

1 Introduction

In September 1993 Mr. Alan Knott-Craig said, “Cell phones will change our lives as much as or more than television did”.

In 1994 the new cellular industry in South Africa was born. Vodacom made projections of 250,000 subscribers in ten years, but a mere two years later Vodacom had passed the milestone of 300,000 subscribers.

With such a background, it is quite intriguing to try and find out why the projections were off the mark by such a great margin. One can assume that the projections were based on figures for an employed base of individuals earning above a certain salary range. This group of individuals would be able to afford a contract with a service provider. One of the criteria for qualifying for cellular service was that one had to be employed. In 1999 the Reserve Bank indicated that only 30% of South Africans had bank accounts. This means that 70% of South Africans deal strictly on a cash only basis. This in itself excluded much of the potential subscriber base from the market potential. The question that follows is, “What actually fuelled the growth of this industry to such high proportions”?

Any product/ service that is meant for consumption or use by a consumer base has to have certain structures that will ensure that the customer base is aware of it. And that customer base must be willing to adopt the product/service as an answer its needs. Diffusion mechanisms are used to achieve the goal of getting the product/service to spread across a broad customer base.

The main objective of this study is to analyse the diffusion of personal telecommunications in South Africa.

A brief overview of the content of each chapter follows.

Chapter One is a brief introduction, an overview of the chapters and the research methodology. Chapter Two describes the telecommunications industry in South Africa, as well as a description of relevant regulators in this industry. Chapter Three is a review of the literature and a description of the theories examined in the literature study. These





theories are used as the basic framework of the research. Chapter Four is an explanation of some of the known diffusion mechanisms used in the cellular industry. Chapter Five describes some of the technologies used in the cellular industry, and discusses data communications. Chapter Six is an overview of competing technologies and a discussion of the rural phone market. Chapter Seven describes an example of a technology cluster within the wireless industry in South Africa. Chapter Eight reports on consumer trends and forecasts and discusses the fuelling of the growth of the cellular industry in South Africa. Chapter Nine reports the results obtained from the questionnaire administered in the industry. Chapter Ten discusses diffusion and Chapter Eleven contains the conclusion and recommendations of the research.

Research Methodology

This research began with an extensive literature review to ensure clarity on the various theories of diffusion. Then a framework/proposal for the research project was established. Following that, a questionnaire was designed to try and link what the theories said to practice in the industry. Along with the questionnaires, interviews with the main players in the industry were undertaken, after which their results were combined in this report and published.

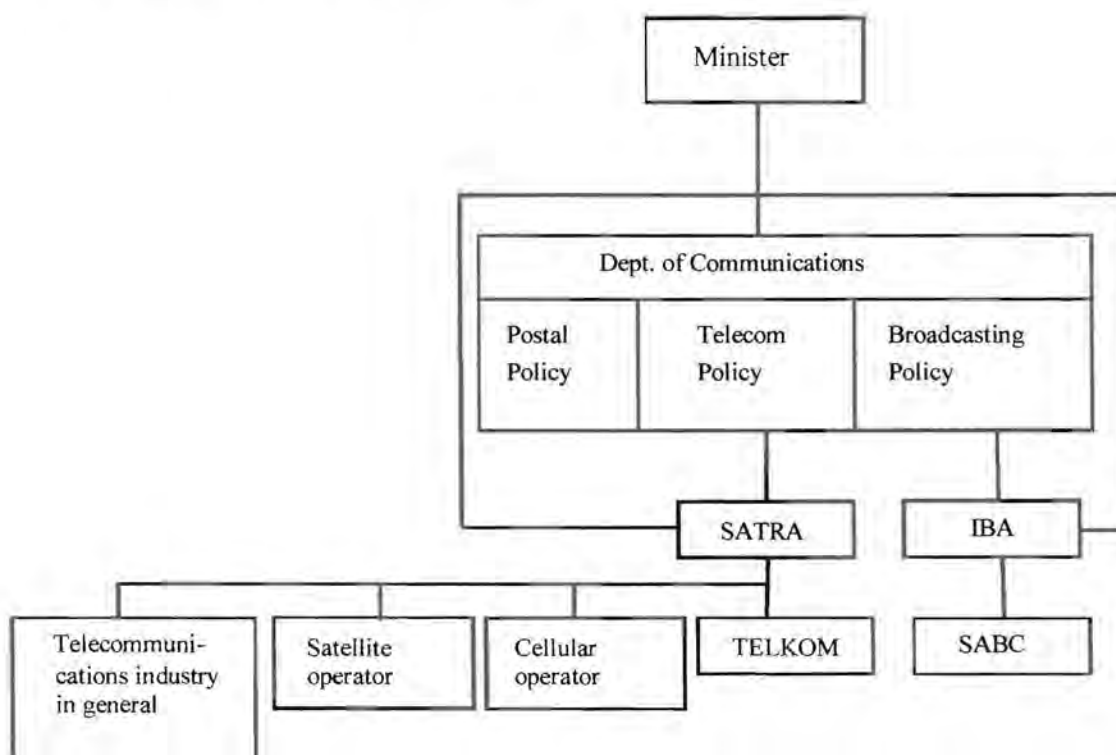


2 Telecommunications Industry Structure And Policy

2.1 Telecommunications Industry Structure

The cellular industry analysed here is part of a much bigger telecommunications industry in South Africa. The Minister of Communications, *Dr. Ivy Matsepe-Cassaburi* heads this industry. The minister's department is charged with policy-making for post, telecommunications and broadcasting services. It is further charged with the responsibility for SATRA and the IBA. SATRA is the *South African Telecommunications Regulatory Authority* and the IBA is the *Independent Broadcasting Authority*. These two bodies are important for the purposes of this research. SATRA is charged with regulating the telecommunications industry in general, including satellite operators, cellular operators and Telkom. The IBA, on the other hand, is primarily charged with manning the *South Africa Broadcasting Corporation (SABC)*. Figure 2.1 below illustrates the structure of telecommunications structure in South Africa.

Figure 2. 1 South African Telecommunications Industry [1]



Telecommunications is the order of the day around the world. It is one of the factors that influence economic success in most countries today. In South Africa a very serious view has been taken with respect to telecommunications, hence the theme: "Telecommunications and Development in South Africa" in the White Paper [2].

According to the White Paper [2], South Africa recognises the central importance of access to telecommunications in order to achieve economic and social goals. The goal of its policy and vision is that there should be affordable communications for all businesses and citizens alike. This vision has to strike a balance in providing services to the disadvantaged rural and urban areas in order to meet the need for a growing South African economy. In order for South Africa to grow economically, it has to be linked to the global village and to compete internationally. For this to happen, it has to have access to the international information highway and have its own integrated, high-quality network, which provides value-added services.

To ensure that this happens, the Ministry of Posts, Telecommunications and Broadcasting has set-up an agency called *The Universal Service Agency*. Its main purpose is to promote telecommunications in South Africa. Its target is members of historically disadvantaged communities, especially those in rural areas. This agency is there to redress the imbalances of the past, socially, economically and politically.

This agency and the regulator SATRA should never be in competition, because they are part of the same team and focused on the same overall objective, but with responsibility for closely linked but different activities.

One set of activities is rule-based and it involves the firm and transparent application and enforcement of the regulation, which embodies the principles of telecommunications policy. The regulator has sole power of enforcement. The agency should identify more creative and innovative methods of promoting a universal methods service within the broad framework of development planning.

2.1.1 Telecommunication Policies

SATRA (The South African Telecommunications Regulatory Authority) was established as an independent body to regulate the telecommunications industry. It was charged with objectives, functions, standard and quality, frequency spectrum, licensing, competition, ownership and investment, service provision and user needs. These are described in the White Paper [2].

SATRA's objectives:

- To regulate telecommunications in the Republic of South Africa in the public interest;
- To achieve progress towards the social goals of the telecommunications policy- the provision of universal service;
- To ensure the provision of a wide range of telecommunications services to stimulate and support economic growth;
- To regulate the activities of Telkom in conjunction with the Minister of Posts, Telecommunications and Broadcasting and to stimulate investment in the public telecommunications network;
- To ensure a 'level playing field' where competitive entry is permitted in terms of the telecommunications policy;
- To protect the interests of telecommunications users and consumers;
- To stimulate innovation in the telecommunication sector with a view to building an information superhighway in South Africa;
- To promote the development of human resources for the telecommunications sector;
- To promote a competitive and effective manufacturing and supply industry;
- To assure the technical pre-conditions for effective telecommunications operations; and
- To manage common national resources, such as the radio frequency spectrum, effectively.

SATRA's functions:

- Set goals for the achievement of universal services;
- Liase with Telkom with regard to universal service during the period of exclusivity;
- Set universal service obligations;
- Administer the universal service fund, which will be managed by the universal service agency and
- Ensure that the needs of disabled people are taken into account in the expansion of universal service.

Service provision and user needs:

- Promote the provision of efficient, effective and affordable telecommunications services for all sectors of society and the development of public and private services, which are responsive to the needs of users;
- Ensure that the provision of public services, the needs of the constituent regions of South Africa and local communities are duly taken into account;
- Ensure that telecommunications services, viewed collectively, develop and promote a sound business environment in the interest of healthy competition, efficient services and modern facilities;
- Protect the integrity and viability of public telecommunications services and
- Develop regulations supporting the achievement of policy objectives.

Ownership and investment:

- Encourage investment in, and promote the stability of, the industry; and
- Encourage ownership and control of telecommunications services in accordance with the requirements of anti-competitive legislation.

Competition:

- Promote fair competition between telecommunications service providers where such competition is permitted, in conjunction with the state's competition policy; and
- Allow service providers maximum freedom in the pursuit of their commercial objectives, while simultaneously taking into account the telecommunications needs of the public and the policy objectives of the Government.

Licensing:

- Undertake the licensing of all telecommunications service providers according to the policy guidelines set by the Minister;
- License radio spectrum users, except those that operate in terms of licences issued by the Independent Broadcasting Authority;
- Undertake the review of existing licences where applicable;
- Monitor and enforce compliance with the relevant legislation and regulations;
- Evaluate and prioritise tenders for new licences;
- Determine appropriate classes of licences; and
- Hear complaints from users and service providers.

Frequency spectrum:

- Ensure the most efficient use of the radio frequency spectrum allocation and institute the mechanisms necessary to achieve this;
- Control and rationalise radio frequency spectrum allocation and usage by means of appropriate measures; and
- Establish and implement a national radio frequency spectrum plan.

Standard and quality:

- Set national standards governing the provision of telecommunications services and ensure compliance therewith;



- Ensure that the needs of disabled people are taken into account, particularly with regard to type-approval for customer premises equipment (CPE);
- Set technical and quality standards applicable in consultation with the telecommunications industry; and
- Undertake type-approval of customer premise equipment (CPE) and the rules for their connection to the network.

