THE ROLE OF TECHNOLOGY MANAGEMENT IN AN INFORMATION STRATEGY FOR THE CHEMICAL INDUSTRY

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TO

Richard and Barbara

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DIE ROL VAN TEGNOLOGIEBESTUUR IN 'N INLIGTINGSTRATEGIE VIR DIE CHEMIESE INDUSTRIE

Probleemspesifikasie

Die chemiese industrie, veral in die Vaaldriehoek, staan voor geweldige uitdagings in terme van hul strategiese plasing in internasionale markte. Hierdie toedrag van sake is die gevolg van die opheffing van internasionale sanksies, boikot-aksies en die verslapping van invoer/uitvoer beleide. Tesame hiermee, het internasionale markte meer toeganklik geraak vir die Suid-Afrikaanse produkte en word die internasionale vraag na sodanige produkte en dienste skerp verhoog deur die groot mate van mededinging wat in die markte bestaan.

Die korporatiewe inligtingstegnologiebedryf, gekoppel aan die chemiese industrie, gaan swaar gebukkend onder die radikale verandering wat hierdie industrie ondergaan. Alle industrieë, om internasionaal mededingend te wees, fokus op daardie kernvaardighede wat hulle uitsonder van soortgelyke industrieë en wat aan hulle 'n mededingende voordeel verleen.

Gekoppel hieraan, vind daar grootskaalse disinvestering plaas in daardie sektore van die bedryf wat nie waarde toevoeg tot die primêre besigheid van die organisasie nie soos, onder andere, die inligtingstegnologiebedryf. Die algemene neiging in die verband is om hierdie tipe van dienste uit te kontrakteer en nie kapitale investerings te maak, vir 'n diens wat hoogstens ondersteunend is aan die primêre waardeketting, nie.

Navorsingsmetodologie

Deur middel van 'n statistiese ondersoek, in die vorm van die doel-ontwerpte vraelys, word inligting versamel om statistiese tendense bloot te lê aangaande die aanwending van tegnieke en metodes wat die rol van tegnologiebestuur in die strategiese formuleringsproses beklemtoon.

Ten einde die statistiese ondersoek teoreties te fundeer, word twee doelmatige studies onderneem om die onderliggende konsepte van tegnologiebestuur en strategiese bestuur te omskryf. Vanuit hierdie benadering, word 'n statistiese analise onderneem en generiese voorstelle gemaak.

Doelstelling van die ondersoek

Die oorkoepelende doelstelling van die studie is gerig op die blootlegging van tendense rakende die integrering van tegnologiebestuurskonsepte en strategie formulering in die chemiese bedryf in die Vaaldriehoek. Hierdie tendense gaan van die veronderstelling uit dat daar 'n aantal tegnieke, metodes en konsepte bestaan wat, wanneer doelmatig aangewend word, 'n ondersteunende strategie vir inligtingstegnologie teweeg bring.

Gevolgtrekkings

Afleibaar vanuit die statistiese analise is bevind dat wanneer die proses van strategiese bestuur uitgevoer word, weinig van die bestuurders, verantwoordelik vir die formulering van 'n strategie vir inligtingstegnologie gebruik maak van die konsepte, tegnieke en metodes wat vervat is in die globale benadering van tegnologiebestuur.

Aanbevelings

Alle aanbevelings wat na aanleiding van die teoretiese studie en die bevindinge van die empiriese ondersoek gemaak is, konsentreer op die inkorporering van die grondleggende beginsels van Tegnologiebestuur in die uitvoering van die proses wat Strategiese Bestuur fundeer. In hierdie verband is alle aanbevelings aan die hand van 'n toepaslike model gemaak wat afgelei kan word uit 'n samestelling van drie ander, onderling uitsluitende, modelle.

Aanbevelings wat in die verband gemaak word, is dat bestuur geleenthede moet skep en identifiseer waartydens tegnologie oordrag kan plaasvind, insluitend die vestiging van 'n formele navorsing en ontwikkelingsfunksie. Tesame hiermee, moet die interne omgewing hom daartoe leen dat innoverende idees en gedagtes nie verlore gaan nie, maar gerig word op die ondersteuning van die primêre besigheidsvermoë instede van daardie funksies wat hierdie primêr ondersteun.

CHAPTER 1

NATURE AND SCOPE OF STUDY

1.1 Introduction

This era is characterised by emerging globalization and the opening of international markets. South African corporations ranging from single business corporations to large conglomerate types are focusing their efforts and financial investment on their primary business competencies in an attempt to be competitive and to maintain a sustainable advantage over their nearest rivals. This is also true for the chemical industry in South Africa and is a phenomenon from which chemical industries in the Vaal Triangle are not exempted.

This modern day tendency leads to the disbanding of massive business enterprises and the formation of individual businesses that focus on a single core competency or around a single field of expertise. Caught amid this modern business tendency, the corporate information industry is undergoing a rapid metamorphosis and is migrating away from the traditional orientation of being a service department in a multi department corporation to an independent business unit, which implies a definite strategic change that incorporates a new market orientation and a totally different client perspective.

The corporate information industry must now focus on a broader range of clients including the traditional corporate clients and new clients of which some could also be outside or independent from the corporate environment. Following this modern day tendency, data processing and information engineering, as the corner stones of the information industry, are moving into a completely new arena where the accent and focus of the day-to-day activities are no longer aimed at rendering a fixed and predefined service to a known and stable client, but to an environment that is client driven, unstable and in a highly competitive market.

Coherent with this new orientation, the corporate information industry faces unique problems in that they were protected by a general corporate company policy and could count on the support of a client base that was loyal to them or had no choice in deciding which data processing facilities to make use of.

With this new market and client orientation, old clients need not make use of the existing facilities and could outsource their data processing facilities to other companies.

Traditionally, the information department was strategically bound to a functional department, like the financial department, and only addressed the specific needs it had. It was restricted by the corporation's budget and never seen as a profit centre but as a typical cost centre and got the technology it needed to fulfill the specific role it had to play and only catered for the internal needs of the corporation that, at the time, was the correct strategy.

In an attempt to break away from this traditional corporate service orientation and striving to be an independent business unit, corporate information centres and data processing facilities find themselves not strategically geared and technologically equipped to fulfill the new business orientation. This implies that they are stuck with technology that was suitable for the traditional role they fulfilled.

Being of a costly nature, replacing this technology could endanger the financial position of the business and make it less competitive, therefore, the new technology strategy becomes a means of protecting the costly technological investment at all costs even if it means that it is outdated and not what the client requires. Therefore, it serves no purpose in gaining and maintaining a sustainable competitive advantage.

Secondly, linked to sound technology management practices, a modern day information strategy must include the participation from the prospective client base it proposes to serve. This implies that, when formulating an information strategy, the specific needs of the client must be addressed directly and the entire organisation, including methods and structures must be client oriented. In a sense, the whole organisation must move closer to the client and thus service the specific needs better than the closest rivals.

1.2 Problem identification and definition

The focus of this study, is the chemical corporate information industry that is currently involved in a struggle for survival. During the last three years, the political infrastructure of the world and specifically South Africa changed radically.

- **European unification**

  The east block countries were reunited into Europe. This meant massive financial needs arising in countries like the former Soviet Union. In an attempt to raise the needed capital, the Soviet Union sold space- and military technology on the international market, but also flooded the international markets with cheap technology and products ranging from heavy industrial utilities to chemicals.

  The implication of this was that the stable international chemical markets were made unstable and very price sensitive. In 1993 the cost of importing a ton of chemicals was cheaper than to produce it locally. This situation forced the South African chemical corporations to look into their primary business fields and to focus on their core business and core competencies to make it not only profitable but also sustainable. In this regard, the corporate chemical information divisions were not seen as typical core competencies and were forced to become individual business units within the corporate environment.

- **South African politics**

  The internal political situation of South Africa was thrown into turmoil and became unstable due to the new and unforeseen influences of the changing political dispensation. Unrealistic demands regarding labour issues, like union affiliation, minimum wages and salaries, hygiene and others made the employment scene unstable.

Stay-aways and strikes stressed the fact that the South African industry had to change and become more accommodating to the specific needs of the work force. This situation forced the corporate chemical industry to redesign their initial business objective and was partly responsible for the massive focus on aspects such as productivity and core business activities. Again, there was no strategic fit between the chemical industry and the corporate information industry and this made the formation of an individual information business unit inevitable.

- **International markets**

Due to the positive changes that have taken place in the political arena in the latter part of 1993, international markets became more accessible to the South African corporations. Although they seemed to be inviting, South African participation was seriously hampered by the inability to successfully compete concerning price, quality, availability and timing, which was mainly caused by a combination of factors, such as a very low productivity rate, government intervention, regulation and the lack of foreign confidence.

South Africa, and especially the products produced locally, were relatively unknown and required massive capital investments to break into the international markets as illustrated by numerous examples, such as the investments made into the development of armaments and helicopters for the international markets. As stated in the previous instances, South African companies were faced with possible international market starvation and this made a strategic change an absolute must for future survival.

Taking all of the above determining factors into account, the typical South African company and specifically the South African chemical industry must undergo radical strategic changes to be competitive in a highly competitive international market.

This implies that all corporate environments are streamlined to focus on those issues and competencies that make it more competitive therefore, splitting off peripheral businesses, like the information departments, makes a lot of strategic sense.

The implication of this is that the corporate information division requires a client oriented strategy and the inclusion of sound technology management practices to enhance the level of service it provides to the chemical industry, but also to clients outside the corporate environment.

1.3 Aims of the study

As can be deducted from the title of the proposed study, a variety of aims of different levels of importance can be derived. To ensure that an unobstructed objective is pursued, the most important aim is to determine possible areas for improving the overall information technology strategy for the chemical industry in the Vaal Triangle.

This can be achieved by clearly defining and emphasising the need to include and integrate technology management concepts, methods and techniques in the formulation of a generic competitive information strategy for the chemical industry in the Vaal triangle.

Diagrammatic overview of the aim could be visualised as follows:

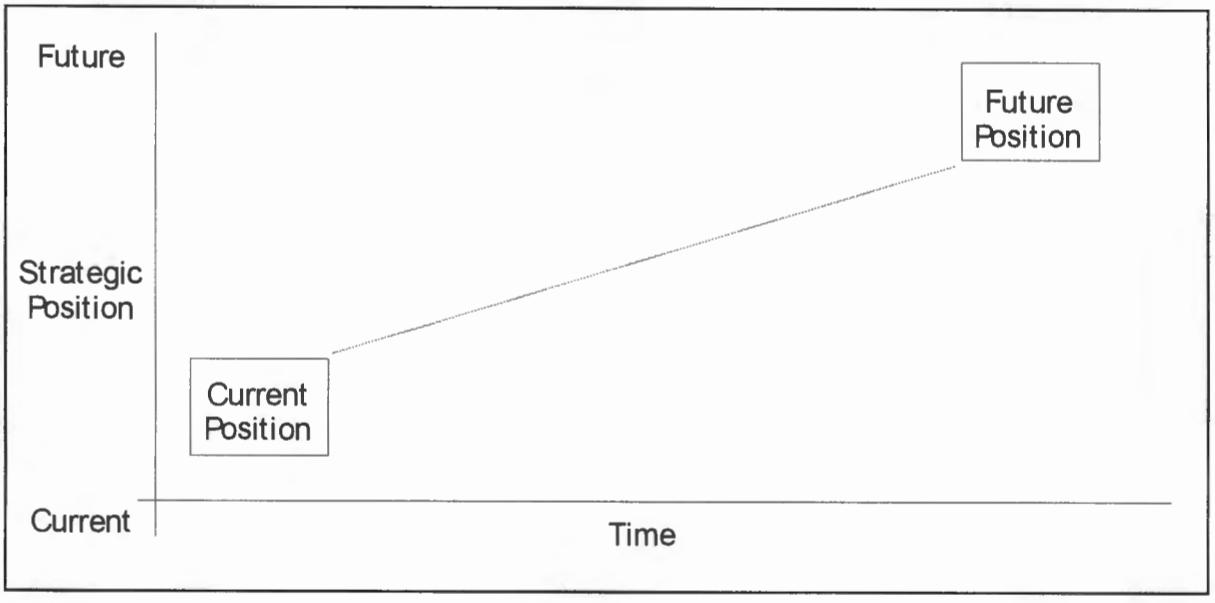


Figure 1.1: Schematic view of aim of study

Besides the above-mentioned main aim, the following lower level aims could be defined:

- To suggest a natural route for the migration of the information industry from a traditional service department to an independent, profitable business or corporate business unit.

- To ensure that the chemical corporate information industry remains strategically innovative through the application of sound technology management techniques and practices.

- To derive measures by which the corporate information industry can determine the extent to which they are successful in obtaining the desired business results.

1.4 Defining the field of study

Although this study can be conducted for and applied to most of the different types of industries in Southern Africa, it is, for the purpose of defining a clear objective and making it manageable, confined to the corporate chemical industry in the Vaal Triangle.

Within each of the identified chemical industries further contact groups will be identified. These groups will typically consist of managers responsible for the creation and formulation of the corporations' information strategy. Aspects that will enjoy special attention, include the following:

- Strategy formulation
- Strategic fit
- Technology management
- Technology transfer
- Innovation
- Needs assessment
- Competitive advantage

1.5 Research methodology

The study is initiated by defining the typical problems that the corporate chemical industry is currently facing, followed by the formulation of the causal factors that underlie these typical problems. To strengthen and support the discussion, a theoretical study will be performed into two distinct areas, that of technology management and strategic management. Derived from the problem definition and theoretical overview, a statistical trend analysis will be performed and will serve as the starting point for further research.

Firstly, theoretical research will be conducted to determine the underlying theoretical concepts and tendencies that directly influence technology management and strategic management, *per se*. Secondly, the theoretical research will be followed up with an empirical analysis by means of questionnaires to obtain an empirical base for the determining of statistical trends.

All information gathered by means of the questionnaires, will be interpreted against the theoretical background gained from the theoretical research in an attempt to suggest strategic changes and corrections to the total managerial approach to strategic management.

A point of importance in regards to the empirical research, is that most of the chemical industries are very sensitive concerning the divulging of information that could lead to a loss of their competitive position in the specific market. For this reason all empirical research will be conducted in an anonymous manner to prevent possible dissemination of information to rival companies.

1.6 Restrictions of the study

1.6.1 Overview of the study

A definite limiting factor of this study is the multitude of related aspects that can be addressed concerning the formulation of a competitive corporate information strategy. It is therefore not an objective of this study to supply a comprehensive method by which a corporate information strategy can be crafted.

For this reason, only technology management and strategic management will be taken into account and the overall success of the study will lie in the objective interpretation of the facts and concepts against this background. All facts and results must therefore be evaluated in the context in which the empirical research was undertaken.

A definite limitation to the entire study is the assumption that the author accepts the fact that all respondents to the questionnaire understands the theoretical implications of aspects such as technology management, strategic management and the aspects related to these subjects.

1.6.2 Literature study

Taking into account that the study incorporates and integrates two individual topics, namely technology management and strategic management, the literature study will be confined to interpretation of the fundamental concepts of the above-mentioned subjects. This implies that the literature study is not aimed at defining or deriving new concepts, but focuses on the interpretation of the existing meaning and the content thereof. This viewpoint does not imply that the literature study will not be comprehensive but implies that existing knowledge and theories will be utilised for identifying areas of improvement of the competitive corporate information strategy.

1.6.3 Empirical study

In an attempt to establish statistical trends, an empirical study will be undertaken. This study will include several pre-identified chemical plants in the Vaal Triangle. The limiting factor in this regard, is the fact that not all chemical plants are of a corporate nature or incorporate a corporate information division in their structures.

A single questionnaire will be sent to pre-identified personnel in these chemical institutions. Firstly, the questionnaire will be sent to pre-arranged managers in an attempt to determine to what extent they have technological backgrounds or have the skills to include technology management principles in the practice of strategic management. An average of **50** percent of the respondents will be considered sufficient for a statistical analysis.

1.7 Layout of the study

- **Chapter 2.** This chapter gives a conceptual overview of the different driving forces and factors stemming from inside the functional corporate environment and from the external, market driven, technological environment. The functional integration of these factors and forces leads to the determining of the overall causal factors that prompt this study.

- **Chapter 3.** This chapter explores the theoretical aspects of technology management in an attempt to determine possible strategic interfaces with the process of strategy formulation.

- **Chapter 4.** This chapter investigates the theoretical aspects of strategic management to obtain and maintain a competitive advantage.

- **Chapter 5.** This chapter introduces an empirical study. This chapter will indicate the type of statistical study undertaken, the methods employed and the results obtained from the experiment. From these statistical results, statistical trends will be identified and discussed.

- **Chapter 6.** This chapter takes all the gained knowledge into consideration and prompts corrective action for information technology strategy formulation for the chemical industry in the Vaal Triangle and concludes the study by giving a brief summary of the successful aspects, less successful aspects, applicability, conclusions and further considerations.

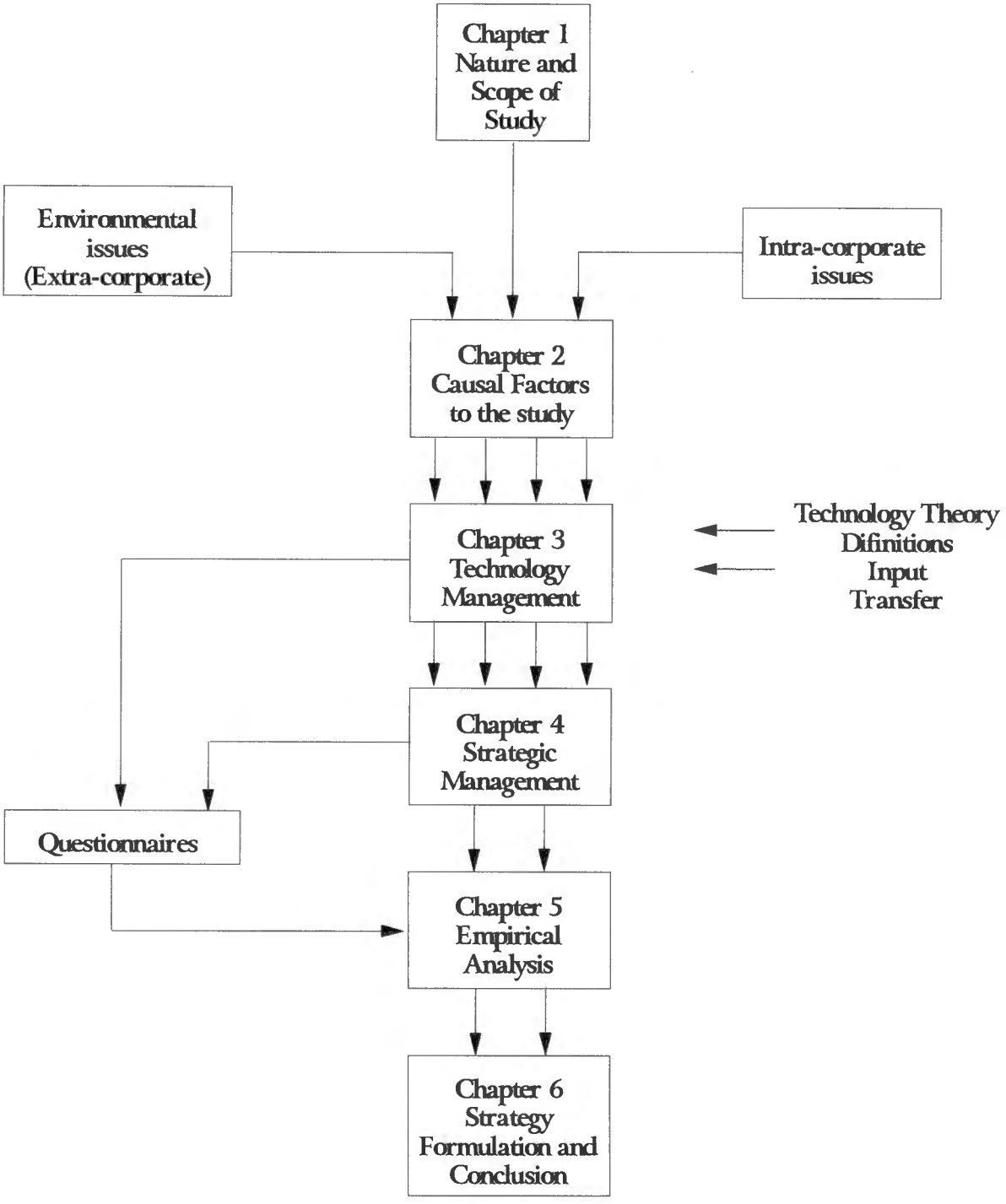


Figure 1.2: Schematic view of the layout of the study

CHAPTER 2

CAUSAL FACTORS TO THE STUDY

2.1 Introduction

The re-entry of South Africa into international markets and associated trade environments and the promise it holds for higher economic growth has forced the typical South African company to re-evaluate its global role and performance. Because of years of economic starvation, the lack of international competition and the detrimental effect past boycott actions had, South Africa faces the most important challenge it has ever had to address in regards to economic rejuvenation and upliftment.

In an economy where free enterprise is the corner stone, rejuvenation lies in the stimulation of industrial growth. To aid this ideal, a new strategic focus is required aimed at breaking away from a traditional situation whereby companies were geared only to serve the internal needs of the country and were protected from all forms of competition by regulation, government intervention and state funding. This new strategic focus implies the acceptance and functional accommodation of continual change and the re-engineering of business processes and strategies for the creation and maintenance of an international business orientation which focuses on the addition of value to the primary business of the existing or potential client base.

Being an integral part of the South African economic setup and subject to the governing economic policy, the local chemical industry is therefore not excluded from this economic phenomenon. Pressures arising from the political easing of sanctions, the lifting of international trade embargoes and the opening of international markets necessitate strategic business changes. For this reason, many former conglomerate types of industries, are disbanding or restructuring and giving rise to individual business units to render a higher level of service to their client base and to focus their business strategies on their core competencies.

The management of technology as a resource to economic growth, prosperity and the creation of wealth is a phenomenon typical of the twentieth century and is becoming more and more important as a foundation of a competitive advantage (Dorf, 1988:302).

Not only is this phenomenon true and applicable for the so-called high-tech environments such as engineering and medicine but also applicable in the information industry, that has over the past ten years, developed into an industry characterised by ongoing technological change and improvement. In this sense, the current information technology of a typical corporate environment can be viewed as an operational tool (Gerstein, 1987:ix).

All forms of technology have a direct impact on a business in that they have the inherent ability to not only change the normal flow of the business, but to redefine and craft the current business processes and even create new business directions in the process. Viewed from this vantage point, no company can survive in an economic sense if sound technology management practices, incorporating the management of information technology, are not followed and strategic plans exist for the implementation thereof.

Information technology can no longer be viewed only as a way by which manual tasks are automated but must be seen as an integral part of the organisation, its strategy, its functioning and its future prosperity. In this regard, the impact technology has on an organisation is too important to ignore and too drastic not to plan for.

Not far removed from the strategic impact sound technological management has on the success and future sustainability of the corporate information industry, a definite strategic move towards the client, focusing all resources and effort on a client orientation is fast becoming a criterium for a business to compete successfully in a highly competitive, international market.

According to Gerstein (1987:43) the general approach a company must follow to be competitive in the international market place, lies in the articulation and specification of its

business mission along three dimensions, namely customer groups, customer needs fulfilled, and technologies employed. This chapter examines the factors that underlie and define the modern day problems the typical chemical corporate information industry faces in regards to the opening of new national and international markets, the inherent promises, challenges and opportunities these markets hold and the influence society and pressure groups have.

In this vein, it defines and explores the global macro- and internal micro factors detrimental and constructive to economic survival and the impact these factors have on the new approach in the information industry of breaking away from a traditional service rendering department to a fully functional, independent business undertaking or business unit responsible for its own funding, financing and strategic planning.

2.2 Macro and micro trends and tendencies

When considering the macro factors that underlie this study, it is necessary to identify and characterise modern day trends and tendencies in those fields of development that have direct bearing and influence on the industries under consideration. Against this background, the scope of this study must be taken into account and the number of major industries, under consideration, must be identified and separately discussed, therefore the scope of the study identifies two major types of industries, namely, the corporate chemical industry and the corporate information industry.

2.2.1 Macro trends in the corporate chemical industry

The chemical industry, as it's known today, was essentially formed due to a prominent, post Second World War need for specialised chemicals. Especially in America, the petrochemical industry and related industries, such as plastics-producing plants grew at a staggering rate of **30** to **50** percent faster than the Gross National Product of the country (Bower, 1986:16).

These massive needs for specialised chemicals arose from the technological awakening that was characteristic of the post war era and prominently applicable in specialised fields such as plastics, medicine, agriculture, mining and heavy industry. As this need for specialised chemicals escalated, more and more chemical industries arose to comply to this cyclic continuum of supply and demand.

Characteristic of these chemical companies, were their total commitment to the product, the process and applied research to develop it to its fullest extent and potential. In sharp contrast to this overwhelming product-orientation, were their total ignorance to issues such as community responsibility, environmental issues and the influence external pressure groups could have on their budding enterprises. Even further removed, was the total lack in understanding of the business activities of their clients, the compilation and functioning of their cost chains and the ways in which they could enhance the client's business by adding value to their organisations.

Due to certain international events, such as a period of global economic depression, the crash of international financial markets, the rise of community consciousness, radical political changes and the birth of the modern day concept of a sustainable competitive advantage, the face of the typical international corporation changed dramatically and left many companies stranded amidst the rapid change it initiated.

During 1980 and the following ten years the petrochemical- and related spin-off industries were faced with major changes threatening to change the industry in a radical way. Bower (1986:19) defines a number of major trends that shaped the industry and served as the main stimuli for change. Although not all of these trends are applicable to the South African situation, the following factors are important:

- **Global recession.** The global recession that characterised most of the previous decade (1980 to 1989) had a significant influence on certain detrimental financial factors such

as the global stagnation of the Gross National Product of all countries involved in the production of petrochemical products. This, combined with a very slow growth rate of the related economies, combined to form a "very sick business" (Bower, 1986:20).

- **Changing managerial principles.** Measured against world standards, the typical South African business has deteriorated mainly due to outdated managerial practices and the stagnation of revitalising strategic thinking placing a large amount of structural and functional stress on the particular organisation. "The extent of organisational distress has also been compounded by structural upheaval in our major industries through new entrants, mergers, competitive shake-out and industrial meltdown." (Nasser & Vivier, 1993:12.)

The traditional mindset of management consisting of aspects such as strict control, flawless planning and rigid reporting structures and channels is due to change to a situation where the manager goes into partnership with the workers, making them more responsible for tasks that, in the past, were part and parcel of a management portfolio. Modern management entails a drastic change in the mindset of the manager and forces him/her to empower workers by devolution of power and shared responsibility. This type of management forces radical changes in any organisation and in some instances causes structural change, which, if not properly implemented, can cause a serious breakdown of production systems.

- **"Green" influences and prominent community (social) pressures**

Montreal protocol. According to the original Montreal protocol all user-products and chemical substances containing chlorofluorocarbons (CFC's), methyl chloroform (CH_3CCl_3) and carbon tetrachloride (CCl_4) have a detrimental effect on the ozone layer in that they contribute to the depletion of this atmospheric layer and give rise to such phenomena as global warming and the hothouse effect (Zurer, 1993:16).

Therefore, these substances must therefore be removed from such products or be replaced by similar, user-friendly, environmentally safe substances that do not have a damaging effect on the ozone layer.

This protocol stipulated a definite deadline that was agreed upon not only by international pressure groups and international governments, but also by the major role players in the chemical industry. Due to pressure from conservation groups and the so called green organisations this date was brought forward to a staggering January 1, 1996 (Zurer, 1993:16).

The clean air act. Recent amendments to this American act place an added burden on American companies in regards to excessive air pollution going beyond the agreed-upon limits. In some instances, these amendments act as a restriction on certain business- and production activities and force such companies to focus on specific environmental issues that could be detrimental to their future sustainability (Robert *et al.*, 1992:34).

In this regard, the petro-chemical industry, including refineries, are at a definite loss. Not only do carbon-based fuels, such as petrol, diesel and paraffin underlie the current automotive- and aviation industry, but seem to be a definite contender in the transport scene of the future. In another sense these amendments could also be positive, in that they give rise to the formation of new business enterprises and related industries. A typical example of this phenomenon is the technological race that arose around the development and production of a suitable chemical catalyst in automotive exhaust systems.

Measured against this background, chemical companies must be extremely flexible in their strategic approach to not only accommodate these external pressures, but also to identify the business opportunity it sometimes holds.

- **Economic pressures.** As can be derived from the nature of the international petrochemical industry, it is usually of utmost importance to the economy in which it functions. This type of industry usually contributes to the Gross National Product (GNP) of the specific country and is therefore closely tied to the conjuncture of not only the domestic economy, but also the international economy. In this regard, countries such as South Africa, America and Germany look upon this industry as one of their mainstays in the international markets.

  Due to this direct relationship between the petrochemical industry and the international and domestic economy, it is therefore directly influenced by changes and factors that affect either or both of these economies. Factors such as international trade embargoes, flooding of markets with cheap products, wars, political strife and boycott actions closely affect this industry and make them very sensitive for these type of influences.

2.2.2 Micro trends in the corporate chemical industry

In an attempt to define the more recent tendencies and factors that shape the modern corporate chemical industry, the following categories of factors can be distinguished:

- **Feed stock prices.** During the era 1980 to 1989, the petrochemical industry was characterised by very high fixed costs and low variable costs, usually in a seventy-thirty ratio (Bower, 1986:19). This tendency changed as major players of the industry restructured their businesses and created other means of financing their products and production facilities.

  Due to the updating of production facilities the prices of petrochemical products were largely determined by the fluctuation in feed stock prices.

This tendency changed the industry remarkably and petrochemicals and plastics became products with low fixed costs and very high variable costs. This tendency made plastics very expensive in regards to substitute products (Bower, 1986:20).

- **Technology.** Due to the rapid changes in the technological arena and the improvements in regards to the more efficient use of feed stock materials, the final product and the physical production facilities, the major global production facilities were rendered more or less obsolete (Scott Mortom, 1991:32).

- **Sources of supply.** Sources of supply became a very scarce commodity as the major suppliers of the feed stock materials changed strategy and no longer only supplied the primary feed stock but started to add value to their products. Value addition was obtained by the construction of very modern ethylene crackers in feed stock producing countries such as Arabia, Canada, Indonesia and Mexico.

  This trend lead to a firmer grip on almost all of the international chemical markets and especially the petrochemical markets as proprietary cracking facilities in America, Europe and Africa became obsolete (Bower, 1986:22).

- **Over capacity.** According to an authoritative article on the business activities of international chemical corporations, there is a marked decline in international chemical sales since the end of 1991. As stated, this situation was brought about by a variety of factors mainly focused around the international financial position, the dollar exchange rate and the international tendency of corporations to move to the production of higher value-added products (Layman, 1992:17).

