial and business sector (Quantec, 2007).

6.2.3.2. Industry is buying technology

In the early 1990s there was a severe skills shortage amongst professionals. Companies that needed to invest in technology utilised the services of foreign companies to perform detailed engineering and design work. Although the situation improved post-1994, in terms of quantity, professionals entering the market place were slow to technological change and adopt new, so-called core, skills. There is

also a belief that engineering faculties have not expanded their curricula to adopt the changing environment as other disciplines have (Jones *et al*, 1983). This left companies with no choice but to outsource skills and the trend still continues up to this day.

6.2.3.3. Utilisation rate of engineers in industry is low

South Africa's labour market is defined as structural. There is a considerable mismatch in the labour market between the type of labour available and that which is required for the country's sustainable economic growth (Pauw *et al*, 2008). The South African Labour market is characterised by high unemployment rates in the lower skills sector and a shortage of skill sets in the more sophisticated technological and professional sectors. This results in a situation where at the lower end of the production chain operations level employees have low skills and the engineer usually plays a supportive and supervisory role to supplement the low operational skill set, hence the utilisation of the engineer is sub optimal.

6.2.3.4. High levels of intake

Since 1994, global demand has put the higher education system under severe pressure and scrutiny. South Africa's higher education participation rate compares poorly with international rates. After an attempt to improve the education participation rate, over the period 2004-2007, graduations in higher education institutions increased by 8.6% and enrolments increased by 2.6% (CHE, 2009). This has led to an oversupply of graduates. In an effort to become responsive to labour demands and to compare with international standards in terms of an educated labour force,

training institutions lowered entrance requirements and produced a high number of graduates.

6.2.4. Conclusive findings to Research Question 1

There is a strong correlation between the results obtained for research question one and the literature on economic theory and growth in terms of the mechanism's supply and demand of labour in the market place. There is also a perception that there exists a shortage of engineering professionals in South Africa, however the data reveals that this is not the case for chemical engineers in the pulp and paper industry.

6.3. Discussions on the results for Research Question Two: *What are the factors that hinder and promote the supply of chemical engineers in the pulp and paper industry?*

The question was broken down into three constructs that sought to determine:

- Factors that hinder supply;
- Factors that promote supply;
- Stakeholders' views on solutions to improve the supply.

6.3.1. Factors that hinder supply

Figure 5.6 depicts the stakeholders' response to what they consider as factors that hinder the supply of chemical engineers to the pulp and paper industry. The participants' responses were categorised into themes and the emergent themes were:

- Level of Maths and Science – refers to the incumbents' proficiency levels in cognitive subjects as measured in mathematics and sciences;
- Industry awareness – refers to the engineers' familiarity with the industry;
- Finance – refers to the ability of the incumbent to secure financial resources to enter the field of study;
- Engineer utilisation – refers to engineers performing engineering related functions.

6.3.1.1 Level of Maths and Science

Maths and Science are important subjects in the study of engineering as they provides the foundation for logical reasoning. As depicted in figure 5.6, there was unanimous concern by all stakeholders with regard to the quality of mathematics and science education. Training institutions are particularly concerned about the maths and science education at secondary school level. The introduction of Outcomes Based Education (OBE) by the department of education has led to a drop in the quality of maths and science education at school level. Training institutions have seen the impact of this by the drop in pass rate in mathematics and physics at first year level, as indicated by one training institution. South Africa rates 133/133 in their quality of maths and science education (World Economic Report, 2009). Mathematics is a major inhibitor for entry into any engineering discipline and reasons cited for poor mathematics in South African schools include the exclusion of mental exercises from the syllabus, the introduction of outcomes based education that does not develop competence, mathematics being perceived as a non learning subject and the obsession of schools to achieve high pass rates leading them to encourage students to take mathematics on the standard grade (Lawless, 2005). Problems

within the education system include, amongst others, lack of teacher training, shortage of infrastructure in terms of teaching facilities, shortage of teaching aids and poor teacher management (OEDC, 2008).

6.3.1.2 Industry awareness

Industry awareness was another factor that was considered by all stakeholders as an inhibitor to the supply of chemical engineers to the pulp and paper industry. All stakeholders concurred that the pulp and paper industry does not do enough to project the industry's image and very little is known about the industry. The industry needs to market itself vigorously. An industry association representative suggested that a public relations department at industry association level be formed to market the industry. The industry has to compete in terms of marketing and awareness creation with the likes of the mining and petrochemical industries.

To create awareness, training institutions suggest that real life industry related problems be incorporated into the curriculum to allow for student participation and discussions on the industry. Engineers that have exited the industry indicate that the introduction of vacation work, in-service training and engineer-in-training programmes be re-vitalised by the industry and recruitment should take place at tertiary institution level to promote industry image. This is not a new intervention as the petrochemical and mining industries often use this approach. This approach would promote the visibility of the industry at training institutions.

6.3.1.3. Finance

The study of engineering is a lengthy four year process and requires a fair amount of financing. As depicted in figure 5.6, financing ranks third as a factor that inhibits the supply of chemical engineers to the pulp and paper industry. Participating stakeholders echoed sentiments that the industry should be proactive in the offering of bursaries and scholarships. To some extent the industry has realised this to be a shortfall and one of the industry associations has started a scholarship programme, with nine students being sponsored to study at post graduate level. From a geographic location, most of the pulp and paper mills are located away from major cities and often bursaries are awarded to people that live outside the location of the factory. This has created problems in the sense that individuals who came from big cities failed to fit into the environment, hence it is imperative that a companies have a good understanding of the personal traits of individuals before awarding bursaries. Sentiments echoed across the training institutions indicate that many students who are enrolled at institutions are funded by student loans or government finance grants; this often places an enormous strain on students as valuable time is spent in the financing process.