Research:

- Promote and conduct research into developments in telecommunications regulation policy and technology.

Interconnection:

- Determine interconnection guidelines, facilitate interconnection negotiations and approve interconnection agreements (with modifications as necessary) in the public interest.

Tariff regulation:

- "Tariffs should be regulated, however, the nature and extent of such regulation will vary in accordance with the circumstances in evidence in different areas of the telecommunications sector".
- "In areas of the telecommunications sector in which a monopoly is in place or in which competition is not sufficient to ensure acceptable levels of affordability, tariffs should be regulated. The preferred mechanism is a price-capping regime, allowing for the freedom to set tariff levels at any reasonable point below the cap and for consumer price index-related increases on an annual basis" according to White Paper [2].
- Regulate tariffs if and when required, in the public interest.

Consumer protection:

- Take responsibility for consumer protection with regard to telecommunications.

Numbering:

- Administer South Africa's numbering plan.

Access to Intelsat:

- Regulate access of others to Intelsat services.

Liaison with Minister:

- Advise the Minister in the event of enquiries, complaints, objections or disputes.

Parliament:

- Report to Parliament on the performance of its functions;
- Annually submit a budget to Parliament for approval.

Consultation and international participation:

- Participate in international delegations, in consultation with the Ministry, on issues relating to telecommunications;
- Provide a forum for consultation with all interested parties.

Once the telecommunications industry had been restructured and this restructuring had taken effect, a new regulatory authority was established. Telkom was stripped of some of its responsibilities with regard to its duties in the industry. This new market structure was needed to accelerate development and take account of technological and international trends in the telecommunications industry. With this in mind, Telkom had to be protected after having been a monopoly for so long. Telkom was allowed a 25-year license to build and operate a public switched telecommunications service, facilitated by the Telecommunications Act of 1996. This operating licence was gazetted in May 1997. For five years, Telkom is protected from competition in certain markets, namely:

- Public switched telecommunications services (PSTS);
- Radio communications and

- Value added network services (VANS).

In addition Telkom will have exclusive rights and protection in the following markets:

- National long distance;
- International;
- Local access;
- Public pay phones;
- Infrastructure for value added network services;
- Fixed lines for use by mobile cellular network operators; and
- Infrastructure for private networks other than Transnet and Eskom.

Prices:

According to the White Paper [2]: "The minister will determine Telkom's price increase for the first three years following the issue of the licence to Telkom. Following this period, SATRA will set tariffs. Over time the effect of this should be to lower the real cost of communications. In turn this should make services more affordable to more people and improve capacity utilisation of the networks, thus improving the network operators' financial health".

"In terms of the Act, only suppliers registered with SATRA will be allowed to trade in communications products. Similarly, only those certified as competent by SATRA may install or maintain communications equipment".

Value added network services:

The value added network services are open to competition, subject to licence conditions. There is a ban on resale capacity and on carrying voice traffic. The licence fee is R 15 000 a year and the licence defines VANS as including, but not only,

- Electronic data;
- Electronic mail;
- Protocol conversation;
- Database access;



- Managed data network services;
- Voice mail;
- Store and forward fax;
- Video conferencing;
- Telecommunications related to publishing and advertising services, whether electronic or print;
- Electronic information services, including Internet service provision;

Radio licence:

Telkom's proposed radio licence is non-exclusive and aimed at permitting Telkom to provide public switched telecommunications services and value added network services via radio. License fees are set at R1540,00 per megahertz of frequency spectrum and R650,000,00 per megahertz of duplex pair, wireless local loop and frequency spectrum.

According to the Department of Communications [12], restructuring of South Africa's telecommunications sector is different from that of the rest of the world. "South Africa is basically an expanding market where restructuring is aimed at achieving universal service. Trends in similar restructuring programmes in emerging economies show that, because the sector is expanding, prospects for job creation are enhanced. Even if, in the long term, one enterprise typically the former monopoly network operator, could shed jobs, there will be a net gain of jobs in the sector over the medium long-term".

South Africa is a member of the World Trade Organisation (WTO) group on telecommunications. South Africa's key offer is that Telkom's monopoly of public switched telecommunications services will end no later than December 2003. Thereafter another public network operator will be permitted. In addition, South Africa has offered to explore the feasibility of licensing more than two public network operators after 2003. However, all traffic, including radio based services, but excepting voice services on value added networks must pass through the duopoly's networks.

In doing this, lessons learnt overseas will be implemented locally. What is clear is that wireless technologies will play a much bigger role in Telkom's plans than previously. The

cost of a GSM (global system for mobile communications) base station is already the same as that of an equivalent fixed wire exchange and a GSM station can be installed more quickly and is not as susceptible to vandalism. The same is true for other, less sophisticated, wireless systems. Already suppliers Altech Alcatel Telecoms, Ericsson, Lucent and Siemens are involved in pilot phase studies in rural areas of the country.

Technologies which show promise include global mobile systems based on low-earth orbit satellites (a number will be in operation by the end of the century), RurTel, CDMA, rural cellular and solar power.

Telkom will enjoy a period of exclusivity, after which various telecommunications market segments are to be liberalised in a phased process put into motion and overseen by SATRA. From the onset it must be realised that it will be difficult to define the boundaries of market segments or services. The reason is that telecommunications technologies are very flexible. SATRA as opposed to Telkom has been charged with legislation to enforce rules of the industry. In order to implement the new market structure SATRA has to move with technology rather than against it.

The other regulatory body apart from SATRA is the IBA, which, in accordance with the White Paper [4], came into operation in April 1994 and has since made a major contribution in opening up the airwaves in South Africa. Amongst other things it has:

- Provided for the transformation of the state broadcaster into a public broadcasting service and the establishment of an entirely new community radio broadcasting sector;
- Expanded the private broadcasting industry, with the sale of six of the SABC's commercial radio stations and the granting of nine private radio licences, as well as the licensing of a new, private, free-to-air national television station; and
- Created a framework for further policy development for the South African broadcasting system.

The principal roles of the regulator include:

- Administration of the statutory scheme for granting and renewing broadcasting licenses;

- Management of the broadcasting services frequency bands and other parts of the radio frequency spectrum properly delegated by Parliament and the Minister for broadcasting purposes;
- Design and implementation of regulatory policies and licence conditions for different categories of broadcasting service, including conditions relating to:
 - Local content quotas and compliance with them and the strategies that evolve from them;
 - Service provision, including coverage obligations and language service provision;
 - Formulation of regulations for ownership and control compliance;
 - Code of Conduct compliance;
 - Empowerment; and
 - Monitoring the broadcasting industry to ensure compliance with broadcasting laws and regulations;
- Conducting research, including research into community standards to inform its regulator role;
- The enforcement, where appropriate and necessary of broadcasting laws and regulatory requirements; and
- An appropriate accountability to Parliament, the minister and the system of judicial review.

The functions of the regulator will include, but not be limited to:

- Planning, in accordance with the overall national plan, the availability of segments of the radio frequency spectrum on a national and area basis, including preparing a frequency allocation plan for South Africa. Efficiency and effectiveness should be the hallmarks of frequency allocation planning;
- The granting and renewal of broadcasting licences;
- Monitoring the operation of the IBA Act, technological developments and service trends in the broadcasting sector, and reporting to the Minister from time to time;



- Dealing with complaints about broadcasters' observance of community standards in programming and advertising;
- Dealing with and prescribing the appropriate radio frequency spectrum engineering characteristics of broadcasting services; and
- Making regulations necessary to give effect to broadcasting policy through due public processes.

The IBA and SATRA are already working hand in hand to prepare for the convergence of telecommunications and broadcasting in the year 2000. A single regulatory authority for broadcasting and telecommunications will be more than welcome, for the two regulatory bodies are charged with the same functions in industries where boundaries have long faded.

The IBA Act of 1993 and the SATRA Act of 1996 established two separate regulatory authorities for the broadcasting and telecommunications areas. These acts vested these two authorities with independent powers to regulate the two areas in the public interest. During 1996 the Telecommunications Act was promulgated after a wide-ranging consultative process.

The Telecommunications Act provided for the establishment of the telecommunications regulatory authority to regulate telecommunications and manage that part of the radio frequency spectrum appropriate for telecommunications services. The convergence of telecommunications, broadcasting and information technologies has forced government to focus on an appropriate regulatory structure.

The increasing difficulty of differentiating between that part of the radio frequency spectrum used for telecommunications and that part used for broadcasting and other services, has made it clear the need to merge the two regulatory authorities into a new authority responsible for regulating both the broadcasting and telecommunications areas.

According to the White Paper [5], the merging of the two regulatory authorities will also ensure that the high costs associated with maintaining separate regulatory structures, that require virtually the same technical skills and facilities will be minimised.

Once this has been achieved, it will be easier to execute government's vision. "This vision is in compliance with Government proposed industrial policies, which state that the long-term vision of South Africa's policy makers is to guide and expedite the country's process of industrial development up to the so called value added chain. And in so doing, to achieve the goal of creating substantial (high skill and high-income) employment opportunities on a sustainable basis in the long term" according to White Paper [2].

The local telecommunications supply industry may establish itself as a major player by niche marketing on the African continent. If the segments of the market are competitive and expandable, then the government will give financial support. This means that if the telecommunications industry finds itself in synergy with the rest of the world, it may reap tremendous benefits. These may come in the form of participation in the global economy, improved personal and business communication expanded trade and revitalised economic growth. These will only be achieved if South Africa is integrated into regional and international telecommunications systems.

The vital link of information flow for trade and social integration can only be realised through co-operation and co-ordination among the different parties involved in its development, as users, operators, manufacturers and policy makers.

According to White Paper [5]: "The government attaches great importance to effective regional integration and will actively support the activities of all South African players in these fields through policies. Which promote such regional co-operation in terms of cross-boarder communications, opening of markets for equipment and services. Adopting harmonised standards and technical specifications, efficient use of the radio spectrum, and formulation of common African positions for international negotiations in various world fora for telecommunications and information development".

2.2 International relations:

As a consequence of South Africa's readmission as a member of the Universal Postal Union (UPU) South Africa started participating fully in activities of the International Telecommunications Union (ITU) late in 1994. The full benefits of re-admission to these



communications agencies of the United Nations, whose fora adopt decisions and formulate strategies concerning the development of communications for the benefit of all its members, can now be reaped for South Africa and its peoples.