  Other factors contributing to this already weak situation was the Gulf war and the economic effect of the Soviet Union's Glasnost-policy that caused major disruptions in international markets.

Because of the inherent inertia of corporations to quickly act on market changes, more chemicals were produced than could be absorbed by the already flooded market. As a result, prices dropped drastically and income normally generated from international sales could no longer support high production- and fixed costs.

Many chemical companies operated at a distinct loss. This was particularly true for the majority of Southern African chemical corporations that, because of years of international isolation and government intervention, did not have the financial ability or internal capacity to change or withstand this dramatic onslaught.

- **Cuts in research and development spending.** Closely related to the global phenomenon of over capacity and the subsequent loss in revenue it encumbered, chemical corporations, especially Southern African companies, struggled to survive. These chemical companies subsequently focused all financial resources on their primary businesses and core competencies that, in many cases, did not include research and development as a strategic option in their business portfolios.

  Although this trend saved many companies from financial bankruptcy over the short term, it also had a detrimental effect on the company's ability to compete with other companies that did not have to starve their research efforts in aid of surviving.

- **Focus on operating cost efficiencies.** Due to the radical changes in the international chemical markets and the effect it had on supply and demand, international chemical corporations had to re-evaluate their production cycles in regards to cost efficiency. This implied a drastic lowering of production costs to make the end product cheaper and more cost competitive.

  During the last quarter of 1992 and first half of 1993, the international chemical market became very price sensitive (Storck, 1993:8) and thus imposed an external pressure on

participating corporations to lower their production costs. Effectively, lower operating costs became the main barrier to entry to partake in these markets. Towards the second quarter of 1993, earnings gains for American chemical corporations started to increase gradually due to factors such as the restructuring of the industry, the drastic cuts in operating costs, improved plant efficiencies, reduced size of the work force, focusing on core competencies, and the shaking off unwanted businesses not related to a core competency (Storck, 1993:9).

This tendency, unfortunately, was not universal and had no positive effect on the typical petrochemical corporation, to name only one. The reason for this lie in more than one sector, like the artificially high price of process feed stock, extremely high energy costs, oversupply and a definite diminished demand in all international markets (Storck, 1993:10).

The South African scenario was worsened by internal strife and an unstable political situation. Due to unrealistic wage issues, and general labour unrest, production costs for Southern African companies stay high and make effective competition impossible.

- **Spin-off of sideline businesses.** In an attempt to be more competitive in the international business arena, it is a modern tendency for corporate environments to identify a single core competency and then reshape and restructure their entire business effort around it. This enables the company to apply their financial and personnel resources in an optimal manner and thus ensure a sustainable competitive advantage (Bower, 1986:23).

Related to this tendency, it is common for such corporations to sell off all potential businesses that do not comply to their specific business definition and this is usually accompanied with programs for personal retrenchments, early retirements and lay-offs

as displayed by Johnson and Johnson who retired **12** percent of their personnel during the first half of 1993 (Anon., 1993a:7).

- **Portfolio analysis.** Due to the restructuring of the corporate environment into smaller, less complicated individual business units, the inherent capability to analyse and control these smaller business units is enhanced. Their primary role within the corporate environment and their relation, in regards to the goals and resources of the governing corporation, becomes much clearer and easier to quantify and qualify.

  By means of a thorough portfolio analysis, as an effective strategic business tool, management gets an global overview of the competitive forces, inherent determining factors and opportunities that underlie the basic environment of the individual business unit. It also supplies and maps the all-important relationships that exist between the business unit and other entities such as the open market, its competitors, the governing corporate environment and the global environment.

2.2.3 Macro trends in the corporate chemical information industry

Measured against other industries, the information industry is surely the international leader when aspects such as technological renewal, continual development and improvement is considered. Ever since the advent of the modern day processing chip, computer technology kept rising to the challenge of meeting needs, specific or general.

In this endeavour, the information industry, because of its close links to the business environment, is under constant pressure for change. Although these pressures can arise from a variety of sources, a few major sources and change agents can be identified.

- **Increasing growth in globalization.** Globalization, as a current trend, increases the overall scope of the corporation's activities beyond its normal geographic boundaries (Scott Mortom, 1991:29). No business entity that wishes to expand its operations further that the geographical area, in which it resides, can ignore this phenomenon. Companies that wish to break through the barriers of international trade need an effective information system to support this trend. "Today's customer shops around the corner - and around the world." (Manning, 1991:11.)

  Globalization of any company rests firmly upon the ability to communicate through-out the organisation in such a manner that critical information can be passed along the various channels to aid the management in the decision process that keeps the organisation economically viable.

- **Responsiveness to market trends.** "Furthermore, by increasing the responsiveness to market trends and the requirements of customers, it is intended to gain sales volume and minimise wasted energy." (Scott Morton, 1991:29.) International markets, especially for specialised chemicals, change according to developments in technology and needs for more specialised chemicals. These changes in needs and requirements prompt the organisation to divert from normal operational practices to accommodate the need. For this reason, responsiveness to these changes can mean the ultimate survival of the organisation. To aid this rapid transformation, effective information systems and technologies must be applied and strategically used to this effect.

- **ISO 9000.** The ISO 9000 (International Organisation for Standardisation) is an internationally accepted series of standards for the assurance of quality and currently supported by almost all European countries and American companies. Although this standard is mainly used and implemented for quality assurance of production of goods and the rendering of specialised services, it is fast becoming an international standard for the development of systems, such as information systems (Weightman, 1993:197).

Enforcing this standard and making it part of the corporations functioning will soon lead to international acceptance, through certification of the specific product and/or service. Therefore supportive information systems and strategies need to be in place and effectively implemented. In regards to a supportive information system, all specifications and requirements of the product and/or service need to be accumulated over a fixed period and be made available for the certification of the product and/or service. To this end, information systems play an essential role.

- **Functional links.** The corporate chemical information industry, as its known today, is actually a conglomeration and integration of several independent and diverse industries, therefore several functional links can be distinguished that each play an essential role in the functional structure and performance of the industry.

Firstly, the corporate chemical information industry is functionally linked to the chemical industry that is currently in a transitional phase due to a global shift in international market sentiments and more explicitly defined needs and demands. These changes where essentially brought about by a definite user-driven attitude displayed as a global tendency (Layman, 1992:16).

Secondly, changes to the corporate chemical information industry are initiated by global trends in the formal information industry. These influences range from changes in user attitudes to the direct effect technology creep has on the industry.

Thirdly, being an industry that relies heavily on technology for its impetus and momentum, it is therefore under the direct influence of factors directly related to the efficient management of technology.

- **The global marketplace.** "As we move into the nineties a global company will not be defined as one that does business internationally but one that provides a consistent level of high quality products and services in every market in which it operates." (Peppard, 1993:28.)

In this regard, the new face of the modern day information technology company, whether tied to a corporate environment or functioning as an individual business unit, is determined by its products and services and the acceptance thereof by their prospective clients. This applies not only to typical manufacturing companies but also to service rendering companies, such as the typical information technology company or corporate information technology-department.

- **Business renewal and re-engineering.** In an attempt to stay economically viable and to still have a competitive advantage, many internationally oriented companies are currently re-engineering and re-thinking their organisations in regards to strategies, business processes and functionality in the structure thereof.

Business renewal and business re-engineering focuses on those processes within the organisation that do not contribute sufficiently to the corporate bottom line and that do not add value to the organisation, its products or range of services. It therefore accentuates the importance of a significant reduction of the overall corporate cost/activity chain and value adding.

Seen from this vantage point re-engineering, is the basis for renewal and through focusing on aspects such as core competencies, core business characteristics, eliminates all processes and functions that do not support or contribute to the overall business of the corporation. Information systems must therefore either be the final product of the company or be extremely supportive of the final product to be viewed as an entity that still justifies investment (Waterman, 1987:18).

Effective business renewal relies on effective and timely information systems to aid the transition in regards to current market information, customer needs, strategic scenarios, what-if analysis and the like. "The renewal companies treat information as their main strategic advantage, and flexibility as their main strategic weapon." (Waterman, 1987:6.)

2.2.4 Micro trends in the corporate chemical information industry

Micro trends refer to the different impulses and pressures that stem from within the information industry and lead to a change thereof. Different sources can be identified, of which the following can be viewed important in this day and age:

- **Strategic alliances.** In a strategic attempt to escape from the detrimental effect fierce competition has on a specific company or business unit of which its resources is determined by factors external to the company, strategic alliances pave the way to overcome these negative influences and still remain competitive. This tendency to form strategic alliances focuses on the sharing of facilities to the mutual benefit of both parties involved. It is therefore highly unlikely that this tendency will not be continued in future as it provides an excellent mechanism by which even information technology companies or departments can function.

- **Downsizing of mainframe processing facilities.** During the past decades, the traditional mainframe computer gave all organisations the ability to accumulate vast amounts of information based upon their day-to-day business processes, but failed to provide a cost-effective and efficient way whereby this information could be made available to a wider range of system users and even potential clients.

Due to this situation, the traditional emphasis placed on the highly centralised role mainframe computers played in the past, is fast changing as these facilities are re-evaluated according to factors such as capital layout, return on investment, availability and applicability (Sullivan, 1993:35).

Newer technologies, such as the concept of client-server processing, networking and distributed processing are placing a new perspective on the role of the mainframe and its rightful place within the processing environment. Therefore, the modern myth that the mainframe computer is due to disappear from the information technology scene is highly unlikely to happen, as a new emphasis is placed on a mainframe facility in the sense that it becomes a integral part of the total client server business solution because of its inherent capabilities that are still lacking in true client-server applications.

The results of this crystallise into a definite trend towards the downsizing of these facilities and the placing of the mainframe computer in a new context and orientation. In this regard, mainframes now serve as powerful data servers due to their inherent ability (Gupta, 1993:25).

- **Networking.** In an attempt to make costly information resources more affordable it must be shareable between a wide variety of users and be able to deliver the required information at the lowest cost. To enable this, modern information facilities are tied into networks that not only integrate physical hardware components but also integrate software systems and makes them available on a wider base (Erasmus, 1993:10).

The main advantage of this trend lies in the effective lowering of operating costs and the sharing of devices amongst more users than was previously possible. Closely linked to the downsizing of mainframe facilities, the mainframe now becomes one of the shareable network components and can be easily addressed by a wider user base.

The implication of this is that the user is empowered to the extent that he/she has the ability to utilise the intelligent workstation (Personal Computer) to interrogate the corporate databases and retrieve data in a manner that was previously only possible via professional data processing personnel.

- Distributed processing. Breaking away from the traditional orientation where a single information technology department (IT Department) serviced all the information needs of the corporation, the modern trend is to have a number of smaller networks in the form of local area networks (LAN's) (Groeneveld, 1993:24). This trend implies the replacement of the old fashioned dumb mainframe terminals with intelligent workstations in the form of highly individualised personal computers on each of the user's desks. This enables each user to take charge of his/her own data and related processing required (Groeneveld, 1993:33).

- **Integrated data processing facilities.** Integrated data processing facilities is fast emerging as one of the key technologies for building enterprise wide information systems. This trend implies that the traditional role of the centralised mainframe computer is redefined and placed into a new perspective.

  In this regard, the once mighty mainframe computer looses its centralised processing position and assumes the role of a sharable resource, in the form of another network component. This enables the users of the network, to utilise the mainframe as a normal network device. "Users today need totally integrated information but do not need to know where the data is or how it is accessed. The system should make those decisions and this is what *NT* (*Microsoft Windows New Technology*) will do." (Anon., 1993b:30.)

- **Enterprise wide communication.** Networking and integrated systems facilitates the interactive linking of users to each other and therefore making bi-directional data exchange and direct electronic communication possible. Characteristic of this trend is the emergence of electronic mail (E-mail) that makes the modern concepts of a paperless office and direct person-to-person communication possible. Recent product innovations regarding network connections makes a remote, wireless connections to a network possible, thus making enterprise wide communications truly portable (Meyer, 1993:58).

- **Client-server computing.** Due to the vast amounts of information gathered over the years, massive data sources are to be found on mainly mainframe computers. Normally, this information is only available to users in direct contact with the mainframe via a terminal or on request via an information technology reporting facility.

Both these situations cause a definite delay in the retrieval of appropriate information. Strategically speaking, the way in which a corporate environment manages its competitive advantage relies to a large extent on the ability to retrieve vital information on a timely and accurate way.

To enable this option, these vital data sources should be moved to a more accessible platform, being personal computer networks. Because of the detrimental affect this data transfer would have on the network traffic, a client-server approach must be adopted whereby data processing is performed by data servers specifically equipped to handle this type of processing. Client-Server applications are based on very efficient processing models and emphasises the placement of processing power where it has the largest impact, therefore powerful data servers and network linked workstations, known as clients, are employed to make this processing type possible.

- **Graphical user interfaces (GUI).** With the advent of the user friendly-concept, computer systems needed to move closer to the user in regards to the interface it has with the user. This concept spurned the birth of user-oriented systems like *Microsoft Windows*, whereby the typical processing environment is made considerably more user accessible by interfacing with the user in a manner that accommodates his/her ability, needs and skill level (Victor, 1993:20).

  These graphical interfaces tend to lower the negative impact complex data processing has on a user, especially those who tend to suffer from a phobia in regards to computers and computer related devices.

- **User-driven information technology installations.** According to an article (Anon., 1993c:14) on end-user involvement, the future networking environment will be owned and funded by end users' budgets as the enterprise wide information technology function will be integrated into the different business units.

  The reason for this corporate trend is the awakening of the empowered user and his/her justified demands for more control over their data and processing power. Information technology and the maintenance thereof will greatly depend on the specific needs and demands of the user base it serves.

- **Computer-aided systems engineering tools (CASE tools).** In an attempt to empower the user to be more self sufficient and take ownership of his/her data and systems, users must be able to develop their own proprietary systems and programs by means of high level supporting software, such as computer-aided systems engineering tools (Anon., 1993c:14).

- **Open systems.** According to Parker (1993:27), director of *Open Computer Technology*, there is a definite trend towards open systems and the development of standards regulating interoperability and interconnectivity as a prerequisite for operating in the global environment.

  This trend enhances the need for the migration of data to lower operating platforms and the incorporation of integrated network systems to accommodate specific user needs and to facilitate data retrieval over a distributed processing platform.

- **Electronic data interchange (EDI).** No organisation can ever be viewed as a functional island or economic entity that exists in total isolation as all internal functions such as production, distribution and financial transactions entail bi-directional interactions with the environment comprising of clients, suppliers and associates. The concept of electronic data interchange can be defined as the transfer of structured data between computers by means of an agreed communications standard (Peppard, 1993:145).

  As a functional concept, it facilitates the linking of communication infrastructures and data processing facilities between organisations for the bi-directional transfer of data in support of the business links that exist between the organisations. Examples of this concept can be found where one organisation has direct contact with another organisation's stock system or production facility, thus enabling the interactive placing of orders without a time delay caused by cumbersome paper work and administrative procedures.

- **Outsourcing.** An important issue when reconsidering business processes, is whether to scale down on facilities that do not contribute to the profitability of the corporation or having the facility as one of the contributors of the current cost chain.

Outsourcing looks at this problem and suggests that facilities, such as hardware maintenance, software development and software support be done by companies that see these functions as their only product or service, that specialise in this field.

Outsourcing should only be driven by strategic business reasons and serve as a major impetus for business rejuvenation. Outsourcing as a innovative rejuvenation tool should be applied to those business units within the corporation that do not add value to the core business of the corporation as a whole (Clarke *et al.*, 1991:44).

Viewed strictly from this context an international chemical corporation will typically not include an information department in its strategic layout and will seek to outsource these facilities as an operational expense. On the other hand, the nature of the data associated with these international companies, is usually of a secretive nature and contributes to their competitive advantage. For this reason, an information department will therefore be included as an important supportive function.

2.3 Conclusion

Viewed from the stance that the international chemical industry and the international information industry is in transitional turmoil, it is clear that business re-engineering and the re-thinking and re-designing of business processes and the concept of international trading is under close scrutiny.

For the typical South African business to survive this rugged environment and to regain international status, drastic, innovative strategic adjustments need to be made. These changes must hinge on sound managerial practices and must lead to the resuscitation of a competitive advantage by which growth can be obtained.

CHAPTER 3

TECHNOLOGY MANAGEMENT

3.1 Introduction

During the past decade, technology, in all its forms, has become an ever-increasing determining factor in the way we think, plan, do and perceive things. Judging by the effect technology had in the past, it is sure to play a deterministic role in the way organisations function and managers manage and plan strategically. "For years technology has been the dominant force creating change in men's lives." (Quinn, 1967:89.)

In an attempt to gain and maintain a sustainable competitive advantage, a principal driving force that has to be contended with, is the ever changing face of technology as it not only influences the very existence of the organisation, but plays a deterministic role in the way organisations structure themselves and strategically place themselves in the international market. "In the final analysis the contribution of technology can only be assessed in relation to the extent that it furthers the prosperity of the organisation it serves." (Twiss, 1990:3.)

Seen from a context where South Africa is faced with unique problems in regard to economic and internal growth, it drastically needs to again become an international contender in fields such as mining, manufacturing, medicine and agriculture. The common denominator in all of the above-mentioned industries, is technology and innovation.

For this reason, South Africa, as any other country that wants to enter international markets, must not only obtain the ability to generate technology and related knowledge, but must also be able to apply and adapt this knowledge to local conditions. Furthermore, acquired knowledge serves no purpose if it is not disseminated and transferred to points where it serves a practical use. The modern practice of management, in contrast to prior managerial approaches, has become a science in itself, implying that traditional view points must be challenged in aid of establishing their contribution to the underlying principles that determine the success of the business in the international arena.

New technologies are forcing modern companies to re-evaluate their stance on the management of technology as a means of regaining their competitive advantage. "Business have to realize that big movements of society are rooted in technology." (Feder, 1981:10E.) Technology management in its broadest sense, not only implies the acquisition of the most suited type of technology, but also the application and effective transfer thereof to the benefit of all parties involved. "....the effective management of technology is increasingly regarded as more than a key to competitive advantage; it may be a prerequisite for economic survival." (Feder, 1981:10E.)

3.2 Definitions

This dissertation attempts to integrate the concepts of technology management with the formulation of a competitive strategy for the corporate information industry, the first aim would be to establish a common frame of reference between the generic term *technology* and the more applicable term, *information technology*.

3.2.1 Technology

"Technology is a specialised body of knowledge that can be applied to achieve a mission or purpose." (Edosomwan, 1989:10.) He further clarifies this definition by accentuating that the term *knowledge* refers to a wide variety of related aspects, such as methods, processes, techniques, tools, machines, materials and procedures. It also stresses the specific aim, mission or purpose it works towards. An important aspect regarding this definition, is that technology is not defined as a single object or tool, but encompasses a range of related 'things', of which the abstract components, such as methods, techniques and procedures are the most important.

According to Peppard (1993:4), technology is only a means to an end, implying that technology, irrespective of which type, only serves to enhance and to enable the management of a specific resource. It refers to a company that has a wide variety of resources available to it and therefore needs a different type of technology to manage each, for example, information technology in the form of computers and related equipment, is only a means to an end that is, to manage information and its various other components.

In summation, technology is products, processes, procedures, tools and devices, for use by people. "We define technology as the physical combined with the intellectual or knowledge processes by which materials in some form are transformed into outputs used by another organisation or subsystem within the same organisation." (Hulin & Roznowski, 1985:47.)

In most all of the foregoing definitions, technology is defined or described as knowledge, processes and mechanisms, tools and a resource that has to be applied and utilised in such a fashion that it contributes positively to an overall aim or goal. In terms of managing a business or an organisation, irrespective of the size, the nature or complexity thereof, the main, and sometimes only objective is to make the business economically viable regarding profits, sustainability and growth.

3.2.2 Information technology (IT)

"More formally, information technology is the enabling mechanism which facilitates the processing and flow of this information, as well as the technologies used in the physical processing to produce a product or provide a service." (Peppard, 1993:5.) He further accentuates that information technology is an "enabling mechanism", pointing the way towards the idea that it empowers the people to manage information to deliver a pre-specified product.

According to Duffy and Assad (1989:521) information technology consists of computers, equipment for communication, programs and systems. In sharp contrast to the more functionally oriented definition of Peppard, Duffy and Assad sets the limits for interpretation and focuses their definition on aspects directly related to the information technology industry such as computers and the like. In another instance, they state that technology "occurs in every value activity" (Duffy & Assad, 1989:113).

To a certain extent, this definition places information technology in the very centre of an organisation's activity chain and therefore can again be seen as an "enabling mechanism" (Peppard, 1993:5). Again, technology is seen as the so-called "enabling mechanism". This definition does not necessarily refer to information technology, *per se*, but can be interpreted in a much wider sense, thus opening the way to see any technology as more than just a tool, but also as an idea.

"Information technology can be viewed as a strategic as well as an operational tool... ." (Gerstein, 1987:ix.) He defines information technology as a "collective means" by which information is stored, transmitted, processed and retrieved, but also refers to this technology type as "devices", implying the physical hardware (Gerstein, 1987:5).

3.2.3 Integration of *technology* and *information technology*

The definitions for technology and information technology bear a unique resemblance to each other in that both focus on, and stresses aspects such as mechanisms, processes and tools by which a specific product or service (information), is delivered. According to the foregoing section, information technology is the enabling mechanism by which information flows and is dispersed within the organisation. It goes further to include physical aspects, such as processing, methods, procedures and even machinery in the form of computers. For the purpose of this dissertation, *technology* and *information technology* must be seen as synonyms of each other.

3.2.4 Technology management (incorporating information technology)

According to Edosomwan (1989:15) technology management is a managerial approach that requires a process of integration of business key-elements and the use of different forms of technology in the workplace and includes aspects such as technology development, technology transfer, implementation of technology and the diffusion of technology. As stated by Gerstein, (1987:7) technology, incorporating information technology, has a strategic potential in that it has the ability to redefine the very nature of the organisation not only in regards to it being a strategic weapon, but in the sense that it can create new businesses where none existed before.

Management encompasses methods, procedures and strategies to become and stay competitive in a specific market that suites its core competencies. Therefore, managerial practices focus on those methods by which the organisation can gain a competitive advantage and will therefore become increasingly more dependent on the proper functioning of its different forms of technology, whether it be production- or information technologies.

Information technology, being a resource needs to be managed in such a manner that it produces the optimum value for the organisation. "... the effective management of technology is increasingly regarded as more than a key to competitive advantage; it may be a prerequisite for economic survival." (Feder, 1981:10E.)

3.2.5 Technology transfer

According to Orbach (1985:40) technology transfer is a process characteristic of management and business and differs from a technological process which occurs within the research and development process. Technology transfer is a transaction between the research and development system and the production system.

This definition places the process in perspective in regards to where it should be within the organisation. It actually fails to qualify what is passed between the two identified bodies, but states that it is a managerial, business-like process.

"(Technology transfer)...can be defined as a process by which a body of technical knowledge, techniques, or tools is transferred from one place to another for use in a production or service environment." (Edosomwan, 1989:93.) According to Goodman *et al.* (1990:64), technology transfer is also seen as the "diffusion" of technology, which as other experts in the field, also sees it as a process which facilitates the spreading of technology to the rest of the organisation. He further defines this process as a typical "organisational-level phenomena" which places it in the same arena as other managerial aspects such as finances, personnel and planning.

"Technology transfer is to be understood as the transfer of technological knowledge from one group to another, but in a purposeful manner." (De Jesus, 1983:6.) He further states that this process must be managed in such a manner that it complies to certain criteria, being that it should be a deliberate and conscious managerial interaction that focuses on the "intelligent manipulation of resources". The ultimate goal of this deliberate interaction should concentrate on the control of quality and quantity of technology to be transferred (De Jesus, 1983:66).

3.2.6 Technology forecasting

Quinn (1967:89) defines technology transfer as an organisational tool used by managers to evaluate, within limits, the probability and significance of certain or possible technological developments that could take place in the future and that can have a detrimental effect on the organisation as a whole. Being an organisational tool, it can be used to make better managerial decisions.

Derived from this, the effective usage of technological forecasting can be aimed at the lowering of risks in regards to the usage and implementation of technology in the organisation's particular field of practice.

Technology forecasting should have a fixed goal that focuses on the usage of the tool to make better managerial decisions based on the interpretation of future technological trends and tendencies (Quinn, 1967:89).

"Technological forecasting is a tool used for the prediction and estimation of the feasible or desirable parameters in future technologies." (Edosomwan, 1989:96.) As in the definition of Quinn, Edosomwan also defines technology forecasting as a tool aimed at determining certain elements in the future, but further clarifies the concept by adding a qualification to it in the sense that it is based on a certain methodology and must be well managed through a formalised program. In similar fashion, Reddy (1990:232) sees technology forecasting as a technological perspective that establishes a forum by which future technologies will influence the particular organisation.

This forum studies future trends and maps them out to determine the future effect, but falls short of Bhalla's description that defines it as a process consisting of individual elements such as the collection of information, the organising thereof in aid of delivering future views, thus, the definition focuses on a process that, in turn, delivers a specific product (Bhalla, 1987:172).

3.2.7 Technology fusion

In an article on the new face of a research and development function, Kodama (1992:70) states that many organisations go under because of the fact that they rely on technology that no longer serve the organisation to adapt to fast-changing environmental pressures.

He stresses that the difference between organisational success and failure lies in the way research and development is defined by the organisation.

Technology fusion is an approach by which older technology is merged and assimilated with new technologies. "It blends incremental technical improvements from several previously separate fields of technology to create products that revolutionise markets." (Kodama, 1992:70.)

3.2.8 Technological innovation

Many technical reference sources refer to technology and innovation as being the same process or concept, but fails to explore the real meaning of these concepts. According to Gerstein (1987:181) a clear distinction exists between technology and innovation, based on the fact that innovation is a social process that arises from many sources, of which technology could be one.

In a similar fashion, Tushman and Nadler (1986:76), describes technological innovation as the creation or production of a distinct product, a particular service or specific process that is new to the organisation. This focuses on the fact that the idea, product or service must be new and that it was created. In turn, it also implies a process whereby this "new" entity was born. Utterback (1971:77) takes this further by commercialising it in the sense that innovation has taken place when a new product reaches the market or when a new process is implemented for the first time.

When considering innovation as a process, it must be manageable and therefore placed under managerial control. To this extent, Roberts (1987:4) declares "technological innovation is a multistage process, with significant variations in the primary task as well as in the managerial issues and effective management practice occurring among these stages."

3.3 The global concept of technology management

3.3.1 Overview

From the definitions for technology and technology management, the effective management of technology is one of the various disciplines a manager has in a portfolio. It thus implies that technology management should also be part of the typical managerial approach which includes aspects such as strategic planning, marketing, production planning and financing.

As this process can be become intricate, depending on the type of organisation, it is recommendable that it be sub-divided into sub-processes which, in turn, could each be discussed in more detail. In sub-dividing the process, the logical model according to Du Preez and Uys (1992:9), will be followed, consisting of a macro-level analysis, an intermediate level analysis, and a micro level analysis

3.3.2 Managerial approaches to technology

Twiss (1990:3) distinguishes two types of technology found in corporate environments, known as a strategy-driven technology approach and the so-called technology-driven approach.

- **Strategy-driven approach**

  This approach implies that an organisation does strategic planning for obtaining the ultimate business success in a particular market and focuses on the driving forces in the business environment and attempts to identify potential opportunities and possible threats. In doing so, the organisation sets strategies to avoid possible business hazards and to optimise their chance to make use of the different business opportunities.

Technology is thus seen as a contributing force and necessitates effective planning and inclusion into all relevant strategic planning and thus suited to the typical production environment or a business that forges an income from the products it makes or the service it renders. ".... the lack of investment in future technology development, plant modernisation, and product quality improvement ultimately will spell failure." (Smerdon, 1989:339.)

- **Technology-driven approach**

This approach assumes that the organisation relies heavily on creativeness and innovative ideas from the work force and that technological ideas are passed on from the workers and implemented by so-called "technical champions" who sees to it that their ideas are successfully implemented. This approach would ideally fit into a research and development department where a particular emphasis is placed on innovation, creativeness and the free flow of ideas.

This approach places a heavy premium on management regarding the creation of an environment that is conducive to being creative and promotes innovative ideas. In an article on staffing, Roberts and Fusfeld (1987:25) paid particular attention to the critical aspect involved when staffing an innovative environment. Their findings stated that different work roles existed and staffing should be appropriate and cater for all of these roles.

This does not imply that all of these roles, seen as abilities, should be present in the same person, but the different roles are made up of the abilities such as idea generating, championing (entrepreneuring), project leading, gatekeeping and coaching.

3.3.3 Technology management on the macro-level

No single company exists outside an environment that plays a deterministic role in the way that particular manager thinks in terms of a mission, a strategy and market planning.

This environment can least be controlled from the managerial viewpoint and is mainly constituted by the technology policy of the national government. Government intervention, in direct opposition to decentralisation in regards to other political spheres, is critical in the successful implementation of a national technology policy. Du Preez (1990:54) outlines reasons why a national government, and specifically the South African government, should get involved for the formulation of a national technology policy.

Amongst others, these reasons are, the promotion of productivity in South Africa, the combating of inflation, the increase of international competitiveness, the combating of unemployment, social aspects such as control over pollution and unsafe products, and finally specific factors such as public health.

Adding to these factors Hillis (1992:140), states that should a government not get involved in the formulation of a national technology strategy, the country will slide towards technological incompetence. On another front, Phillips (1992:105) reasons that the recent years were characterised by globalization of the world economy.

This phenomenon redefines the world economy as a world without borders and delivers ample opportunity for any country or business enterprise to be competitive in any field of business it wishes to do so.

Only capital-intensive organisations can make use of these opportunities, therefore government intervention, in the sense of controlling it, is useless, but intervention in the sense of supplying capital and supporting these ventures is of critical importance.

Hillis (1992:141) does not describe government intervention as strict control, but supplies constructive ways by which this involvement should materialise.

- **Government funding.** Government funding in terms of guaranteed loans for the construction of production plants or process development could further be exploited and adapted to include the funding of research and development in fields of international importance.

- **Tax-alleviation.** This form of indirect state funding could stimulate the national economy in the sense that industry, especially of the 'high-tech' classification, could enter the country. This incentive could also spurn new industries and make a meaningful contribution to the overall economy.

- **Banks and shares.** This implies that financial institutions will become active partners in companies that pursue technical inventions. To a certain extent this could entice private investment and lower the burden on the state.

In addition, Du Preez and Uys (1992:12) takes government intervention further by adding the following, making venture capital available, making high-level manpower available and the funding of students that study in directions that is crucial to the upliftment of technology.