Given the history of South Africa and the level of poverty that exists, funding is always an issue in terms of students wanting to continue with their studies after completing secondary schooling. Very few students from disadvantaged backgrounds can afford tertiary education and bursaries are essential. Generally bursaries are awarded after the matric examination results. The award process is time consuming and funding becomes available by the end of the first university term. During this process students have had to secure residential accommodation,

tuition and book deposits, and many can ill afford this and drop out of academic institutions (Lawless, 2005).

6.3.2. Factors that Promote Supply

As depicted in figure 5.7, participating stakeholders consider the following factors as factors that promote the supply of chemical engineers into the pulp and paper industry:

- Competitive packages – refers to the salaries and fringe benefits offered by companies;
- Roles and utilisation – refers to the position, tasks and functions engineers perform;
- Industry profile and image – refers to the type of unit operations with the companies and the overall positioning of the company in the context of other process related companies.

6.3.2.1 Competitive packages

Competitive packages play an important role in promoting the supply of chemical engineers into the pulp and paper industry. Five of the engineers who were interviewed left the industry for better salaries. Companies have acknowledged this and have also ranked this highly, however the bottlenecks in this sphere emerge from the profitability of the industry. Pulp and paper are commodity products implying that companies are price takers. In the broader context, South African companies have to compete against global players from Europe and the east, where producers are highly efficient and capitalise on economies of scale. Unless the industry does

not embark on efficiency improvements, profitability will always be under pressure and the industry would not be able to translate the improved profitability into salaries.

The industry competes in terms of salaries with the mining and petrochemical industries which are far more profitable than the pulp and paper industry. The industry associations have also played a very docile role in terms of benchmarking salaries and fringe benefits for scarce skilled professionals, and little information is available in this regard. The industry associations need to play an active role in supporting the industry by providing relevant information in this regard.

6.3.2.2 Roles and Utilisation

Sentiments echoed by most participating stakeholders indicate that chemical engineers are not playing an appropriate role in the industry. Engineers are utilised in trivial roles, where they add little value to the profitability of the business. This is more so due to the fact that managers in the industry have come up the ranks from the production environment, where emphasis is placed on operations and very few understand the potential and the role that the chemical engineer can play in the areas of optimisation and efficiency improvement. Organisations are often guilty of not supporting high level professionals and menial administrative tasks are allocated to them. These factors result in the professionals undertaking tasks that are beneath their technical and intellectual capability, which minimises their influence within the firm and discourages them from continuing careers in engineering (Jones, Nelson & Parks, 1983). A lack of understanding of the role of a chemical engineer leads to the perception that training institutions do not prepare graduates for industry requirements.

6.3.2.3. Industry Profile and Image

Industry profiling and image play an important role in attracting young chemical engineers to the pulp and paper industry. Participating stakeholders acknowledge this factor as the biggest contributor to the supply of chemical engineers in the pulp and paper industry. The industry has suffered from an image problem due to the location of plants, which are more often than not in remote rural areas. The location stems from the fact that the plants were traditionally located near the forests, as wood is a key resource for the manufacture of pulp and paper. Pulp and paper mills can range from being fully integrated plants with the all unit operations that are to be found in process plants, to single tissue plants that purchase raw materials and convert them to tissue. The single small tissue plant offers no challenges to process engineers and is often deemed as an operations centred plant, whilst the fully integrated plant is a chemical engineers' heaven. Fully integrated plants are often remotely located, hence the socio-economic environment does not make it attractive for young engineers, whilst the small plants do not offer sufficient challenges to engineers.

The industry is old and the lack of technological advancement over time has also led to the image problems that it faces. The big role players like Mondi and Sappi started operations in the early 1950s and have failed in many respects to upgrade mills to keep up with modern technology. This does not offer young graduates an opportunity to explore the effects of modern technology. Technological advancement in the pulp and paper industry is capital intensive; this factor has impacted on growth and expansion that provides the creativity for modern day engineers. Working in these environments does not allow for the status and professionalism associated with chemical engineering as a career. This lack of social status leads to an anti-

engineering, ant-industrial culture which denies engineers a social status when compared to other professions like doctors, lawyers and accountants. This factor marginalises the engineers' influence and economic role (Jones *et al*, 1983).

6.3.3. Stakeholder views on promoting supply

As depicted in figure 5.7, four promising themes were found to be likely solutions that may be implemented to improve the supply of chemical engineers in the pulp and paper industry. The themes are:

- Engage with academia – refers to the contact and involvement of the industry with academic institutions;
- Promote image – refers to the industry's ability to market itself in the context of other process related industries;
- Harness and adopt students early in the life cycle – refers to the company's ability to engage with students when students enter training institutions;
- Provide study assistance and orientation – refers to the industry's ability to sponsor students and provide vacation work.

6.3.3.1. Engage with academia

The data gathering process revealed that very little engagement takes place between industry and academia. This was confirmed by all participating stakeholders. Engaging with academia provides the following benefits:

- Helps shape curriculum – this allows for the preparedness of graduates for the pulp and paper industry and allows for the development of real life case studies that benefit academia and industry;
- Promotes branding and industry image;

- Provides a pipeline for the supply of high calibre students.

As echoed in the interview process by academics, the industry does not play an active role in promoting itself with academia and very few people in academia understand the dynamics of the industry. Training institutions believe that a partnership between academia and the pulp and paper industry is possible and can yield positive benefits. The partnership is already adopted at one training institution that offers an elective in pulp and paper. This institution gets lecturers from the industry to continue with post graduate studies whilst lecturing to undergraduates. The philosophy augers well for the industry as students get firsthand experience from people within the industry, who offer a practical approach to the curriculum. A partnership between academia and industry will help with narrowing the gap that creates the perception that engineering faculties have not expanded their curricula to adopt the changing environment as other disciplines have (Jones *et al*, 1983). An active engagement between academia and industry will also help bridge the gap caused by the perception that industry players have been burdened by the need to provide training skills that should be part of the curricula (Kruss, 2004).