South Africa was elected as a member of the council of the ITU and the council of administration of the UPU in 1995. Both councils are responsible for the functioning of the unions in the four years between meetings of their highest decision-making organs, namely the *Plenipotentiary Conference* in the case of the ITU, and *Congress* in the case of the UPU. Consequently, their agendas include items on a wide variety of subjects and personnel matters, including the consideration and approval of the biennial budgets. This is a budgeting method generally followed by United Nations agencies. This is development assistance in the field of communications to the least developed and developing countries with special problems. They also deal with agendas and duration's of future conferences and meetings, progress measurements of strategic plans adopted by both unions and other aspects related to the smooth functioning of their respective Secretariats, which are situated in Born and Geneva (ITU).

The radio communications sector is one of the three sectors of the International Telecommunications Union (ITU) that hold regional seminars on frequency management annually. This is to assist administration in keeping abreast of regulatory issues associated with frequency management, and technological developments in radio communications. In co-operation with the ITU the department of Posts and Telecommunications decided to host such a seminar for some of the countries in the African Regions from 4 to 8 September 1995. The St. George's Hotel in Midrand, chosen as the venue for this seminar, was intended to mark the re-admission of this Administration to the organisation and to promote and consolidate regional co-operation.

The main objective of the seminar was to discuss amongst other things:

- Frequency management for both the telecommunication and broadcasting bands;
- Regulatory and procedural matters; and
- Preparations for the World Radio Communication Conference (WRC-95).

In addition, South Africa has joined two more bodies, which are INTELSAT and INMARSAT in an endeavour to join the global community by way of telecommunications. According to Government Documents [6].

2.3 International Telecommunications Satellite Organisation (INTELSAT)

A Telecommunications Department delegation attended the twentieth Assembly of members of INTELSAT, held in Copenhagen from 29 August to 1 September 1995. At this meeting the Assembly, the highest governing body of the organisation, decided among other things, to give the highest priority to the study of the new structure needed in order to adapt the organisation to a more competitive market environment. A working party was established to undertake the study, and the South African representative, in close collaboration with representatives from other African countries, has participated actively in the work of the working party.

2.4 International Mobile Satellite Organisation (INMARSAT):

The eleventh INMARSAT Assembly was held in London from 27 February to 1 March 1996 and was attended by delegation from the Department Of Telecommunications. One of the more important decisions taken at this meeting was that there is an urgent need to introduce changes to the structure of the organisation in order for it to remain commercially viable in a very competitive market. A special working group is undertaking a study and will make recommendations on a suitable new structure for the organisation, which was planned for implementation in 1997.

3 Literature Review and Diffusion Theories.

3.1 Overview

In this chapter some, but not all, of the literature will be reviewed. The main aim is to describe the theory needed for the analysis of the diffusion of personal telecommunications in South Africa. Rogers [7] says that Gabriel Tarde had an analytical eye on trends in his society. He was of French descent, a lawyer by profession and was the main European forefather of the field of diffusion. Tarde is said "to have observed certain generalisations about the diffusion of innovations which he called the law of imitation". The purpose of his scholarly observations, Tarde (1903) said, was to learn why, given one hundred different innovations conceived at the same time, - innovations in the form of words, in mythological ideas, in industrial processes, etc. - ten will spread abroad while ninety will be forgotten".

With this historical background, one can start reviewing some of the theories proposed in the literature.

3.2 Diffusion theory

Masters, like Rogers with regards to the diffusion of innovation [7], state that "diffusion is the process by which innovation is communicated through certain channels over time among the social system. Diffusion is a kind of social change, defined as the process by which alterations occur in the structure and function of the social system".

Rogers takes it further by pointing out that in order for diffusion to take place four elements must be present, namely an innovation, communication channels, time and a social system. He says that an innovation is an idea, practice or object, which is perceived as new by either an individual or a unit of adoption. In this study our innovation is the cellular phone or satellite phone.

The rate, at which the cellular phone is adopted, depends on its perceived newness to the individual. One has to look at the characteristics of the innovation itself to determine its rate of adoption in practice. The characteristics that play a role are relative advantage, compatibility, complexity, trialability and observability.

Rogers' explanation of these elements is as follows: relative advantage is the degree to which an innovation is perceived as better than the idea it supersedes, and this degree may be measured in economic terms, social prestige, convenience and satisfaction. The relative advantage of the cellular phone is that an end-user does not have to be at a fixed location to make a call. An end-user could be travelling and making a call at the same time. This is viewed as an added advantage, for it cuts down on time wasted travelling to fixed places to communicate. Another advantage is that it allows for timely decision-making and definitely improves time management.

Compatibility is the degree to which an innovation is perceived as being consistent with existing values, past experience and the needs of potential adopters. The compatibility of the cellular phone is related to the fact that consumer are already used to being able to communicate with anybody on a regular phone, and the cellular phone simply add the freedom of mobility.

Complexity is the degree to which an innovation is perceived as difficult to understand and use. Cellular telephones are similar in use to regular telephones.

Trialability is the degree to which an innovation may be experimented on. Access to cellular phones is quite easy today - everybody knows somebody who owns one or has access to one, which can be used for trial purposes.

Observability is the degree to which the results of an innovation are visible to others. Cellular phones are visible because people use them in public places. This makes them very visible to potential buyers.

Rogers [7] adds and highlights the fact that in order for the innovation (cellular phone) to be diffused, information about it must reach potential users. In order to achieve this, communication channels have to be used, which are a means by which messages go from one individual to another. In some cases the nature of the information-exchange relationship between a pair of individuals determines the conditions under which a source will or will not transmit the innovation to the receiver, and the effect of the transfer. For example, communication channels could be billboard advertising, radio advertising, newspaper advertising, colleague to colleague conversation and magazines.

One must bear in mind that diffusion does not happen instantaneously. It happens over a period of time. This is, firstly, because before an end-user makes a decision to either adopt or reject an innovation, the adopter must have information that such an innovation exists. Secondly, the relative earliness or lateness of the adoption of the innovation by a certain individual or unit of adoption, in comparison to that of other individuals or members of a unit, depends on the type of individual or unit. Thirdly, the number of adopters influences the rate of adoption of an innovation in a certain system over a certain period.

In order for an innovation to diffuse, Rogers [7] says there must be a social system to which the innovation will be diffused. This system may consist of individuals, informal groups, organisations and subsystems. Within the social system, a social structure exists that affects the diffusion, the effects of norms on diffusion, the roles of opinion leaders and change agents, types of innovation-decisions, and the consequences of innovation. These issues involve relationships between the social system and the diffusion process that occurs within it.

Rogers [7] points out that once an innovation has been launched, there are two types of individuals within a social system, that influence others' attitudes towards the innovation. Firstly, there is the *opinion leader*, who has earned this position through his/her technical competence and social accessibility. Secondly, there is the *change agent*, who influences the clients' innovation-decisions in a direction deemed desirable by a change agency. Both of these individuals are a centre of interpersonal communications networks. A communications network consists of interconnected individuals who are linked by patterns of flows of information.

Mike *et al* [8], used transcutaneous oxygen monitoring as a case study to examine how new technologies are introduced into clinical practice. They identified certain major factors in the adoption of transcutaneous oxygen monitoring in their description of the diffusion of medical technology.

The social systems involved in this process were biomedical researchers, clinicians, hospital administrators, the health care industry, policy makers, the legal profession, educators, the news media and the general public. The aim was to share responsibility in

the spirit of the ethics of evidence, but the ultimate responsibility was seen to be that of the physician.

Mike *et al* [8] use the diffusion factors identified to analyse the diffusion of the monitoring system. These diffusion factors are prevailing theory, the innovation, environmental constraints and incentives, evaluation and methods, evaluation and communications channels.

What they discovered first, was that transcutaneous oxygen monitoring was the culmination of hailed achievements of the period, because of the prevailing theory and explanations for observed phenomena, which strongly influence the acceptance of new technologies. Innovations that reflect currently held beliefs tend to be readily adopted, whereas the introduction of new conceptual approaches may be delayed.

Second they realised that transcutaneous monitoring was rapidly adopted because it had, at that time, no competitors. Its disadvantage was that it was not easy to use and caused some frustration to the clinical staff, which made it vulnerable to competition. Because it was an innovation of that time and a new procedure it was more readily accepted, even though it was not easy to use. It required little change in practice style. It was highly remunerative, satisfying and had no worthy clinical competitors.

Thirdly, there were many incentives for adopting the technology for routine use in the neonatal intensive care unit and essentially there were no environmental constraints. The influence of the policy makers was thus seen, because the decisions of regulatory agencies, medical care insurers, institutional review boards, as well as the general climate of malpractice litigation determined its use.

The fourth factor was evaluation and methods of evaluation. Also sensitive to change by policy makers, this factor encompasses the role of technology assessment in affecting physician behaviour. Formal evaluation may have a direct influence on physicians, or it may influence experts who then influence physicians, who may in turn have an impact on medical practice.

The fifth discovery about channels of communication, was that there was a great deal of interest in studying the ways in which doctors learn about new procedures, in order to find

out which sources of information and channels of communication may be most influential. It is a complex scenario, including direct contact with sales representatives, the recommendations of colleagues, medical journals, conferences, continuing education and even the public news media. There are also different patterns particular to the type of innovation, the physician speciality group and the time elapsed since the initial announcement of the new procedure. In the transcutaneous monitoring study, for example, there was a strong effect from advocates, with extensive coverage in the medical literature, as well as aggressive detailing by the device manufacturers.

Mike *et al* [8] indicate that it is easier to introduce a new technology where it is needed. Transcutaneous oxygen monitoring was readily accepted within this medical community because it did not require medical staff to change the way in which they worked. This innovation turned out to be a highly remunerative. It was accepted more readily by medical personnel because they got recommendations about the innovation from colleagues and sources of information that were highly influential.

Girifalco [9] says there are two elements that are relevant when talking about technology diffusion: the extent of use and time. The extent of diffusion of a technology at any given time is defined by the degree to which it is in use at that time. So the process of diffusion is the gradual growth of the use of a technology as time passes.

He emphasises that the diffusion of technology should start with:

- A definition of the technology;
- A specification of the problem or its proxy within which the technology diffuses; and
- A choice of parameter which measures the extent of diffusion.

Once these definitions have been established, technology diffusion can be determined from the analysis of the time series for the diffusion parameter that measures the extent of the technology. The definitions affect the kinds of conclusions that can be drawn, as well as the framework of the analysis.

In addition, Girifalco [9] states that after a population and a diffusion parameter have been defined, there are still two major issues to be considered. The first of these is that a population may not be constant in time. We can expect most populations in which



technological diffusion takes place, change with time. The time series for the diffusion must then be supplemented with a time series for the size of the population.

Girifalco [9] continues by saying that the diffusion of technology is always preceded by the diffusion of information about that technology. Modern travel and communications have enormously increased the rate of information transfer, but even today information on new technologies is not available to everyone instantaneously. While advertising reaches large numbers of people very rapidly, it often takes more information about a new product than can be presented or absorbed from an advertisement before a decision to buy is made.