Irrespective of the governing body, a national policy regarding technology should be of utmost importance and should focus on ways and means by which technology and associated industries could be supported, not only to benefit the particular organisations individually, but to contribute to the overall well-being and social upliftment of the country as a whole.

3.3.4 Technology management on the intermediate-level

Du Preez and Uys (1992:13) defines technology management on the intermediate level as the intra-industrial management of technology that implies that the managers and custodians of technology must rethink technology on a wider scale than just the influence it has on their own organisations.

They go further and describes specific examples of this level of technology management, such as intermediary networks, - databases, - technology industries and - technology bodies.

In a South African context, an intermediary technology body in the form of the Council for Scientific and Industrial Research (CSIR) that focuses on the research of applicable technology as requested by several companies.

Similar bodies exist on a global scale, such as the government controlled Department of Industry and Trade in the United Kingdom and the Maxplanck-institute of Germany.

Costello (1992:142) speaks in favour of national technology agencies that focus on technology in its broadest sense and fulfill three basic roles, namely, act as the chief advisor to the government on matters of a technological nature, act as governing body for technology and control the functioning of this body, and finally, act as a national coordinator for the technological community.

The institution of such a centralised body goes further than just the management of technology on the intermediate level, but also cuts into the macro-level of technology management, integrating the two levels on a functional basis and creating a bridge for communication flow.

Costello (1992:142) further strengthens his argument by supplying definite benefits for the creation of such a body, being:

- Research done by this body could be of a focused nature and could branch off into advanced, generic, precompetitve technologies indicating that this research is of global importance to a very wide range of industries and not directly focused on a specific type of technology that delivers a competitive advantage to only one company.

- A stable base for the management of government-industry teams, with shared funding. This benefit cuts into the macro-level of technology management and implies that government, with its funding-potential, becomes an active partner in an industry.

  Typical of a joint venture, all parties involved aim at reducing the risk of the particular technology or the development thereof, but are both custodians of the technology and share in the potential profits it holds.

- Cooperative Research and Development within federal agencies and activities.

- Integrated and focused federal technology transfer.

These statements imply that relevant technology must be disseminated and transferred between organisations or between a particular organisation and the national government.

In an article Sisodia (1992:40) describes information networks and databases in Singapore that are functionally integrated and interlinked on a national basis and serve as splendid examples of intermediate networks and intermediate databases.

He further mentions that these information networks serve as common links between organisations, the government and the private sector and is generally used for conducting business between organisations.

In conclusion, Sisodia (1992:40) puts this entire issue of technology management on both the macro-level and the intermediate level into perspective by means of the following quotation: "Technology management and the effective use of information technology have become the central managerial concerns of our time; Singapore is a significant world presence precisely *because* of it's prowess in these two factors."

3.3.5 Technology management on the micro-level

Technology management on the micro-level is a process. Edosomwan (1989:14) defines technology management as an intricate process consisting of various stages that are functionally integrated aimed at the ongoing improvement of the entire organisation.

As to distinguish this level from the previous two levels, the micro-level is the only one that is under direct control of the management of the organisation and can therefore be controlled as an individual managerial function.

To a certain extent, this process runs purely within the organisation and is, in many instances, directly influenced by powers and forces pertaining in the external environment of the organisation.

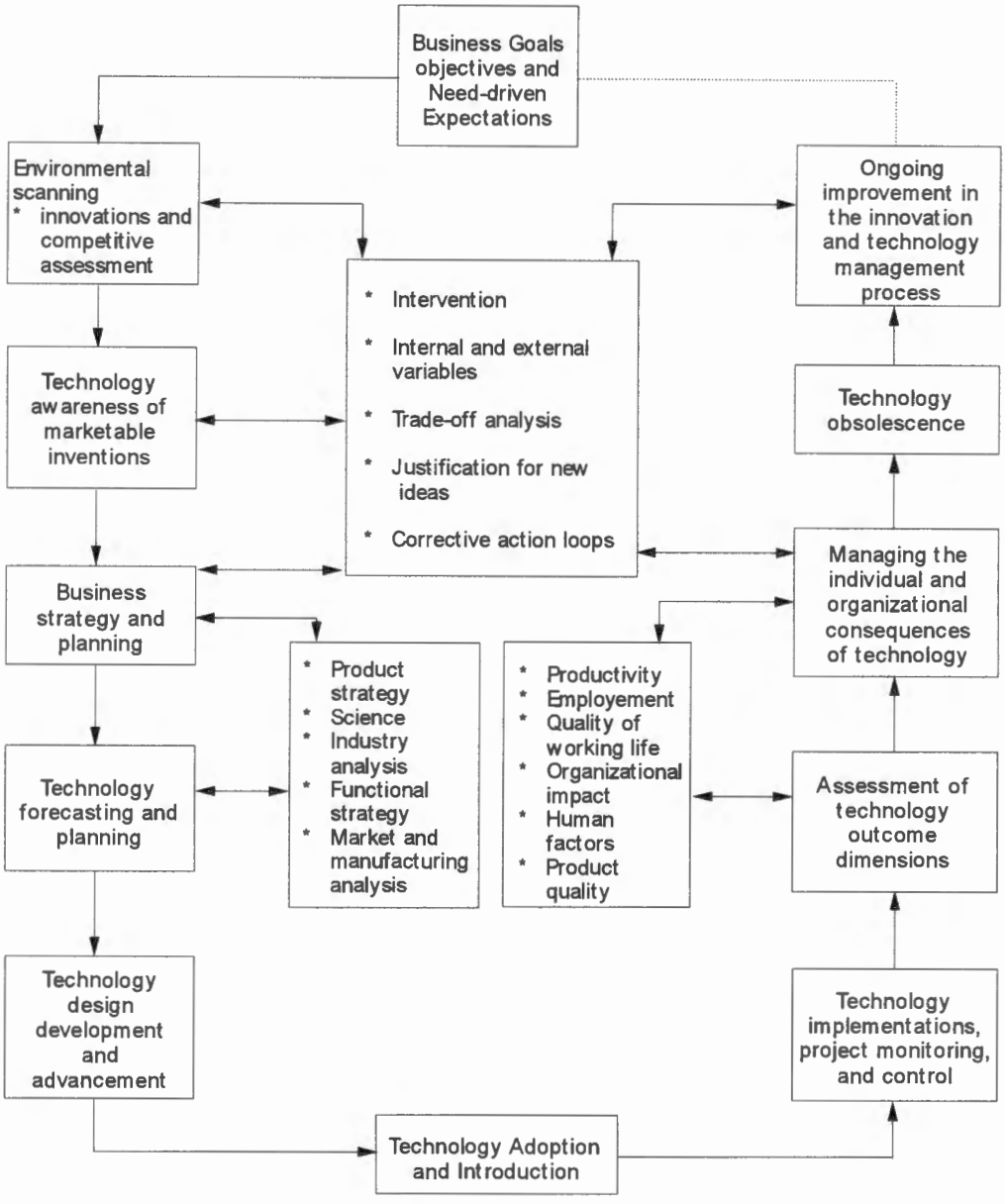


Figure 3.1: Schematic layout of the technology management process (Edosomwan, 1989:14)

In close resemblance to the above model, Du Preez and Uys (1992:10) suggests a much simpler model based on the assumption that some of the steps and phases of the previous model is incorporated into single steps.

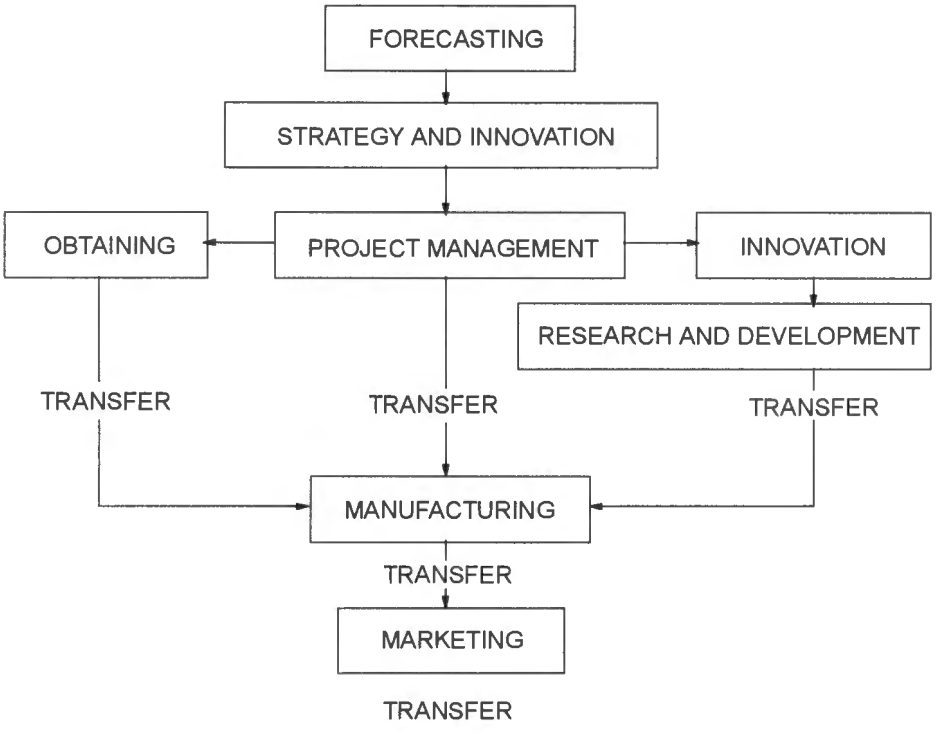


Figure 3.2: The technology management process (Du Preez & Uys, 1992:10)

As seen from these comprehensive models, many individual phases can be distinguished. In aid of simplifying and integrating them into a more suited model for further discussion, an analysis of the steps can be made in order to determine those steps that constitute processes in themselves. In this regard, the following basic steps are then recommended:

- Technology forecasting and strategy formulation
- Innovation and research and development
- Technology transfer
- Technology implementation and integration

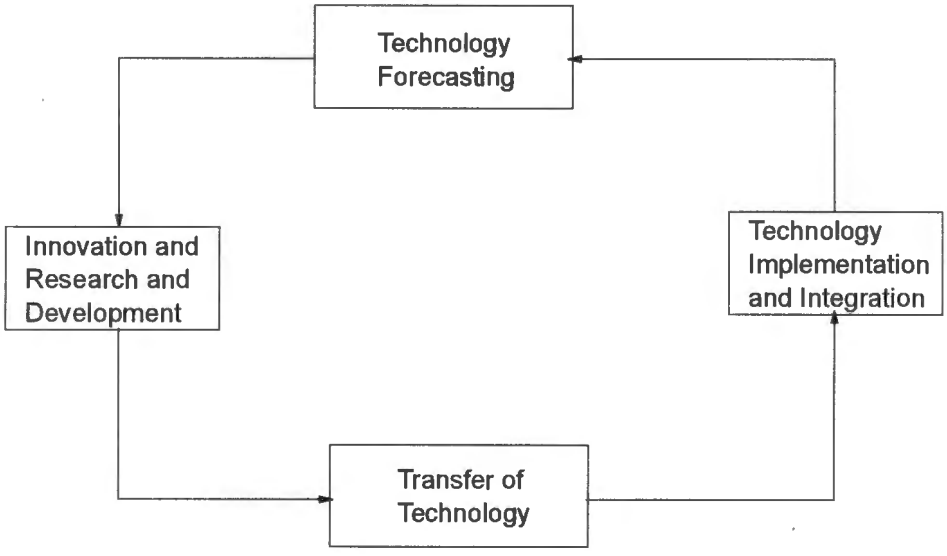


Figure 3.3: Simplified representation of the technology management process

According to the simplified technology management process-model in **Figure 3.3**, four basic steps can be distinguished that integrate in such a manner that they, together, form a holistic approach to the total concept of technology management.

3.4 Technology forecasting

3.4.1 Overview

Derived from the various definitions given for technology forecasting, the concept is more clearly defined in terms of a tool developed for and aimed at facilitating the decision-making process in regards to technology and related issues. Being a managerial tool, and especially a tool focusing on the future, it therefore has a strategic objective of minimising the inherent risk that comes with the implementation of new technologies. In certain instances, this tool defines and limits, as a result, the parameters of future technological trends and gives, the user of the tool, a future perspective.

3.4.2 The product life cycle

Every new product or technology goes through stages within its useful life span after which it 'dies' or undergoes a modification which could extend its usefulness. For this reason, product life cycles, or for that matter technology life cycles, are important to managers as it makes technology forecasting indispensable for the long term survival of the organisation.

"Product life cycles are directly affected by technology discontinuities, thereby making critical decisions regarding advertising, marketing, outsourcing, capital equipment purchases, facilities layout, manpower allocation, and so on." (Edosomwan, 1989:18.)

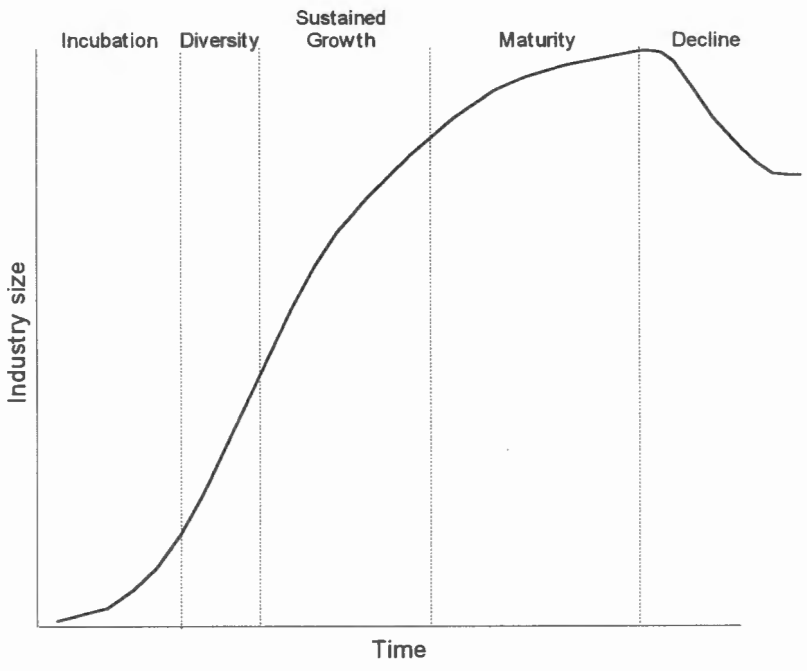


Figure 3.4: S-curve showing product life cycle stages

Bhalla (1987:18) distinguishes five distinct stages, starting at "conception" and leading through to consecutive stages comprising of market acceptance, growth and maturity. The final stage to this life cycle is a stage referred to as decline.

Twiss (1986:40) replaces the term conception with a more appropriate term, innovation bringing it more into context with technology management. Irrespective of the naming conventions used for the individual stages, the entire life cycle can be represented by the familiar S-curve. Seen from a marketing point of view, Kotler (1991:349) states that this curve (cycle) implies that all products (technologies) have a limited life, that different stages occur during the life cycle, and that profits rise and fall during the different stages.

- **Stage 1: Conception (innovation, incubation).** According to Twiss (1990:12) this is "the early stage of a new technology". A lot of uncertainty exists within the market as to what its implications will be or where it might lead. During this phase, massive investments are made to develop the product or technology and make it more acceptable to the market, but realises little or no income for the developer there-of.

- **Stage 2: Market acceptance (diversity).** This stage is characterised by fast growth in the product's selling potential or the new technology's acceptance in the market place. Within this stage other, sometimes similar products appear, but soon disappear due to lacking the same outstanding feature of the original product or technology.

- **Stage 3: Growth (sustained growth).** In this stage of the product and/or technology life cycle, accelerated growth occurs. It is during this period that the initial barriers to market-entry has been broken down and the product or new technology is widely accepted. Accelerated growth takes place as there are no or very few other similar products or technologies available.

  Twiss (1990:19) refers to this stage as the period of rapid advance and gives opportunities for the product or new technology to be exploited to suit other fields of application.

- **Stage 4: Maturity.** This stage is characterised by a decrease in the growth of the product. Bhalla (1987:18) states that this gradual decrease in growth is due to the fact that the product/technology becomes standardised and many of the patents and production rights cease to exist. Seen from a marketing perspective, this should be the stimuli for the particular organisation to re-think the product or technology in terms of removing it from the market or blow new life into it to initialise a completely new growth cycle.

- **Stage 5: Decline.** During this, the final stage of the growth cycle, the creator of the specific product or new technology looses all associated benefits and in some instances the competitive advantage that the product/technology ensured. Due to the fact that numerous competitors has entered the market at this stage, total demand for the product/technology diminishes to a level where all competitors co-exist with each other with virtually fixed market shares.

3.4.3 The process of technology forecasting

As described in the various definitions for technology forecasting, it is a process consisting of individual steps and actions to be completed. As with any generic type of process that caters for all eventualities, some of the steps are superficial when referring to technology forecasting in the sense of integrating it with a information technology strategy. Edosomwan (1989:97) proposes a comprehensive model to illustrate that this process starts with the deliberate intervention of senior management and the incorporation of the particular strategic intent of the organisation and could consist of the following steps:

- **Management strategic meetings**. During this meeting a strategy is fixed in regards to the forecast itself, the proposed objectives, schedules and constraints (Edosomwan, 1989:97).

- **Technology forecasting group activities.** In regards to technology forecasting in a information division of a corporation, this group of people will typically consist of experts in the field of information technology and information systems (Edosomwan, 1989:99). This ensures that all findings are validated against a panel of experts in their particular field.

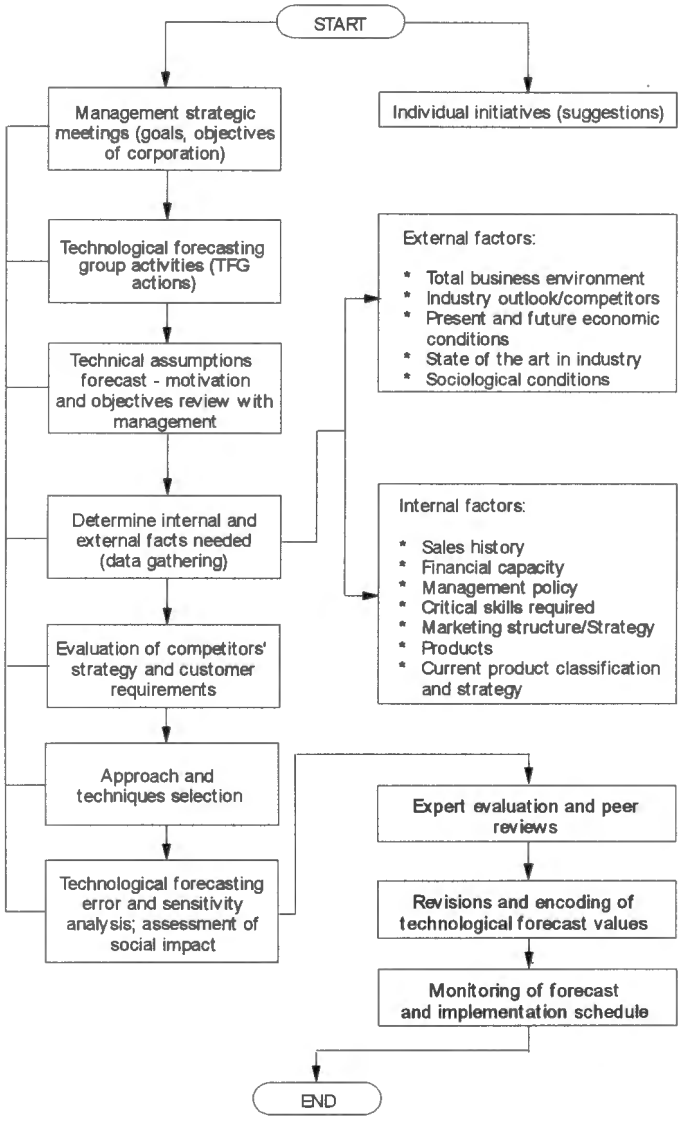


Figure 3.5: Technology forecasting process model (Edosomwan, 1989:98)

- **Technical assumptions forecast.** Edosomwan (1989:99) states that during this stage all technical assumptions and motivations made by the technology forecasting group about the specific technology is clearly defined. This stage seem to direct the group towards a common end goal and sees to it that all objectives are defined clearly in terms of the desired output.

- **Determining internal and external facts needed.** Edosomwan (1989:99) describes this stage in terms of an internal and an external analysis to determine needs and request that are relevant to the technology needed. This is a comprehensive stage and involves the entire organisation. By doing this the technology forecasting team is sensitised to the needs of the organisation and the environment it functions in. Du Preez and Uys (1992:15) suggests that this stage could also encompass a needs assessment by looking at aspects such as:

  - A demographic- and social analysis to determine the nature and scope of future technological needs and trends.

  - A needs circumstances analysis. This analysis focuses on the circumstances that might prevail in the future that could lead to a needs arising in regard to a new type of technology.

  - Opportunity identification techniques. These techniques aid management to isolate latent needs and requirements concerning new technological developments that will be needed.

  - Evaluation of competitors' strategy and customer requirements.

In a similar vein to the previous stage, this stage focuses on factors external to the organisation, especially the commercial aspects.

The technology forecasting team analyses the strong - and weak points of their competitors in aid of determining possible opportunities and threats within the commercial environment (Edosomwan 1989:99).

- **Approach and techniques selection.** In this regard Edosomwan (1989:100) suggests a wide variety of appropriate techniques such as single-trend analysis, growth analogy, regression and correlation, substitution, fitted curves, Delphi techniques, and scenarios.

Adding to this already comprehensive list, Du Preez and Uys (1992:15) suggests the following techniques being, parameter analysis, system analysis, scientific analysis, S-Curve analysis, and morphological research techniques. This stage actually encompasses the following three stages as they are very similar in their approach and are aimed at, what Edosomwan (1989:100) describes as a sanity check of the technology forecasting teams outputs. This stage can be described as the final stage of the forecasting process as it performs the following main functions:

- Correlates and checks the findings of the forecasting group's outputs and correlates them with the strategic direction of the organisation.

- Intelligently interprets the facts and findings of the forecasting group.

- Determines the validity of the approach and the technique used.

- Assessment of the social impact.

- Recognition of the limitations of the technological forecast.

Two very important aspects about this stage, is that it includes the determining of an implementation schedule and the establishing of an appropriate time horizon for the implementation of the forecaster technology. This stage implies that the forecast will be of no value to the organisation if it is not implemented.

This entire process is therefore finalised by an appropriate stage, that does not end when the formal process ends, but is of an ongoing nature. This stage is described by Edosomwan (1989:101) as the monitoring of the forecast implementation and the appropriate schedule.

3.4.4 Factors that limit technology forecasting

Quinn (1967:101) states that, even though there are definite benefits to the different techniques used in the technology forecasting process, the following aspects could limit the process drastically:

- **Unprecedented demands**. Quinn (1967:102) states that, due to the fact that the future is uncertain, future events and occurrences might influence the situation to such an extent that totally new demands may occur.

- **Unpredictable interactions**. During the forecasting process, it might occur that, due to different technological discoveries and advances, these different technologies interact in such a manner that it shatters all forecasts (Quinn, 1967:101).

- **Major discoveries**. As seen from the past radical advances were made in the field of technological innovation. New products seem to reach the international markets at an alarming rate of which some are, as Quinn (1967:102) states major discoveries that forces the world to think and act in a totally different manner.

This, in itself, could capsize the entire current technological forecasting process and force a new process to be launched.

- **Inadequate data**. Quinn (1967:103) establishes that the lack of adequate data for the technological forecasting process is the single most important factor for the failure of this process.

3.4.5 Benefits of technology forecasting

Quinn (1967:90) describes the benefits of this process in terms of the value it holds for the management of the organisation and stresses aspects such as the identification of opportunities and potential threats the organisation will face in the future. It places management in the ideal situation to strategically plan for eventualities and to act more pro-actively.

3.5 Innovation and research and development

3.5.1 Overview

Compiling a generalised version of the different formal definitions that were given for innovation and technological innovation, De Jesus (1993:5) defines it as "the process of bringing invention into use" and focuses on aspects such as innovation being a process and as Gerstein (1987:181) concludes, a social process that emphasis the fact that innovation "brings into use" the specific invention that places a commercial stance on the process and its outputs.

Innovation as a process will be further examined and the crucial areas where management play a deterministic role will be identified and exploited in aid of placing it into perspective in the global process of technology management.

3.5.2 The process of innovation

When considering innovation as a process, it must be manageable and therefore placed under direct managerial control. To this extent, Roberts (1987:4) declares "technological innovation is a multistage process, with significant variations in the primary task as well as in the managerial issues and effective management practice occurring among these stages".

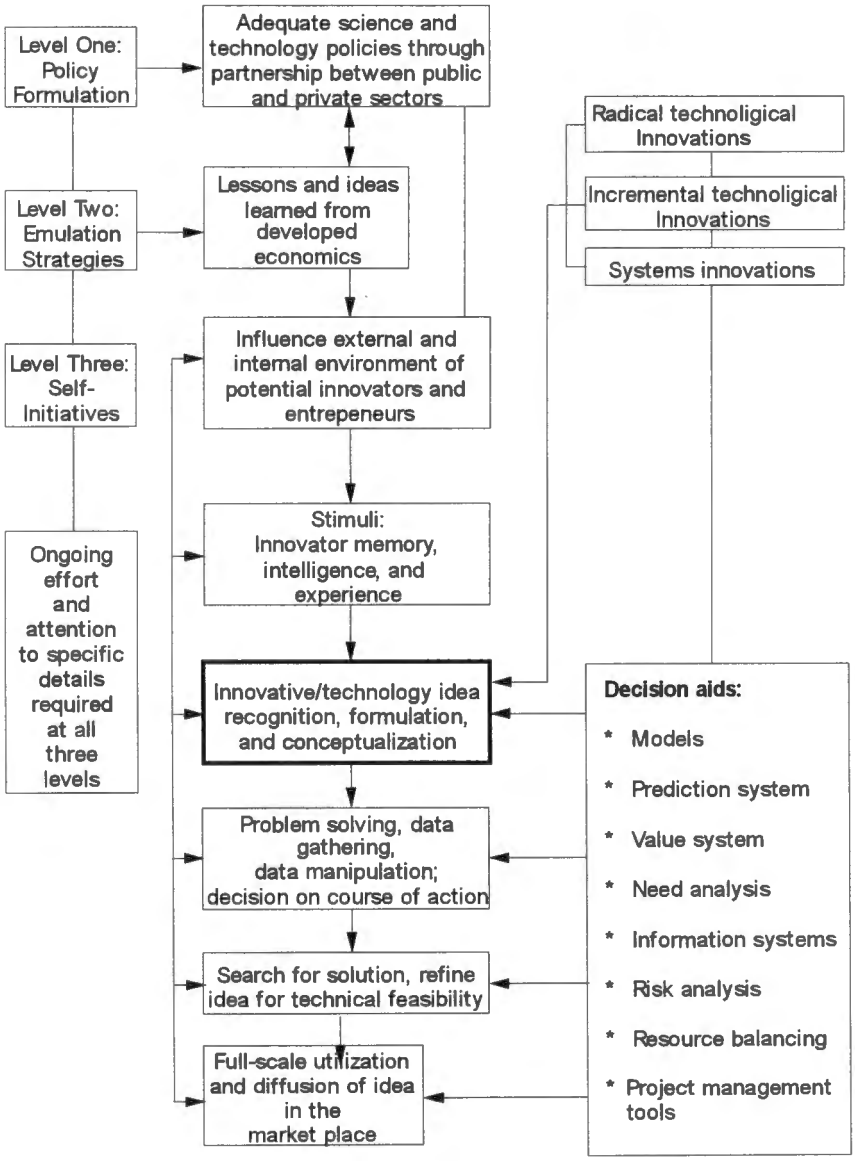


Figure 3.6: The innovation process model (Edosomwan, 1989:7)

This model is very comprehensive in terms of the correct approach an organisation should follow in the effective management of technological innovation.

For the purpose this dissertation it is only appropriate if it can fit into the simplified technology management process model and is a logical continuation of the technology forecasting process. In this regard, this process will only be applicable from the step identified as the stimuli-step.

The stimuli for innovation arises from the outcomes the forecasting process delivered, where-upon, this process starts. The stimuli received, irrespective of source, must first be recognised as being of importance to the organisation. Chatterji (1993:241) sees this stage as "idea generation" whereby an organisation must act on the impulses and opportunities that arise in the business environment. He describes this approach the "Think globally - act locally"-approach. Furthermore, the new idea must be formulated and conceptualised in aid of placing it into perspective and supply a definite direction for the exploiters and researchers there-of.

Following on this step, Edosomwan (1989:7) suggests an interim step before going over to the actual solving of the problem. This interim step focuses on aspects such as data-gathering, data manipulation and determining a course of action. Kim *et al.* (1993:216) underscores this point and states that "Technological innovation is subject to influences by different categories of variables including environmental, strategic organisational, and individual factors."

In the consecutive step, all actions are focused on problem solving and the search for the possible solutions to the particular problem and relies heavily on an assortment of techniques ranging from the usage of decision models, prediction systems, need analysis, risk analysis and project management tools. Chatterji (1993:241) defines this stage as problem solving where research leads to inventions.

The final stage focuses on the utilisation of the new products or technologies and the diffusion there-of into the organisation or appropriate market. Chatterji (1993:242) describes this stage as implementation and market introduction and describes it as the transformation of an invention into an innovation for use.

In close collaboration with the foregone model, Twiss (1986:3) describes technological innovation as a conversion process that can have two definite outcomes. Firstly, it aims at a product orientation and secondly, it aims at a technology/market-orientation. The product-orientation emphasises the product and pays little or no attention to the client. This orientation is destined to fail if the product or technology is developed only for its inherent potential and not aimed at the market or the satisfying of a certain need of a certain client.

The second approach, a technology/market approach focuses on the market and the client and can be considered as a truly market-driven approach which develops products/new technologies according to the stated needs and demands of the particular market it serves and can have massive potential in terms of a realisable income for the organisation, as a whole (Twiss, 1986:3).

3.5.3 Technological innovation and research and development

The integration of the concepts of technological innovation and research and development lies in the fact that technological innovation can be found at any level of the organisation, even without the direct intervention of management.

Research and development, as a department or division in a corporate environment, can be seen as a formalised, strategy-and budget-driven section of a business enterprise.

For this reason, a research and development department resorts under a formal research and development manager or research and development executive and focuses solely on the research and development of new products or new technologies in aid of either making them available as commercially viable products or as services within the organisation to obtain and uphold the competitive advantage of the organisation.

Chatterji (1993:242) describes the role of the research and development executive in no uncertain terms: "The research and development executives must now transform their time-evolved agenda of managing the research function and supporting the business strategies to an agenda of providing meaningful and measurable competitive advantage to a global, decentralised, culturally diverse, but interactive, business enterprise."