6.3.3.2. Promote image

This aspect of supply enhancement is covered in section 6.3.2.3.

6.3.3.3. Harness and adopt students early in the life cycle

The theme of “harness and adopt students early in the life cycle” resonated with all stakeholders and was ranked third in the frequency distribution. It is a sentiment that was echoed by all stakeholders, but more so by companies, training institutions and industry associations. It is an important aspect of supply enhancement in that it helps provide a constant pipeline of engineers to the industry. It also affords both

companies and new entrants an opportunity to find out whether they like the industry or not. In addition, it provides companies with an opportunity to enhance their selection processes, as not much can be determined in terms of job fit in an hour's interview. Provision of vacation work not only provides orientation for the new engineer, but also provides both the employer and employee an opportunity to understand each other's role in the industry. It further assists companies in the process of recruitment and selection by allowing ample opportunities for both parties to ascertain job fit and cultural dynamics. In many instances, new recruits find it difficult to adapt to the culture of the pulp and paper industry due to the communal environment that the location offers. Many factories are built and a village with basic amenities is created to house employees.

In light of this, if the individual does not fit in the company has to bear the costs of a high turnover, which amounts to a financial loss of in the region of 22% of a highly skilled individual's annual salary (Sutherland & Jordaan, 2004). Apart from a financial loss, other intangible losses include loss of productivity, loss in knowledge transfer, loss of momentum and continuity and loss of morale of existing employees.

6.3.3.4. Provide study assistance and orientation

These aspects are covered in sections 6.3.1.3 and 6.3.3.3

6.3.4. Conclusive findings to Research Question 2

There is a strong correlation and linkage between the results obtained for research question two and the literature cited in chapter 2. The data and linkage to literature provides some comfort in the sense that the pulp and paper industry is not unique to the issues of labour markets, as other industries also experience similar dilemmas.

6.4. Discussion of the results for Research Question Three: *What are the demand factors that promote and hinder the demand for chemical engineers into the pulp and paper industry?*

The question was broken down into three constructs that sought to determine:

- Factors that promote demand;
- Factors that hinder demand;
- Stakeholder view on solutions to promote demand.

As depicted in figure 5.9, four prevalent themes pertaining to the factors that promote demand for chemical engineers in pulp and paper industry emerged. The themes are:

- Competitiveness - refers to the salaries and fringe benefits offered by companies;
- Improved working environment - refers to working conditions and flexibility to harness potential relative to other industries;
- Understanding the demand – refers to the industry's ability to forecast the demand for chemical engineers;
- Training and development – refers to the ability of companies to provide industry specific training needs to generalists.

6.4.1 Factors that promote demand

6.4.1.1 Competitiveness

Discussions on competitiveness were discussed in section 6.3.2.1.

6.4.1.2. Improved working environment

There is a strong linkage between “Improved working environment” and “roles and utilisation” covered in section 6.3.2.2. When roles are defined and engineers are utilised effectively, the working environment is impacted positively. Improving the working environment has two dimensions:

- The first dimension looks at the working environment, where the engineer functions in an environment that is conducive to promote engineer functionality and growth;
- The second dimension looks at the social environment.

As stated earlier, the first dimension is covered in section 6.3.2.2. In this section focus is given to the social environment. Pulp and paper mills, by virtue of their locations, do not provide any social status in terms of where an individual lives. Mills are normally located in rural areas far from major cities and close to the availability of raw materials (forests). This environment provides very little social life for young engineers who prefer frequent visits to shopping malls and night clubs. The environment also hinders the ability for engineers’ spouses to find employment if they are not employable in the industry.

Although many pulp and paper companies have embarked on programmes to provide housing in plush suburbs by subsidising rents and providing subsidies to home ownership schemes, this has not attracted engineers to the industry. The findings tie up with literature by Jones *et al*. (1983), where it was found that the engineering discipline suffers from the lack of social status.

6.4.1.3 Understanding the Demand

Understanding the demand is a construct that was echoed by most participating stakeholders and is interrelated to the theme of "High levels of intake" discussed in section 6.2.3. There is a dichotomy in the understanding of the skills requirements of the country, with many believing that there is shortage of professionals and engineers. The lack of understanding of the requirements, coupled with the country's stagnating growth rate, makes it difficult to balance supply and demand. The data, contrary to popular belief, indicates that there is an excess of chemical engineers in the market place, which has negative impacts at all levels. Post 1994, training institutions were pressurised to increase intakes to a point where the teacher to student ratio and the entry requirements were sacrificed, which led to an oversupply and a drop in quality. The laws of economics show that an oversupply leads to engineers' remuneration packages being decreased, as well as under utilisation and an exodus into different sectors such as the financial and services sector.

On a more positive note, understanding the demand allows for capacity planning and improvement in quality. Demand management in the pulp and paper industry must be controlled and supported by the industry associations.

6.4.1.4. Training and development

The theme "training and development" ranked third amongst the factors that stakeholders consider as demand promoting factors. This sentiment was echoed by all participating stakeholders. Training and development plays a crucial role in attracting engineers to the industry, as at training institutions chemical engineering is offered as a generalist course with only one institution offering pulp and paper as an

elective. For engineers coming from the other institutions, the industry is deemed 'foreign' in the sense that chemical engineers would be exposed to the industry for the first time. Many stakeholders echoed the sentiments of the benefits of a short course in pulp and paper to align new engineers to the industry specifics and requirements.