Girifalco [9] also points out that diffusion focuses on a particular technology and measures its spread independently of any other technology. However, a new technology often fulfils the same function in a better way than, one already in use. The new technology then grows at the expense of the old. This is the phenomenon of technological substitution. The particular nature of the technology and the circumstances in which it exists and grows are basic determinants of the causes, mechanisms and rates of its diffusion, however there are some obvious generalisations that can be made for a technology to diffuse:

- There must be some adopters who accept and implement technology.
- There must be some advocates of the technology who act as the primary agents of change.
- There must be reasons for both advocacy and acceptance.
- There must be a mechanism for communication between the advocates and the adopters.
- A certain quantity and quality of information must be attained before a decision to adopt can be made.
- For a given level of information, the probability of adoption may be different for different adopters.
- Technological diffusion takes place in a changing technical, economic, political, and social environment. The nature of this environment has a profound effect on the rates of diffusion and even on the types of technologies that will diffuse. While this is only a bare framework of the adoption process, it illustrates that technological diffusion is a complex technical, economic, and social phenomenon.

Girifalco, like Rogers, says that diffusion of an innovation will happen over the extent of use and time. He emphasises the fact that information must precede the innovation itself, so that people can make the decision to adopt or reject the innovation. He also mentions that an advocate for the innovation should exist and adopters should be present to use the innovation. In order for the information to flow to adopters from advocates of the innovation, some form of communication mechanisms must be in place. The environment must also be conducive for the diffusion to take place politically, environmentally and in a changing technical world and a social system.

Moore [10] looks at diffusion through what he calls "the technology adoption life cycle". He says our attitude toward technology adoption becomes significant, at least in a marketing sense, any time we are introduced to products that require us to change our current mode of behaviour or to modify other products and services we rely on. Such change sensitive products are called *discontinuous innovations*. The contrasting term, *continuous innovations*, refers to the normal upgrading of products that does not require us to change behaviour.

Moore [10] says classical industries introduce discontinuous innovations only occasionally and with trepidation, however high-tech enterprises do so routinely and confidently. From their inception, therefore, high-tech industries needed a marketing model that coped effectively with this type of product introduction. Thus the technological life cycle became central to the entire sector's approach to marketing.

Moore [10] presents us with a model that describes the market penetration of any new technology product in terms of a progression in the types of consumers it attracts throughout its useful life. The curve is bell shaped. Its divisions are equivalent to the standard deviation. That is the early majority and the late majority fall within one standard deviation from the mean, the early adopters and the laggards within two, and way out there, at the very onset of a new technology, about three standard deviations from the norm are the innovators.

The groups, Moore [10] says, are distinguished from each other by their characteristic response to a discontinuous innovation based on a new technology. Each group has a unique psychographic profile: a combination of psychology and demographics that makes

its marketing responses different to those of the other groups. Understanding each profile and its relationship to its neighbours is a critical component of high-tech marketing.

Moore [10] describes the behaviour of each group. Innovators pursue new technology products aggressively. Marketers seek innovators out even before a formal marketing program has been launched. This is because technology is a central interest in their lives, regardless of the function it performs. At root level, they are intrigued by any fundamental advance and often make technology purchases simply for the pleasure of exploring the new device's properties. There are not very many innovators in any given market segment, but winning them over at the outset of a marketing campaign is key nonetheless, because their endorsement reassures the other players in the market that the product does, in fact, work.

Early adopters, like innovators, buy into new product concepts very early in the life cycle, but unlike innovators they are not technologists. Rather, they are people who find it easy to imagine, understand and appreciate the benefits of a new technology and relate these potential benefits to their other concerns. Whenever they find a strong match, between these benefits and concerns, early adopters are willing to base their buying decisions upon it. Because early adopters do not rely on well-established references in making these buying decisions, preferring instead to rely on their own intuition and vision, they are key to opening up any high-tech market segment.

The early majority shares some of the early adopter's ability to relate to technology, but ultimately they are driven by a strong sense of practicability. They know that many new inventions end up as passing fads, so they are content to wait and see how other people make out with them before they buy in themselves. They want to see well-established references before investing substantially. Because there are so many people in this segment - roughly one third of the whole adoption life cycle - winning their business is key to any substantial profits and growth.

The late majority shares all the concerns of the early majority, plus one major additional one. Whereas, people in the early majority are comfortable with their ability to handle a technology product, the late majority will only buy such a product if it has become an established standard. Even then, the late majority wants to see lots of support and they tend to buy from large, well-established companies. Like the early majority, this group

comprises about one third of the total buying population in any given segment. Courting its favour is highly profitable indeed, for while profit margins decrease as the products mature so do the selling costs and virtually all research and development costs have been amortised by this stage.

The laggards simply do not want anything to do with new technology, for a variety of reasons, some personal and some economic. The only time they ever buy a technological product is when it is buried deep within another product.

Moore [10] takes us further by introducing us to what he calls the High Tech Marketing Model in his endeavour to clarify the diffusion of technology. What Moore is pointing out here is the unfolding, through all stages, of the Technological Adoption Life Cycle. What is dazzling about this concept, particularly for those who own equity in a high-tech venture, is its promise of virtual monopoly over a major new market development. If you can get there first, "catch the curve" and ride it through the early majority segment, thereby establishing the de facto standard, you can get rich very quickly and "own" a highly profitable market for a very long time.

Moore [10] points out some interesting facts about what may go wrong in the marketing ploy of the companies. He introduces a gap between any two psychographic groups. Each of these gaps represents an opportunity for marketing to lose momentum, to miss the transition to the next segment, thereby never to gain the Promised Land of profit-margin leadership in the middle of the bell curve.

Moore [10] states that the first crack gap is between the innovators and the early adopters. It is a gap that occurs when a new technology product cannot readily be translated into a major new benefit. Such a benefit is typically symbolised by a single compelling application, the one thing that best captures the power and value of the new product. If the marketing effort is unable to find this compelling application, then market development stalls at the innovators and the future of the product falls through the crack.

There is another crack between the early majority and late majority. By this point in the Technological Adoption Life Cycle, the market is already well developed and has absorbed the technology product into the mainstream. The key issue now is the transition from the

early to the late majority. It has to do with demands on the end user to be technologically competent.

The most important gap highlighted by Moore [10] is the deep and dividing chasm that separates the early adopters from the early majority. This is by far the most formidable and unforgiving transition in the Technological Adoption Life Cycle and it is all the more dangerous because it typically goes unrecognised. The notion that part of what defines a high-tech market is the tendency of its members to refer to each other when making a buying decision is the key to successful marketing.

Many marketing professionals break "the market" up into isolable "market segments". Market segments, in this vocabulary, meet our definition of markets, including the self-referencing aspects. When marketing consultants sell market segmentation studies, all they are actually doing is breaking out the natural market boundaries within the aggregate of current and potential sales.

According to Moore [10], marketing professionals insist on market segmentation because they know no meaningful marketing program can be implemented across a set of customers who do not refer to each other. Every program must rely on some ongoing chain-reaction effects - what is usually called word of mouth. The more self-referencing the market is, the more tightly-bounded its communication channels are and the greater the opportunity for such effects.

In the early markets stage, Moore [10] discusses different types of customers for high-tech marketing the initial customer set for a new technology product is made up primarily of innovators and early adopters. In the high-tech industry, the innovators are better known as technology enthusiasts or just *techies*, whereas the early adopters are visionaries. The visionaries are the ones who first appreciate the architecture of a product and why it has a competitive advantage over the current crop of products established in the marketplace. Visionaries make great critics for they truly care.

In business, technology enthusiasts are the gatekeepers for any new technology. They are the ones who have the interest to learn about it and the ones everyone else deems

competent to do the early evaluation. As such, they are the first key to any high-tech marketing effort.

As a buying population, or as key influences in corporate buying decisions, technology enthusiasts have fewer requirements than any other group in the adoption profile, but one must not ignore the issues that are important to them. Their primary need is the truth.

Secondly, whenever possible, when they have a technical problem, they want access to the most technically knowledgeable person to answer it.

Thirdly, they want to be the first people to get new products. By working with them under nondisclosure - a commitment to which they typically adhere scrupulously, one can get excellent feedback early in the design cycle and begin building supporters, who will influence buyers not only in their own companies but elsewhere in the marketplace as well.

To reach technology enthusiasts, Moore [10] says, one needs to place one's messages in one of the various channels - computer bulletin boards, retail stores that cater specifically for the technology expert, technical publications, technology conferences and the like.

Enthusiasts can be compared to the kindling that helps to start a fire. They need to be cherished for that reason and letting them in on the secret, allowing them to play with the product and give you feedback does this. Wherever appropriate, you should implement the improvements they suggest and let them know that you have according to Moore [10].

The early adopters or visionaries, are those rare breeds of people who have the insight to match an emerging technology to a strategic opportunity. They have the temperament to translate that insight into a high-visibility, high-risk project and the charisma to get the rest of their organisation to buy into the project, according to Moore [10].

The core of their dream is a business goal, not a technology goal and it involves taking a quantum leap forward in how business is conducted in industry or by their customers. It also involves a high degree of personal recognition and reward. Understanding their dream, one understands how to market to them. Visionaries are not looking for an improvement; they are looking for a fundamental breakthrough. Technology is important only inasmuch as it promises to deliver on this dream. The key point is that, in contrast

with the technology enthusiast, a visionary derives value not from a systems technology itself, but from the strategic leap forward it enables.

Visionaries drive the high-tech industry because they see the potential for an "order of magnitude" return on investment and are willing to take high risks to pursue their goal. They will work with vendors who have little or no funding, with products that start life as little more than a diagram on a white board and with technology gurus who bear a disconcerting resemblance to Rasputin. They know that they are going outside the mainstream and they accept that as part of the price they have to pay when trying to leapfrog over the competition.

This means they can usually provide up-front money to seed additional development that supports their project - hence their importance as a source of high-tech development capital. As a buying group, visionaries are easy to sell to but very hard to please. Visionaries see the future in terms of windows of opportunity and see those windows closing.

Furthermore, Moore [10] explains the dynamics of early markets by saying that to get an early market started requires an entrepreneurial company with a breakthrough technology product. That enables a compelling new application, a technology enthusiast who can evaluate and appreciate the superiority of the product over current alternatives and a well-healed visionary who can foresee an order of magnitude improvement from implementing the new application. When the market is unfolding as it should, the entrepreneurial company seeds the technology enthusiast community with early copies of its product while at the same time sharing its vision with visionary executives. It then invites the visionary executives to check with the technology enthusiasts of their choice, to verify that the vision is indeed achievable. Out of these interactions comes a series of negotiations in which, for what seems like a very large amount of money and time, but which will later be recognised as just the tip of the iceberg. The technology enthusiasts get to buy more toys than they ever dreamed of. The entrepreneurial company commits itself to product modifications and system integration services, it never intended to and the visionary has what, on paper, looks to be an achievable project, but which is, in fact, a highly improbable dream.