3.5.4 Factors that inhibit innovation

- **Funding.** Chatterji (1993:242) states that funding for research and development is mostly inadequate and more money must be made available for it to achieve its goals.

- **Resistance to change.** As innovation and innovative ideas bring change to the way the organisation functions and is structured, managers and the workforce alike seem to develop a certain amount of resistance to these innovations and the change it implies. Du Preez and Uys (1992:25) finds that, among other, communication is to blame for this resistance.

- **Commitment.** "Innovations do not happen, they are made to happen." (Twiss, 1986:14.) Innovations happen through commitment of one or more persons who drive it and supply the energy by which the innovation is developed or brought forward.

- **Role of management.** Pearson (1990:28) concludes that the management of the research and development function should set up goals and objectives that are consistent with the goals and objectives of the business itself.

  Therefore the organisational structure they manage, should be focused on the optimal usage of the company resources, such as is the case with any other department or division of the organisation.

- **Organisational structure**. Pearson (1990:28) states that the organisational structure of the research and development function should be set up in such a way that aspects deriving from the behavioral sciences be stressed. "Emphasis is placed on leadership style, participation, team-building, establish and clarify goals, roles and procedures, and the importance of improving communication, negotiation and conflict resolution skills." Pearson (1990:31.)

3.5.5 Importance of innovation and research and development

"Products obtained through technological innovation have demonstrated the capability to enhance the quality, effectiveness, and productivity of a decision-making behaviour or a decision-making process." (Edosomwan, 1989:3.) This statement is a type of a motherhood statement as it can be sub-divided into several sub-advantages that sprouts from the innovation process and related research and development activities.

- "Technological innovation is a critical factor for the survival and growth of most industrial enterprises, ..." (Twiss, 1986:3.)

- "Research and development is an agent of change. It provides management with the technology required to keep the company healthy and growing." (Thomas, 1982:7.)

- "Research and development can bridge the barriers to linkage by providing solid support for the company's existing business. In this way, it contributes to company profitability and gains credibility with business-oriented colleagues." (Thomas, 1982:7.)

3.6 Transfer of technology

3.6.1 Overview

In an attempt to assimilate the different definitions supplied for technology transfer, different aspects are crucial and needs to be mentioned. These aspects characterises the concept and makes it more accessible in terms of discussing the different components on the global concept of technology transfer.

According to this generalisation, technology transfer is a managerial process that facilitates the passing of knowledge between two pre-defined bodies, either within the same organisation or between the organisation and another external body.

The knowledge referred to here need not only be in a theoretical form, but can be as functional as a procedure, a process or a strategy. What distinguishes technology transfer from any other passing of knowledge, is that it is done in a purposeful manner with a very definite intent and objective.

This section, will emphasise technology transfer as a process that needs to be managed in a purposeful way and will stress the different objectives this type information dissemination will achieve.

3.6.2 The process of the transfer of technology

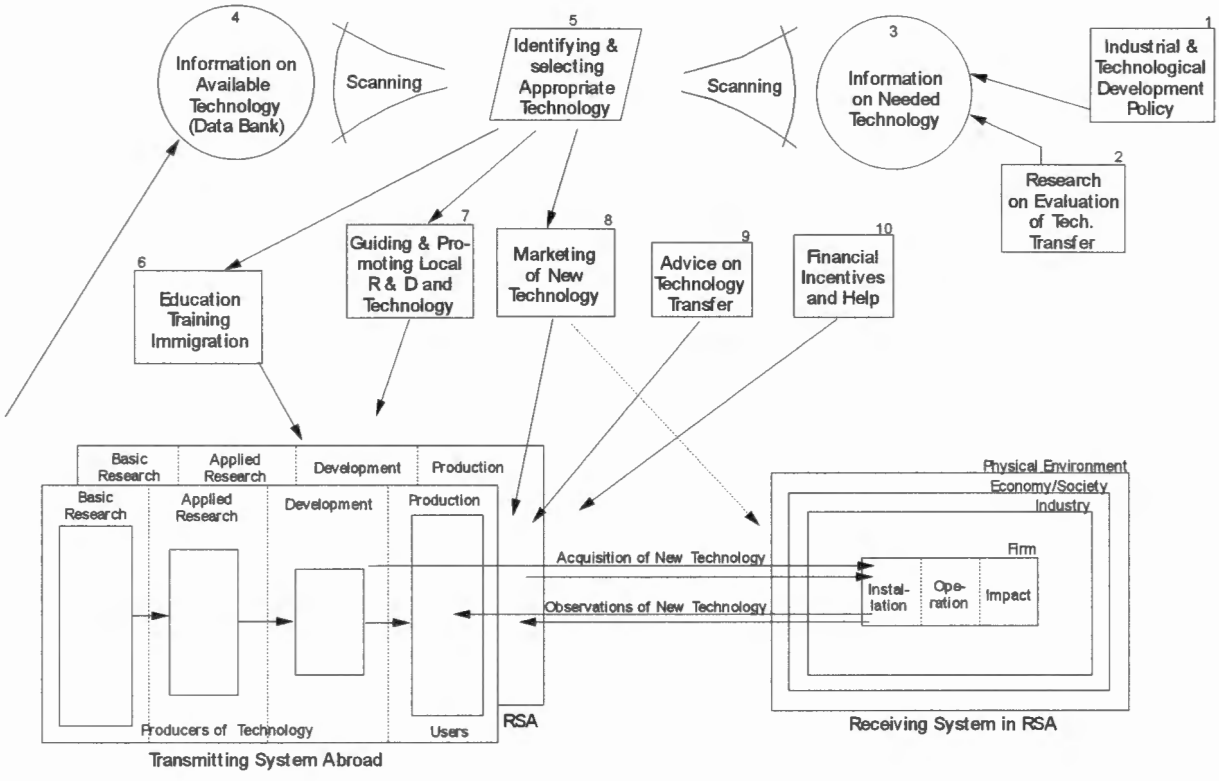


Figure 3.7: Technology transfer process model (Orbach, 1985:39)

- **Step 1.** According to this model, technology transfer starts at the technology policy of the particular organisation and determines to a large extent what the organisation will support in terms of technology, what they are going to develop themselves and what technology they (the organisation) will purchase from vendors outside the organisation.

  Souder *et al.* (1990:5) refers to this stage as prospecting. This refers to a range of aspects as research, analytical activities, and decision making activities aimed at the screening of different technological options in search of the best alternative.

- **Step 2.** This step determines the way in which technology will be transferred. The necessary research in this regard will be done to determine the most applicable type of transfer process by evaluating the different advantages and disadvantages each of the processes entails.

- **Steps 3, 4 and 5.** In combination, these steps, refer to the innovation process, previously discussed. This process delivers, as an output the following deliverables:

  - **Step 3.** This evaluation process, by means of a needs-analysis, defines the specific technology needs within the organisation and represents the technology gap that exists.

  - **Step 4.** This step takes into account the information that is readily available in a data bank. Information of this nature can include information that was obtained through techniques such as technology forecasting and technology surveys.

  - **Step 5.** This step can be considered as the culmination of the previous two steps and delivers, through scanning, an answer in regard to the most appropriate type of technology that needs to be obtained or to be developed. In effect this focuses on the technology that needs to be transferred.

- **Steps 6 to 10.** The different steps depicted in this range (**6 - 10**) implies to a large extent a psychological sensitising of the appropriate receivers of the specified technology. This so-called preparatory process is very important in the whole transfer process in that it makes the receivers ready and qualified to be worthy receivers. This process is facilitated through numerous steps, as follows:

- **Step 6.** Through this step, the appropriate training is given or training received by means of formalised, structured training programs and on-the-job training. If training is not adequate, a process of immigration can be followed by which the person who developed the product or new technology is actually purchased and incorporated into the organisation.

- **Step 7.** This step promotes the idea that local research and development be presented as a possible solution. By interpretation, this step will serve a commercial objective if the organisation at hand is a typical research and development facility.

- **Step 8, 9 and 10.** These steps occur in combination and is aimed at the marketing of the product or new technology and addresses aspects such as financing, advice and marketing aspects.

- **Step 11.** Orbach (1985:38) explains that the suppliers of technology, through research and development deliver new products and technologies by starting at basic research and leading through other stages till it reaches a production stage. From this sub-process flows information that the developer gained but fails to reach other sources as the main focus of the development was to develop the product or new technology.

  Souder *et al.* (1990:6) describes this stage in terms such as enhancing, elaborating, embodying, and tailoring of technologies previously selected to match the specified needs of the user.

- **Step 12.** This step depicts the recipients of the product or new technology. In this instance the new technology is accepted, implemented and the impact it has evaluated.

Although this model promotes the idea of technology transfer between organisations, it is as applicable within organisations. In this instance all the role players are from the same organisation and the transfer remain within the functional boundaries of the organisation.

In an attempt to streamline the above model in terms of role players, Souder *et al.* (1990:7) suggests that there are only three role players involved in the transfer of technology, namely the sponsor, the developer and, thirdly, the implementor. To bring these role players into perspective and to integrate them into the model, steps **1** to **10** fits into the description of the so-called sponsor. Step 11 aligns with the developer and step 12 refers to the implementor.

"The most successful transfers of technology from a research to a manufacturing group occur when some committed person champions the program, mustering support for it and giving it a high level of visibility." (Damerell, *et al.* 1983:15.)

In supporting this statement Damerell *et al.* (1983:16) states that a "solid, systematic approach" must be followed when technology transfer takes place. This approach rests on three main bastions, being the process itself, people and administration.

- **The know-how (the process itself).** In this regard Damerell *et al.* (1983:16) defines the transfer of technology in terms of the transfer of a chemical process from its inception in a research laboratory to a plant where it is then implemented. He states that the initial technology resides in the minds of the persons that invented or researched the process. This body of applicable knowledge is therefore isolated to one or a few persons.

- **People.** Damerell *et al.* (1983:16) concludes that the body of knowledge must be transferred from the inventor(s) to the people who are going to operate the process (chemical process).

- **Administration.** This aspect refers to the actual integration of people and the method that is used to transfer the information. To this extent, Damerell *et al.* (1983:16), sees this stage as the actual implementation of the technology.

Although the previous two models differ in layout, they seem to correspond in regards to aspects such as the all-important role people has to play in the transfer process and the need for applicable and effective methods or procedures whereby information is transferred from one individual to another.

3.6.3 Barriers to technology transfer

- **Training.** Pinick (1987:25) states that effective technology transfer requires training. As new technologies dawn on the horizon, many older technologies and associated skills disappear, but the human in charge of the skill, remains on. This sanctions training as a method by which technology can be transferred. Training and re-training facilitates the transfer of technology.

- **Management philosophy.** Pinick (1987:25) stresses the importance of a paradigm shift in the management philosophy from a purely production orientation to a recognition of people being a very important element in the day-to-day functioning of an organisation and the transfer of technology.

- **Management styles.** Management styles should change from a traditional autocratic style to a more informal style whereby workers take part in the day-to-day making of decisions in regards to the functioning of the organisation. As production decisions are made on the lower levels of the organisation, it is also the levels that are directly influenced by technology transfer. To aid this objective management styles should empower workers and encourage worker participation (Mitchell, 1988:22).

- **Loss of jobs.** Keller and Chinta (1990:78) points out that the import of a new technology could impose a threat on jobs that are currently supported by older technologies.

- **Other factors.** Other factors supplied by Keller and Chinta (1990:78) are political, social, loss of security and cultural. Although these factors are important, the do not play a major role in inter-corporate transfer of technology.

3.6.4 Benefits of technology transfer

Marsh (1985:8) lists the following benefits of technology transfer, being, it accelerates development, it maximises research payoff, it lowers international barriers, it protects the domestic economy, it promotes employment, and ensures continuity of services.

3.6.5 Measurement of technology transfer benefits

Souder *et al.* (1990:9) defines five dimensions for the measurement of the benefits of technology transfer. These dimensions portray the way an organisation looks at technology transfer, but could also apply to the international transfer of technology.

- **Number of units of the technology adopted.** This statement implies that the more successful or beneficial technologies will be applied by more than one receiver.

- **The gateway quality of the technology.** The more successful and beneficial type of technologies will act as so-called gateways for other technologies.

- **The extent of adaptation in use.** This statement implies that only those technologies that are regarded as successful and beneficial will undergo definite adaptations and modifications.

- **The value added from adoption.** In this instance that value added is measured by means of the perception of the client in terms of how much this new technology has saved.

- **Sustained use.** This implies to the total time span the specific technology was in use. The longer it was in use, the more successful and beneficial it was.

3.7 Technology implementation and integration

".... technological change must be accompanied by organisational changes that are compatible with the technology and with the changes in the personal working style of the employees working within the organisation." (Tarr, 1991:165.)

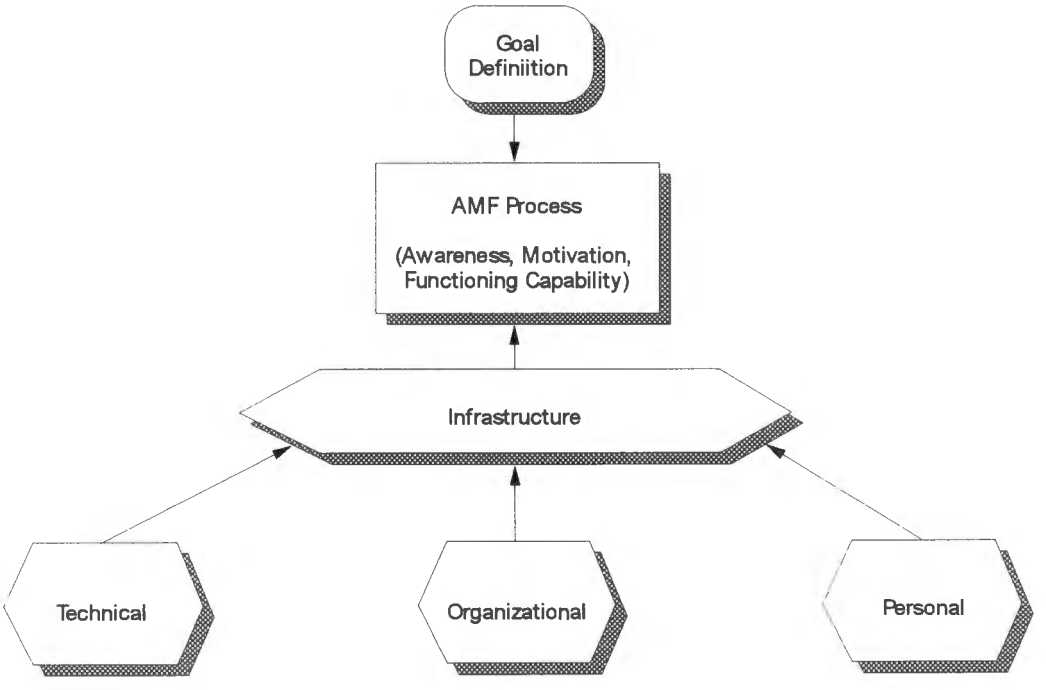


Figure 3.8: Technology integration model (TIM-model) (Tarr, 1991:172)

This extract implies that with new technologies come changes, not only for the organisation in terms of its structuring, but also in terms of how employees function within the organisation. He states that these foreseen changes should encourage the processes of innovation and be conducive to being creative and the inevitable changes it brings.

According to Tarr (1991:171) in the Technology Integration Model (TIM-model) the first step is the "Goal Definition" which states the intent of the whole process, irrespective of it being commercial or aimed at integrating the technology into the business at any point. It is stressed that there should be a certain level of commitment to this goal to direct the rest of the process and make everyone involved sensitive to the inevitable changes that are inherent to the process.

In the following step, the so-called "AMF-Process (Awareness, Motivation, Functioning Capability) relies on the goal statement and can differ according to the content of the goal statement.

This AMF-process possesses different agents each playing a role in the integration of the technologies, being **everybody** (all), **the target** (the individual or group with the problem), **the sponsor** (the individual or group who can supply resources to solve the problem), **the stake holder** (the individual or group who will be affected by changes), **the expert** (the source or group of knowledge to be applied to the problem) and **the change agent** (the individual or group leading the change process) (Tarr, 1991:171).

Each of these agents will progress through each of the phases, being **awareness** (introduction to the technology and a basic understanding of its uses), **motivation** (a matching between the technology and domain problems to which the technology can be applied, resulting in understanding and belief that the work can be done) and **functioning capability** (assimilation of the skills, tools and methodologies needed to successfully apply the technology) (Tarr, 1991:172).

At the bottom of the model are the three basic perspectives that can be placed on the integration of technology. The **technical perspective** focuses on matters more technical and will determine the infrastructure component of the technology integration from a technical viewpoint. In a similar fashion, the **organisational perspective** will view the technology integration process and define the infrastructure component from a viewpoint focused on aspects such as procedures, methodologies and standards.

The final perspective, being the **personal perspective** determines the infrastructure from a people stance, their behaviours, actions and perceptions.

According to the perspective taken, the infrastructure will differ and will therefore play a governing role on the **AMF**-process. In contrast to the above model, Kodama (1992:70) suggest a process whereby new technologies be integrated into existing technologies, called "technology fusion". This approach articulates existing technologies with new technologies and makes the organisational impact much lighter.

3.8 Conclusion

Technology management and its components and sub-processes remains a managerial process of strategic importance to the organisation as a whole not only in the sense of making it more competitive in its commercial ventures, but also serves as one of the crucial elements that guarantee its survival in the face of ever-changing business parameters and the unstable global environment.

CHAPTER 4

STRATEGIC MANAGEMENT

4.1 Introduction

Every business exists within a dynamic environment characterised by constant change, therefore the nature of modern management has to change from a traditional perspective of only focusing on factors that are internal to the organisation, to a global viewpoint that takes into account the different stimuli that arise in the external environment and determine the way in which business is conducted.

Musselman and Jackson (1984:xv) implies that the term *business* refers to a collective group of entities including consumers, employers, workers, institutions and the government and points to the interactions that have to take place in order to establish the concept of a business as it is currently known. This places the total idea of a business in a new perspective and forces traditional managerial practices to be re-evaluated in terms of applicability, sustainability and future acceptability. This managerial change, and the importance of a future prospect, forms the foundation for strategic management.

Wheelen and Hunger (1989:iii), states that the corporate world is fast becoming a different place, influenced by factors such as the fading of international boundaries, the ever-increasing influence of technology and the modern concept of a global perspective. This is especially true for the South African environment, as can be seen from the recent initiatives of international industry to re-invest in a country that was previously characterised by sanctions and economic starvation.

Focusing on the strategic aspect of management, the term *strategy* is taken from the Greek, implying *a general* in the military sense. This connotation implies that a business should be managed and the day-to-day activities be conducted in a similar fashion as a general would mobilise his military forces in a situation of war (Harvey, 1982:7).

Management of an organisation that aims to be competitive in international markets, need to take cognisance of happenings and developments in not only the markets they are competing in, but must have a panoramic view of the global situation in aid of identifying possible threats and opportunities that may arise. Strategic management further implies that managers, especially in the field of strategy formulation, need to take from the environment that what is useful in terms of possible lucrative opportunities and threats that could be detrimental to the organisation and implement it in such a way, that it serves to fortify the organisation against the harsh realities of international competition.

Strategy, and the management thereof, serves as the global game plan by which the organisation is managed and steered for future growth and future sustainability.

4.2 Definitions

4.2.1 Strategy

According to Thompson and Strickland (1992:33) four different levels of strategy can be identified within a corporate environment that correspond to the different levels that exist in accordance to the logical sub-division of activities within the organisation. These strategies are a corporate strategy, a business strategy, a functional strategy, and an operating strategy.

These strategies cover different aspects and levels within the organisation and serve as an effective way by which the organisation can be sub-divided into more manageable portions. Although this logical layout suites a corporate environment, it can easily be applied to a smaller type of business by merging two or more of these strategic levels. This viewpoint is shared by Pearce and Robinson (1985:8) in that they also define only three levels of strategy within an organisation, the lowest level being, the functional strategy.

Peppard (1993:9) places these different levels of strategies into perspective and creates a fixed relationship between the different levels of strategy. "... every corporate planning system is premised on a strategic hierarchy in which corporate strategy guides business unit strategy and business unit strategies guide functional tactics."

- **Corporate strategy**

"Corporate strategy explores the ways a firm can develop a favourable portfolio strategy for its many activities." (Wheelen & Hunger, 1989:9.) This implies a global strategy for the entire organisation and is descriptive of the specific type of business the organisation is to move into, and to a certain extent determines the flow of resources that will enable the organisation to move into the specified business type.

Pearce and Robinson (1985:8) defines the corporate strategy in terms of the people responsible for this strategy and states that it is the sole responsibility of the members of the board, the Chief executive and administrative officers. According to Newman *et al.* (1982:29), a corporate strategy supplies the "overall direction to operations and takes priority over the often-diverging interests of various departments." In contrast to the pervious definitions, this definition places the corporate strategy in its rightful place, that is as the governing strategy whereby all other strategies are deemed of a lower order.

- **Business strategy**

A business strategy is defined and formulated for a lower level within the organisation and describes the actions at the divisional level and is more concerned with the competitive advantage of the organisation (Wheelen & Hunger, 1989:10). "The essence of business strategy lies in creating future competitive advantages faster than the competitors." Peppard (1993:9.)

This definition emphasises the aspect of competitive advantage and points out to what extent a business strategy should function within an organisation.

Pearce and Robinson (1985:8) defines a business strategy as a translation of the corporate strategy into "concrete, functional objectives and strategies" aimed at implementing in the sub-divisions of the corporate environment, being departments and divisions.

The foregoing definition defines a business strategy and focuses on the relationship that exists between the overall corporate strategy and the lower-level business strategy in that the corporate strategy points the company in a certain direction and the business strategy defines the ways and means whereby these objectives can be achieved.

- **Functional strategy**

A functional strategy is defined for the lowest level of the organisation, that is the level where the actual production takes place and focuses on the maximising of resource productivity (Wheelen & Hunger, 1989:10). Thompson and Strickland (1992:38) describes a functional strategy as a set of strategic initiatives taken in one part of a business.

Derived from both these definitions, is that a functional strategy is a managerial plan of action whereby a certain section of the business, whether small or large, is being run and managed. It serves as a directive for success and focuses on aspects such as customer service, market services, distribution, human resources and financing.

Harvey (1982:6) describes a functional strategy as the game plan for the micro level of the organisation. On this level, decisions are made that directly affect the relationship between operating units within the organisation, but also plays a role in the

process of mediation between other elements of the organisation, such as the relationship between the customers and suppliers.

- **Operating strategy**

Thompson and Strickland (1992:33) describes this type of strategy as "still narrower strategies" implying that there could be lower levels of organisational divisions, especially in multi-department organisations. These strategies could consist of game plans for issues such as sales, regions and other functional environments. In most of the literature on the subject, only three levels of strategies are identified implying that an *operating strategy* is combined with the a *functional strategy*.

It is the firm opinion of the author that, although it is stressed that only three levels do exist, the fourth level could be applicable in those instances where the organisation is multi-divisional or even if the organisation reaches over international boundaries.

4.2.2 Strategic management

"Strategic management is concerned with making decisions about an organisation's future direction and implementing those decisions." Byars (1984:6.) This definition focuses the attention on managerial functions such as the making of decisions and projection there-of into the future. This implies a process aimed at the future.

Thompson and Strickland (1992:2) defines the organisational strategy as the moves and approaches devised by management to produce successful organisational performance. This definition places the emphasis on the management of the organisation and especially the actions taken by them to make it successful in its venture. Thompson and Strickland (1992: 2) further states that management can only be considered successful if the strategy they formulate is good and implementation thereof is good.

In consolidation, Wheelen and Hunger (1989:7) defines strategic management as "a set of managerial decisions and actions that determine the long-run performance of a corporation. It includes strategy formulation, strategy implementation, and evaluation and control."

4.2.3 Mission

"The corporate mission is the purpose for the corporation's existence." (Wheelen & Hunger, 1989:14.) As can be derived from this definition, it encompasses the very heart of the organisation in terms of the reason(s) why it does exist. This forms the foundation for the organisation and supplies a basis form where the organisation can be developed. Thompson and Strickland (1992:3) further clarifies this by stating: "A mission statement establishes the organisation's future course and outlines who we are, what we do, and where we're headed".

"... the mission statement is to provide employees, customers, and other organisation stakeholders with both an identity and an understanding of growth directions." (Aaker, 1984:42.) Adding to this, McNamee (1985:26) defines a business mission as a set of long term goals and targets which "the top decision-makers in the business have determined that the company shall have". In summation, the company mission is identified and defined as the absolute and unique reason for existence and that sets a particular business apart from other companies of a similar type.

4.3 The concept of strategic management

4.3.1 Overview

From the definitions for strategic management, a few aspects form the core of the concept, being, that strategic management is a process, consisting of different phases, aimed at making decisions to better facilitate the growth potential of the particular organisation and project the

organisation into the future by means of better planning, structuring and directing of the common effort. This chapter explores the concept of strategic management in terms of its sub-elements and attempts to discuss these elements in such a manner that it lends itself to easy implementation through structured plans and methodologies.

4.3.2 Tasks of strategic management

Managers responsible for the creation, formulation and implementation of strategy has, according to Thompson and Strickland (1992:3) five basic tasks, being:

- Developing a concept of business.
- Forming a vision of where the organisation needs to be headed.
- Converting the mission into specific performance objectives.
- Crafting a strategy.
- Implementing and executing the chosen strategy efficiently and effectively.

4.3.3 Strategic management model

Wheelen and Hunger (1989:12), in their model for strategic management, defines four basic elements that make up the model, being environmental scanning, strategy formulation, strategy implementation and evaluation and control. These elements also constitute the different functions of the strategic manager and can therefore be subdivided into smaller, more manageable portions.

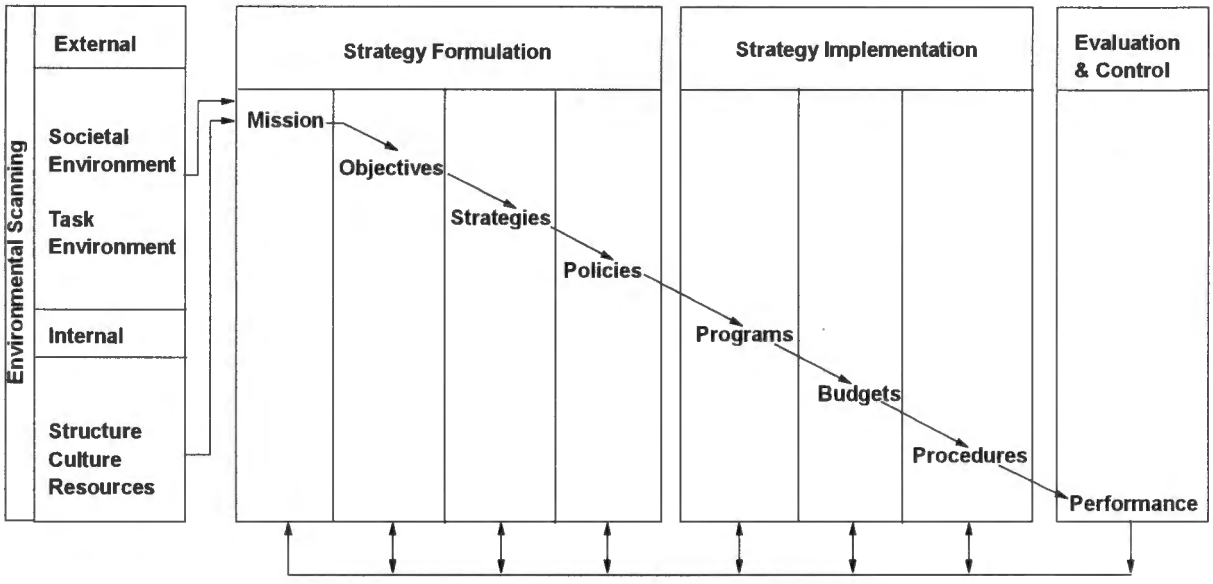


Figure 4.1: Strategic management model (Wheelen & Hunger, 1989:12)

- **Environmental scanning**

Derived from the model, there are two types of environmental scanning, each focusing on a particular segment of the total organisational environment. External environmental scanning focuses on those aspects that lie outside the organisations boundaries and as Byars (1984:51) puts it are "... those factors that may influence the success of the organisation but are external to and not under the total control of the organisation."

Wheelen and Hunger (1989:13) clarifies these factors and names them economic forces, technological forces, political-legal forces and sosiocultural forces.

In accordance to the well-known SWOT-analysis, Wheelen and Hunger (1989:12) considers these factors as typical opportunities or typical threats.

Internal environmental scanning focuses on the factors internal to the organisation and represent those factors that are classified as either strengths or weaknesses (Wheelen & Hunger, 1989:13).

Implying a similar process, Byars (1984:51) refers to internal environmental scanning as an internal organisational audit looking at factors related to aspects such as financial position of the organisation, the organisational structure, personnel, product line and products, marketing, research and development and resources.

- **Strategy formulation**

Wheelen and Hunger (1989:14) sub-divides this managerial process into smaller, more manageable processes consisting of the formulation of a mission, the setting of particular objectives, formulation of strategies and the formulation of policies.

Mission. The formulation of a mission is a managerial process whereby the organisation is prepared for the future in terms of where and what it aims to be. This process consists of all aspects related to the organisation that could influence it in a future dispensation.

Objectives. Wheelen and Hunger (1989:15) states that these objectives, set by the management of the organisation, lies within the constraints set by the corporate mission and define what is to be accomplished by the organisation and states when it should be completed. In some instances, these objectives should also quantify the mission.

Aaker (1984:5) describes objectives in terms of their function as a link between the mission and the strategies of the particular organisation by stating that objectives are the guidelines whereby the mission can be translated into specific strategies.

Strategies. Wheelen and Hunger (1989:15) sees company strategies as the "master plan" of the organisation, whereby it will achieve the different objectives set by management. Strategies encompasses the ways and means by which the organisation will be competitive and remain competitive in the future. "The generic strategy specifies the fundamental approach to competitive advantage a firm is pursuing, and provides the context for the actions to be taken in each functional area." (Porter, 1985:25.)

Policies. "Policies are thus broad guidelines which serve to link the formulation of strategy with its implementation." (Wheelen and Hunger, 1989:15.)

Derived from this definition, policies are the guidelines intent on guiding and leading the management in making the right decision based on the foregoing mission and objectives and thus also enabling management to control the process of strategy formulation. Policies ensure ongoing conformance with the strategic plan when middle management and operating decisions have to be made.

- **Strategy implementation**

This, the third element of the model proposed by Wheelen and Hunger (1989:12), is further sub-divided into three distinct aspects, namely programs, budgets and procedures which all relate to the implementation of a strategy in terms of the way a strategy can be implemented. Wheelen and Hunger (1989:15) defines implementation as the "process by which strategies and policies are put into action ... ."