Apart from the technical aspects, studies by Kruss (2004) indicate that training institutions lack the ability to prepare graduates for skills in the areas of problem solving, communication, entrepreneurship, good citizenship, managerial skills and leadership skills. Engineering degrees are normally aimed at developing technical competence and in light of Kruss' findings companies must offer these training needs internally. The impacts of training and development are well documented in terms of employee development and retention, and stakeholders believe that to enhance the demand this factor would play an important role (Altman, 2005).

6.4.2. Factors that hinder demand

As depicted in figure 5.10, the prevalent themes that hinder the demand for chemical engineers in the pulp and paper industry are:

- Utilisation – refers to engineers performing engineering related functions;
- Knowledge of what engineers can do – refers to tasks that the engineer has been trained to carry out;
- Emphasis of technical excellence – refers to the ability of the industry to focus on rational approaches in operations;
- Expansion and industry growth – refers to the capital spend to foster growth.

6.4.2.1 Utilisation

The theme “utilisation” has been extensively covered in sections 6.2.3.3 and 6.3.2.2.

6.4.2.2. Knowledge of what engineers can do

The abovementioned theme relates to stakeholders’ understanding of the role that the chemical engineer has to play in the modern plant. Chemical engineers are normally segmented into three roles:

- Operational role – where the engineer takes a managerial role after some development of managerial and leadership skills;
- Optimisation role – where the engineer becomes more of a specialist and plays the role of a process optimisation expert and focuses on efficiency improvement and waste reduction;
- Projects and design role – where the engineer focuses on plant design and project related work.

The role of the engineer is often not understood at plant level and the engineer is then tasked with the role of ‘the production manager’s clerk’. Furthermore there is often a misconception or overlap of responsibilities for the chemical engineering technician who has a diploma level qualification and the engineer who holds at least a bachelor’s degree.

At plant level, the chemical engineering technician by definition is responsible for the day to day plant level problems, providing support to operations personnel. The engineer should play a more strategic role however, by looking at the medium to long term objectives of the plant. If utilised in this manner the chemical engineer is

able to add value to the business. This area is well researched by Jones *et al.* (1983). The inappropriate use of the engineer often leads to them leaving the organisation in search of more challenging opportunities, hence the industry experiences a high turnover rate of up to 20% (Nice, 2008).

6.4.2.3. Emphasis on technical excellence

The industry's growth and sustenance lies in the areas of technical excellence, as it now competes globally where production, acquisition and application of new knowledge are critical to increased profitability**.** Growth and competitiveness is dependent on continuous technological improvement and innovation, which is driven by a highly skilled workforce. Emphasis on technical excellence grows when focus is placed on the correct levels of utilisation as discussed in sections 6.2.3.3 and 6.3.2.2.

6.4.2.4. Expansion and industry growth

The industry has experienced little growth in the last decade. Growth and expansion allows for engineering design, project and developmental work. With the lack of growth in the industry, the demand for chemical engineers has been hindered to a large extent. Expansion and industry growth is a macro-economic function and as long as the country's GDP remains stagnant; there is very little opportunity for the industry to grow extensively. Having stated this, one can view growth rate as a function of innovation and improved efficiencies. Should this model be adopted then there are ample opportunities within the industry for the creation of employment in the chemical engineering sector, as the current focus is strongly placed on:

- Renewable energy;

- Environmental sustainability.

6.4.3 Stakeholder views on demand promotion

As depicted in figure 5.11, six promising themes were found to be likely factors that may be implemented to improve the demand for chemical engineers in the pulp and paper industry. The themes are:

- Good career shaping – refers to the company's ability to train and develop engineers in careers that are rewarding and show growth potential;
- Career development opportunities – refers to the company's ability to have programmes that allow for development;
- Competitive salaries - refers to the salaries and fringe benefits offered by companies;
- Improve utilisation - refers to engineers performing engineering related functions;
- Industry involvement in academia - refers to the contact and involvement of the industry with academic institutions;
- Demand determination - refers to the industry's ability to forecast the demand for chemical engineers.

6.4.3.1. Good Career Shaping

As depicted in figure 5.11, the theme of "good career shaping" is predominantly echoed by companies as a factor that can be implemented to improve demand. Salary grading systems in companies are structured in manner that rewards people only if they move into managerial positions. Technocrats and engineers do not necessarily want to become managers, hence they are not remunerated accordingly.

There is a slow shift towards dual career shaping, whereby technocrats and engineers that want to remain technical specialists are rewarded accordingly.

Often it is noticed that engineers are promoted into managerial positions based merely on their technical excellence; this often is to the detriment of the engineer as they are not given managerial training and exposure prior to being promoted. Companies have identified this weakness and there is a strong drive to remedy this situation by exposing chemical engineers that show enthusiasm for management to training.

6.4.3.2. Other factors

Other factors like career development opportunities, competitive salaries, improved utilisation, industry involvement in academia and demand determination, are elaborated and discussed in detail above.

6.4.4. Conclusive findings to Research Question Three

The literature cited in chapter 2 alludes to most of the demand side factors that emerged in the data collection process; however it must be borne in mind that some factors are specific to the pulp and paper industry and have not been covered in the literature. These factors can be deemed as new findings and would need to be researched further.

6.5. Discussion of the results for Research Question Four: *Is the quality of chemical engineers entering the pulp and paper industry in line with employer expectations?*

The question was broken down into four constructs that sought to determine:

- The employers' view of the quality of engineers exiting training institutions;
- The factors that should be considered to meet employer expectations;
- Whether a mismatch exists between vocational training at training institutions and employer expectations;
- An approach to align training institutions to employers' expectations.