Moore [10] cautions that at this stage there might be a problem where marketing falls through the crack between the technology enthusiast and the visionary. By failing to discover what provides the order of magnitude leap in benefits.

Moore [10] says mainstream markets, are dominated by the early majority, who tend to be accepted as leaders by the late majority, which are best thought of as conservatives and rejected as leaders by the laggards or sceptics.

The members of this pragmatic group are best known to their closest colleagues, from whom they typically have earned the highest respect, by their peers within their industry, where they show up near the top of the leader board year after year. To market successfully to pragmatists, one has to understand their values and work to serve them. If the goal of visionaries is to take a quantum leap forward, the goal of pragmatists is to make a percentage improvement. They will take risks when required, but they put safety nets in place first and manage the risks very closely.

If pragmatists are hard to win over, they are loyal once won, often enforcing a company standard that requires the purchase of the product, for a given requirement.

When pragmatists buy, they care about the company they are buying from, the quality of the product they are buying, the infrastructure of supporting products and system interfaces and the reliability of the service they will get. They control the bulk of the money in the marketplace. The rewards for building relationships of trust with them are very much worth the effort. They communicate vertically within their industry. They will not buy from one unless one is established and one cannot be established until they buy from one. Pragmatists want to buy from proven market leaders because they know third parties will design support products around the market-leading product. They are price-sensitive. They are willing to pay a modest premium for top quality or special services but, in the absence of any special differentiation, they want the best deal.

According to Moore [10], the *late majority* or *conservatives* like to buy pre-assembled packages, with everything bundled, at a heavily discounted price. The last thing they want to hear is that the software they have just bought does not support the printer they have just installed.

Last, but not least, Moore [10] mentions the dynamics of downstream markets. Just as the visionary drive the development of the early market. Winning their support, is not only the point of entry, because they are the key to long-term dominance, but having done so, one cannot take a market for granted.

To maintain leadership in a mainstream market, one must at least keep pace with the competition. It is no longer necessary to be the technology leader, nor is it necessary to have the very best product, but the product must be good enough and should a competitor make a major breakthrough, one has to make at least catch-up response.

Moore takes the adoption of a new product further by saying that, there are different types of audience in a social system. There are those people who will adopt a product early like innovators, they are usually very few in number. Then there are the early adopters who are just people in the high-tech market. They too are still quite few in numbers. These two groups of people do not indicate that there is a market, for whatever product has been sold or is on the market. The emergence of an early majority starts to indicate that a market does exist for a product. A rise in profit is realised at this point, which occurs just before the emergence of the late majority, which is the mass market. Then the very last to adopt are those who will buy the innovation only because it is part of a product they want.

Jaakkola *et al* [11] use the Heuristic Diffusion Model to increase our understanding of the diffusion process. The authors look at adopter categories to try and understand diffusion. The first buyers are the innovators and who serve the role of technological innovation as differentiator and inspirator, (the emotional (e.g. category imagery and perceived need) and rational (e.g. costs and quality of offer), barriers are very high for further uptake after this class of people.

Then secondly, its the early adopters, innovation translates into having money to afford products and the ability to manage needs, often met in business. Thirdly there is the early majority, who want to follow development of technology, but also finds functional benefits as well as the means to satisfy personal needs. Just before the late majority the technological innovation reaches its growth peak. In this category very low emotional and rational barriers exist to accept technology. At different user group levels, end-user perception and usage needs dominate the various stages of the technology diffusion



process. Jaakkola *et al* [11] state that end user adoption of mobile technology can be influenced by various factors and drivers to describe market mechanisms.

Diffusion is divided into three main parts. First, what affects the triggering of diffusion, is regulation, end user category, services, substitutes, previous generations and distribution. Second, what impacts on the speed of diffusion are price, services, distribution, substitutes, previous penetration and GDP. Third, what determines the maximum level of diffusion is price, service, distribution, competition and GDP.

According to Jaakkola *et al* [11], drivers change as diffusion moves from one phase to the next, which means that those in the mobile industry have to be dynamic about changing conditions as the diffusion progresses. If the next generation of technology is positioned correctly, the existence of a previous generation of technology may, in fact, help enable the diffusion of the next generation.

What Jaakkalo *et al* [11], point, out furthermore, is that in the cellular industry, two diffusion processes take place concurrently: equipment diffusion and service diffusion. Diffusion of equipment leads diffusion of usage. Saturation in the usage increases continuously as services are developed. In this industry, diffusion can be categorised into usage groups, which in turn can have different drivers for triggering, speed and maximum level of diffusion. The utility of this approach stems from the fact that it helps target business activities in the direction where the most benefits can be expected.

In order to trigger diffusion, usage group with the most potential should first be identified. Then, with the help of an analysis of the drivers of diffusion, marketing activities should be carefully designed to fit the drivers of the targeted usage group's profile.

Main drivers identified for the diffusion of mobile phones are economic factors, substitutes, previous market generations, regulations, distribution, competition, user equipment, service and price. Once these have been identified their sensitivity with respect to diffusion can be examined.

Jaakkola *et al* like Rogers and Moore, look at different adopter categories. They use the Heuristic Diffusion Model to increase understanding of the diffusion process. The authors look at what triggers the diffusion process, which can be substitutes and services. In order

to trigger the diffusion process, they must identify a potential user group. The authors are also interested in the impact on the speed of diffusion of factors such as price, services, previous penetration and distribution and to determine the level of diffusion, they look at price, service, competition and GDP. In the industry of telecommunications two processes of diffusion take place, that of the equipment and that of the service. One cannot continue without the other.

Communication seems to be of paramount importance in the process of diffusion. In order for an innovation to diffuse, there must be a way of communicating the availability of that innovation. Some communications structures have to be in place for it to be possible to disseminate this information. According to Allen *et al* [12], technological gatekeepers are the most effective source of information. The authors illustrate how information flows through certain structures, and discussing first how information enters an organisation. It is clear that entry does occur, because without it, no research and development organisation could survive for long. No research and development organisation, no matter how large, can be fully self-sustaining. In order for the organisation to survive, its members must keep themselves abreast of current developments in those technologies, which are central to the mission of the organisation. It must, in other words, constantly import technical information. Not only were the organisations studied by Allen *et al* [12] surviving, they were, to all appearances, thriving. They were extremely successful and highly regarded technically. They must, therefore, have been successful, somehow, in acquiring information from outside and disseminating it within their borders. Allen *et al* [12] wished to find out how they did this.

They discovered that the process by which organisations most effectively import information is an indirect one. There exists, in the organisations that they studied a small number of key people upon whom others rely for information. These key people, or 'technological gatekeepers', differ from their colleagues in their orientation toward outside information sources. They read far more, particularly more difficult 'harder' literature. Their relationship with professional engineering and scientific journals is significantly greater than that of the average technologist. They also maintain broader-ranging and longer-term relationships with technologists outside of their organisations. The technological gatekeeper mediates between his colleagues and the world outside their

organisation and he effectively links the organisation to scientific and technological activity in the world at large.

Allen *et al* [12] point out that there is what is called the network of gatekeepers. This communications network (or portions thereof) can be characterised according to the degree of interconnectedness that exists among nodes. There are several degrees of interconnectedness or 'connectivity' that can exist in a network. In this, only that degree of connectivity, which Flammet in Allen *et al* [12] calls 'strong', will be considered. A strong connected component, or strong component in a network, is one in which all nodes are mutually reachable. In a communication network, a potential exists for the transmission of information between any two members of a strong component. Gatekeepers, therefore, maintain close communication among themselves, thus increasing substantially their effectiveness in linking the organisation to the outside world. In fact, if one were to attempt to design an optimal system for bringing in new technical information and disseminating it within the organisation, it would be difficult to better or improve this model.

New information is brought into the organisation through the gatekeeper. It can be communicated quite readily to other gatekeepers through the gatekeeper network and disseminated outward from one or more points to other members of the organisation.

In addition to formal organisation structure, there are available to management at least two other factors that can be used to promote (or discourage) communication. The first operates through the extension of informal friendship-type relationships within the organisation. Simply stated, people are more willing to ask questions of others whom they know, than of strangers.

The second factor is that transfers. The transferred individual will provide a communication path back to his old organisation. His influence lies far beyond the direct link, though. Probably the most important contribution of the transferred person lies in his ability to make referrals.

Allen *et al* [12] says that gatekeeping is still the most effective way of transmitting information, whether it is from company to company, or just within the ranks of a firm or

between colleagues. It is even more effective when the gatekeepers operate in a network. This makes them highly effective in the dissemination of information.

Banta [13], on the other hand, illustrates the diffusion of an innovation, by looking at the driving forces of the diffusion.

Since its introduction in the USA in the summer of 1973, the computed tomography (CT scanner as the Cat or EMI scanner) has come to exemplify the problems facing the USA in developing policies to deal with medical technology. Its diffusion has been extraordinarily rapid, and given a capital investment of about \$500,000 per scanner, millions have been spent acquiring this highly visible technology. Controlling the diffusion of the CT scanner was an early test for the new Health Systems Agencies and State Health Planning Agencies developed under the 1974 health planning legislation. Despite rapid acceptance by the medical community, CT scanners have also often been cited as an example of a technology whose efficacy (or benefit) has not been clearly shown to explain its diffusion of CT scanners.

Why, then, did, CT scanning spread so rapidly? It is not because of its dramatic effects on patients' health, nor because it made possible diagnoses neither possible before, nor even because the medical literature indicated its great usefulness. In fact, up until June 1995, only 13 clinical papers had been published on CT head scanning. While almost 100 CT scanners were in use, allowing physicians to visualise conditions, such as tumours, that they had had difficulty seeing previously. In addition, reports at professional meetings preceded the published literature by more than a year. Nonetheless, the nature of the technology itself does not seem to fully explain the rapidity with which it spread.

Those who have written on the diffusion of medical technology have stressed the explanatory importance of organisational and economic variables.

CT scanning diffused most rapidly among large hospitals. Similar tendencies have been observed with other technologies. Early diffusion to those hospitals affiliated with medical schools was observed for intensive care units and nuclear medicine.

According to Banta [13], the type of descriptive analysis presented does not allow the inference of explanatory models of diffusion trends. It is striking, however, that health-planning agencies seem to have very little effect.

It seems as if there was no information strategy in place. Much of the problem with CT scanners is related to a lack of information about their efficiency and indications for appropriate use. Physicians did not know when CT scanners should be used and institutional purchasers had no reliable information indicating whether or not the CT scanner was an essential part of medical care. An information strategy would require the development of new mechanisms for ensuring that important technologies are evaluated in a timely way by competent investigators. Furthermore, such a strategy would require the periodic synthesis and dissemination of information on specific technologies to those who make decisions on medical technologies.