Due to the vague characteristics of a strategy, it could be almost impossible to implement it without having proper control over it. In this regard, linking a mission to specific objectives, strategies and policies and further breaking up these overall ideas into manageable programs, budgets and procedures ensures that there are sufficient control embedded into the process.

- **Evaluation and control**

Wheelen and Hunger (1989:17) describes evaluation and control as a process whereby all corporate activities, such as production, marketing and planning, to name a few, can be monitored in regards to their actual performance in contrast to their desired performance.

As can be seen from the model, the evaluation and control phase links back to the previous two phases thus ensuring continuous feedback and opportunity to revise those aspects of strategy, goals, objectives and mission that fails to deliver the desired performance set by the overall mission of the business.

4.3.4 Benefits of strategic management

- **Guidance.** On the aspect of guidance, Thompson and Strickland (1992:17) states that strategic management provides a route whereby fixed goals and future objectives can be reached. Pearce and Robinson (1985:20) sees this benefit as incentives for goal-directed behaviour, thus directing the effort of all managers towards a common goal and strategic direction.

Newman *et al.* (1982:22) states that a strategy, implemented by means of thorough strategic managerial practices works through the entire organisation with a sense of mission, guiding the resource allocation decisions.

Aaker (1984:20) states that resources are best allocated when guided by functional parameters such as budgets and plans.

- **Change.** "... making managers more alert to the winds of change, new opportunities, and threatening developments." (Thompson & Strickland, 1992:17.) Newman *et al.* (1982:22) summarises this viewpoint in terms of describing the relationship between the organisation and the internal - and external environment in the sense that a strategy, and for that matter strategic management, guides the entire organisation in regards to this relationship.

- **Evaluation**. "... providing managers with a rationale to evaluate competing budget requests for investment capital and new staff .. ." (Thompson & Strickland, 1992:17.)

- **Proactive management.** "... creating a more proactive management posture and counteracting tendencies for decisions to be reactive and defensive." (Thompson & Strickland, 1992:17.)

4.4 Environmental scanning

4.4.1 Overview

Derived from the model in the previous section, the total concept of environmental scanning consists of two individual, but essential processes, namely external environmental scanning and internal environmental scanning, that can be related to the well-known SWOT-analysis.

Thompson and Strickland (1992:61) states that all types of industry goes through different changes due to a wide variety of external and internal "driving forces" that originate in the immediate environment of the organisation and/or within the particular organisation.

These forces need to be anticipated as they do determine the general survival of the organisation over time.

4.4.2 The process of external environmental scanning

Environmental scanning is a managerial process whereby the immediate and distant business environment is scanned and analysed in aid of determining the different driving forces that do exist and could be either beneficial or detrimental to the organisation as a whole. In this context, environment" implies a whole array of conditions affecting success that cannot be controlled by management (Newman *et al.,* 1982:131).

As environmental scanning is a process, it therefore implies that different techniques do exist whereby environmental stock-taking can be performed ranging from simplistic techniques of judging current trends and projecting them into the future, to more elaborate techniques such as Delphi-techniques, scenario-analysis and making use of computer-based expert systems designed for environmental analysis.

Amongst others of less importance, Thompson and Strickland (1992:62) defines a wide variety of external driving forces or so-called environmental factors that do play a role in the long-term survival of the organisation. Examples of these driving forces are growth rate related changes for the particular industry, changes concerning the product and its relevant market, technological changes, firms entering and leaving the particular market, globalization of the industry, government influences, and international events related to markets and financing.

In an attempt to categorise these different driving forces, Aaker (1984:25) distinguishes a range of external analysis from which the different driving forces can be derived, as follows:

- **Environmental analysis.** This type of analysis includes changes and influences stemming from technology, the current government, cultural factors, demographic

aspects, scenario analysis and impact analysis. Driving forces identified from this analysis are more than likely beyond the control of the management and leaves little or no opportunity to react to them in regards to changing them.

It therefore remains the task of the management to react to these influence in such a manner that the organisation is ready and able to overcome these influences should they pose a threat to the organisation.

- **Competitive analysis.** Competitive analysis implies looking at the organisation's inherent capability to be competitive relative to different aspects of its closest competitors. This type of analysis focuses on a wide range of aspects and characteristics of the competition.

  Aaker (1984:64) mentions aspects such as who the current competitors are that pose a direct threat, who the potential competitors are, the size, growth and profitability of the competitors, objectives and assumptions of the competitors, strategies of the competitors, cost structure of the competitors and the strengths and weaknesses of the competitors.

- **Customer analysis.** Aaker (1984:64) states that this analysis firstly focuses on the characteristics of the customer segmentation in terms of market preferences, who the largest buyers are and the general market segmentation. In the second instance, customer analysis focuses on those aspects that motivates a customer and what their objectives are. In the third instance, the analysis of the customer focuses its attention on those needs of the customers that are currently unfulfilled and unmet and where these potential markets could arise.

- **Industry analysis.** Thompson and Strickland (1992:57) supplies a framework consisting of several factors that shape the industry being, the major economic factors

of the industry, the driving forces and their impact, the different competitive forces and their relative strengths, the companies in the strongest and weakest positions, strategic moves from competitors, key factors that determines success, and overall industry attractiveness.

After data has been accumulated about the foregoing questions, a conclusion about the total industry attractiveness needs to been drawn up which will serve as the starting point from where the company strategy can be formulated. Porter (1985:5) designed a model depicting the five major driving forces that arise from the associated industry and exerts external pressure on the organisation and forces it to change and determine industry profitability by means of influencing prices, costs and level of company investment.

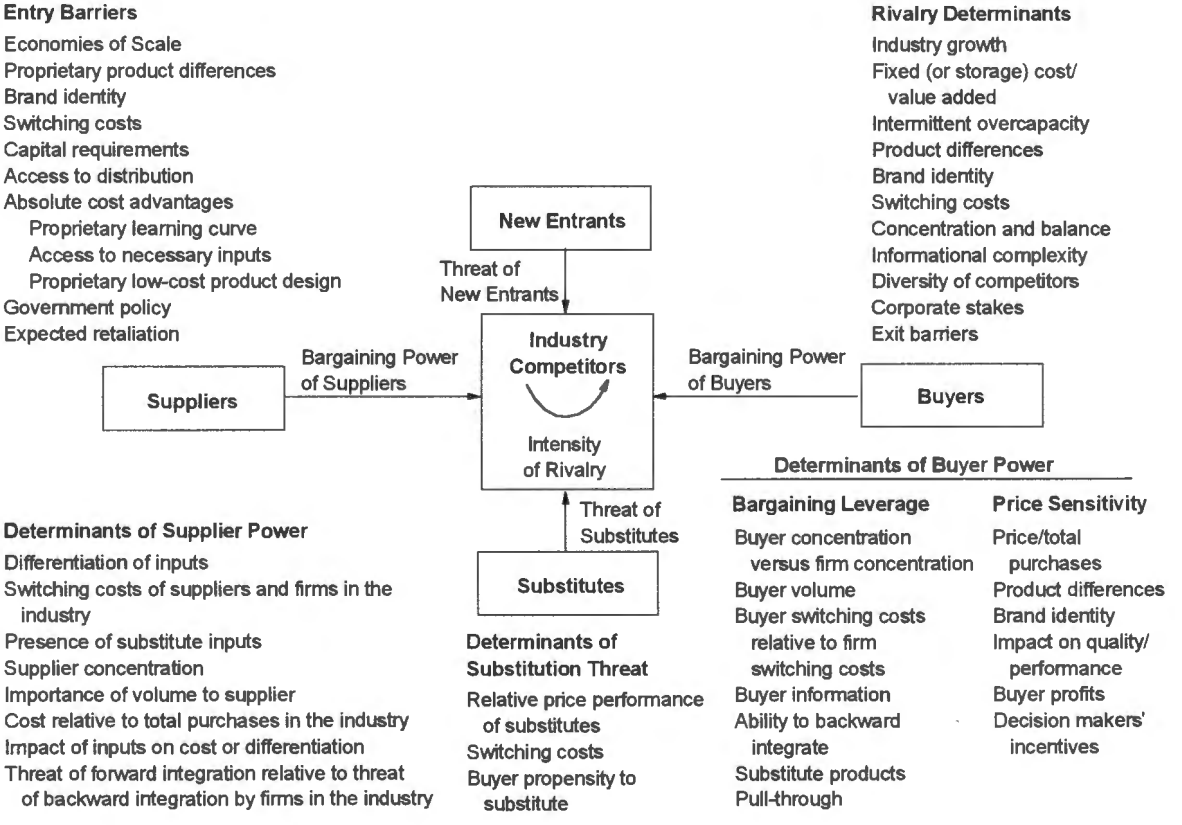


Figure 4.2: Porter's five forces model (Porter, 1985:5)

According to Thompson and Strickland (1992:69), this model can be considered as a rivalry model as it depicts fierce competition that effects the organisation as a whole. Rivalry increases if:

- demand for the product is low or growing slowly,
- the number of competitors becomes more for the same market,
- when competitors are forced to cut their prices to still be competitive,
- when the cost to customers are low when switching form one product to another,
- when a competitor attempts to increase its market share,
- when strategic moves of a competitor pays off and delivers a bigger market share, and
- when the price of leaving is larger than remaining in the particular market.

4.4.3 Internal environmental analysis

In the previous analysis, those factors were assessed that were not under the direct control of the management. This segment deals with those elements and factors that come from within the organisation, that is under managerial control and plays a deterministic role in the future prospect of the organisation. Thompson and Strickland (1992:87) refers to this analysis as not an internal environmental analysis but as a company situation analysis. For the same reason Byars (1984:51) refers to this as an internal organisational audit.

Aaker (1984:25) distinguishes several factors that needs to be examined in aid of determining the overall internal situation of the organisation.

- **Performance analysis.** Aaker (1984:30) states that the bottom line of performance analysis could be seen as the long-term return on investment (commonly known as the ROI of the organisation). This financial ratio, seen against a clear understanding of its interpretation in terms of what is deemed as bad or good for the particular organisation,

gives a clear picture of the financial status and determines it its performance is comparable to similar organisations within the same industry.

- **Strategy review.** According to Aaker (1984:31) regular review of the current strategy in terms of its performance, applicability and sustainability is essential in aid of determining its future potential. It therefore leads to constant re-evaluation of the situation to determine if the strategy is still correct and still supports the organisation for future growth.

  "Successful strategists aim at capturing a company's best growth opportunities and create defense against threats to its competitive position and future performance." (Thompson & Strickland, 1992:90.)

- **Strategic problems.** "A strategic problem is a problem that, if uncorrected, could have damaging strategic implications." Aaker (1984:31.) It focuses on those strategic aspects that are in contrast to the general organisational flow and not supportive of the organisation as whole.

- **Internal organisation.** The internal organisation of a company refers to how the company is structured in terms of its personnel and reporting levels. Structure plays a deterministic role in the effective functioning of the organisation as it facilitates easy work flow and lays the foundation whereby communication can be positively affected Aaker (1984:31).

  A badly structured organisation can lead to what Newman *et al.* (1982:173) refers to as organisational distance, which implies that workers, and for that matter different managerial levels, are removed from each other by the hierarchy of the organisational structure. This situation is further worsened by the difference in educational levels of the different workers in the organisation.

- **Cost analysis.** "Assessing whether a company's costs are competitive with those of its close rivals and is a necessary and crucial part of company situation analysis." (Thompson & Strickland, 1992:90.)

When assessing the strategic position of the organisation within the particular industry, it is essential to determine its cost position relative to other contenders in the same industry. This analysis places the organisation in a particular cost-position and determines to what extent it will survive in the future or will remain the leader of the particular market segment.

The primary tools used to do this type of analysis is called the activity-cost chain that shows how costs are occurred and how it builds up to the final level. This aspect will be dealt with in the section on competitive advantage.

- **Financial resources and constraints.** Financial scanning requires thorough examination of those financial issues that highlights aspects crucial to the survival of the organisation, such as ratio-analysis, pro forma cash flows, balance sheets and application of funds (Newman *et al.,* 1982:170).

- **Strengths and weaknesses.** This analysis focuses on those aspects that are not present in the above categories, but still could be of major importance in that they are either strengths or weaknesses. In this regard, the corporate culture could either be a strength and lend itself to rapid adjustment, facilitation of work flow and communication.

In other instances, the culture could be seen as an organisational weakness by not facilitating change or the implementation of new strategies or objectives (Wheelen & Hunger, 1989:13).

4.5 Strategy formulation

4.5.1 Overview

As expressed by the model for strategy management in **Section 4.3.3**, strategy formulation consists of aspects such as the formulation of a mission, the formulation of objectives, the formulation of strategies and the formulation of policies. This section will deal with each of these aspects in an overall sense as to emphasise the importance there-of.

4.5.2 Formulation of a mission

As defined in an earlier section, a mission is the directional statement that guides the organisation into the future by defining *who we are*, *what we do* and *where we are headed* and setting the business apart from any other business in the industry (Thompson & Strickland, 1992:21).

They describe the formulation of a strategy as a managerial process consisting of three steps of which two need direct addressing and one being a sense of knowing when to change the mission. Irrespective of the specific steps to be followed, each focuses on a different aspect but all lead towards the composition of a guiding statement that enables the formulation of strategies, objectives and policies. "One role of the mission statement is to provide employees, customers, and other organisational stakeholders with both an identity and an understanding of growth directions." (Aaker, 1984:42.)

- **Understanding and defining the business.** Wheelen and Hunger (1989:14) states that the mission conveys the reason and purpose for the business and can be viewed from two vantage points, that of a broad mission that states the overall type of business (for example transportation) and a narrow mission that specifies the particular sub-type of business (for example busses).

In an attempt to define and understand the type of business, Thompson and Strickland (1992:21) prescribes three aspects that need to be addressed, that of firstly identifying the needs of the customer that have to be satisfied, secondly identifying the customer groups that need to be satisfied and thirdly, how these needs must be satisfied in terms of the technology used.

- **Communicating the mission.** For a mission to have any managerial success or impact, it has to communicated to all levels of the organisation. By communicating it to the workers, the mission becomes widely known, understood and becomes a guiding force within the organisation. All parties need to buy into the new mission, need to accept it, feel inspired by it, and need to feel co-responsible for its success.

  For this reason an effective mission statement is stated in realistic terms and makes use of a type of language that is easily understood in terms of the message it has to convey (Thompson & Strickland, 1992:25).

  Aaker (1984:33) states that the mission should be of such a nature that it has a very dynamic orientation.

4.5.3 Formulation of objectives.

"Objectives are a managerial commitment to achieve specific performance targets by a certain time." (Thompson & Strickland, 1992:27.) This definition emphasises two very important aspects about objectives, namely that the formulation thereof is a managerial task and that these objectives require commitment towards a particular goal or target.

In this regard, Wheelen and Hunger (1989:15) states that objectives are the end result of planned activity.

According to Pearce and Robinson (1985:61) objectives should be structured and formulated around aspects and issues of utmost importance to the organisation and could involve areas such as financing, profitability, return on investment, competitive position, technology leadership, productivity employee relationships and other issues that affect the internal functioning of the organisation.

In a certain sense, objectives is the crystallisation of the, sometimes vague mission statement in terms that are easily understood by all and easily interpreted in the sense that each one focuses on one aspect only.

4.5.4 Formulation of a strategy

As previously mentioned, different strategies exist for different levels of the organisation, namely a corporate strategy for the entire business environment, a business strategy for each of the individual business units within the corporate environment, a functional strategy and an operational strategy.

Seen from the top, the corporate strategy is superior to all lower levels and dictates the general direction of the organisation and implies therefore that all lower-level strategies must strive to make the corporate strategy possible.

When strategy is formulated for the particular organisation, a selection has to be made between a wide variety of strategic alternatives, each having its own pro's and cons. According to Wheelen and Hunger (1989:229) four crucial factors determine the choice of strategy for the organisation.

- **Management's attitude towards risk.** Certain managers are less sensitive to risk if a particular strategy entails a very high possibility of better-than-average returns in

terms of investment, resource allocation and possibility and will accept the new strategy more likely than managers more sensitive to taking risks.

- **Pressures from the external environment.** Pressures from the environment forces management to evaluate different strategies against criteria such as the compatibility thereof with the aims and goals of the stakeholders, the needs of the industry and the demands of the market it serves.

- **Pressures from the corporate culture.** Seen from the viewpoint that a corporate environment consists of many individual human components that each has different norms and values that could determine the choice of a strategy and could also imply the wilful sabotage of an unwanted strategy.

- **Needs and desires of key managers.** "Even the most attractive alternative might not be selected if its is contrary to the needs and desires of important top managers." (Wheelen & Hunger, 1989:231.) According to this statement, a strategy will fail if it poses a threat to a particular manager regarding his/her managerial style or so-called empire that was created around him/her.

The process of strategy formulation can be considered as a series of decisions that needs to be taken in aid of crafting the best strategy for future survival. Rothschild (1979:45) groups these decisions into the following categories:

- **Investment decisions.** According to this decision, those segments of the corporate environment are selected that yields the largest income for future investment, therefore different sets of criteria, such as rate of return, growth, and areas of current strength can be used. In some instances, a combination of these criteria can be used (Rothschild, 1979:46).

- **Industry attractiveness.** As in the previous instance, the overall industry attractiveness is a definite decision that needs to be taken to determine the best possible strategy for the corporate environment.

Possible criteria for taking this decision can consist of aspects such as the nature of the market, the nature of the clients, client preferences, demographic distributions, geographic factors, competitive environment, technological change, the current processing facilities, the competitors and the sociopolitical environment.

Aiding managers in making these decisions, a wide variety of managerial tools exist that facilitates the formulation of a strategy. These tools are mostly found in the form of a model, depicting a range of criteria and measurements that needs to be taken and then integrated into the model to produce a recommendation for a specific strategy.

- **SWOT-Analysis** (strengths, weaknesses, opportunities, threats). This technique encompasses the age old analysis aimed at placing the organisation into a perspective that is easily understood by all involved in the process of strategy formulation. This technique focuses on those aspects that are of value to management regarding its external opportunities and threats and also its internal strengths and weaknesses (Thompson & Strickland, 1992:87).

- **Boston consulting group (BCG) growth-share matrix.** This technique is aimed at a diversified company. It consists of a two-dimensional array (matrix) comparing the strategic position of each of the diversified businesses against their growth and their relative market share (Thompson & Strickland, 1992:193).

- In this matrix, each business is identified as a circle of which the size is indicative of the contribution this particular business makes to the overall corporate business portfolio.

  By means of this analysis, all business entities in the corporation is categorised as either "stars" (high growth, high market share), cash cows (low growth, high market share), question marks (high growth, low market share), and dogs (low growth, low market share).

- **Life-cycle portfolio matrix**. This analysis determines the position of each of the corporation's business activities on the growth curve and shows the distribution over the entire spectrum of growth phases of the life-cycle curve. Each business entity is represented as a circle of which the size is representative of the size of the industry the business entity is involved in. Adding to this, pie-slices in the circle indicates the relative market share the particular business has in the industry (Thompson & Strickland, 1992:204).

In conclusion Aaker (1984:35) states that when deciding between different strategic alternatives, the following aspects should also be considered:

- **Responsiveness to the external environment.** This implies that the final strategy selected should cater for external changes that could affect the organisation.

- **Sustainable competitive advantage.** The strategy must lead to the establishing of as sustainable competitive advantage or it is not suited to the particular organisation.

- **Responsive to organisational objectives.** For a strategy to be successful, it needs to make the objectives possible.

- **Relationship to other firm strategies.** A strategy should fit into the portfolio of strategies without spoiling the balance that exists in terms of their "cash usage" .

4.5.5 Competitive advantage

If taking into account that value is what a client is prepared to pay for, competitive advantage therefore lies in the organisation's ability to generate value for its customers at a cost that is lower than the cost of creating this value (Porter, 1985:3). Competitive advantage therefore is a function of selecting the right strategy for the organisation.

Porter (1985:1) states that two factors determine the choice of a strategy for the organisation to be competitive, namely the extent to which the industry is attractive measured in terms of a long term profitability. Secondly, the extent to which the organisation has a competitive position in the particular market or industry.

In terms of the influence management can have over these two factors, the first is beyond the reach of the management, but the incorrect choice of a strategy (second factor) can cause the organisation to loose its competitive position in the industry (Porter, 1985:3).

By means of **Figure 4.2**, Porter describes the five basic forces that shape an organisation and determines the overall industry attractiveness. By means of this model, three generic strategies can be identified to remain competitive, namely cost leadership, differentiation, and focusing (Porter, 1985:12):

Cost leadership. A cost leadership strategy entails that the organisation becomes the supplier in the industry with the lowest cost regarding delivering the product to the market. This form of market leadership is obtained through various methods of which the use of proprietary technology, using economies of scale and preferential access to a scarce or fundamental resource or raw materials to name only a few (Porter, 1985:13).

Differentiation. By means of this strategy, an organisation strives to be unique in terms of delivering a product or rendering a particular service by focusing on those aspects that current and potential customers deem to be important or be of value to them and are prepared to accept and pay for (Porter, 1985:14). This strategy aims to make the organisation different in its approach to the market, the industry and its competitors.

Focus. This strategy forces the organisation to sub-divide the entire industry or market and then direct all its resources and production facilities to service the identified market. By selecting a pre-defined market segment, the organisation can have one of two perspectives on the market. Firstly, a cost focus strategy enables the organisation to have a cost advantage in specific market segment. Secondly, a differentiation focus causes the organisation to differentiate in a particular market segment (Porter, 1985:15).

According to Porter (1985:33) competitive advantage stems from a wide range of activities that are internal to the particular organisation and encompasses activities such as designing, production, marketing, and the support of the product after it is sold. In a closer analysis, these activities all contribute to the relative cost position of the organisation in the industry or market as they all influence the cost occurred for delivering the product or service.

Porter (1985:33) suggests a value chain analysis as a primary tool whereby the different activities of the organisation can be analysed and understood by sub-dividing all the activities of the organisation into groups that are of strategic importance.

By doing this, each group of activities becomes an entity that contributes to the overall cost of the product when it is delivered to the market and therefore influences the cost position of the organisation in the market.

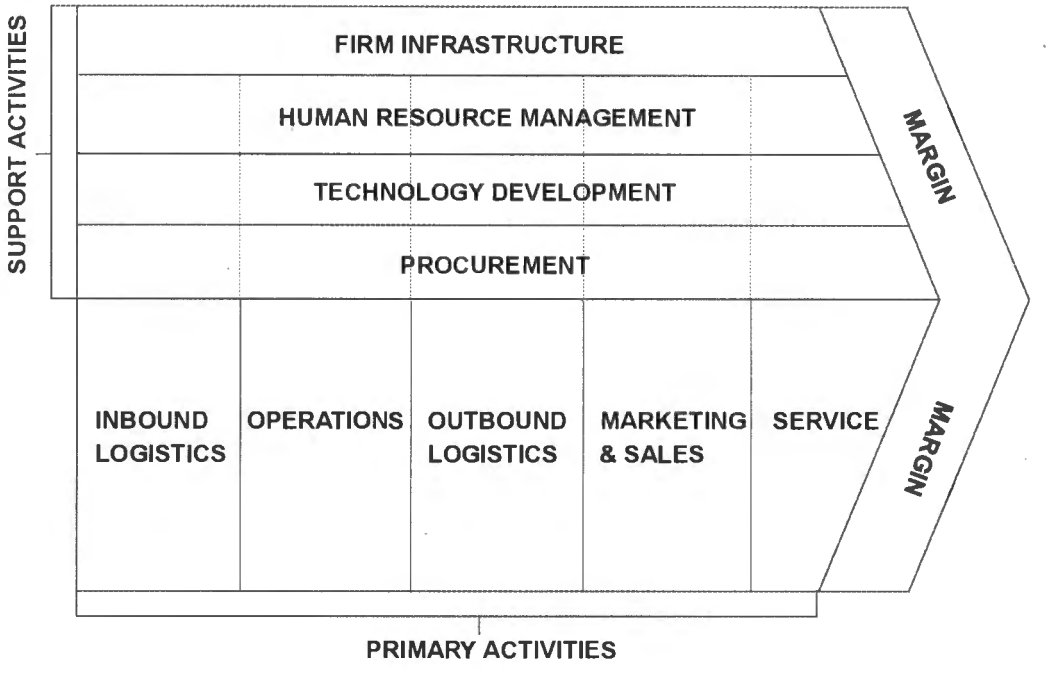


Figure 4.3: Generic value chain (Porter, 1985:37)

Because of the inherent characteristics of a business, the value chain is mostly unique for each individual business in a particular industry and is the basis for the competitive advantage of the business. All activities of an organisation can be divided into two types, being primary activities and support activities.

Primary activities are those activities that directly effect the product or service the business is supplying and is organised at the bottom of the diagram. Support activities can be considered as those activities that supports the primary activities.

Porter (1985:39) defines five primary activities, that integrates to produce or deliver a particular product.

- **Inbound logistics.** This primary activity encompasses all activities in connection with receiving, storing, and dissemination of the different inputs for the process.

- **Operations.** This activity focuses on the actual transformation of the inputs into the product or service.

- **Outbound logistics.** As indicated in the name, this activity focuses on those aspects regarding the distribution of the product or service to the customers including aspects such as marketing, promotion and the actual distribution facilities.

- **Marketing and sales.** These primary activities are associated with aspects such as providing the means whereby customers can obtain the product or service.

- **Service.** This aspect implies the after sales service which enhances the product such as installation thereof, maintenance thereof and the general service given to the product after it has been sold.

Regarding the support activities, Porter (1985:41) states that there are four groups of activities that support the primary activities:

- **Firm infrastructure.** This support activity includes all aspects such as general management, planning, financing and quality and supports the entire value chain in its entirety.

- **Human resource management.** As indicated by the name, this activity includes all aspects of personnel management, being recruitment, training, development, and the like.

- **Technology development.** These activities are focused on the improvement of the primary activities and the process they are linked into.

- **Procurement.** All activities included in this group are about the function of getting the inputs for the primary activities, such as the raw materials needed for the process.

4.5.6 Formulation of policies

"Flowing from the strategy, policies provide broad guidance for decision making throughout the organisation." (Wheelen & Hunger, 1989:15.) In this regard, policies are the managerial tools whereby the formulated strategies of the organisation is linked to the successful implementation thereof and could be seen as realizing the potential of the strategies through the practical application of ways and means whereby the strategies could be achieved.

Pearce and Robinson (1985:313) gives a number of benefits in regards to the formulation of policies and states, that amongst other, policies promote the uniform handling of similar activities, ensure quicker decisions, and afford managers a mechanism for avoiding hasty and ill-conceived decisions in changing operations.

4.6 Strategy implementation

Wheelen and Hunger (1989:15) considers the implementation of strategy as a process whereby the different strategies are put into action through devices, such as programs, budgets, and

procedures. Thompson and Strickland (1992:214) adds to this list by suggesting support systems and organisational building as a way strategies can be implemented.

Regarding the process of strategy implementation, Thompson and Strickland (1992:218) suggest a framework consisting of six distinct components that all contribute to the successful implementation of the different strategies that were formulated in the previous process.

4.6.1 Organisation building

As indicated by the name, this component of strategy implementation involves actions by which the organisation is built up over time to have a structure that is conducive and supportive for the successful implementation and functioning of the strategy. It further implies selecting and employing personnel that is competent to implement the strategy to its fullest potential, also referred to as the structure-follows-strategy thesis (Thompson & Strickland, 1992:221).

Pearce and Robinson (1985:321) refers to this step of strategy implementation as institutionalising the strategy implying not only structural changes to ensure functionality, communication, performance enhancement, and higher profitability, but also defining organisational leadership in terms of the role of the Chief Executive Officer(s), the assignments of key managers, and the organisational culture.

4.6.2 Strategy supportive budget

The successful implementation of any strategy is, to a large extent, made possible by supplying sufficient funds to finance the different aspects that determine the success of the strategy. This also implies that management must be prepared to allocate and to re-allocate resources in such a manner that the shortage of resources does not impede the successful implementation of the

chosen strategy. "Strategy must drive how budget allocations are made." (Thompson & Strickland, 1992:240.)

"Budgets express the objectives, goals, and strategies of the organisation in numerical terms." (Byars, 1984:190.) In context with the previous paragraph, this definition links the implementation of a strategy to the practical allocation of resources by means of a budget and should ideally include funds for programs, implying that funds be allocated to programs such as the implementation of a particular strategy.

4.6.3 Support systems

According to Thompson and Strickland (1992:240) internal support systems must be created featuring policies and procedures whereby strategy can be facilitated and accommodated. This involves putting in place administrative criteria to enhance the critical capabilities of the proposed strategy. "Successful strategy implementers are good at creating policies and procedures that make the strategy work better." (Thompson & Strickland, 1992:240.)

Wheelen and Hunger (1989:16) refers to this aspect as the "putting in place of programs and procedures" that details the specific steps that needs to be done before a strategy can be deemed successful.

4.6.4 Rewards and incentives

For strategy to be implemented successfully, personnel needs to be motivated and be committed to the success of the strategy. It is the task of management to ensure that an environment exists that is conducive to the motivation of employees to do those things that make the strategy work and be successful (Thompson & Strickland, 1992:249).

This implies that management needs to design reward structures, salary structures and incentive schemes that strive to motivate employees to perform according to criteria that leads to the correct functioning of procedures and policies that facilitates the implementation of the strategy.

4.6.5 Corporate culture

Enabling this aspect of the organisation, Thompson and Strickland (1992:218) suggests the establishing of shared values, the setting of ethical standards, the creation of a supportive work environment, and the building of a spirit of high performance.

As can be seen from the nature of these objectives, they are all aimed at improving the corporate culture and instilling a sense of belonging in the employees.

Pearce and Robinson (1985:341) sees the organisation culture as "an intangible yet ever-present theme that provides meaning, direction, and the basis for action."

4.6.6 Strategic leadership

According to Thompson and Strickland (1992:265) leadership entails leading in terms of shaping values, modelling culture, energising strategy, be creative and innovative, being responsive, being opportunistic and being able to deal with aspects such as politics, power struggles, building consensus and initiating corrective actions. As can be seen from these aspects, they all deal with the personal traits of the particular manager and focuses the attention on those aspects that makes a manager successful in his/her approach to the important job of managing an organisation.

4.7 Evaluation and control

This, the final component of the strategic management model proposed by Wheelen and Hunger (1989:12) focuses on the managerial practice whereby the current corporate activities are measured in terms of performance and compared to the desired performance of the organisation in aid of determining the possible differences that might be present.

If any differences do occur, managers use corrective actions to enhance performance and bring it in-line with the desired performance.

Effective evaluation and control rests on the premise that sufficient and prompt feedback is received from the lower levels of the organisation and that this information is the true representation of the prevailing situation. As Harvey (1982:314) puts it, "The focus of control is on results", implying that control is the process whereby checking that all activities are producing the desired results.