6.5.1 Quality of Engineers exiting training institutions

As depicted in figure 5.12, there is a unanimous belief amongst stakeholders that the quality of engineers exiting training institutions meets the employer requirements. 83% of stakeholders agree that the quality of engineers exiting training institutions is at an acceptable level. 17% believe that the quality is not of an acceptable level. The sentiments of low quality are only echoed by companies.

Measurement of quality is subjective. There is no benchmark on what quality is required and there are varying degrees of perception of what stakeholders expect or define as good qualities in a chemical engineer. The perception of quality emanates from the inappropriate utilisation and roles of the chemical engineer. The work conducted by Nice (2008) indicates that fundamental problems in the pulp and paper industry exist at operational level. Significant levels of capital investment have been made in new equipment, technology and levels of automation, without up-skilling the workforce. This has led to chemical engineers adopting supervisory roles to enhance process and production efficiencies. The chemical engineering curriculum is designed in a generalist approach to cover the various unit operations of the processing industry, with a focus on technical excellence and plausibility.

Research conducted by Kruss (2004) indicated that employers find that graduates entering the industry lack communication, entrepreneurship, good citizenship, managerial skills and leadership skills. This is obviously not the aim of engineering faculties at tertiary institutions; skills that develop managerial and business acumen are taught at business schools. This creates a difference in perception of the understanding of what a chemical engineer is trained to do. The issues of "roles and utilisation" discussed in section 6.3.2.2 and the discussion on the "knowledge of what engineers can do" discussed in section 6.5.2.2, further clarifies the perception of stakeholders on what chemical engineers in the pulp and paper industry are doing as compared to what they should be doing.

6.5.2. Factors that should be considered to meet employer expectations

As depicted in figure 5.13, the following factors were considered by stakeholders as factors that must be considered to meet employer expectations of chemical engineers entering the industry. Stakeholders consider the following constructs as important factors in meeting employer expectation:

- Engagement - refers to stakeholders' involvement with training institutions;
- Engineers must be practical and involved;
- Proper recruitment and selection.

6.5.2.1 Engagement and proper recruitment and selection

As depicted in figure 5.13, engagement with training institutions was highly considered by up to 70% of stakeholders, and is a crucial factor in terms of aligning employers' expectations. In addition, some stakeholders (25%) believe that early proper recruitment and selection may help in aligning employer expectations.

Issues on engagement are discussed at length in section 6.5.1.4 and the issues of recruitment and selection are discussed in sections 6.3.3.3 and 6.5.1.2.

6.5.2.2. Engineers must be practical and involved

There exists a sentiment in the workplace that the modern day engineer is not keen on being practical and is reluctant to get involved in issues that are core engineering issues. This stems from the fact that engineers entering the industry have very little, if any, exposure to the industry prior to employment. For this reason, the issues of engagement with academia and harnessing and adopting students is important and must be addressed. There is also a sentiment in companies that the modern day engineer is not sufficiently equipped to adapt to the modern day plant and companies are used as the training ground for new engineers. This theme has also been echoed by work done by Kruss (2004). Employer expectations are that engineers entering the industry must be "able to hit the ground running." This is at times an unfair statement as involvement and practicality cannot be taught from a textbook and there must be employer involvement in the development of the engineer from early on.

6.5.3. Existence of a mismatch

There is a perception in the industry that a mismatch exists between the vocational training offered by training institutions and employer requirements. The data revealed that 78% of participating stakeholders believe that no mismatch exists. This information is depicted Figure 5.14.

The issue of mismatch stems from the perception of what stakeholders believe are the core functional tasks of the chemical engineer and the role that the chemical

engineer plays in the workplace. Chemical engineers are expected to perform tasks that are analytical and rational in nature. These tasks encapsulate process design, process optimisation and troubleshooting. In his studies, Nice (2008) found that the industry utilises engineers in supervisory roles due to the fact that the industry, at operations level, suffers from a severe skills shortage. As long as this phenomenon remains, there will always be a perception that there is a mismatch between the training provided by training institutions and employers' expectations. The engineering curriculum is not designed for the purposes of managerial and leadership skills; this is the function of business schools. Studies conducted by Kruss (2004) have also found that employer organisations iterated the need for managerial and leadership skills. In essence, mismatch is a perception and emanates from the improper placement of engineers in managerial positions.

6.5.4. Alignment of training institutions to employer expectations

To align training institutions with employer expectations, there must be a partnership which can only be conceived through engagement. The pulp and paper industry must play a crucial role in engaging with academia in curriculum development and promoting industry image. The themes of "industry image" and "engagement with academia" are discussed in sections 6.4.2 3 and 6.4.3.1 respectively.

6.5.5. Conclusive findings to Research Question 4

In terms of the quality of engineers entering the industry, the literature cited in chapter 2 suggests that the quality of engineers entering the industry is of a poor standard as it does not meet employer expectations. The data in this study revealed that the quality of engineers entering the industry meets employer expectations. This was confirmed by research undertaken by Kruss in 2004.

Having stated this, it must be noted that Kruss' work in 2004 showed that graduates lack managerial, entrepreneurial and leadership training. The purpose of engineering faculties is to develop graduates for the engineering discipline and there has never been a focus on managerial training in the engineering curriculum. Traditionally, managerial and leadership training is offered at business and leadership schools, hence Kruss' research has to be understood in the context of engineers in a management position versus engineers in engineering positions. The data also revealed that engineers are utilised in supervisory positions for which they do not receive formal training and on entry are very inexperienced in managerial and leadership roles. This cannot be the criteria used to evaluate engineers in industry and indicates that the employers do not have a clear understanding of where to place the engineer on entering the organisation. The misuse of the engineer can lead to problems like high turnover and poor performance which may be considered to be related factors.