In addition the regulator strategy seemed to have flaws. There are two major regulatory programs related to medical technology such as the CT scanner. The medical devices regulatory program under the Food and Drug Administration; the Professional Standards Review Organisation (PSRO's) under the Health Care Financing Administration, which exist to ensure appropriate utilisation of technologies used under the Medicare and Medicaid programs.

Finally it seems that a reimbursement strategy seemed not to be enforced. In other countries, an approach often used to restrain diffusion is to limit the total available budget, thereby forcing physicians and institutions to choose among technologies or investments. This strategy has been little used in the USA, but seem to have great potential.

What Banta illustrates is the fact that under-developed policies sometimes interfere with the diffusion process. This is because it becomes unclear which guidelines to use to diffuse an innovation, which makes it difficult to draw boundaries or to determine how well the innovation actually does what it is supposed to do.

3.3 Competition Theory

Porter [14] says that, "in any industry, whether domestic or international, produces a product or a service. The rules of competition are embodied in the five competitive forces:



the entry of new competitors, the threat of substitutes, the bargaining power of buyers, the bargaining power of suppliers and the rivalry among existing competition". This is illustrated in Table 3.1 and Figure 3.1 below.

Table 3.1 Elements Of Industry Structure [15]

<u>Entry Barriers</u>	<u>Determinants of Supplier Power</u>	<u>Rivalry Determinants</u>
Economies of Scale	Differentiation of inputs	Industry growth
Proprietary product differences	Switching costs of suppliers and firms in the industry	Fixed (or storage) costs/value added
Brand identity	Presence of substitute inputs	Intermittent over capacity
Switching costs	Supplier concentration	Brand identity
Capital requirements	Importance of volume to supplier	Switching costs
Access to distribution	Cost relative to total purchases in the industry	Concentration and balance
Absolute cost advantage	Impact of inputs on cost or differentiation	Information complexity
Propriety learning curve		Diversity of competitors
Access to necessary inputs		Corporate stakes
Proprietary low-cost product design		Exit barriers
<u>Determinants of Substitution Threat</u>	<u>Determinants of Buyer Power</u>	<u>Price Sensitivity</u>
Relative price performance of substitutes	Bargaining leverage	Price/total purchases
Switching costs	Buyer concentration versus firm concentration	Product differences
Buyer propensity to substitute	Buyer volume	Brand identity
	Buyer switching costs relative to firm switching costs	Impact on quality/performance
	Buyer information	Buyer profits
	Ability to backward integrate	Decision makers' incentives
	Substitute products	
	Pull-through	

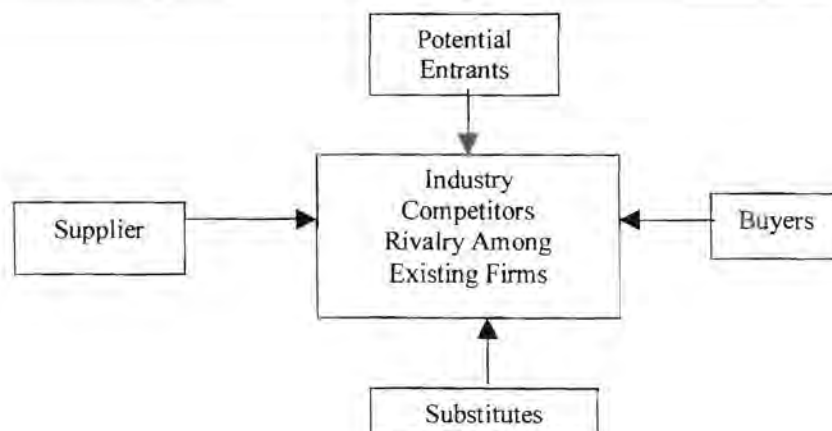


Figure 3. 1 The Five Competitive Forces That Determine Industry Profitability [15]

According to Porter [14], competitive strategy does not only respond to the environment, but also attempts to shape that environment in a firm's favour. The five competitive forces (See Figure 3.1) determine the industry's profitability because they influence price, cost and required investment of firms in an industry.

Buyer power influences the prices that firms can charge, as does the threat of substitution. The power of buyers influences cost and investment. This is because powerful buyers demand costly service. The bargaining power of suppliers determines the costs of raw materials and other inputs. The intensity of rivalry influences prices as well as the costs of competing in areas such as advertising and sales force. The threat of entry places a limit on prices and shapes the investment required to deter entrants.

The crucial question in determining profitability is whether firms can capture the value they create for buyers, or whether this value is competed away to others. Industry structure determines who captures the value (see Table 3.1).

The threat of entry determines the likelihood that new firms will enter an industry and compete away the value, either passing it on to buyers in the form of lower prices or dissipating it by raising the costs of competing. The power of buyers determines the extent to which they retain most of the value created for them, leaving firms in an industry only modest returns.

The threat of substitutes determines the extent to which some other product can meet the same buyer needs and thus places a ceiling on the amount a buyer is willing to pay for an industry's product.

The power of suppliers determines the extent to which value created for buyers will be appropriate by suppliers rather than the firms in industry. The intensity of rivalry acts similarly to the threat of entry. Determines the extent to which firms already in an industry

will compete away the value they create for buyers among themselves, passing it on to buyers in lower prices.

Porter [14] continues by saying the two basic types of competitive advantage combined with the scope of activities which a firm seeks to achieve, leads to three generic strategies for achieving the above, namely average performance in industry: cost leadership, differentiation and focus.

If a firm can achieve and sustain overall cost leadership, it can command prices at or near the industry average. At equivalent or lower prices than its rivals, a cost leader's low cost position translates into higher returns. A cost leader cannot, however, ignore the bases of differentiation. If its product is not perceived as comparable or acceptable to buyers, a cost leader will be forced to discount prices well below those of competitors to gain sales.

This means product differentiation is peculiar to each industry. Differentiation can be based on the product itself; the delivery system in which it is sold; the marketing approach and a broad range of other factors.

A firm that can achieve and sustain differentiation will perform above average in its industry if its price premium exceeds the extra costs incurred in being unique. A differentiator must always seek ways of differentiating that lead to a price premium greater than the cost of differentiating that lead to a price premium greater than the cost position.

Porter [14] says, furthermore, that the differentiation strategy requires that a firm choose attributes in which to differentiate itself that are different from those of its rivals'. A firm must truly be unique at something or be perceived as unique, if it is to expect a premium price.

The focus strategy has two variants. In cost focus, a firm seeks a cost advantage in its target segment, while in differentiation focus, a firm seeks differentiation in its target segments. Both variants of the focus strategy rest on differences between a focussed target segments and other segments in industry.

The target segments must either have buyers with unusual needs or else the production and delivery system that best serves the target segment must differ from that of other industry

segments. Cost focus exploits differences in cost behaviour in some segments, while differentiation focus exploits the special needs of buyers in certain segments. Such differences imply that the segments are poorly served by broadly targeted competitors who serve them at the same time as they serve others. The focuser can thus achieve competitive advantage by dedicating itself to the segments exclusively. Breadth of target is clearly a matter of degree, but the essence of focus is the exploitation of a narrow target difference from the balance of the industry. Narrow focus, in and of itself, is not sufficient for above-average performance.

According to Prahalad *et al* [16], competition occurs not just between individual product or service offerings, but between firms and coalition firms. Top management teams compete in the acquisition of foresight about a broad new opportunity arena, such as genetically engineered drugs.

Companies compete in building core competencies that transcend the resources of individual business units. Coalitions compete to create new competitive space. Economists, strategy researchers and management have too often assumed that competition is limited to the market for goods and services, yet competition for foresight, competition to build competencies and competition to shape industry evolution through a coalition, are all examples of extra-market or non-market competition.

The fact that this competition takes place outside the "market" does not make it any less real. Insensitivity to this broader scope of competition can prevent a company from preparing adequately for the future.

Prahalad *et al* [16] also say that understanding a business's competitive position gives some indication of its relative potential for profits. The theory is that different industries and industry segments have different average profitability levels and that these differences persist over time. Depending on the array of competitive forces at work, a particular industry segment may be, on average, inherently more or less profitable than another.

The industry structure analysis is well suited to describing the 'what' of competitiveness (i.e. what is it that makes one company or industry more profitable than another). As new 'what' have been uncovered, companies have been exhorted to "compete on time", become

"customer-led", strive for quality, simultaneous engineering and pursue a host of other desirable advantages. Yet, with all the attention given to understanding the particulars of cost, quality, customer service and time-to-market advantages, 'why' of competitiveness seems to have gone largely unanswered.

Why do some companies seem able to continually create new forms of competitive advantage, while others seem only to observe and follow? Why are some firms net advantage creators and others, net advantage imitators? There is a need not only to keep score of existing advantages -what they are and who has them -but to discover the "engine" that propels the process of advantage creation.

Argwal *et al* [17], as an illustration of competition in service industries say, some of the major potential sources of sustainable competitive advantage that seem relevant for telecommunications firms are:

- Economies of scale and scope;
- Brand equity;
- Long term relationships;
- Information technology; and
- Corporate culture and organisational expertise.

With the entry of larger competitors and firms with multiple service lines, economies of scale and scope will become extremely important. Once a corporate infrastructure is in place, the cost of providing additional services to customers is small.

The costs of providing call screening, voice mail and caller ID to a customer who has already bought basic Personal Communications Services (PCS) is minimal. Companies that can provide a full range of services, like local, long distance, wireless voice, data, television and internet access are likely to be more successful due to economies of scale and the ability to market a whole bundle of services. Wireless companies will be able to offer bundled local, long distance and wireless services. However, interchange carriers and others also have the capability to offer "service bundles" and may have larger existing customer bases to which they can offer this service. In addition, multi-product firms can

better bear the financial burden of marketing Personal Communications Services (PCS) products, as large amounts have already been invested in licence costs.

Argwal *et al* [17] say that bundling of services is preferred by many customers in proprietary studies that have been undertaken. Customers prefer bundles of local, long distance and wireless services from one company to buying separate services from two or three different firms. Having a single point of contact for customer service, billing and service activation provides utility for customers.

Large firms can achieve these economies of scope through acquisition and mergers, while other firms will obtain this advantage through partnering arrangements.

In the telecom market, brand equity is defined as a set of assets and liabilities linked to a brand. Some of these assets include brand awareness, brand loyalty and perceived quality. AT&T has a strong competitive edge in terms of its brand equity, which was built on the basis of extensive advertising over a long period of time. Since many firms are entering the wireless markets only now, the level of brand equity in the market can be judged by examining the strength of the brands in the local and long distance markets.