Harvey (1982:316) proposes four key-elements to control that arranged in sequential order in aid of achieving the prescribed result, that of measuring and correcting.

4.7.1 Setting standards

When setting standards for the measurement of any type of performance, it is essential that the standards are not only achievable but also within reach of all the contenders. This forces management to evaluate all set standards and ensuring themselves that they are realistic in terms of the common goal they are aiming at.

Harvey (1982:316) emphasises that all standards can posses qualitative- and quantitative characteristics that needs to be cleared out and placed into perspective before they are enforced or user as a evaluation criteria.

Qualitative criteria refers to those aspects of a strategy that address issues such as internal consistency, environmental consistency, appropriateness of resources, acceptability of degree of risk, appropriateness of time horizon, and workability. The quantitative criteria of a standard, in regards to strategy, refers to aspects such as net profit, dividend rates, earnings per share, and market share, to name only a few.

4.7.2 Measuring performance results

Measuring the performance results relies on effective feedback of aspects pertaining to the actual situation in the organisation, that could be in the form of frequent reports, daily status reports and frequent computer printouts (Harvey, 1982:316).

4.7.3 Comparing planned and actual results

When comparing actual results with the desired results, deviations are detected that needs to be evaluated against the known facts of the organisation. This analysis is aimed at identifying existing and potential problem areas (Byars, 1984:228).

4.7.4 Corrective actions

Harvey (1982:322) sees corrective actions as changing conditions implying that it is a managerial process whereby wilful actions are taken to correct those aspects deemed as being problems in connection with the successful implementation of a particular strategy.

4.8 Conclusion

Strategic management, as one of the components of the total managerial approach, focuses, as technology management, on only a small part of the total managerial spectrum, but forms the essence of the future potential of the organisation.

For this reason, strategy management should be seen deemed as the single most important competency of a manager as it entails and encompasses not only the current success of the organisation, but ensures a sustainable competitive advantage for the organisation, now and in the future.

CHAPTER 5

EMPIRICAL STUDY

5.1 Introduction

In the foregoing chapters different aspects of management regarding the effective management of technology and the formulation of a strategy, as a strategic management concept, were discussed. The managerial aspects that surround these practices needs to be enlightened in terms of testing their theoretical value against the practical applicability thereof.

In this chapter certain concepts of technology management and of strategic management are tested by means of an empirical study whereby actual responses from pre-identified information technology managers and information technology personnel are statistically analysed in aid of determining certain statistical trends and tendencies and gathering information that could support these trends and tendencies in the management of information technology.

Apart from the statistical analysis, the statistical data accumulated, as well as the trends and tendencies derived from it, all will be used in the final chapter of this dissertation, that focuses on those aspects that are crucial to the formulation of a strategy for the corporate information industry currently serving the corporate chemical industry in the Vaal Triangle.

5.2 Empirical methodology

5.2.1 Objectives of the empirical study

For the empirical study to be successful, it needs to measure those aspects that were focused on during the discussion of the theoretical aspects of technology management and strategic management and deliver statistical data that could be analysed and serve as a basis from where a generic information technology strategy for the chemical industry in the Vaal Triangle can be formulated.

5.2.2 Statistical sampling by means of a questionnaire

Derived from the foregoing theoretical chapters, those aspects were included in the questionnaire that would shed light on the current status of technology management in the corporate chemical environment. In aid of gathering this crucial information, it was decided that a well-structured questionnaire would deliver the best results as this would least impose on the time of those managers and information technology personnel that played a leading role in this regard. The following objectives were set for the questionnaire:

- **Questionnaire optimisation**

  The questionnaire should be optimised to gather the most information in the least possible time. A preliminary questionnaire, distributed to pre-identified managers, was used to determine the potential problem areas in regards to questions that were stated in uncertain terms and could lead to confusion and eliminating those questions that had very little bearing on the aspects under consideration.

  Further emphasis was placed on the time to complete the questionnaire. In this regard, fifty questions delivered the desired result as it took, on average, only twenty minutes to complete. This time span did not lead to frustration on the behalf of the respondent and was well within the concentration span of most people.

- **Contents of the questionnaire**

  Regarding the content of the questionnaire, it was decided to sub-divide the entire questionnaire into three distinct areas, being a biographical section, a section concerning aspects of technology management, and a third section focusing on aspects of strategic management.

Because of the limitation of fifty questions, only those questions, that could be used in a statistical analysis were included in the questionnaire. Where uncertainty still existed concerning the desired feedback, areas were included where the respondent could supply additional information which could enhance those particular questions. A copy of the questionnaire is to be found in **Appendix A.**

- **Anonymity of the questionnaire**

As the contents of the questionnaire refers to aspects that could be sensitive to certain key personnel in certain organisations, it was decided to make the questionnaire anonymous and to protect the rights of those partaking in this exercise.

By doing this, respondents could feel free to respond to all questions in an inhibited manner without the fear of retribution.

5.2.3 Selection of the respondents

As this dissertation refers to chemical corporations in the Vaal Triangle, questionnaires were sent to all major chemical plants in the Vaal Triangle that are of a corporate nature. During negotiations with the different information technology managers of each of the corporations, its was agreed upon that all questionnaires be forwarded to them for approval and distribution.

It was also agreed upon that managers of information technology departments and some related departments would participate. As a control measure, **Questions 4, 5** and **9** were aimed at determining the responsibility level of the respondents (See **Appendix A**).

5.2.4 Composition of the questionnaire

Within the limitation of fifty questions, three major categories had to be addressed, being, biographical details (**Questions 1 to 9**), technology management details (**Questions 10 to 27**), and strategic management details (**Questions 27 to 50**). Please refer to **Appendix A** for an example of the questionnaire. In an attempt to aid the respondents to complete the questionnaire in as little time as possible, all questions forces the respondent to either answer **Yes** or **No**. In no instance were there any opportunities of taking a neutral stance by answering in terms such as "sometimes", "uncertain" or "don't know".

Where possible, the respondents had the opportunity to expand on certain answers by supplying examples or adding comment to their answers. A summary of these answers can be found in **Table 9, Appendix B**.

5.2.5 Administration of the questionnaires

All questionnaires were delivered to the different information technology managers at each of the pre-identified chemical plants and agreed that the analyst collect them in one weeks time, at noon of that particular day.

This control measure made it possible for the analyst to determine a cut-off point in the empirical data collection phase and continue with the analysis of the data without much delay.

5.2.6 Statistical analysis

As previously mentioned, the statistical analysis will be in the form of determining possible trends and tendencies that might exist within this specific field of study.

5.3 Preliminary data analysis

5.3.1 Respondent return rate

A total of seventy (**70**) questionnaires were distributed amongst five organisations (**A** to **E**). After one week, a total number of **46** questionnaires were received back which, when calculated, amounts to a **65.7** percent return rate. This return rate is higher than the anticipated **50** percent that was envisaged in Chapter 1 of this dissertation. **Table 1** in **Appendix B** gives an overview of the return rate of questionnaires per organisation. Derived from this response rate, is that many of the organisations responded better that initially thought.

5.3.2 Collection and structuring of the data

Refer to **Appendix B, Table 2**, (Parts **One** to **4**) for a complete layout of the acquired data in the statistical sample. In this table, the actual questionnaires received (**One** to **46**) are arranged across the top of the data sheet on the horizontal axis, with all the different responses (**One** to **140**) of the questions (**One** to **50**) arranged on the vertical axis. A **"One"** on the data sheet represents the exact answer that was supplied on the particular respondent's answer sheet.

On the left margin of this table, in the shaded area, the different **possible responses** are listed in numerical order from **One** to **140**. A brief description of each of the questions are supplied and corresponds with the questions on the original questionnaire. To the right of the actual data representation, a summary of the responses are supplied in three numerical values. The first value (**Total Quest.**) is a checksum to determine the actual responses to the particular question.

The second value (**Freq.**) represents a frequency per possible response. This response is indicated per question element, numbered from **One** to **140**. In the final column, an average is given in regards to the previous column, that is concerning the percentage of the specific response in regards to the total number of respondents per question.

5.4 Statistical analysis

5.4.1 Overview

As mentioned in foregoing chapters of this dissertation, it is the unqualified belief of the analyst, that many of today's information technology strategies do not take into account those aspects and techniques of the managerial practice of technology management, especially concerning the formulation of applicable strategies for the information departments of the chemical industries in the Vaal Triangle.

In an attempt to either prove or discard this belief, it is necessary to derive an answer by means of a scientific, statistical methodology. Such a testing means, lies within the boundaries and limitations of trend analysis.

5.4.2 Technology management versus strategic management

In **Table 2** of **Appendix B**, questions **13, 15, 22, 23, 26, 27** give a brief overview of the different concepts that comprise the managerial approach of technology management. From this table, the summation of the data of these questions could not serve as a scientific answer to the question if technology management concepts are used in the formulation of an information technology strategy.

For this reason, **Table 3** was set up and only the **yes**-answers carried over. From this, the data was further analysed to supply insight into the number of managers using any combination of the **six** possible concepts.

Question 13: Planning methods
Question 15: Transfer methods
Question 22: Innovation stimulation
Question 23: Research and development
Question 26: Forecasting methods
Question 27: Implementation methods

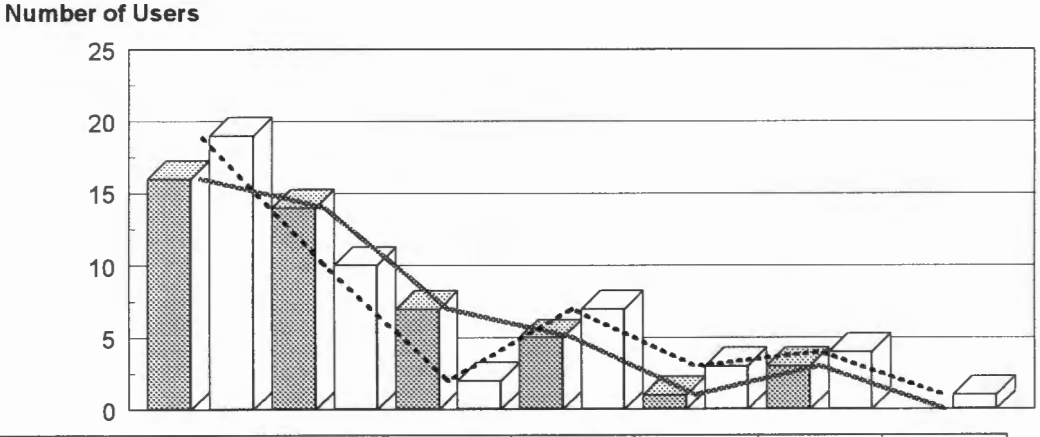
Derived from these questions, it can be seen that they actually encompass all the different facets of technology management. In actual fact, should one of these aspects be neglected, technology management, can be deemed ineffective. For this reason it would be fair to say that should **five concepts** of the possible **six concepts** be used, technology management is still reasonably effective.

From the statistical analysis made in **Table 3 (Appendix B)**, only **three** of the respondents made use of **five** of the possible **six** techniques, where none of the respondents made use of all of the techniques. When adding up, only **6,52** percent of all respondents made use of either **five** or **six** of the possible techniques. This trend seem to repeat itself for lower numbers of techniques used. For instance, should the criteria be that **50** percent or more of the techniques be used, it adds up to only **nine** respondents, giving a **19,56** percent return.

Based on the data presented in **Table 3** of **Appendix B,** it is clear that very few managers make use of the concepts of technology management. From an analysis made of the specification part of **Question 13 (Table 9, Appendix B)** the respondents stated **nine** different methods, of which only **two**, namely **SWOT-techniques** and **research and**

development have direct relevance, suggesting that the majority of respondents have a very vague idea concerning technology planning methods.

Taking this very low percentage into account when considering the incorporation of technology management techniques and concepts into strategy formulation, it becomes an issue to determine whether it is that the techniques of technology management that are unknown to management, or the very issue of strategy formulation that falls short. In an attempt to visualise the utilisation of technology management concepts and strategy management concepts, a similar analysis was made for those concepts that constitute strategic management **(Table 4, Appendix B)**.



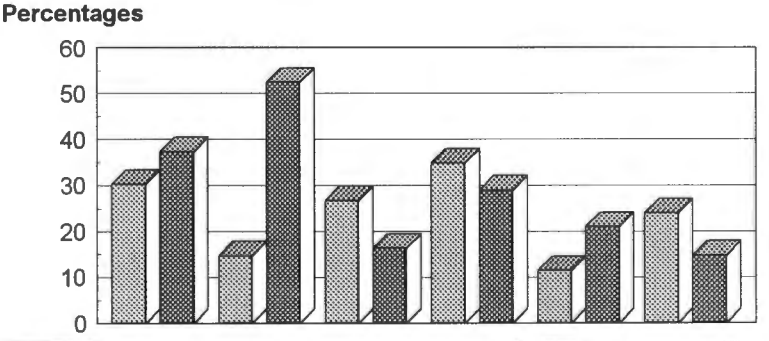
Techniques	0 of 6	1 of 6	2 of 6	3 of 6	4 of 6	5 of 6	6 of 6
Techn. Man.	16	14	7	5	1	3	0
Strat. Man	19	10	2	7	3	4	1
Techn. Man.	16	14	7	5	1	3	0
Strat. Man.	19	10	2	7	3	4	1

Figure 5.1: Graphical representation of technology management concepts versus strategic management concept

Although no formal hypothesis testing was performed to evaluate the usage of technology management concepts versus the usage of strategic management concepts, there seem to

be a very similar tendency between those concepts that determine the effectiveness of technology management (solid line) and the concepts that constitute strategic management (dotted line). This seems to imply that current managerial practices, in regards to the technological impact and strategic fit with future growth, fall short of being effective and therefore successful.

The foregoing analysis showed that there is a marked resemblance in regards to the concepts that constitute technology management and those concepts that underlie strategic management. In aid of determining the intensity of usage of the different technology management - and strategic management concepts, a further quantitative analysis needs to be performed.



Techniques	Techn. 1	Techn. 2	Techn. 3	Techn. 4	Techn. 5	Techn. 6
Techn. Man.	30.23	14.63	26.67	34.78	11.36	23.91
Strat. Man.	37.21	52.38	16.28	28.89	20.93	14.63

Figure 5.2: Quantitative analysis of the usage of the different concepts of technology management versus strategic management

This graph is based on the **no-answers**, expressed as percentages, of the summary of questions as presented in **Table 7, Appendix B.**

As can be seen from this analysis, the overall usage of technology management concepts is far lower that the overall usage of strategic management concepts.

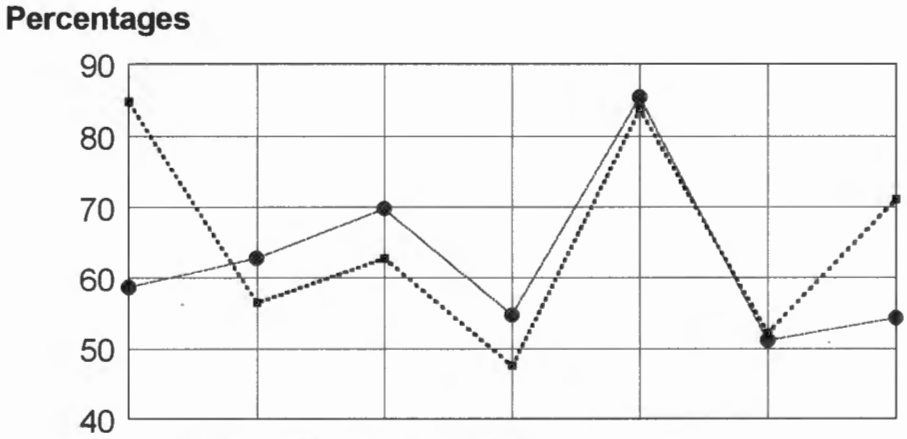
It again implies that although managers do strategic planning through the formulation of strategies, they, to lesser extent make use of the concepts of technology management. This finding is further supported by the type of supportive answer supplied in the specification sections of **Questions 15**, which focuses on different techniques.

Here, none of the respondents could shed light on any applicable techniques. In a similar vain, **Questions 22, 26** and **27** where very vague, and sometimes off-the-mark supportive answers are given, indicating the lack of knowledge in matters relating to technology management.

Regarding strategic management, the supportive answers, given in response to **Questions 30, 32** and **44** are less vague and more on-target, indicating that the underlying concepts of strategic management are known and are possibly more utilised that the concepts of technology management.

To further qualify this phenomenon, a further data-analysis is necessary taking into account those aspects that formalise the concepts of technology management and strategic management. In this regard, certain questions were identified and then analysed determine a trend or display a common tendency.

From the questionnaire (**Appendix A**), the following groups of questions were identified and only their **no-responses** taken into account. Please refer to **Table 8** in **Appendix B** for the data summation.



Questions	Q11 / Q28	Q12 / Q29	Q13 / Q30	Q14 / Q31	Q15 / Q32	Q16 / Q33	Q17 / Q34
Techn. Man.	58.70	62.79	69.77	54.76	85.37	51.16	54.35
Strat. Man.	84.78	56.52	62.79	47.62	83.72	52.27	71.11

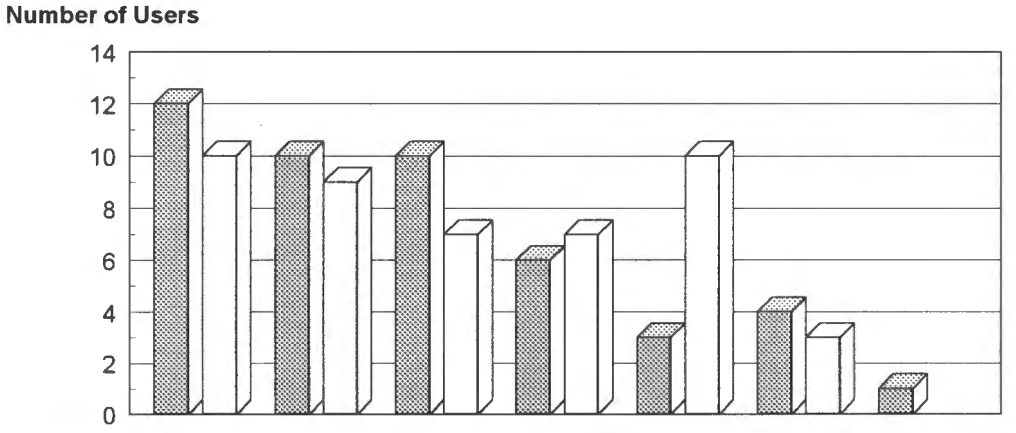
Figure 5.3: Technology management tendencies versus strategic management tendencies

From this analysis, excluding the **no**-responses to Questions **11** and **28**, there again seem to be a similar tendency indicating the that formalisation of managerial actions concerning technology management and strategic management, through acceptance of responsibility for those actions, the involvement there-in, the formalisation of methods, and the communication actions, seem to be at a very low level in the corporate chemical industry in the Vaal Triangle.

5.4.3 Managerial actions towards involvement and awareness

An interesting aspect that arose from the analysis of the original data, is the determination of the extent to which the managers could involve people of the same and lower levels in the formulation of an information technology strategy.

To further enhance this analysis, an analysis was done to determine the level of managerial effort to create an awareness towards the usage of technology management concepts and the resulting strategy it implied. The analysis for this graph can be viewed in **Table 4** and **5** of **Appendix B.**



Combin.	0 of 6	1 of 6	2 of 6	3 of 6	4 of 6	5 of 6	6 of 6
Opport.	12	10	10	6	3	4	1
Awaren.	10	9	7	7	10	3	0

Figure 5.4: Graphical representation of involvement versus awareness

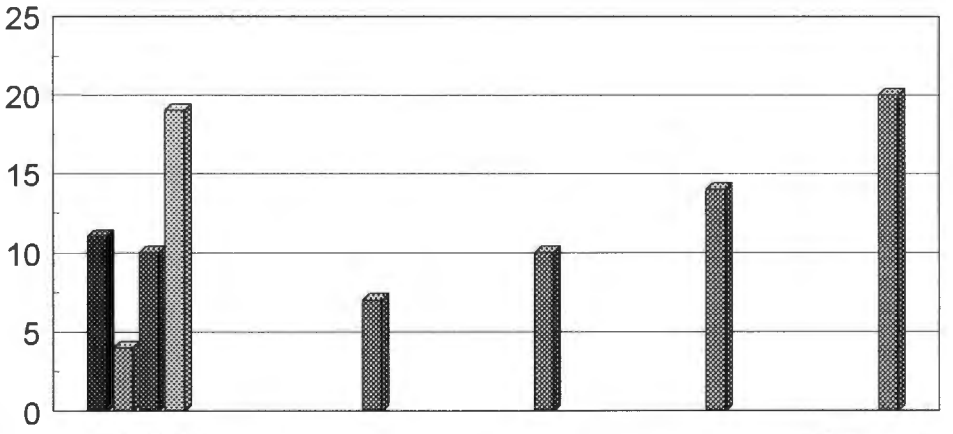
As in many of the forgone graphical representations of the original sample data, this graph seem to indicate a certain level of correspondence between the different **opportunities** that do exist for the **involvement of people** in the managerial practices of technology management and strategic management and the **level of creating awareness** of these managerial actions.

In both instances, a very low percentage was returned when more than one of the different techniques are incorporated. This, in turn, suggest that very few of the different techniques are used, either independent or in combination with other.

5.5 Additional statistical analysis and results

5.5.1 Academic qualification analysis of information technology management

Although academic qualifications are not the only criteria whereby the success or failure of a particular manager can be measured, it surely is an indicator of the extent to which the particular manager has been exposed to the theoretical aspects of management.



	Q6	Q7(37+39+40)	Q8(46)	Q8(43)	Q8(44)
Std. 10	11				
Tech Col	4				
Technic	10				
University	19				
Comp Degrees		7	10	14	20

Figure 5.5: Academic background of managers

In this regard, **Questions 6, 7** serve as the basis for this analysis. A full record of all the statistical results is available in **Table 2** of **Appendix B**. Of the **46** respondents, **29** had any form of tertiary education, this calculates to about **63.04** percent.

Taking **Question 7** in to consideration, this high percentage becomes much lower, as only **seven** of the possible **42** respondents obtained degrees with computer science as one of the subjects.

This amounts to **16.67** percent, and implies that only **16.67** percent of those managers who had any tertiary exposure to the theoretical aspects of management are involved or directly responsible for the management of information technology and/or the formulation of a information technology strategy. Represented in the graph as **Q7(37+39+40).**

This percentage ties up with the result of **Question 28** which indicates that only **seven** out of a possible **46** respondents were responsible for strategy formulation. This works out to roughly **15.22** percent. Against this distribution of academic qualifications, the number of managers with **MBA-degree** (or similar) were plotted. against the **Q8(46)**-description.

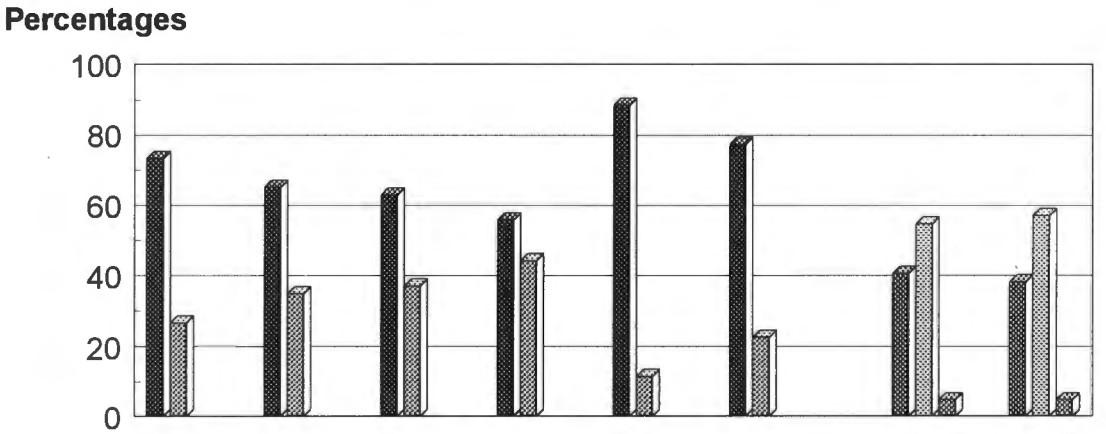
In similar fashion, the number of managers without any formal managerial qualifications are plotted against the **Q8(43)**-description, and lastly, those managers who attended only internal company courses were plotted against the **Q8(44)**-description.

5.5.2 Company orientation towards research and development

Technology and the successful management thereof is a global approach resting on a number of sub-elements, of which research and development is one of the more important aspects. This also, is true concerning strategy formulation and the effective management of strategy. Research and development in regards to technology management and also concerning strategic management, is represented by **Questions 22, 23, 24, 25, 26, 45, 46**, and **50**.

In the foregoing graphical representation, especially the responses given to **Questions 45** and **46** only **5.26** percent of the respondents stated that their unique information technology strategies were totally unresponsive to either external and/or internal forces.

In comparison to this, an average of **40,79** percent (42.11 percent + 39.47 percent) of the respondents stated that their individual information technology strategies were good concerning the level of responsiveness to internal and external forces.



Questions	Q22	Q23	Q24	Q25	Q26	Q50	Q45	Q46
No	73.33	65.22	63.04	55.81	88.64	77.42		
Yes	26.67	34.78	36.96	44.19	11.36	22.58		
Good							40.48	38.10
Poor							54.76	57.14
Not							4.76	4.76

Figure 5.6: Company orientation towards research and development

Seen from the percentages quoted, a clear-cut distinction could not be made between good- and bad strategic responsiveness as an average of **59,21** percent (57.89 + 60,53) stated that their strategies were not quite responsive to either internal or external forces.

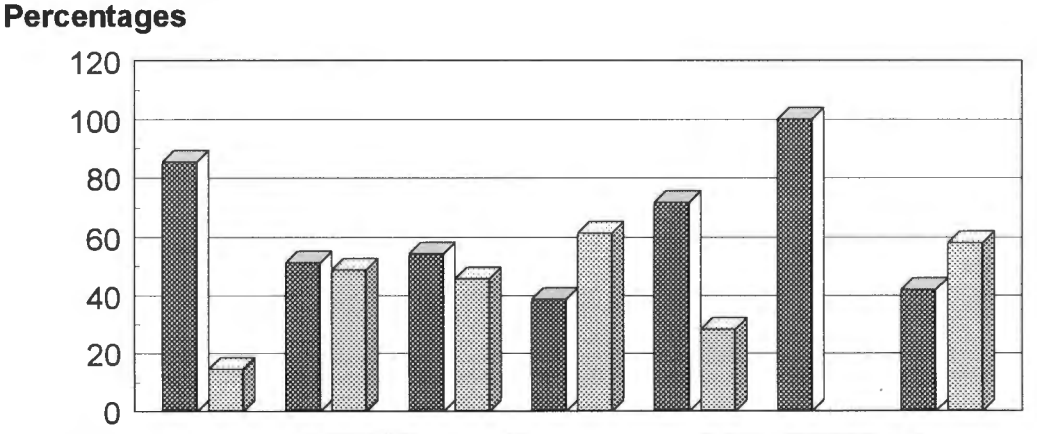
In an attempt to either clarify the **60:40** ration in terms of supporting it or totally rejecting it, an analysis was made of the supportive data that the respondents supplied, as depicted in **Table 9 (Appendix B)**. Seen from this table, responses to **Question 47** and **48** made it clear that the respondents had a good understanding of those factors normally characterised as the typical internal and external driving forces normally constituting changes in a particular strategy, such as an information technology strategy.

Depicting the rest of the responses on the foregoing graph, shows that the **no**-answers are heavily laden in those questions that characterise research and development.

Factors such as the promotion of the free flow of ideas (**Question 22**), and the existence of an incentive scheme for good ideas (**Question 50**) are badly supported by all respondents. Regarding the actual aspects of research and development (**Questions 23, 24, 25**, and **26**) all respondents felt that they fall short in managing and/or supporting it.

5.5.3 Company tendency in regards to technology transfer

Technology transfer is one of the corner stones of the global approach to technology management and should, for that matter, also be included in the formulation of a successful information technology strategy. Because of its importance, an analysis were made of those factors that reflect on the current situation regarding technology transfer. An important aspect that comes into contention, in this regard, is that the transfer of technology rests on the ever-important aspect of communication, therefore aspects concerning communication were also included in the analysis.



Questions	Q15	Q16	Q17	Q18	Q19	Q20	Q21
No	85.37	51.16	54.35	38.64	71.74	100.00	41.86
Yes	14.63	48.84	45.65	61.36	28.26	0.00	58.14

Figure 5.7: Company orientation towards technology transfer and communication

In response to the direct question if technology transfer takes place (**Question 15**), **87.50** percent of the respondents were adamant that this was not the case. As a certain amount of doubt existed to the validity of this response, the data specification responses (**Table 9, Appendix B**) shed no further light on this.

When evaluated against the responses to **Questions 16, 17** and **18**, it seems that the respondents either misunderstood the original question or did not know what was meant by it, as these responses shows that some of the elements of technology transfer do take place, even though not on the scale that was originally foreseen.

An aspect that causes a certain amount of concern, is that, from the stated responses, it seems that most of the technology transfer takes place within the particular organisation and seldom reaches other organisations. This tendency is seen from the overwhelming response to the question of presenting external seminars (**Question 20**), as **100** percent of the respondents stated they the do not present external seminars, thus not dissemination information of a technical nature outside the normal boundaries of the particular organisation.

5.6 Conclusion

From the different trend analysis done, it shows that the concepts of technology management and the subsequent formulation of an information technology strategy for the corporate chemical industry in the Vaal Triangle seem to be ill understood and therefore delivers strategies that are very unresponsive to factors that arise internally in the organisation and especially arising externally to the organisation. This factor was originally stated as one of the aspects that could limit the study.

It therefore also necessitates the need for corrective actions as information and its associated technology is the so-called glue that keeps the value chain of an organisation together and functioning optimally.

CHAPTER 6

STRATEGIC IMPLICATIONS AND CONCLUSION

6.1 Introduction

Given the findings and results of the statistical trend analysis of the foregoing chapter and the concepts that were analysed in regards to the managerial practices of technology management and strategic management, this section will focus on the possible corrective actions the management of an information technology department (or division) of the corporate chemical industry in the Vaal Triangle, can take.

In addition to this, this section will give a brief overview of the entire study and will consolidate the concepts of technology management and strategic management as to support the foregoing findings.

In the theoretical discussions of technology management (Chapter 3) and strategic management (Chapter 4), the two topics were discussed and theoretically analysed as independent entities. As the contents of these topics are crucial for the ultimate success of the particular field this dissertation was written for, stronger emphasis was placed on those facets of technology management and strategic management that, according to the author, can cause the practice of both these managerial approaches to fail.