There also exists a perception that there is a mismatch between vocational training provided by training institutions. Research undertaken by Jones *et al* in 1983 concluded that training institutions do not produce graduates that meet the requirements of modern day industry and there is a mismatch between the vocational training provided by training institutions and industry expectations. It must be noted that students studying chemical engineering are trained in a generalist manner on the various unit operations of a chemical process industry. If industry expects the production of specialists, then they need to engage with academia and make their expectations known so academia can incorporate their requirements into the curriculum. The data indicates that there is insufficient engagement with academia, which can be considered a contributor to the issues of misalignments in

vocational training and employer expectation. The issue of specialist development must also be addressed at industry level where industry specific development is undertaken.

In summary, the quality of engineers entering the industry and the vocational training provided by tertiary intuitions are at an acceptable level. This is contrary to the literature cited in chapter 2. Rather, a problem exists in terms of role clarification and utilisation.

6.6 Discussion of the results for Research Question Five: *What are the reasons for chemical engineers leaving the pulp and paper industry?*

The question was broken down into four constructs that sought to determine:

- The demographic related questions and a profile of the interviewees;
- Positions that engineers occupied in other organisations after exiting the industry;
- The reasons for leaving;
- Positives in the pulp and paper industry for chemical engineers.

6.6.1. Positions occupied after exiting the industry

80% of the respondents occupied the position of a process engineer upon exiting the industry, which is similar to the position they occupied whist in the pulp and paper industry. This provides a clear indication that most of the respondents moved laterally into similar position in other industries which is an area of concern. This is a clear indication that the pulp and paper industry has problems in terms of retention of chemical engineers as process engineers.

6.6.2 Reasons for leaving

As depicted in figure 5.17, the data revealed that engineers exited the industry for higher salaries and career development.

6.6.2.1. Salaries

The industry faces challenges and severe competition from other industries such as the petrochemical and mining industries, in terms of competing for chemical engineering resources. The subject of salaries and associated benefits were discussed in section 6.3.2.1.

6.6.2.2. Career development

Career development is essential for the progressive growth of individuals in any organisation. Effective engineer utilisation is characterised by the following distinctive areas of specialisation:

- Operations;
- Optimisation;
- Design and project engineering.

Each sphere requires industry specific training and development to foster career development. These aspects are discussed in section 6.5.1.4, which addresses the needs of training and development, and section 6.5.3.1, which addresses the needs of career shaping.

6.6.3. Positives for chemical engineers in the industry

As depicted in figure 5.18, prevalent themes pertaining to the positives of working in the industry were “diversity of the operations and the ability to apply engineering principles” and “training”.

6.6.3.1 Diversity of operations and ability to apply engineering principles

An integrated pulp and paper operation is diverse in nature in that the unit operations range from power generation and pulp manufacture (which involves a variety of chemical manufacturing plants and chemical recovery plants), to bleaching operations, conversion of pulp to paper, water treatment, environmental engineering and various other by product conversion plants. The operating principles are covered by a variety of courses that make up the chemical engineering curriculum. This makes the industry a heaven for chemical engineers to apply their knowledge and provides the challenges that chemical engineers require. The variety and sheer size of units provide for the rotation and exposure of chemical engineers to the various aspects of chemical engineering.

6.6.3.2. Training

The diversity of the industry and training are interrelated in the sense that a chemical engineer has the ability to apply all the skills taught at the training institutions. A classic example to demonstrate this is to look at the training opportunities available to a chemical engineer working in a power generation plant like Eskom. The chemical engineer in this operation has exposure to power generation only, whereas the chemical engineer in the pulp and paper industry can have exposure to power

generation and various other unit operations as discussed in section 6.6.4.2. Of late, as eluded to by company experts and employees exiting the industry, the industry has focused on an intensive engineer-in-training programme that encapsulates the rotation of young chemical engineers to various plants, whereby they have the ability to interact with specialists in various unit operations. These initiatives auger well for the future.

6.6.4. Conclusive findings to Research Question Five

The industry offers significant opportunities for training and development. These positives, coupled with an understanding of proper engineer utilisation and a good retention and talent management programme, can make the industry an employer of choice. A collaborative approach by involving schools, colleges and universities, must be adopted to enhance talent retention (Hall & Sandelands, 2009).

Chapter 7: Conclusion

7.1 Introduction

This chapter provides linkages to the research problem outlined in chapter 1, highlights the main findings of the research, provides recommendations to the stakeholders in the industry and provides insight to future research.

7.2. Key Research Findings

The research report produces a rich and deep understanding of the factors influencing the labour market with regard to chemical engineering skills in the South African pulp and paper industry. The following findings are deemed as key to enhance the effectiveness of the chemical engineer in the industry.

7.2.1. Excess Supply

Prior studies in the area of skills and skills shortage have been well documented and presented in chapter 2, which gave an indication that there is a shortage of skilled professionals in South Africa. This might have been the case in the early 1980s where labour policies of many governments and policy makers relied on macroeconomic policy to stimulate and generate employment, however the data indicates that there is an excess of chemical engineering skills in the market. There was unanimous agreement in this regard by participating stakeholders.

7.2.2. Quality of engineers entering the industry

Prior research and literature cited and presented in chapter 2 gave an indication that employers believe that the quality of engineers entering the industry is of a low standard, however this research shows that this is not the case, with most

participating stakeholders believing that the quality of engineers entering the industry is of an acceptable level, hence there is a disconnect between perceptions and reality.

7.2.3. Mismatch between training provided and industry expectations

The literature cited in chapter 2 indicated that most employers believe that training institutes do not provide the necessary skills required by modern day industry and the engineer entering the industry lacks the required skills to perform at a level that adds value. The data revealed that this is not the case and there is strong representation from stakeholders to back the sentiment that no mismatch exists between vocational training and employer expectations. It must however be stated that there is a dichotomy in the expectations of what employer perceptions are of the role of the chemical engineer in the workplace.