Long-term relationships will be extremely valuable to firms in the market. Retaining current customers is much less expensive than acquiring new ones. Churn is a major problem in the industry. Strategies have to be adopted to reduce churn by increasing the transaction cost for the customers and providing more value. One way to do this is to provide a bundle of services, including both wireless and land-line telecommunications and other related services. This will improve the relationship with customers and also increase the implicit cost of switching for the customer. This strategy will be effective, if the bundle of potential services, offered by one firm, is much wider than that of the other firms.

Having comprehensive databases of customers will be a major asset to players in the wireless market. Having a unified billing system provides a competitive advantage in the marketplace. Thus, having state-of-the-art information technology can provide tremendous competitive advantages to firms in this industry.

Argwal *et al* [17] continue by saying that in mobile telephony, some firms will have superior management skills. In recent years, cellular marketing departments have had difficulty processing large volumes of orders for service and have found it problematic to deal with high volumes of customer care inquiries. Since there have been more than enough customers coming to the carriers and seeking their services, little attention has been paid to innovate marketing and branding programs. This situation, will, however, have to change as competition for customers becomes more intense.

Other new Personal Communications Services (PCS) players may have smaller, more agile organisations and may be better able to take quick action. Agile firms can gain from the first mover advantage by rapidly bringing new services to the market. Constantly being in touch with the market will therefore be important. Innovation in packaging and marketing will need to be used to provide positional advantage.

Firms that leverage some of these bases of potential competitive advantage will, potentially, see results in terms of strong customer satisfaction, a high degree of loyalty, a large market share and profitability.

Some proprietary research shows that early adopters of Personal Communications Services (PCS) in the residential sector are likely to be buyers of high technology products such as pagers, compact disc players and video cameras. Those who are single, male, younger and with higher expenditures on telephone services are also more likely to acquire wireless services early. Early adopters in the business sector will likely be current users of cellular, paging, private mobile radio and voice mail services. In addition, they are likely to be drawn from larger establishments in business services.

In addition Argwal *et al* [17] identify four generic strategies for survival, which overlap with those suggested by Porter. They are:

- Lowest cost service, offering acceptable quality at the lowest competitive cost and thus being best able to meet commodity type price competition;
- Focused product superiority, providing superior value through product innovation and leadership;

- Horizontal service integration, being able to offer a broad range of bundled mobility and non-mobility types of services, e.g. local, long distance, wireless, video, internet, etc;
- Superior customer relationships, focusing on satisfying the customer, building long-term relationships and reducing churn.

The lowest cost provider does not need to focus as heavily on customers or innovative service, as on cost management. The firm's size, economies of scale and information resources can provide comparative advantage. The segments for this strategy will clearly be the price-sensitive ones. Acceptable customer service will have to be provided. Products offered will be limited.

The focused product superiority strategy involves continuous innovation in products and services. Strong brand equity will be needed to maintain a name in the marketplace. While relationship management is important, product innovation is key. Some firms for example, could offer single number offerings, allowing the subscriber to give one number on which callers can reach them anytime or any place. One can program the system to develop a calling protocol in case there is no answer. For example, it may first try the subscriber's home, the office, the car and finally, if there is no answer, then it can revert to voice mail. Providing call management features enhances user control. These will include call screening, call blocking and voice mail, all of which can be combined into an integrated package. On the hardware side, multi-mode terminals that are able to function with both cellular and (Personal communications Services) PCS networks could be marketed.

Horizontal integration requires strategic alliances with other service providers and in-depth understanding of the needs of customers. Economies of scale will be crucial here, as well as good information technology to integrate the various services into one bill, customer service, etc. Marketing personnel need to be well trained in diverse products and services. A key marketing challenge will be to decide which features and bundles are valuable for which segments, at what prices and to be able to provide them more efficiently than competitors.

As the competition intensifies, average airtime prices are bound to decline. Various pricing strategies may be relevant: lowest cost per minute, high fixed cost with low per minute cost, or no fixed cost with high per minute cost for emergency use. In addition, there are seeing "free" and bundle-in free minutes that are part of the basic monthly service charge. The challenge will be to provide value to the customer.

The superior customer relationship strategy requires an existing base of customers and strong marketing and customer care programs to maintain and grow the customer base. Superior training of personnel and delegation of authority to customer contact employees will be critical for delivering superior service. A strong corporate culture and a good information technology infrastructure will help provide superior customer relationships.

The marketing landscape for mobile telephony is changing rapidly. Cellular operators will have to upgrade their marketing personnel and skills quickly to be able to compete in this evolving environment. Old strategies that used to work in a relatively secure, duopoly market may no longer be profitable. New Personal Communications Services (PCS) competitors will have to determine their strategic postures and fashion a marketing strategy to meet their goals. Three major marketing challenges will be to develop a compelling buying position beyond low price; to identify and capture distribution channels, and to develop and maintain brand equities.

The main marketing challenge in the short term will be that of the defining the needs of different segments, differentiating offerings competitively and overcoming barriers associated with less-than-ideal services in the early years. Creating brand equity and providing bundled services to reduce churn in the market are going to be key ingredients in this new environment.

As the mobile telephony market becomes more broad-based, distribution will become the key to the fight for survival and prosperity. Retail re-sellers who can provide information to potential subscribers have to be recruited. Companies may not have the time or the resources to establish in-house direct sales forces. Existing telemarketers may be used, perhaps with strategic alliances and equity participation, to provide wide coverage of the markets. Franchising opportunities may also arise.

One key to success in the market will be brand equity. With similar technology available to all players, it will be difficult to differentiate the services being offered. Brand equity may therefore emerge as a key to this market. Players with existing brand-awareness will have to make much lower investments in entering mobile telephony. Newer firms with PCS licences will have the opportunity to create and establish their unique brand names.

Gorhing [18] illustrates that competition in the wireless industry clearly exists and has led to many successes, the most apparent of which may be the evidence that the wireless is beginning to replace wireline. Gorhing [18] says that Mauldin's research indicates that 25% of PCS customers in Louisiana use a wireless service as their primary telephone. Users may not rely on that phone as their only phone, but 15% of those users have actually disconnected their wireline phones.

Gorhing [18] says that Mauldin says the concept of disconnecting wireline phones primarily attracts two groups of customers: low -end users who are typically not interested in long-distance calls and upper-end customers who are heavy roamers and make high volumes of long distance calls. In between those segments is a large middle market, which does not have as great an interest in substitution.

Despite the high percentages of customers who are already substituting wireless for wireline. Mauldin does not see this becoming a more widespread occurrence for some time, because wireline will continue to offer a superior connection for data use, even though people express interest in replacing their wireline phones with wireless ones. Such people are especially likely to fall into the upper-income brackets and to be heavy business users. These users have fax lines and PCs in their homes and their Internet and faxing needs are best served by wireline offerings.

Driving the possibility of wireline replacement is the emergence of pricing plans that include large number of minutes at low prices. The proliferation of One Rate-type plans will fuel a wholesale market. AT&T uses an intelligent roaming database that instructs roaming phones on which network to log onto in a specific area. AT&T designates that network because it offers the lowest of prices. Operators are eager to carry AT&T's roaming traffic because they can earn significant profits from these minutes and they get wholesale airtime.

AT&T's Digital One Rate plan led to a perceived need by some operators and industry followers to operate a national network. Bell Atlantic's acquisition of Nynex and its pending acquisition of GTE, are about achieving scale. Scale allows for the purchasing economies, which in turn allows Bell Atlantic to invest in technology. While Seindeberg acknowledged that low rates are important and that Bell Atlantic matches competitors' low rates over the long term, value will be most important and continued investment in technology will yield valuable service.

Gorhing [18] states that pricing plans are now the name of the game. The technology battles are over for consumers who are now primarily interested in price. Throughout price plans will continue to evolve. Then they will stabilise and consumers will grow more interested in valuable features.

The decisions operators are making today regarding the shape of their businesses, whether they are to pursue tiny towns or the whole globe, will likely determine the makeup of the wireless market that we see in the future.

3.4 Forecast Theory

Burgelman *et al* [19] say that forecasts are made possible by the established relationship between the rate of technological advance and time. These forecasts are used to follow the trends of technology at different phases of its lifecycle. Analysis of historical data from a considerable number of phenomena shows that progress is not random and discontinuous, but follows a regular pattern when a selected attribute, such as functional performance, a technical parameter, or economic performance, is plotted against time. One finds an S-curve pattern.

The S-curve is similar to a product life cycle, in that there is a slow initial growth, followed by a rapid rise to exponential growth, which slows down as it approaches, asymptotically, an upper limit.

According to Gaynor [20], all technologies are systems whose operations are controlled by many different variables and specifications. The appropriate performance measure for a technology is one, which relates technical progress directly to customer utility. The choice

of the technological performance with which to characterise the utility of technical progress is therefore a critical choice in forecasting technological change.

Twiss *et al*, in Gaynor [20], say that one can plot the rate of change of a performance parameter over time and one will likely see a kind of S-curve. This common pattern, which has occurred consistently in the past, has been called the "technology S-curve" and has been used as the basis for extrapolative forecasts of technology change. The curve has three periods: an early period of new invention, a middle period of technology improvement and a late period of technology maturity.

There are two kinds of rates of technical progress:

- Incremental progress along the S-curve, as improvements are made in a technology utilising one physical process; and
- Discontinuous progress, jumping from an old S-curve to a new S-curve as improvements in a technology use a new and different physical progress.

Gaynor [20] says that according to Smith, the substitution process is being considered explicitly in functional terms. It is viewed in terms of the technical and marketing capabilities associated with the existing product as well as the innovations. Also recognised are the high levels of uncertainty that surround young industry and the rivalry among those who seek to structure the framework of competition in ways that favour their interests. The dynamics of this rivalry and the rules of competition that are formed as the new industry develops can have a significant impact on long-term substitution patterns.

According to Gaynor [20] functional perspective is vital for analysing substitution dynamics and long-term substitution outcomes. This suggests that while the range of functions for which an existing product is used may be narrowed, its sales can be largely unaffected within principal markets even as a new product gains widespread acceptance. Thus it may not be necessary to stem adoption of the new product in order for the existing product to be able to survive and prosper.

Gaynor [20] also talks of the resource-based perspective, which says in itself it is important to look beyond the impact on a traditional product and view the threat of substitution in

terms of the firm's existing research and development, manufacturing and marketing capabilities. Such capabilities are the foundation of a firm's position in the given markets. The extent to which they prove to be valuable for the new product, is a key issue for continued viability where an existing product is displaced.

In addition, Gaynor [20] discusses competitive perspective, pointing out that how an industry evolves can affect substitution patterns. The strategies of various firms may reflect different competitive capabilities and/or economic interests. Competing designs may vary in the range of functions they perform the potential effectiveness with which they perform given functions, the technical capabilities on which they are based and their marketing requirements.