Despite attempting to be thorough and comprehensive, little or no emphasis was placed on the integration of the two topics as this would cloud the scientific approach and value of the topics. It therefore remains the main objective of this section to create the consolidating bridge between the two topics with the integration of proposed corrective actions.

6.2 Integration of concepts

In **Chapter 3**, technology management was discussed with special reference to the management of technology on the micro level, implicating that this field of management is

especially important to mangers with a strategic focus. The management of technology on the micro level encompasses several methodologies and techniques bound into a single process, as described by many authors and depicted in **Figure 3.1** and **3.2.**

As these models are very comprehensive by nature, a special, simplified model is depicted in **Figure 3.3**. This model takes what is essential for the management of technology and sequentially bounds them into a stepped approach to the overall science of technology management. Each of the steps in this model are processes in themselves, thus making this model an integrating tool by which an scientific approach can be followed in the management of this strategic important aspect.

6.2.1 Integration of models

As is the case with technology management, a suitable model for the global aspect of strategic management is depicted in **Figure 4.1**. This model depicts the entire strategic management process, breaking a comprehensive approach up into manageable steps and procedures, starting at the highest level of strategic management, that is the formulation of a mission, and following through to the actual implementation, evaluation and control thereof.

In an analysis of both these models, no cross-references exist between these models and none of them refer to the other in any respect, thus making them almost individual and mutually exclusive entities, creating ample opportunity for integration by means of identifying break points in the strategic management model where the concepts of technology management can be slotted in and functionally integrated.

When approaching the integration of the aforementioned models, it would be advisable to use one of the models as the fundamental approach, while randomly taking from the second model those aspects that ties up with the aspects of the first model.

By doing this, a systematic and sequential approach can be obtained and the value of both models be utilised in its fullest extent. In an attempt to obtain the maximum effect, the strategic management model will be used as the fundamental model and the aspects of the technology management model be randomly incorporated into the foregoing model, thus keeping the strategy formulation process intact.

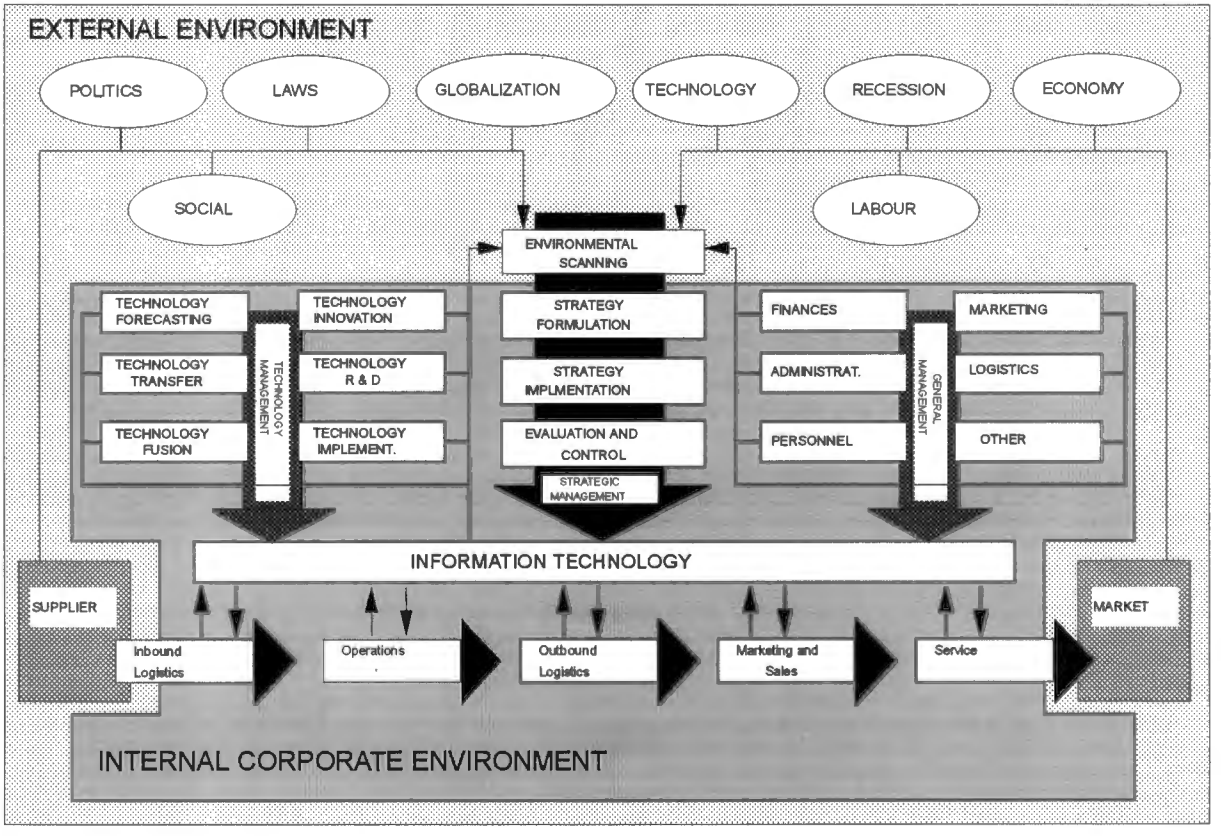


Figure 6.1: Integration of technology management and strategic management

In the foregoing model two distinct areas are depicted namely, a surrounding shaded area representing the external environment where-in the organisation functions and a second shaded area in the centre of the model representing the theoretical boundaries of the organisation encapsulating the processes of technology management, strategic management and the functional position of information technology.

An important aspect of this model, is the relationship it emphasises in regards to the central position of information technology as to the production process, depicted in the terms of the well-known Porter-model (source, **Figure 4.3**, **Chapter 4**), the process of strategic management (source, **Figure 4.1**, **Chapter 4**), and the process of technology management (source, **Figure 3.1**, **Chapter 3**).

6.2.2 Integration of environmental scanning and technology management concepts

In terms of strategic management and especially the first concept thereof, namely **environmental scanning,** two very important aspects come to mind, that of external environmental scanning and internal environmental scanning. Seen from the preceding model, environmental scanning focuses on those aspects outside and inside the organisation that could influence the organisation as a whole. Viewed from the information technology stance, this aspect should ideally take into account those aspects of technology management that focuses on the gathering of information regarding information technology.

- **Environmental scanning and technology forecasting**

  Managers responsible for the formulation of an information technology strategy for the organisation, perform environment scanning from the viewpoint that ***what*** they are contemplating, in terms of including it into a strategy, should enable the organisation to perform its primary business better. In terms of Porter's value chain analysis (**Figure 4.3**), an information technology strategy should add value to the primary activity chain of the organisation.

  As can be seen from the model, environmental scanning is elevated above the theoretical boundaries of the organisation, thus serving as an integrating link between the external environment and the internal corporate environment, especially in regards to the formulation of a strategy.

Environmental scanning must be for the sole purpose of taking from the internal and external information technological environments those aspects that could either pose a threat to the current information technology strategy or could possibly be an opportunity for further expansion. This process is at best a difficult process to follow as it focuses on aspects that are uncertain or not easily defined.

To aid this process, technology management supplies a process, called technology forecasting (**Figure 3.5**) that suggests a process whereby a significant amount of uncertainty, in regards to the way technology is moving, is cancelled out.

Taken from the viewpoint that information technology is an enabling mechanism supporting the primary business of the organisation, the management of information technology should focus on developments in the external markets regarding information technology that could be advantageous to the primary business of the organisation as a whole.

Stemming from the foregoing statistical analysis **88,64** percent (**Figure 5.6**) of the managers responsible for strategy formulation stated that no formal techniques existed for the implementation of technology forecasting as a technology management concept.

Recommendation 1: *It is recommended that regular technology forecasting sessions be implemented to identify emerging and upcoming information technologies.*

This recommendation implies that goals should be fixed to direct the forecasting effort and to make the results it delivers applicable in the gathering of information during the environmental scanning phase of strategic management. This form of pro-active anticipation of technological changes enables management to continuously create scenarios and to test the possible applicability of each of the possible changes.

In regards to the implementation of typical technology forecasting sessions, information technology management should incorporate the expertise of those people primarily responsible for the mainstream business of the organisation. This implies that these sessions be held in conjunction with production personnel of the chemical plant.

During these sessions, the specific needs and desires of the production personnel must be translated into possible trends that could arise in the information technology field.

Derived from the foregoing, is that technology forecasting sessions should not only focus on information technology as the primary concern, but should have a client intimacy approach whereby the client (production personnel) and the primary process becomes the focus of the forecasting session, thus making information technology a true enabling mechanism.

- **Environmental scanning and technology transfer**

In this regard a second technology management concept comes into focus, that of gathering technological information through the process of technology transfer, a process that conveys information between different organisations in the form of forums and attending applicable seminars. Forthcoming from the statistical analysis performed in **Chapter 5** of this dissertation, (**Figure 5.7**, **Question 15**) it became clear that very few of the organisations paid much attention to this aspect by not supporting the attending of seminars or the presentation thereof.

Recommendation 2: *It is recommended that managers responsible for strategy formulation, in regards to information technology, identify all possible opportunities that convey information about technological advances in those areas that play a crucial role in determining the best possible technological solutions to support the primary business of the organisation.*

The foregonig recommendation implies that all levels of management, including production management, be made aware of the importance of conveying technology throughout the organisation. This means that inputs, in regards to information technology and the applicability thereof in a strategy, be taken from all possible opportunities that may arise.

Typical procedures to ensure this approach include identifying key personnel in different areas of the organisation, whether it be in the information technology department or the production department, that play a crucial role in supporting or enabling the primary business of the organisation to frequently attend functions and seminars that are beneficial to the gathering of information, especially in regards to information technology.

To ensure that the gathered information is captured for future use, this information should ideally be incorporated into central knowledge databases that could support expert systems and decision support systems and the subsequent formulation of a competitive information technology strategy for the entire organisation.

This ensures a continual rejuvenation of applicable information and the prevention of *re-designing the wheel* every time technology changes.

6.2.3 Integration of strategy formulation and technology management concepts

Seen from **Figure 4.1**, **(Chapter 4)**, the process of strategy formulation consists of several steps that are performed in a sequential order to deliver a fixed mission, commonly accepted objectives, derived strategies and, finally, policies. Although these steps are of a sequential nature, they are also performed by different managerial levels within the organisation.

In some instances, even the actual workers can be involved in the formulation of aspects such as objectives and policies, making the concept of empowered workers and participative management possible. Irrespective of the forces driving strategy formulation, technology management plays a deterministic role in the formulation of the different components of strategy formulation.

- **Mission formulation and technology management concepts**

  As a mission is a future projection of the organisation, it should ideally incorporate those aspects that would indicate a general direction and intent. As in the previous instance the premise of a mission is that of knowing the particular business the organisation is currently in, thus focusing all effort, all resources at gaining an advantage in the particular field of expertise and maintaining that advantage.

  Concerning information technology, the proposed model indicates that information technology forms the adhesive property that holds together and integrates the different aspects of the organisation. It serves as the common consolidating body whereby all aspects of the organisation is linked, functionally integrated and moulded into a unit. For this reason, the management of this facility, should, as in the case of the formulation of a mission, know the business the organisation is in, thus streamlining the facilitation, dissemination and integration of knowledge, information and know-how.

  Viewed from the stance of technology management, the crucial function of information technology management, must rest on or make use of those concepts of technology management that, by implication, make the functioning supportive, timely and pro-active of changes in the primary business of the organisation as a whole.

In this regard, the concepts of technology management, that are most suited to this facilitation, is research and development into information technology, the transfer of technology, and stimulation of an innovative environment.

Information technology research and development serves as a formal, continual basis whereby the applicability of current information technology is evaluated, strategically positioned to deliver best strategic fit possible.

Recommendation 3: *It is recommended that a formal information technology research and development function be established supported by a formal budget.*

Research and development is very important in regards to any form of technology, especially concerning information technology when it is used as the enabling technology whereby the mainstream activities of the organisation is supported and made possible.

In some instances, the research and development function could be formally instituted in a research and development department. This, more traditional approach, removes the researcher from the production environment and places him/her in an isolated environment, thus breaking the crucial link between the work floor situation and theoretical study. This type of research facility has the potential to focus on research that is out of line with the real life situation and in many instances deliver results that is of theoretical value only.

To prevent research from becoming a cost to the organisation and losing touch with the real life, work floor issues, it is the belief of the author that research is best done by the people that are experts in a particular field, without removing them from the production environment.

This approach implies that research be done on the work floor level, thus keeping the researcher in touch with the actual situation and ensuring that the results are applicable. This approach places a heavy premium on the manager in charge as in it entails facilitating the research function for the duration of the research and managing the budgetary implications.

The advantages of this approach, is that the gained knowledge is not removed from the actual situation and accumulated in a central research facility that are more than likely removed from the work floor. Gained knowledge is easier disseminated and learning takes place where it matters most.

Technology must be seen as a collection of knowledge, competencies and tools that is used to generate products and services measured against the competitive advantage of the organisation and is found in people. Keeping this information in people and not disseminating or capturing it in a central repository forces the organisation to re-evaluate its stance every time technology changes or becomes a factor for future survival.

- **Objectives setting and technology management concepts**

As stated by Thompson and Strickland (1992:27), strategic objectives are managerial commitments to achieve certain pre-defined targets at a certain time, thus linking a time factor to a specific managerial task. By implication, objectives guide managerial actions and forges a route for future sustainability.

As in the case with mission formulation, the setting of objectives should ideally be structured and formulated around the ultimate concept of what it aims to achieve.

In terms of technology management, and the integration thereof with the setting of objectives, management should focus on those concepts of technology management that facilitates this process.

When considering technology transfer as one of the several processes underlying technology management, is serves as a common platform from where objectives can be set. By using the constituting process of technology transfer, lower levels of the organisation can be incorporated into the setting of objectives by making available a common frame of reference from where information about current and upcoming technologies, in the field of information technology, can be discussed and/or disseminated.

As information technology is an enabling mechanism and a supportive function to the main stream activities of the organisation, it would be the ideal to include even personnel of other departments in the process of creating objectives for the information technology department and thus giving the users of the systems co-ownership and co-responsibility for the specific objectives.

By further including the users of the information technology facility in the planning methods used for information technology planning, an innovative environment is created where different users feel free to contribute to the overall successful implementation of technologies supporting the core competency of the organisation.

Recommendation 4: *It is recommended that an environment be implemented that facilitates the free flow of ideas of a technological nature by means of the opening of managerial channels, the institution of training programs and the scheduling of informal sessions where knowledge of a technical nature can be disseminated.*

An environment that is conducive to the free flow of ideas rests on the assumption that workers are empowered to the extent that they can make decisions regarding aspects that are beneficial to the process and the organisation as a whole. In this regard, management makes the worker not only responsible for the decision, but makes him/her accountable for the decision, thus raising the level of the worker to being co-responsible and recognised for the input he/she has.

To further promote the free flow of ideas, the worker can assigned a research project that places him/her in the focal point of determining a technology that could become part of the overall information technology strategy. In this instance, the worker(s) not only become involved, but accepts co-ownership and become committed to the overall success of the proposed technology.

- **Strategy formulation and technology management concepts**

When strategies are formulated for the different levels of the organisation the crucial aspect of how these strategies should be implemented, must be part and parcel of the entire formulation. For a strategy to be effective, it needs to be directional, commonly accepted and within reach of all involved in the formulation and implementation thereof.

When a strategy is formulated for the management of the information technology function, different aspects of technology management can be considered. As the choice of a applicable strategy is largely determined by the management's sensitivity to risk and the avoidance thereof, the techniques incorporated in the typical technology forecasting approach can be used to minimise the taking of a decision that is based on a lot of uncertainty.

In the ultimate formulation of the suitable information technology strategy the overall aim, that of supporting the main stream business of the organisation, be a key consideration.

To facilitate this formulation, in terms of the applicability of the particular strategy, proper, pro-active research and development could be done to prevent possible failure due to the non-acceptance thereof by other components of the organisation.

Recommendation 5: *It is recommended that when strategy is formulated for the implementation of information technology, the applicability thereof be evaluated through thorough research and development functions in aid of making the particular strategy achievable and supportive of the core competencies of the organisation.*

In current times, characterised by an overwhelming explosion of new technologies to make the facilitation and dissemination of information possible, the information technology manager must create information technology strategies that is innovative in its context.

It must also acceptable to the entire organisation when taking into account aspects such as budget constraints, general direction of the primary business activities and sustainability of the current information technology strategy.

This implies that it serves to better facilitate the main objective it was created for, that is linking the different components of the organisation together by means of supplying an open channel whereby crucial information can be passed forward and backward in the organisation and strengthens the functional bond that exists between the different departments within the particular organisation.

- **Policy formulation and technology management concepts**

Policies form the guiding rule whereby decisions are made within the organisation. It therefore needs to be clearly stated and defined in terms that are ambiguous and leaves no chance of misinterpretation.

Concerning the management of technology and especially the concepts of technology management, policy formulation can be facilitated by aspects such as the implementation of technology planning methods. Technology fusion, as a technology management planning method, implies that newer, better suited technologies be implemented and integrated with existing technologies in such a manner that their inherent potential are realised in collaboration with existing technologies, to support the main stream business of the organisation.

6.2.4 Integration of strategy implementation and technology management concepts

According to the strategic management model proposed by Wheelen and Hunger (1989:12), **Figure 4.1 (Chapter 4)**, and the integration model proposed in **Figure 6.1** strategy implementation is, as the forgoing process of strategy formulation, a phased approach consisting of elements such as programs, budgets and procedures.

In an attempt to integrate the concepts of technology management and making it applicable to the implementation and management of information technology, it is proposed that the process of technology implementation (**Figure 3.7**) be followed. This model supplies a comprehensive implementation methodology whereby any type of technology be implemented successfully. This model, as the managerial concept of objectives setting, makes use of a common goal which is the focus point of the entire process, thus making extremely directional in its nature.

The concept of technology fusion focuses on the implementation of newer technology with existing, older types of technology, thus using the older technology as a guideline whereby newer types of technology be implemented and used in collaboration with the existing technology. This approach links up with different aspects of technology management, such as making use of the techniques suggested by properly constituted research and development practices, technology transfer processes, and the stimulation of innovative ideas.

When considering the sub-processes of strategy implementation, being programs, budgets and procedures, the forgoing technology management concepts, such as fusion, transfer, and research and development are logical vehicles whereby this implementation can be facilitated.

Proven by the statistical analysis in **Chapter 5** of this dissertation, very few of the different technology management concepts are being used when an information technology strategy is formulated for the chemical industry in the Vaal Triangle. This is especially true when Porter's model **Figure 4.3** is taken into account. In this model, the basic business process is depicted and the supportive structures displayed. Concerning information technology and the positioning thereof, only the adapted model (**Figure 6.1**) shows its place in perspective to the other managerial functions, that of being supportive of the primary business process and serving as integrating link between the different sub-functions.

Recommendation 6: *It is recommended that when an information technology strategy is implemented, its focus be directed at supporting the primary business activities of the organisation and not support the supporting functions of the primary business activities.*

This recommendation stems from the forgoing discussion and the fact that very few of the managers, responsible for information technology strategy, responded positively to the question whether their information technology strategy supported their primary business activities (**Question 37**).

In this response, **65,91** percent of the respondents claimed that their current strategy supported the supportive functions of the organisation, such as finances, personnel and the like. Only **34,09** percent of the respondents claimed that their information technology strategies focused on the primary business activities of the organisation.

For the modern day organisation to be competitive in its particular field of business, all resources must be focused on those activities that makes the core competency possible. This changes the focus of the typical information technology department from only supporting functions such as the finance department, the personnel department or other supporting departments and directing the focus to the actual process that makes the organisation competitive.

6.2.5 Integration of strategy evaluation and control and technology management concepts

This, the final step in the process of strategic management, could be considered as the most important phase, as it serves as an evaluation phase whereby current and new strategy implementations are constantly monitored and positive feedback collected. If technology management concepts, such as technology transfer be incorporated, sufficient feedback will be received concerning the effectiveness and applicability of the new or suggested technological implementations.

As shown in **Figure 6.1**, this process finalises the entire strategic management process regarding information technology, but should ideally be of a continual nature to constantly evaluate the current situation and not only feature when management is in the process of strategy formulation. For this reason, feedback arrows are shown in the aforementioned model, especially between the in main business activities and the information technology function.

6.2.6 Awareness and involvement

Derived from the foregoing statistical analysis, it was found that a similar trend existed when managers responded to a set of questions that underlie the basic concepts of involvement and awareness. In both instances, **(Graph 5.4)** managers stated that very few of the opportunities, that existed to involve people in the formulation of an information strategy, were utilised to its fullest potential.

In a similar vein, very few managers felt that all the different techniques and/or processes to generate awareness of technological changes were used. This, in turn, again boils down to not involving people in the crafting of an information strategy.

The common denominator in both of these issues, is communication. Managers, at all levels of the organisation should foster a conducive environment where communication is not hampered by the normal running and functioning of information. To this extent, the information technology currently utilised should form the backbone of the corporate communication function and should for that matter be managed to its fullest extent.

6.3 Overview of the study

6.3.1 Overall objectivity of the study

In **Chapter 1** of this dissertation, different objectives were set whereby this study would be executed.

Throughout this study, excluding **Chapter 6**, only the views of learned practitioners were used in the discussion of the different concepts, techniques, and approaches. Where possible extraction's were made from their work and embedded into the text and in some instance supported by views of other professionals in the particular field of study.

6.3.2 Main objective of the study

Regarding **Chapter 6** of the dissertation, the different views were used as a background from where a new approach could be formulated. In this chapter the author proposed a different approach, based on the forgoing study.

In some instances, this approach may fall short but serves as a basic departure point form where the different techniques of technology management and strategic management can be incorporated into a single approach. This model will therefore only serve as an attempt to combine, to integrate, and functionally place into perspective two managerial tools that, in normal circumstances, fail to enhance each other.

It is the belief of the author that this approach supports the title of this dissertation as it defines the role of technology management in the process of strategic management.

6.3.2 Statistical trend analysis

The statistical analysis performed in **Chapter 5** is based on the actual results and responses received from the respondents. In no instance was the data changed to suit the beliefs of the author. The fact that the outcomes of the analysis correspond with the pre-defined beliefs of the author, is purely accidental, based on the fact that the author works in an information technology environment.

6.4 Suggested fields of study

Derived from the different sources used for this study, none of then actually places emphasis on the fusion of technology as one of the corner stones of modern technology management concepts. As this concept underlies the basic premise that technology is forever in a renewal phase and that

modern business practices are more-and more relying on information technology for the continual rejuvenation of their competitive advantage.

Technology fusion ensures that each organisation takes from the new technology only that what is needed and incorporates it into their existing technology, thus making the implementation of newer information technology less capital intensive and therefore more manageable.

6.5 Conclusion

Technology management and strategic management, consisting of individual approaches and elements and being part of the total spectrum of managerial tools, are more commonly seen as two individual areas of expertise, implying that both these approaches are followed to obtain different objectives and results.

In the previous chapters emphasis were placed on both these approaches as individual entities and discussed to their fullest extent. By means of an integrating model, an approach was suggested whereby management could see both these fields in collaboration to each other. Although this implies a totally different approach to the traditional way in which strategies were planned and formulated, the basic concepts that underlie technology management and strategic management still holds true, but are now interdependent of each other, implying a wider managerial vision and a new focus for the directional aspects of information technology strategies.

It is foreseen, that in the near future a new strategic emphasis will be placed on the management of information technology. This new emphasis stems form the inherent possibilities that are encapsulated in these information technologies and the changes they could enforce on the entire industry. It is the belief of the author that information resources will determine the extent to which any industry can deem itself competitive in the international market. Sharing of information and the technology incorporated to perform this function will soon underlie the very basic premise on which an organisation builds its basic and primary business activity chain.

It is for this reason, that the proper management of information technology is too important to ignore and too detrimental not to plan for. Management, for this reason, needs a new approach to the global concept of technology management, focusing on the actual incorporation of technology management tools in their daily approach to management and particularly strategic management.

APPENDIX A

PO Box 62458
VAALPARK
9573
22 September 1994

The Respondent

Thank-you for your willingness to be involved with this project and to fill out the attached questionnaire.

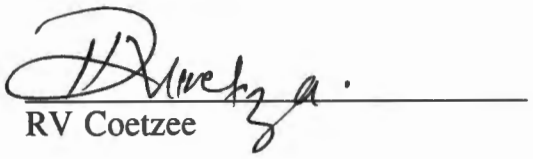
Your answers will enable me to determine the general status of **Technology Management** in regards to **Strategy Formulation** in the **Information Divisions of the Chemical industry in the Vaal Triangle.** This will enable me to finalise a statistical analysis for the completion of a MBA-degree.

As can be seen from the attached questionnaire, there are only **50 questions**, each requiring only a single answer. This questionnaire should not take more that **20 minutes** of your time and is completely anonymous. No reference to your name or address is mentioned anywhere in the questionnaire.

Concerning confidentiality, the permission of your IT-managers has been obtained beforehand and the questionnaires supplied to him/her for further distribution. I, the analyst have no means of determining who completed the questionnaire or who took part in the project. Any relevant questions can be forwarded to your local IT-manager who will, in turn forward them to me if applicable and allowed by him/her.

Should nobody collect this questionnaire from you, please forward it to me at the above address as promptly as possible.

Thank-you for your co-operation.



RV Coetzee

INFORMATION TECHNOLOGY STRATEGY

1	**At which Chemical Plant in the Vaal Triangle are you employed ?**		
	AECI (Polifin – Midland)		1
	Karbochem		2
	Natref		3
	Safripol		4
	Sasol Chemical Industries		5
2	**How long have you been employed at this particular firm ?**		
	3 years or less		6
	3 to 6 years		7
	Longer than 6 years		8
3	**In which department of the organization are you currently working ?**		
	Administration		9
	Information Technology		10
	Maintenance		11
	Production		12
	Other – Please Specify		13
4	**How many people are currently reporting to you ?**		
	None		14
	Less than 8		15
	Between 8 and 12		16
	More than 12		17
5	**What is your current job title within the organization ?**		
	Senior Manager		18
	Middle Manager – Department Head		19
	Junior Manager – Section Head		20
	Senior Project Leader		21
	Project Leader		22
	Senior Systems Analyst		23
	Systems Analyst		24
	Analyst Programmer		25
	Senior Programmer		26
	Programmer		27
	Other – Please Specify		28
6	**What is the level of your formal training ?** **Do not indicate any courses that you are currently working on.**		
	Std. 8 Certificate		29
	Matric (Std. 10)		30
	Technical College Certificate		31
	Technicon Diploma or Technicon Degree		32
	University Certificate/Diploma/Degree		33
	Other – Please Specify		34

7	**In what field or discipline is your formal training ?** **If you don't have a degree, mark none.**		
	None		35
	Commercial (B.Com without Computer Science)		36
	Commercial (B.Com with Computer Science)		37
	Scientific (B.Sc without Computer Science)		38
	Scientific (B.Sc with Computer Science)		39
	Scientific (B.Sc Computer Science)		40
	Scientific (Chemistry, Engineering)		41
	Other – Please Specify		42
8	**What Management courses have you done ?**		
	None		43
	Internal (Company) Management Courses		44
	Technicon Management Diploma		45
	MBA / MBL / University Middle Management Program		46
	Other – Please Specify		47
9	**How many years of Management Experience do you have ?**		
	None		48
	1 to 5 years		49
	5 to 12 years		50
	More than 12 years		51
10	**How many years of Information Technology Experience do you have ?**		
	None		52
	1 to 5 years		53
	5 to 12 years		54
	More than 12 years		55
11	**Are you responsible for Information Technology planning ?**		
	Yes		56
	No		57
12	**Are you involved in the process of Information Technology Implementation ?**		
	Yes		58
	No		59
13	**Are there formal Information Technology planning methods and processes in your organization ?**		
	No		60
	Yes (If 'Yes', please name a few)		61
14	**Is there a formal Information Technology Policy in your organization ?**		
	No		62
	Yes (If 'Yes', please state two features)		63
15	**Do you use formal techniques or methods for Technology Transfer ?**		
	No		64
	Yes (If 'Yes', please name a few)		65
16	**Are there regular Management sessions or newsletters that convey details about Information Technology issues in the organization ?**		
	Yes		66
	No		67

17	**Is there a training facility that conveys Information Technology to lower levels in the organization ?**		
	Yes		68
	No		69
18	**Do you receive any external publications on Information Technology from an internal library service or similar facility ? (Don't indicate those you buy yourself)**		
	No		70
	Yes (If 'Yes', please name a few)		71
19	**Do you frequently attend external seminars on Information Technology as part of your work ? (Does your company encourage this ?)**		
	Yes		72
	No		73
20	**Do you frequently present external seminars on Information Technology ?**		
	No		74
	Yes (If 'Yes', please name a few)		75
21	**Do you disseminate (spread, communicate) Information Technology details to other people within your organization ?**		
	No		76
	Yes – Please Specify		77
22	**Does your firm stimulate the free flow of innovative ideas by creating a conducive work environment ?**		
	No		78
	Yes – (If 'Yes', Please Specify How ?)		79
23	**Does your firm have a formally instituted Research and Development Department or Corporate function for Information Technology only ?**		
	Yes		80
	No		81
24	**Are there integrating links between the Research and Development Department and the Information Technology Strategy forming body of your organization ?**		
	Yes		82
	No		83
25	**Is there a formal Buget for Research and Development for Information Technology in your organization ?**		
	Yes		84
	No		85
26	**Do you use formal techniques or methods for Technology Forecasting ?**		
	No		86
	Yes – (If 'Yes', Please Name a Few)		87
27	**Does your organization have a formal model or process for the Implementation of Information Technology ?**		
	No		88
	Yes – (If 'Yes', Please Name a Few)		89

28	**Are you responsible for the formulation of an Information Technology Strategy for your organization ?**		
	Yes		90
	No		91
29	**Are you involved in the process of Strategy Formulation for Information Technology in your organization ?**		
	Yes		92
	No		93
30	**Are there formal Information Technology Strategy planning methods and processes in your organization ?**		
	No		94
	Yes – (If 'Yes', Please Name a Few)		95
31	**Is there a formal Information Technology Strategy in your organization ?**		
	Yes		96
	No		97
32	**Do you use formal techniques or methods for Information Technology Strategy Formulation ?**		
	No		98
	Yes – (If 'Yes', Please Name a Few)		99
33	**Are there regular Management sessions or newsletters that convey details about aspects in regards to Information Technology Strategies in the organization ?**		
	Yes		100
	No		101
34	**Is there a formal forum that conveys Information Technology strategy to all the lower levels in the organization ?**		
	Yes		102
	No		103
35	**How are strategy changes conveyed to lower levels in the organization ?**		
	None		104
	Other – Please Specify		105
36	**When information strategy changes are foreseen, are lower levels of the organization used and consulted for inputs ?**		
	Yes		106
	No		107
37	**Does your current Information Technology strategy focus mainly on those functions that support the main process of your organization ? (Finances, Personnel)**		
	Yes		108
	No		109
38	**Does your current Information Technology strategy focus mainly on the main process of your organization (Production, Maintenance) ?**		
	Yes		110
	No		111
39	**Does your overall Company Strategy mention the terms "Technology" and "Technology Management" in any section thereof ?**		
	Yes		112
	No		113
40	**Do the words "Innovation", "Creative" and "Employees" appear anywhere in your organization's Information Technology Strategy ?**		
	Yes		114
	No		115