7.2.4. Roles and utilisation of chemical engineers in the pulp and paper industry

The results presented in chapter 5 indicate that there is consensus amongst all participating stakeholders that there are concerns about the role that engineers play and the manner in which engineers are utilised in the industry. Improper roles and utilisation lead to low value add and low return on investment made in the recruitment and development of the chemical engineer. The findings by Nice (2008) of problems existing at operational levels as a result of a low skill base need to be addressed. For as long as up-skilling at operations level is compromised, the chemical engineer will continue to play a sub-optimal supervisory role to enhance productivity and efficiencies. Sub optimal roles and under utilisation lead

professionals to be tasked with menial administrative duties which are beneath their technical and intellectual capability, which in turn minimises their influence within the firm and discourages continuing careers in engineering (Jones *et al*, 1983).

An understanding of the chemical engineer's impact and ability in demonstrating value add is often not understood by the employer, as many employers focus on managerial and leadership qualities and expect chemical engineers to perform this function upon entry into the work environment. Work done by Barrie (1994), Bueret and Webb (1983) and Spurling (1992) concurs with managements' beliefs that suggest that academic preparation of undergraduates is inadequate for the needs of modern, technologically advanced industries, as the graduates lack business techniques or the commercial and managerial understanding required by employers of the modern day.

7.2.5. Competitiveness

In an attempt to gain a deeper understanding of why the industry cannot retain chemical engineers, the data presented in chapter 5 indicates that salaries and remuneration is a key factor in that it leads to high levels of turnover. All five engineers that exited the industry indicated that the reason for exiting was motivated by higher salaries offered by a new employer. Chemical engineers, by the nature of their training, become highly marketable once they have served their internships in a reasonably sized reputable industry like the pulp and paper industry, hence the industry is under constant threat to compete with the petrochemical and mining industry in terms of competitive remuneration packages. An improvement in efficiencies and increased productivity often translate into high profit levels, and for as long as low productivity and efficiency levels prevail in the industry, profitability

cannot be transferred into good levels of remuneration. Profitability is highly dependant on proper utilisation of the workforce and has a knock on effect in translation of remuneration, hence the role of the chemical engineer cannot be over emphasised as the chemical engineer plays an important role in improving efficiencies by optimising unit operations and eliminating waste.

7.2.6. Industry image

Most participating stakeholders believe that the industry suffers from a severe image problem. The fact that the industry is not marketed and very few people have an understanding of what the industry has to offer, creates a problem in the attraction of talented chemical engineers to the industry. The industry is not well represented at training institutions and has failed in many aspects to harness the opportunities offered by good marketing.

The industry is old and the lack of technological advancement over time has also led to the image problems that it faces. Young graduates are not offered an opportunity to explore the effects of modern technology. Technological advancement in the pulp and paper industry is capital intensive; this factor has impacted on the growth and expansion that provides creativity for modern day engineers. This factor marginalises the engineers' influence and economic role (Jones *et al*, 1983).

7.2.7. Engagement

The data revealed sufficient evidence to indicate that very little engagement exists between the industry and academia. The industry needs to leverage off academia to harness the benefits of close collaboration with them in terms of curriculum

development, the identification of prospective candidates for future employment, and marketing the industry.

7.2.8. Harnessing and adopting students early in the lifecycle of an engineer

A strong sentiment was echoed by most participating stakeholders on the importance of adopting prospective young students from training institutions to promote orientation and adaptation to the environment, determine job fit and develop industry specific training for prospective students. This would also aid in balancing the supply and demand of chemical engineers and provide a pipeline of continuous supply of chemical engineers to the industry.

7.3. Recommendation to stakeholders

The research findings provide a wealth of information on enhancing the role of the chemical engineer in the pulp and paper industry by providing an overall understanding of supply and demand side factors. In light of this. the following recommendations would benefit the industry.

7.3.1. Collaboration

Stakeholders tend to operate in silos. There must be a concerted effort to enhance collaboration between companies, industry associations, employees and academia to form a united approach in dealing with chemical engineer development and retention in the industry. Collaboration will enhance commonality in roles and utilisation, and would aide in the benchmarking of remuneration and fringe benefits. Collaboration will also benefit the industry in the research and creation of new

knowledge and technology development. Collaboration enhances the capture of prior experience and will contribute to the development of a curriculum that would be industry-oriented.

7.3.2. Defining the roles and effective utilisation of the engineer

Consensus must be reached on the roles and effective utilisation of the chemical engineer. Employers have an understanding of how to effectively use the chemical engineer, however this is often not translated into a practical approach of proper utilisation as the pressure and focus is placed on production. There must be a paradigm shift from operations to technical excellence, albeit that this process would be slow, the benefits would translate to high profitability in the long run.

7.3.3. Promoting image and marketing the industry

There must be a concerted effort by all stakeholders to promote the industry's image and market it as an employer of choice. A lot in this regard can be learnt by mimicking what the petrochemical industry does to promote industry image.

7.4. Recommendations for future research

This research has explored the key factors that impact on the labour markets for chemical engineers, and has contributed to the knowledge base by examining the weaknesses and strengths for chemical engineer development. Future research in the areas listed below will certainly help to augment the understanding and enhance the utilisation of highly skilled trained professionals in a manner that will contribute to sustained economic growth.

- Career pathing and the roles and utilisation of engineers;

- Upskilling of operations personnel in order to relieve the engineer from menial tasks which are beneath their technical and intellectual capability;
- Bridging the generation and knowledge gap between operations personnel and engineers;
- Collaboration between stakeholders in engineer development.

