

# MANAGING RAPID DIFFUSION: THE CASE OF CELLULAR COMMUNICATIONS IN SOUTH AFRICA

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## ABSTRACT

South Africa has experienced extraordinarily rapid growth in the cellular communications industry, with subscriber numbers growing from zero to 5,3 million in the first six years since its introduction in 1994. Research was conducted to investigate the way in which the industry managed this rapid diffusion. The study highlighted the way in which the diffusion of cellular communication was managed, particularly through networks and linkages between hardware suppliers, network operators and service providers. The study has found that industry cooperation is the most important factor that drives rapid diffusion of new technology in a non-integrated industry such as the cellular communications industry in South Africa. The findings of this single-case study support propositions based on the innovation network theory.

## OPSOMMING

Suid-Afrika het buitengewoon vinnige groei in die sellulêre kommunikasiebedryf ervaar, en intekenaarsyfers het van nul tot 5,3 miljoen in die eerste ses jaar sedert die bekendstelling daarvan in 1994 opgeskiet. Navorsing om vas te stel op watter wyse die bedryf hierdie snelle verspreiding bestuur het is, gedoen. Die studie het gekonsentreer op die manier waarop die verspreiding van sellulêre kommunikasie bestuur is, veral deur middel van netwerke en skakeling tussen apparatuurverskaffers, netwerkkoperateurs en diensverskaffers. Die studie het bevind dat industriësamewerking die belangrikste faktor is wat vinnige verspreiding van nuwe tegnologie dryf in 'n nie-geïntegreerde nywerheid soos die sellulêre kommunikasiebedryf in Suid-Afrika. Die bevindinge van hierdie enkel-gevalstudie ondersteun proposisies gebaseer op die innovasie-netwerkteorie.

## **1. INTRODUCTION**

The cellular communications industry in South Africa was born in 1994. At that time one of the network operators made a projection of 250,000 subscribers in ten years. This projection was exceeded within two years. South Africa has experienced very rapid growth in the cellular communications industry, with subscriber numbers growing from zero to more than 18 million since its introduction in 1994. This prompts the question: What fuelled the extremely rapid growth of this industry? This study attempts to explain how diffusion has taken place and which factors influenced the growth.

The research question was investigated by conducting a case study as empirical verification of a theoretical proposition. In this case there was a preference for the "economic network model" as opposed to the "autonomous entity model". Given this preference, the aim was to find the most important variable governing the success of the chosen model. The variables associated with the "autonomous entity model" that were considered are board participation, corporate culture, technical expertise, organisational gatekeepers, industry structure, regulations, corporate research, technology transfer, technology conferences, expeditions, competing technologies, price, convenience and advertising. Factors in the network environment that were considered are outsourcing, long-term contracts, collaboration, joint ventures, partnerships and clusters.

## **2. THE CELLULAR COMMUNICATIONS INDUSTRY**

Cellular communication is currently a major sector in the local telecommunications industry. More than 5500 Vodacom base stations are in place to provide coverage to 60% of the geographical area of the country. Together the three GSM networks cover more than 71% of the population. People in previously under serviced areas are making over 35 million calls per month from Vodacom's 2135 community phone shops. Vodacom's network currently switches 30% of telephone volumes in South Africa and 10% of Africa's. Most of the urban areas and national roads in South Africa have GSM 900 coverage. The SA market is currently worth around SAR 45 billion [1].