41	**Does a copy of your formal Information Strategy appear anywhere in your offices and in places where other employees can see them ?**		
	Yes		116
	No		117
42	**Can you say for certain that you are thoroughly aware of all the objectives of your current Information Technology Strategy ?**		
	Yes		118
	No		119
43	**Does your current information systems allow users and non IT–people to suggest changes and improvements to the current systems ?**		
	Yes		120
	No		121
44	**Does your organization have a formal model or process for the implementation of an Information Technology Strategy ?**		
	No		122
	Yes – (If 'Yes', Please Name a Few)		123
45	**How responsive are your Information Technology Strategies to changes in the external environment of your organization ? (Politics, Economy, ect.)**		
	Good		124
	Poor		125
	Not at all – Please Specify Why ?		126
46	**How responsive are your Information Technology strategies to changes in the internal environment of your organization ? (Culture, Users Needs, ect.)**		
	Good		127
	Poor		128
	Not at all – Please Specify Why ?		129
47	**Which external factors has the biggest impact on your Information Technology Strategy ? (Please Name three)**		
			130
			131
			132
48	**Which internal factors has the biggest impact on your Information Technology Strategy ? (Please Name three)**		
			133
			134
			135
49	**Who, in your organization, are responsible for the setting of standards in regards to Information Technology ? (Please Specify)**		
			136
			137
			138
50	**Is there, in your organization, a scheme whereby rewards and incentives are offered to employees for innovative ideas in regards to Information Technology ?**		
	No		139
	Yes – (If 'Yes', Please Name a Few)		140

APPENDIX B

Organization	Number of Questionnaires Sent Out	Number of Questionnaires Received Back	Percentage
A	20	13	65 %
B	10	4	40 %
C	10	6	60%
D	10	7	70 %
E	20	16	80 %

Table 1: Response per organization expressed as percentages

Raw data collection and summation sheet

Questionnaire Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	Total	Freq.	Perc.
Aspect	No.																																														Quest.		Total
Q1 – Company A	1														1	1	1	1	1	1	1	1	1	1	1		1																				46	13	28.26
Q1 – Company B	2																																		1	1	1	1										4	8.70
Q1 – Company C	3																																							1	1	1	1	1	1				6	13.04
Q1 – Company D	4																												1	1	1	1	1	1	1													7	15.22
Q1 – Company E	5	1	1	1	1	1	1	1	1	1	1	1	1	1													1																			1	1		16	34.78
Q2 – Employed <=3 Years	6														1		1		1		1			1		1							1				1				1				1		46	10	21.74
Q2 – Employed 3–6 Years	7					1			1	1		1						1		1				1					1	1				1					1									11	23.91
Q2 – Employed >6 Years	8	1	1	1	1		1	1			1		1	1		1						1	1				1	1	1			1	1		1	1			1	1			1	1	1		1		25	54.35
Q3 – Section Admininstartion	9																		1																1														44	2	4.55
Q3 – Section Information Technology	10	1	1	1	1	1	1	1	1		1	1	1	1		1	1	1		1			1	1		1	1	1	1	1		1	1	1		1		1	1		1	1						31	70.45
Q3 – Section Maintenance (Production)	11																																										1					1	2.27
Q3 – Section Production	12																				1	1																											2	4.55
Q3 – Section Other	13																								1					1						1				1				1	1	1	1	8	18.18
Q4 – Reporting None	14		1										1		1														1	1		1				1	1			1				1	1		46	12	26.09
Q4 – Reporting – Less than 8	15	1			1		1		1			1					1				1		1	1	1	1	1				1		1			1			1	1		1		1				19	41.30
Q4 – Reporting – Between 8 an 12	16			1												1		1		1							1						1													1	7	15.22
Q4 – Reporting – More than 12	17					1		1		1	1			1					1			1																										8	17.39
Q5 – Senior Manager	18								1					1	1																																	46	3	6.52
Q5 – Middle Manager	19						1			1						1	1										1						1		1												1	8	17.39
Q5 – Junior Manager	20				1	1		1					1																	1																	6	13.04
Q5 – Senior Project Leader	21			1															1		1					1										1												5	10.87
Q5 – Project Leader	22	1	1									1										1	1																										6	13.04
Q5 – Senior Systems Analyst	23								1																																							1	2.17
Q5 – Systems Analyst	24																	1						1		1			1												1							5	10.87
Q5 – Analyst Programmer	25																								1					1					1													3	6.52
Q5 – Senior Programmer	26																															1		1														2	4.35
Q5 – Programmer	27																			1																													1	2.17
Q5 – Other	28																																					1	1	1			1	1	1				6	13.04
Q6 – Std. 8 Certificate	29																																															46	0	0.00
Q6 – Std. 10 Certificate	30		1	1	1										1					1		1							1			1						1	1			1						11	23.91
Q6 – Technical College Certificate	31																1							1	1																		1						4	8.70
Q6 – Technicon Diploma/Degree	32															1		1	1				1				1	1				1		1		1								1				10	21.74
Q6 – University Degree or Diploma	33	1				1	1	1	1	1	1	1	1	1					1				1				1			1		1			1		1			1				1		1	1	1	19	41.30
Q6 – Other	34																				1					1																							2	4.35

Table 2: Sample data collection and summary sheet (Part 1 of 4)

Raw data collection and summation sheet

Questionnaire Number / Aspect	No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	Total Quest.	Freq.	Perc. Total
Q7 – None	35		1	1	1	1		1				1	1				1		1					1	1			1				1	1			1		1			1	1						42	18	42.86
Q7 – B.Com (Without Computer Science)	36						1							1												1					1																		4	9.52
Q7 – B.Com (With Computer Science)	37								1		1					1																																	3	7.14
Q7 – B.Sc (Without Computer Science)	38																	1				1																											2	4.76
Q7 – B.Sc (With Computer Science)	39																												1																				1	2.38
Q7 – B.Sc (Computer Science)	40																			1			1																								1		3	7.14
Q7 – B.Sc (Chemistry, Engineering)	41																																				1			1			1		1	1			5	11.90
Q7 – Other	42	1								1			1		1						1																							1					6	14.29
Q8 – Management Courses – None	43														1			1	1					1	1	1			1	1				1		1		1			1	1				1		45	14	31.11
Q8 – Management Courses – Internal	44	1	1	1	1	1	1		1		1					1	1			1		1	1				1	1					1		1					1				1	1				20	44.44
Q8 – Management Courses – Technicon	45																															1																	1	2.22
Q8 – Management Courses (MBA, MBL)	46							1		1		1	1	1							1										1						1						1				1		10	22.22
Q8 – Management Courses – Other	47																																																0	0.00
Q9 – Management Experience – None	48																												1	1		1		1				1			1				1	1		45	8	17.78
Q9 – Management Experience – 1–5	49	1	1		1				1							1			1	1				1				1					1		1	1	1					1							14	31.11
Q9 – Management Experience – 5–12	50			1		1		1		1	1	1	1		1		1				1	1	1		1						1									1			1	1			1		18	40.00
Q9 – Management Experience – 12>	51						1							1				1								1	1																						5	11.11
Q10 – IT Experience – None	52																																		1									1				46	2	4.35
Q10 – IT Experience – 1–5 Years	53									1						1			1	1				1							1			1			1	1			1	1	1		1	1			14	30.43
Q10 – IT Experience – 5–12 Years	54	1			1				1								1				1	1	1		1				1	1		1				1			1	1									14	30.43
Q10 – IT Experience – >12 Years	55		1	1		1	1	1			1	1	1	1	1			1								1	1	1					1														1		16	34.78
Q11 – Responsible for IT Planning – Yes	57	1	1		1				1	1					1	1	1	1	1		1	1	1	1	1	1	1		1	1	1	1		1	1	1	1							1	1			54	27	50.00
Q11 – Responsible for IT Planning – No	57	1	1		1				1	1					1	1	1	1	1		1	1	1	1	1	1	1		1	1	1	1		1	1	1	1							1	1				27	50.00
Q12 – Involved in IT Planning – No	58	1	1	1		1	1				1	1	1	1						1								1	1	1	1	1	1	1	1	1		1		1	1	1	1		1	1	1	43	27	62.79
Q12 – Involved in IT Planning – Yes	59								1	1					1	1	1	1	1		1	1	1	1	1	1	1										1							1					16	37.21
Q13 – Technology Plan. Methods – No	60		1		1	1	1		1	1	1	1			1	1	1		1	1	1	1	1		1	1	1	1	1	1		1	1	1		1	1	1			1		1					43	30	69.77
Q13 – Technology Plan. Methods – Yes	61	1		1				1					1	1				1						1							1				1					1		1				1	1		13	30.23
Q14 – Formal Technology Policy – No	62		1		1										1	1	1	1	1	1	1	1	1	1	1	1	1		1	1				1		1	1				1	1	1					42	23	54.76
Q14 – Formal Technology Policy – Yes	63	1		1		1	1	1	1	1	1	1	1	1														1			1	1	1		1			1		1							1		19	45.24
Q15 – Technology Transfer – No	64	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1				1		1	1			1	1	1	1	1	1			41	35	85.37
Q15 – Technology Transfer – Yes	65																										1	1			1				1			1									1		6	14.63
Q16 – Technology Trans Sess – Yes	66					1		1		1	1		1	1					1				1	1	1		1	1		1		1			1		1	1			1	1	1				1	43	21	48.84
Q16 – Technology Trans Sess – No	67	1		1	1		1		1			1			1	1	1	1		1	1	1				1			1		1		1	1		1				1				1	1				22	51.16
Q17 – Training – Yes	68	1	1		1	1	1	1		1		1															1	1		1	1	1	1		1	1	1				1	1				1	1	46	21	45.65
Q17 – Training – No	69			1					1		1		1	1	1	1	1	1	1	1	1	1	1	1	1	1			1					1				1	1	1			1	1	1				25	54.35
Q18 – External Publications – No	70		1				1			1						1			1			1	1	1		1		1	1		1		1	1				1						1	1			44	17	38.64
Q18 – External Publications – Yes	71	1		1		1		1	1		1	1	1	1	1		1	1		1	1				1		1						1		1	1	1		1	1	1	1	1			1	1		27	61.36
Q19 – Attend External Semin. – Yes	72				1	1	1					1		1														1		1			1						1		1	1	1				1	46	13	28.26
Q19 – Attend External Semin. – No	73	1	1	1				1	1	1	1		1		1	1	1	1	1	1	1	1	1	1	1	1	1		1		1	1		1	1	1	1	1		1				1	1	1			33	71.74

Table 2: Sample data collection and summary sheet (Part 2 of 4)

Raw data collection and summation sheet

Questionnaire Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	Total Quest.	Freq.	Perc. Total
Aspect	No.																																																
Q20 – Present External Seminars – No	74	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	45	45	100.00
Q20 – Present External Seminars – Yes	75																																															0	0.00
Q21 – Disseminate Info – No	76	1	1				1		1	1					1		1	1	1				1			1					1			1	1		1			1				1	1			43	18	41.86
Q21 – Disseminate Info – Yes	77			1	1	1		1			1	1	1	1		1				1	1	1		1	1		1	1	1			1	1			1					1	1	1			1	1		25	58.14
Q22 – Stimulate Innovation – No	78	1	1	1	1		1	1	1		1		1	1	1		1	1	1			1	1	1	1	1	1		1		1	1	1	1		1	1	1		1			1	1	1	1		45	33	73.33
Q22 – Stimulate Innovation – Yes	79					1				1		1				1				1	1							1		1					1						1	1					1			12	26.67
Q23 – Formal R&D – Yes	80	1	1	1		1		1		1	1	1	1	1												1				1				1							1		1				1	46	16	34.78
Q23 – Formal R&D – No	81				1		1		1						1	1	1	1	1	1	1	1	1	1	1		1	1	1		1	1	1		1	1	1	1	1		1		1	1	1			30	65.22
Q24 – R&D – Strategy links – Yes	82					1		1		1	1	1	1	1														1			1				1		1	1			1	1	1				1	1	46	17	36.96
Q24 – R&D – Strategy links – No	83	1	1	1	1		1		1						1	1	1	1	1	1	1	1	1	1	1	1		1	1		1	1	1		1				1	1				1	1			29	63.04
Q25 – R&D Budget – Yes	84	1		1	1			1		1	1	1	1	1												1	1			1	1			1		1				1	1	1				1	43	19	44.19
Q25 – R&D Budget – No	85		1			1	1		1						1	1	1	1	1	1	1	1	1	1	1	1			1	1			1	1		1		1	1	1								24	55.81
Q26 – Technology Forecast. – No	86	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1			1	1		1	1	1	1		1	1	1		1	1	1	44	39	88.64
Q26 – Technology Forecast. – Yes	87										1																	1			1	1			1												5	11.36
Q27 – Technology Impl. Proc. – No	88		1	1	1		1	1	1	1			1		1	1	1	1	1	1	1	1	1	1	1	1	1			1			1		1	1	1	1	1	1	1	1	1	1	1		46	35	76.09
Q27 – Technology Impl. Proc. – Yes	89	1				1					1	1		1														1	1		1	1		1												1		11	23.91
Q28 – Respon. Strategy Form. – Yes	90																																1			1				1	1	1	1				1	46	7	15.22
Q28 – Respon. Strategy Form. – No	91	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1		1	1					1	1	1			39	84.78
Q29 – Involved Strategy Form. – Yes	92			1	1	1	1	1		1	1	1	1	1																1		1			1	1			1	1	1	1			1	1	46	20	43.48
Q29 – Involved Strategy Form. – No	93	1	1					1							1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		1	1	1		1						1	1			26	56.52
Q30 – Strategy Plan. Methods – No	94		1		1		1		1			1			1	1	1	1	1		1	1	1	1	1	1	1		1	1		1	1	1		1	1	1		1					1		43	27	62.79
Q30 – Strategy Plan. Methods – Yes	95	1		1		1		1	1			1	1							1								1			1										1	1	1				1	46	16	37.21
Q31 – Formal Tech. Strategy – Yes	96	1		1	1	1		1		1	1	1	1	1									1					1			1	1		1	1		1	1		1	1	1				1	42	22	52.38
Q31 – Formal Tech. Strategy – No	97		1				1		1						1	1	1	1	1	1	1	1		1	1	1	1		1	1			1		1				1				1					20	47.62
Q32 – Techn. Strategy Form. – No	98	1	1		1	1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1			1	1	1		1	1	1		1	1	1	1	1	1		43	36	83.72
Q32 – Techn. Strategy Form. – Yes	99									1	1																	1		1	1				1											1	7	16.28
Q33 – Convey Strategy – Yes	100		1			1		1		1	1	1	1	1			1					1	1			1		1		1	1	1			1	1	1				1						1	44	21	47.73
Q33 – Convey Strategy – No	101	1		1	1		1		1						1	1		1	1	1	1			1	1		1		1			1	1				1		1		1		1	1	1	1			23	52.27
Q34 – Strategy Forum – Yes	102					1		1	1				1	1														1			1	1	1			1				1	1	1					45	13	28.89
Q34 – Strategy Forum – No	103	1	1	1	1		1			1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		1	1				1	1	1		1		1				1	1	1	1		32	71.11
Q35 – Strategy changes – None	104		1			1					1				1	1	1			1	1	1				1	1		1	1		1	1	1		1	1			1				1	1	1	1	44	23	52.27
Q35 – Strategy changes – Other	105	1		1	1	1		1	1	1	1		1	1				1	1				1	1	1			1			1						1			1	1	1						21	47.73
Q36 – Levels used – Yes	106							1		1																		1			1	1	1	1		1										1	45	9	20.00
Q36 – Levels used – No	107	1	1	1	1	1	1	1		1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1				1		1		1	1	1	1	1	1	1			36	80.00
Q37 – Focus on Support – Yes	108	1	1	1	1		1				1				1	1	1	1	1		1	1	1	1	1	1		1		1	1		1	1	1	1	1	1			1	1	1				44	29	65.91
Q37 – Focus on Support – No	109					1		1	1	1		1	1	1													1		1			1								1					1	1	1	1	15	34.09
Q38 – Focus on Main – Yes	110			1	1	1		1		1	1		1	1														1		1	1		1	1		1		1		1	1	1	1	1	1		44	21	47.73
Q38 – Focus on Main – No	111	1	1				1		1			1			1	1	1	1	1		1	1	1	1	1	1	1		1		1			1		1									1	1			23	52.27

Table 2: Sample data collection and summary sheet (Part 3 of 4)

Raw data collection and summation sheet

Questionnaire Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	Total Quest.	Freq.	Perc. Total
Aspect	No.																																																	
Q39 – Terms – Yes	112			1		1		1		1	1	1	1	1														1			1											1	1	1			1		39	14	35.90
Q39 – Terms – No	113	1	1		1		1								1	1	1	1	1	1	1	1	1	1	1	1					1	1	1	1	1	1			1							1		25	64.10
Q40 – Words – Yes	114			1	1	1	1	1		1	1	1															1			1				1						1							1	39	13	33.33
Q40 – Words – No	115	1	1										1	1	1	1	1	1	1	1	1	1	1	1	1	1		1			1	1	1		1	1					1	1	1					26	66.67
Q41 – Strategy in Office – Yes	116			1	1	1	1					1																		1																		43	6	13.95
Q41 – Strategy in Office – No	117	1	1					1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1			1	1	1	1	1	1	1	1		37	86.05
Q42 – Objectives – Yes	118									1	1																			1	1			1						1	1	1				1	43	9	20.93
Q42 – Objectives – No	119	1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1		1	1				1				1	1	1			34	79.07
Q43 – User Changes – Yes	120	1		1		1	1	1	1	1	1	1	1	1														1	1	1	1	1	1	1	1				1	1	1	1				1	44	24	54.55
Q43 – User Changes – No	121		1		1										1	1	1	1	1	1	1	1	1	1	1	1	1									1							1	1	1			20	45.45
Q44 – Strategy Impl. Proces. – No	122		1	1	1	1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1		1	1		1	1	1			1	1	1	1			1		41	35	85.37
Q44 – Strategy Impl. Proces. – Yes	123	1								1	1																	1			1																1	42	6	14.63
Q45 – Responsive External – Good	124				1					1	1			1							1				1			1		1	1	1			1	1				1	1	1	1				1		17	40.48
Q45 – Responsive External – Poor	125	1	1	1		1	1	1	1			1	1		1	1	1	1		1		1	1	1			1		1			1	1			1										1		23	54.76
Q45 – Responsive External – Not	126																		1							1																						2	4.76
Q46 – Responsive Int. – Good	127				1				1	1	1										1				1			1		1	1	1			1	1				1	1	1					1	42	16	38.10
Q46 – Responsive Int. – Poor	128	1	1	1		1	1	1				1	1	1	1	1	1	1		1		1	1	1			1		1			1	1			1				1						1		24	57.14
Q46 – Responsive Int. – Not	129																		1							1																						2	4.76
Q50 – Incentive Scheme – No	139	1	1	1	1		1	1	1	1	1	1	1	1														1	1	1			1	1	1	1	1			1				1	1	1			31	24	77.42
Q50 – Incentive Scheme – Yes	140					1																								1	1										1	1	1				1		7	22.58

Table 2: Sample data collection and summary sheet (Part 4 of 4)

Trend analysis for the use of technology management techniques in the formulation of an information technology strategy (Data to be used in testing)

Questionnaire Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
Q13 – Yes: Techn. Planning Methods	61	1		1				1					1	1				1						1							1				1					1		1				1	1
Q15 – Yes: Techn. Transfer Methods	65																										1	1			1				1			1									1
Q22 – Yes: Innovation	79					1				1		1				1				1	1							1		1					1						1	1					1
Q23 – Yes: Research and Development	80	1	1	1		1		1		1	1	1	1	1													1				1				1						1		1				1
Q26 – Yes: Techn. Forecasting Methods	87										1																	1			1	1			1												
Q27 – Yes: Techn. Implement. Methods	89	1				1					1	1		1														1	1		1	1		1													1
Number Techniques / Respondent		3	1	2	0	3	0	2	0	2	3	3	2	3	0	1	0	1	0	1	1	0	0	1	0	0	2	4	1	1	5	2	0	1	5	0	0	1	0	1	2	2	1	0	0	1	5
Using 0 of 6 Techniques	16				1		1		1						1		1		1			1	1		1	1							1			1	1		1					1	1		
Using 1 of 6 Techniques	14		1													1		1		1	1			1			1		1	1				1				1		1			1			1	
Using 2 of 6 Techniques	7			1				1		1			1																			1									1	1					
Using 3 of 6 Techniques	5	1				1					1	1		1																																	
Using 4 of 6 Techniques	1																											1																			
Using 5 of 6 Techniques	3																														1				1												1
Using 6 of 6 Techniques	0																																														

Table 3: Data preparation for trend analysis of technology management concepts

Data analysis for strategic management and strategy formulation (Data to be used in testing)

Questionnaire Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
Q30 – Yes: Strat. Planning Methods	95	1		1		1		1		1	1		1	1						1								1			1				1						1	1	1				1
Q31 – Yes: Technology Strategy	96	1		1	1	1		1		1	1	1	1	1									1					1			1	1		1	1		1	1		1	1	1					1
Q32 – Yes: Strat. Formulat. Methods	99									1	1																	1		1	1				1												1
Q34 – Yes: Strat. Communications	102					1		1	1				1	1														1			1	1	1				1				1	1	1				
Q42 – Yes: Understand Objectives	118									1	1																				1	1			1						1	1	1				1
Q44 – Yes: Strat. Implemt. Methods	123	1								1	1																	1			1																1
Number Techniques / Respondent		3	0	2	1	3	0	3	1	5	5	1	3	3	0	0	0	0	0	1	0	0	1	0	0	0	0	5	0	1	6	3	1	1	4	0	2	1	0	1	4	4	3	0	0	0	5
Using 0 of 6 Strategy Concepts	19		1				1								1	1	1	1	1		1	1		1	1	1	1		1							1			1					1	1	1	
Using 1 of 6 Strategy Concepts	10				1				1			1								1			1							1			1	1				1		1							
Using 2 of 6 Strategy Concepts	2			1																																	1										
Using 3 of 6 Strategy Concepts	7	1				1		1					1	1																		1											1				
Using 4 of 6 Strategy Concepts	3																																		1						1	1					
Using 5 of 6 Strategy Concepts	4									1	1																	1																			1
Using 6 of 6 Strategy Concepts	1																														1																

Table 4: Data analysis for strategic management concepts

Summation of people–involvement opportunities in strategy formulation and technology transfer (All data expressed as percentages)

Questionnaire Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
Q17 – Training – Yes	68	1	1		1	1	1	1		1		1															1	1		1	1	1	1		1	1	1				1	1				1	1
Q19 – Attend External Semin. – Yes	72				1	1	1					1		1														1		1			1						1		1	1	1				1
Q22 – Stimulate Innovation – Yes	79					1				1		1				1				1	1							1		1					1						1	1					1
Q36 – Levels used – Yes	106								1		1																		1			1	1	1	1		1										1
Q43 – User Changes – Yes	120	1		1		1	1	1	1	1	1	1	1	1															1	1	1	1	1	1	1	1				1	1	1	1				1
Q50 – Incentive Scheme – Yes	140					1																								1	1										1	1	1				1
Number Techniques / Respondent		2	1	1	2	5	3	2	2	3	2	4	1	2	0	1	0	0	0	1	1	0	0	0	0	0	1	3	2	5	3	3	4	2	4	2	2	0	1	1	5	5	3	0	0	1	6
Using 0 of 6 Involvement Opportunities	12														1		1	1	1			1	1	1	1	1												1						1	1		
Using 1 of 6 Involvement Opportunities	10		1	1									1			1				1	1						1												1	1						1	
Using 2 of 6 Involvement Opportunities	10	1			1			1	1		1			1															1					1		1	1										
Using 3 of 6 Involvement Opportunities	6						1			1																		1			1	1											1				
Using 4 of 6 Involvement Opportunities	3											1																					1		1												
Using 5 of 6 Involvement Opportunities	4					1																								1											1	1					
Using 6 of 6 Involvement Opportunities	1																																														1

Table 5: Data analysis for involvement opportunities in strategy formulation

Summation of creating awareness opportunities in strategy formulation and technology transfer (All data expressed as percentages)

Questionnaire Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
Q11 – Responsible for IT Planning – No	57	1	1		1				1	1					1	1	1	1	1		1	1	1	1	1	1	1		1	1	1	1		1	1	1	1							1	1		
Q28 – Respon. Strategy Form. – No	91	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1		1	1					1	1	1	
Q33 – Convey Strategy – No	101	1		1	1		1		1						1	1		1	1	1	1			1	1		1		1				1	1				1		1		1	1	1	1		
Q39 – Terms – No	113	1	1		1		1								1	1	1	1	1	1	1	1	1	1	1	1	1					1	1	1	1	1	1			1							1
Q40 – Words – No	115	1	1										1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1			1	1	1		1	1				1	1	1				
Q41 – Strategy in Office – No	117	1	1					1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1			1	1	1	1	1	1	1	1
Number Techniques / Respondent		6	5	2	4	1	3	2	4	3	2	1	3	3	6	6	5	6	6	5	6	5	5	6	6	5	6	2	5	2	2	5	4	6	4	5	4	2	1	3	2	3	3	4	4	2	2
100% Effort for Creating Awareness	0																																														
83% Effort for Creating Awareness	3					1						1																											1								
67% Effort for Creating Awareness	10			1				1			1																	1		1	1							1			1					1	1
50% Effort for Creating Awareness	7						1			1			1	1																										1		1	1				
33% Effort for Creating Awareness	7				1				1																								1		1		1							1	1		
17% Effort for Creating Awareness	9		1														1			1		1	1			1			1			1				1											
0% Effort for Creating Awareness	10	1													1	1		1	1		1			1	1		1							1													

Table 6: Data analysis for awareness opportunities in strategy formulation

Technique 1	Question 13(Yes) for Technology Management Question 30(Yes) for Strategic Management
Technique 2	Question 15(Yes) for Technology Management Question 31(Yes) for Strategic Management
Technique 3	Question 22(Yes) for Technology Management Question 32(Yes) for Strategic Management
Technique 4	Question 23(Yes) for Technology Management Question 34(Yes) for Strategic Management
Technique 5	Question 26(Yes) for Technology Management Question 42(Yes) for Strategic Management
Technique 6	Question 27(Yes) for Technology Management Question 44(Yes) for Strategic Management

Table 7: Quantative analysis of technology management and strategic management concepts

Formalization of Techniques	
Question	**Respons**
Question 11 and Question 28	Responsibility
Question 12 and Question 29	Involvement
Question 13 and Question 30	Formal Methods
Question 14 and Question 31	Formal Policy
Question 15 and Question 32	Formal Techniques
Question 16 and Question 33	Communication
Question 17 and Question 34	Communication

Table 8: Formalization of techniques

Specification data from questionnaires					
#	Aspect	Freq.	#	Aspect	Freq.
3	Financial Department	1	26	In–House Developed	2
	Projects Department	1			
	Process Control Department	3	27	Standard Project Methodology	7
	Research and Development	2		Process Models	2
				Prototyping	3
5	Information Technology Manager	1			
	Administrative Assistant	1	30	SWOT	3
	Network Administrator	1		CSF's	2
	Process Control Engineer	4		Strategic Objectives	1
				Strategy Planning Sessions	1
6	No Response	0		Business Process Re–Engineering	3
				Custom Methodology	1
7	Electronic Engineering	1			
	BA	1	32	Conventional Strategy Planning	1
	B.Ed	1			
			35	Research and Development Reports	1
8	Project Management	1		E–Mail	1
				Meetings	7
13	SWOT–Techniques	3		Computer User Groups	1
	Requirement Surveys	1		Newsletters	6
	In–House Developed	1		Communication Sessions	8
	Strategy planning	3		Informal Communication	1
	Strategy Development	1			
	Change Control	1	44	R&D Prototyping Models	2
	Project Managment Systems	9		Strategy Sessions	1
	Formal Strategy Planning Department	2			
	Research and Development	1	45	No Response	0
14	Integration	1	46	No Response	0
	Business Process Re–Engineering	1			
	Risk Management	1	47	Globalization	2
	Desaster Recovery	1		Information Technology Trends	24
	Information Standards	1		General Business Trends	3
	Leading Edge	1		Econonmic Considerations	13
	Buy Before Develope	1		Market Forces	4
	Value Systems	1		Information Technology Availability	1
	Innovative Climate	1		International + Local Politics	6
	Value Added	1		User Requirements	2
	Customer/Client Intimacy	3		Corporate Policy	3
	Hardware, Software, Networks	12		Company Strategy Requirements	1
	Strategic Analysis	1		Internal Politics	1
	Strategic Planning	1		Trade Unions	1
				Competitors	2
15	Mathematic Process Models	1		Employee Training levels	1
	Change Control	1			
	We Don't Do It	1	48	Budget Constraints	18
				Resistance to Change	2
18	Computer Week	4		Internal Company Politics	9
	PC Magazine	7		Communication	5
	Byte	7		Staff Turnover (Manpower)	3
	LAN Network Advisor + LAN Times	3		Staff Skill Levels	6
	Computer Mail	1		Business Strategy	3
	Information Technology	1		Internal Competition	1
	Communication Technology	2		Bad Managerial Decisions	4
	Computing SA	4		Corporate Environment	2
	Datamation	1		Business Process Re–Engineering	2
	Audit And Security	1		User Requirements	12
	Newsletter (SentraChem)	1		Projects	1
	Computers & Chemical Engineering	1		Client Perceptions	2
20	No Response	0	49	Self (Employees)	1
				Information Department	12
21	Managerial Sessions	4		General Management	9
	Roadshows	1		Research and Development	3
	Presentations	4		Information Strategy Comittee	2
	Training	3		User	3
	Meetings	3			
	E–Mail	2	50	Awards	4
	Joint Projects	3		Merit Assesments	2
22	Quality Circles	3			
	Participative Strategic Planning	1			
	Research and Development	1			
	Informal Atmosphere	1			
	SWG's	2			
	CAT's	2			
	Open Relationships – Universities	1			
	Knowledge Worker Environment	1			

Table 9: Specification data from questionnaires

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