According to Tidd *et al* [21], the diffusion of innovation is typically described by an S-shaped curve. Initially the rate of adoption is low and adoption is confined to innovators'. Next to adopt are the early adopters and then the late majority and finally the curve tails off as only laggards remain.

Kwasnicki *et al* [22] say that the word "to diffuse" was derived at the end of the fourteenth century from the Latin *diffundere*, which means, "to spread over". In science, the term "diffusion" refers to the phenomenon of the spreading over time, in space or acceptance in a social environment, of some specific term or pattern. Spatial diffusion is the object of interest mainly of sociologists and development planners. Diffusion in the human-social environment interests researchers in market development and planners of technological development at the firm, regional and national levels. Integration of these two approaches is however, possible and has in fact been done.

One aim is to develop a relatively simple and easy model of technological substitution (diffusion). Ryan *et al* in Kwasnicki *et al* [22], say that in their early investigations of diffusion, they noted two important features of that process: the very wide range of rates at which different innovations spread and the general S-shaped diffusion of most innovations. These two features have now become the key stylised facts of the diffusion process, but it is necessary to add that the S-shaped pattern of diffusion is recorded only in the case of two competing technologies, the new and the old. At any moment, more than two technologies compete, so that we have multi-technological diffusion (sometimes called substitution).

The diffusion of a single technology has the form of a bell shaped curve. Broadly speaking, the bell-shaped curve consists of an introductory phase, when the diffusion rate is not very high, followed by a phase of relatively quick diffusion. The third phase may be called the matured phase, in which the market share of the technology declines and the use and emergence of new and better technology (typically the new technology emerges during the second phase, of quick diffusion of the old technology).

3.5 Cluster Theory

In strategic management and industrial economics the formation of competitive high technological clusters is important to technological innovations. According to Sabourrin *et al* [23], they indicate that Shumpeter was the first to "indicate that technological innovations are not an isolated phenomenon, equally distributed in time in the economic system, but tend to appear in the form of bunching in specific industrial sectors. Since Shumpeter, several researchers have shown that the study of innovation should focus on the process underlying the formation of competitive high technological clusters".

It is generally agreed that technological clusters are formed and shaped by the collective and innovative behaviour of technological firms. In addition, Porter [14] is also quoted "as proposing a model for analysing the competitiveness of regions and countries and argued that this concept should include four strategic resources in the formation of high technology clusters: highly qualified manpower, technological infrastructure, knowledge resources and capital resources".

According to Sabourin *et al* [23]: "strategic resources are represented as a sequential path of causality where highly qualified human resources play a key role in initiating dynamics in the creation of a competitive cluster. Knowledge resources then assume the role of protecting the assets of the firms and technological infrastructures become the firm's leverage in its capacity to develop new technological products and processes. Then in the end the availability of capital is a factor of financial leverage with a multiplier effect on the technological and commercial capabilities of the firm".

In addition, Porter [14] says that economic, technological and competitive developments are increasing the competitive advantage to be gained by those who can identify and

exploit interrelationships among distinct but related businesses. He talks about horizontal strategy, which he says cuts across divisional boundaries. This horizontal strategy is a co-ordinated set of goals and policies across distinct but interrelated business units. It provides for explicit co-ordination among business units, that make corporate or group strategy more than the sum of the individual business strategies.

Porter [14] points out three types of interrelationships among business units, namely tangible interrelationships, intangible interrelationships and competitor relationships.

Tangible interrelationships arise from opportunities to share activities in the value chain among related business units, due to the presence of common buyers, channels, technologies and other factors. Tangible interrelationships lead to competitive advantage if they share costs or enhance differentiation enough, to exceed the cost of sharing.

Intangible interrelationships, transfers the management of *know-how* among separate value chains. Here the competitive advantage is shown by transference of know-how about how to manage a particular type of activity from one business unit to another.

Competitor relationships stem from the existence of rivals that actually or potentially compete with a firm in more than one industry. From what has been discussed above, one can conclude that business unit clusters are formed around intangible and tangible interrelationships.

3.6 Managing Innovation Theory

Gaynor [20] says that managers must understand both the importance of new-product innovation to business success and their own role in supporting the new innovation process.

New product innovation is a fundamental business process, whose purpose is to create and sustain growth in both revenues and profits. This process is the innovation engine. The innovation engine gathers information on topics such as new technology, market trends, and customer needs and new manufacturing techniques.

Information from the innovation engine enables the introduction of a steady stream of new products into the customer and user world. The value that these products provide



stimulates an ever-increasing customer base to make purchases that result in steadily-increasing revenues for the company.

Top-level business managers decide whether or not to invest in new-product innovation and how much money to spend this way. A key objective of managers of new-product innovation activities should be to make sure that high-level executives believe that their innovation engine is the best investment opportunity available.

A primary objective of the innovation engine must be to ensure that the cash-flow cycle for each new product makes a return on investment. This is because a new-product innovation activity addresses a new opportunity in the marketplace. An opportunity exists when congruence occurs between a customer need and the ability of technology to create a solution for that need.

A key management goal is to direct innovation activity in a way that maximises business success. If a manager wants to increase total project profitability, priority should be given to moving extinction time as far as possible and taking time to maximise gross profit.

Top-level executives are responsible for both achieving acceptable business performance today and steering their corporation to a successful future in a competitive world. To improve future revenue performance, executives must do their part in improving the selection of opportunities for investment. This means establishing strategic directions for new product innovation activity that guide the corporation towards markets that will support future growth. Gaynor [20] adds that management of these plans should be done in a way that will effectively guide the selection of individual project opportunities.

Executives must communicate that new products will provide a high rate of return, excellent competitive performance and superior value for the customer. They should also stress that all dealings with customers will reflect the high integrity of the corporation.

The innovation engine must anticipate and support the manufacturing infrastructure so that newly introduced products fit naturally within the effort.

To be competitive, leading companies must focus on the capabilities that they are best at, those core competencies that differentiate them from their competitors and that provide the

necessary competitive edge for the future. They must then find vendors and partners to fill in the rest of the capacity they need to provide products and services to their customers.

All managers of new-product innovation activity must strive to optimise cash flow for their projects. Given that an opportunity fits with corporate plans, the best opportunities will also have the following attributes:

- A population of potential customers;
- A substantial profit potential;
- Technical, market and manufacturing feasibility; and
- The potential for a sustainable competitive advantage.

Spending time and energy initially to describe the best possible product response for a given opportunity will help a great deal to ensure the desired financial return.

The size of project teams should allow efficient achievement of the best time to market. The goals of management should be to provide the team with what they need to meet commitments and to remove any obstacles that get in their way. The responsibility for ensuring that the output of innovation efforts fits with required manufacturing and regulatory constraints rests with the managers of the innovation activity.

Members of staff from almost every function in the business are involved in some way in new product innovation. The innovation engine must therefore be owned and managed by the top-level leadership team of the business unit.

The process of developing a product must involve expertise from both manufacturing and marketing, to ensure that the right product is designed into a market-competitive and manufacturable form. This will happen if the opportunity-scanning process crosses functionality. Inputs into this process include non-specific tidbits of information from the technical, market and manufacturing arenas in which business enterprise is involved.

Potential opportunity with the division of business leadership provides the sense of alignment with strategies and core competencies needed to establish the right priorities.

Once an opportunity to define a product presents itself, information from the opportunity scanning process, that describes the business opportunity selected and includes information



about customer needs and new technologies. At the end of this process, a business proposal should emerge that will be presented to the business management team, to enable them to make a well-informed decision on whether or not to invest the necessary resources.

Once product development has been initiated, the information created in product development should be captured and managed by an effective product data management system that controls access to the information, manages revisions and provides systematic backup and safe storage of the information.

According to Gaynor [20], once a product has been developed it has to be introduced, sold and supported. To do this, support services have to be put together that will distribute the product, support its application and repair services. This marketing capacity can only be achieved through on going exchange of information between product development and manufacturing engineering efforts. After this exchange is achieved and information about the product is available, then awareness of the product among target customers is established. New distribution channels are initiated and the sales force gains initial experience with the product and the customer.

There are specific roles which managers' play in the innovation process. These roles include that of project management skills, engineering process and project staffing.

The project manager's role is to ensure a clear, stable product definition, a consistent and pervasive understanding of both customer and user needs, and a common understanding of priorities and decision criteria.

With the engineering process, engineers must understand the requirements of their tasks and the needs of the customer. They must understand how their work relates to the needs of the ultimate user of the product and how others will use the information that they produce in the innovation process.

In order for the project to be successful, the right type of staff has to be available. Meaning that the right people during start-up phase and the right level of resources during development phases.

Portfolio management is a key issue, so that when opportunities are scanned the range of project investments should also be scanned. The objective of this selection process is to create and maintain a relatively small portfolio of projects that has the highest possible future value.

Sometimes, in innovation, some projects stall for one reason or another. This creates a bottleneck. The project manager should be able to shift limited resources to alleviate this. If this is impossible portfolio management should be charged with dealing with the problem.

Gaynor [20] says that an innovative environment has to be created for a product to be developed. Product development is achieved by empowering a workforce that can depend entirely on the environment created by management. Leaders from project managers up through to executives must balance their behaviour across a range of roles to create such an environment. Managers need to wander around, stay in touch with what is happening and provide assistance when an individual gets off track.

Innovation is a process according to Tidd *et al* [21] and they claim that it should be managed as such. They add that, "successful innovation management is primarily about building and improving effective routines. Such learning comes from recognising and understanding effective routines (whether developed in-house or observed in another enterprise) and facilitating their emergence across the organisation". Innovation management is about putting on a good all round performance. Some of the routines it uses are successful, because innovation is strategy based, but it can only be achieved by learning from experience and being analytical.

Tidd *et al* [21] also say that successful innovation depends on effective internal and external linkages: Linkages offer opportunities for learning from tough customers, lead users, competitors, strategic alliances and alternative perspective.

Successful innovation requires enabling mechanisms for making change happen. This process involves systematic problem-solving and works best within a clear decision-making framework, which should help the organisation stop as well as progress

development if things are going wrong. It also requires skills in project management and control and parallel development of both the market and the technology streams.

Tidd *et al* [21] emphasise the fact that successful innovation only happens within a supportive organisational context, in which creative ideas can merge and be deployed effectively. Building and maintaining such organisational conditions is a critical part of innovation management. It involves working with structures, work organisation arrangements, training and development, reward and recognition systems and communication arrangements. Above all, the requirement is to create the conditions within which a learning organisation can begin to operate, with shared problem identification and solving and with the ability to capture and accumulate learning about technology and about management of the innovation process.