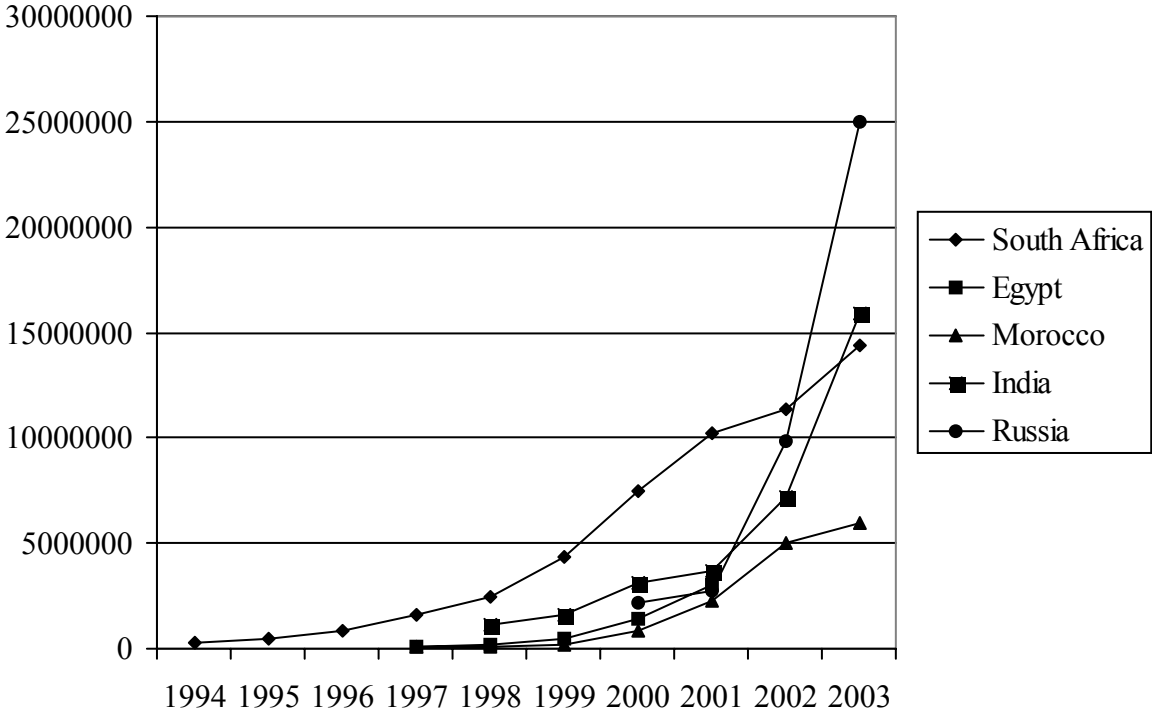
### **2.1 Rapid diffusion of cellular services**

Extremely rapid growth of cellular communications in terms of subscriber numbers has been observed in developing countries. Figure 1 shows the growth of cellular subscriber bases in a number of developing countries.

Gruber and Verboven [2] pointed out that in the cellular communications industry:

- Countries that adopt mobile telecommunications late have higher rates of diffusion than the first entrants to the market.
- Multiple entries of firms and an increased number of firms increase the rate of diffusion.
- Mobile telecommunications is a regulated industry with competition and entry of firms regulated by government giving licenses with respect to technology limitations, and
- Digital technology accommodates more subscribers which add to the rapid diffusion of technology.

The growth of the cellular communications industry in South Africa has been phenomenal. Since its introduction in 1994, the market size has grown to 18.2 million users (80% of these are active users) as of May 2004 and the potential market by 2006 is estimated to be 19 million users. The local market is dominated by Vodacom and MTN who operate at GSM 900 MHz. A license was awarded in June 2001 to the Cell C Consortium that went live on Nov 17, 2001. It operates at GSM 900 and 1800 MHz. Vodacom had 10m million users, MTN had 5.22 million users and Cell C had 3 million users as of May 2004. Market expansion is still rapid with over 9000 users signing up per day [1].



**Figure 1: Growth of cellular subscriber bases in developing countries.**  
Sources: Cellular Online [1], GSM World [3].

**2.2 Innovation in the cellular communications industry**

The cellular communications industry has been characterised by rapid and sustained innovation. Innovation has driven the growth of this industry. Product innovations have been fast and sustained since the first cellphones were introduced to the local market in 1994. Locally used cellphones are developed and manufactured overseas. Local innovations have therefore focussed on service innovations rather than product innovations.

In 1994 telecommunications shifted from a state monopoly to market dominated supply. In this year SATRA (South Africa Regulation Authority) awarded licenses to two cellular network operators in South Africa. Initially both network operators focused on increasing their subscriber bases. They started by providing services in the large cities. During the period 1994-1996, cellphones were only available on contract to creditworthy clients. A wide variety of service contract options is now available to different end-user groups, from business users

to low-income private users. Creditworthiness in this context meant that an end-user had to have a bank account and therefore be employed or at least earned an income over a certain amount. This limited the scope of the market to 30% of the South African population.