In order to further build on the insights gained from this research, the findings from this research can be compared to other industries to determine if similar problems exist in other industries and other disciplines of engineering including civil, mechanical, electrical and electronic engineering.

7.5. Conclusion

Chemical engineers are a highly skilled and highly paid resource. When utilised effectively, the chemical engineer can contribute to a high level of efficiency improvements, innovation and sustained economic growth. This research has created new knowledge in understanding the influences of labour markets, as it is important in that it allows for the ability of stakeholders to respond to changes in the labour market in a rational manner. It also provides a deeper understanding of the influential factors that promote and retard engineer productivity and wealth creation.

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APPENDIX 1: Research Approach

Construct	Explanation	Duration
1. Introduction	Formal meeting and introduction of the researcher.	5 minutes
2.Explanation and Purpose	Provide information on the research topic and the benefits of undertaking such a research to stake holders and explanation on the contents of the "letter of consent".	10 minutes
3. Questioning	Questions asked as per the interview schedule. Encourage participation and dialogue.	50 minutes
4. Conclusion	Vote of thanks.	2 minutes

Appendix 2. Research Questions

Research Question 1

Please indicate your level of agreement with the following statements. Mark a **X** in the appropriate block. . Strongly disagree = A, Disagree = B, Neutral= C, Agree = D, Strongly Agree = E	**A**	**B**	**C**	**D**	**E**
Is demand for chemical engineers in the pulp and paper industry exceeding supply?					

1.1. What evidence do you have to support this?

1.2. What do you believe is the reason for this phenomenon?

1.3. What solutions do you propose to overcome this phenomenon?

Research Question 2: ***What are the factors that hinder and promote the supply of chemical engineers into the pulp and paper industry?***

2.1. Can you name factors that hinder supply?

2.2. Can you name factors that promote supply?

2.3. What are the likely solutions that may be implemented to improve the supply?

Research Question 3: ***What are the demand factors that promote and hinder the entrance of chemical engineers into the pulp and paper industry?***

3.1. Can you name factors that promote demand?

3.2. Can you name factors that hinder demand?

3.3. What are the likely solutions that may be implemented to promote demand and have these been implemented elsewhere?

Research Question 4: ***Is the quality and quantity of chemical engineers entering the pulp and paper industry in line with employer expectations?***

4.1. If not, what factors should be considered to meet employer expectations?

4.2. Do you believe that there exists a mismatch between the vocational training provided at tertiary institutions versus what industry expectations are?

4.3. What do you believe should be done to align your expectations with that of the skills provider?

Research Question 5: ***What are the reasons for chemical engineers leaving the pulp and paper industry?***

5.1. What is your current occupation?

5.1. What were your reasons for leaving the industry?

5.2. What did you like about the industry?

GENERAL INFORMATION ON CHEMICAL ENGINEERS EXITING THE INDUSTRY					
Mark with **X**	Black	Coloured	Asian	White	
	SEX	Male	Female		
Age Group Please Mark with a **X**	21-25 yrs	26-30 yrs	31-35 yrs	36-40 yrs	>40 yrs
Number of years as an engineer in the paper industry- Mark	> 10yrs	5-9 yrs	3-4 yrs	1-3 yrs	<1 yr
Job title					
Please indicate by marking with a **X** the area in which you practiced in the industry					
Process engineering	Product Development	Marketing	Design and consulting.	Environmental Engineering	
Project engineering	Technical Support	Production	Engineering Management.	Other (Please specify)	

APPENDIX 3

Stakeholder	**Participant**
University	
University of KwaZulu-Natal	Prof. M Carsky
University of Pretoria	Prof. P Devaal
University of Technology	
Durban University of Technology	Dr. V Ndinisa
Mangosuthu University of Technology	Dr. J. Baah
University of Johannesburg	Dr. M. Mollagee
Regulatory Bodies	
PAMSA	Mr. C. H. J. Nice
FIETA	
Industry – Technical Managers	
Sappi	Mr. B. van der Merwe/Mr. A Rossi
Mondi	Mr. A. T. Swart
Kimberley Clarke	Mr. F. Hansen
Engineers left the industry	
Engineer 1	Mr. R. Sebnath
Engineer 2	Mrs. L. Jacobs
Engineer 3	Mr. V. Pillay
Engineer 4	Mrs. S. Ali

Engineer 5	Mr. R. Phunwasi
Industry – Human Resources Managers	
Sappi	Mr. C. Gengan
Mondi	Mr. O. Sebotoma
Kimberley Clark	Ms. R. Lewis

Appendix 4

Informed letter of Consent

As partial fulfilment for the requirement for the degree of Masters in Business Administration(MBA) at the University of Pretoria's Gordon Institute of Business Science, I have undertaken a research study.

My research topic is on ***The Influences of and Responses To The Labour Market For Chemical Engineering Skills In the South African Pulp and Paper industry***.

Currently very little research is done in this arena within this specific industry. The industry is a large employer of engineering personnel and a deeper understanding of the labour markets for this industry would be beneficial to all stakeholders.

Your participation is voluntary and you can withdraw at any time without penalty. The study will take the form of semi-structured and structured interviews with a few predefined questions to facilitate elaboration. All data would be kept confidential and responses will be aggregated into themes. No reference will be made to institutions, companies and individuals. If you have any concerns or questions please contact me or my supervisor. Our details are provided below.

	Researcher	**Supervisor**
Name	Rakesh Singh	Prof. Margie Sutherland
E-mail address	rakesh.singh2@sappi.com	sutherlandm@gibs.co.za
Contact number	083 229 8916	073 170 6917

Signature of Participant: _____ Date: _____

Signature of Researcher: _____ Date: _____