In 1996 the service providers introduced a service innovation - the prepaid service. This offered a starter pack and prepaid airtime to users already owning a cellphone. The use of second hand (and stolen) cellphones increased the growth of the subscriber base substantially. In 1998 an additional service innovation was introduced. This was called the “incomer” prepaid. The “incomer” enables calls to be received without making any calls. This opened up a new market, especially amongst school children.

Service providers have penetrated the market for users with very low income. School children from the age of five upwards are a significant component of this group. Network software was developed to create new packages popularly known as “call-a-lot” and “receive-a-lot”. Running costs of these packages are as low as R10.00 a month.

The South African cellular communications industry infrastructure was designed in a way that made mobile telecommunications very accessible to the end-user. Cellphones, starterpacks and airtime vouchers are available from a wide variety of outlets, ranging from dedicated cellphone shops to grocery stores. The prepaid vouchers are also available from coin-operated machines.

Service innovations have kept pace with product innovations as new features became available such as Short Messaging Service (SMS), WAP and many other innovations.

### **2.3 Structure of the cellular communications industry**

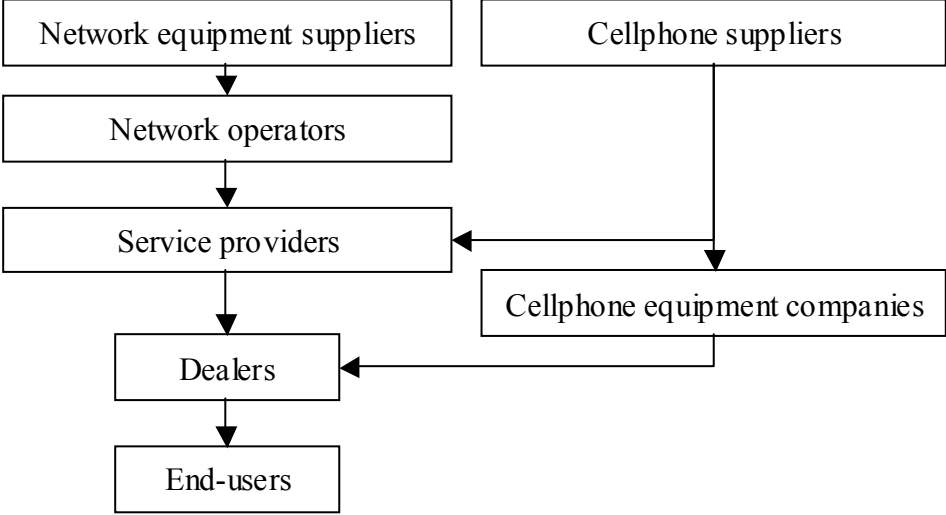
An integrated industry consists of self-contained firms that are engaged in all or most of the functions in the value-chain; that is to develop, produce and supply their products or services to the end-users. Non-integrated industries have specialised firms that are individually engaged in only one or a few functions in the value chain.

The cellular communications industry is a non-integrated industry consisting of a number of key role-players as shown in Figure 2. These are the network equipment suppliers, network operators, service providers, cellphone suppliers, cellphone equipment companies and dealers. Each has a distinct role in the industry:

- The *network equipment suppliers* supply network equipment to the network operators.
- The *network operators* provide and operate the telecommunications networks.
- The *service providers* provide the airtime and are responsible for setting up the dealership infrastructure.
- The *cellphone suppliers* supply the cellphones.
- The *cellphone equipment companies* distribute cellphones to the service providers
- The *dealers* sell the airtime and cellphones to the end-users. Service providers use departmental stores, cell-shops, grocery stores and many other types of outlets to sell to the end-users.

There are two possible routes for a cellphone to go from the supplier to the end-user. The first

is where the cellphone goes from the supplier to the service provider. The service provider adds value to the cellphone by supplying airtime. The cellphone and airtime package is then supplied by the service provider to a dealer. The dealer sells the package to an end-user. The second route is where the cellphone goes from the supplier to a cellphone equipment company, then to a dealer, and then to the end-user. The equipment companies buy cellphones from the suppliers in bulk.



**Figure 2: The Structure of South African Cellular Communications Industry**

There is a high degree of interdependence between the role players in the cellular communications industry. The role players are dependant on each other to introduce and diffuse the technology to the market. The cellphone suppliers depend on the service providers to promote and sell their handsets since they do not have direct access to the end-users. Similarly service providers need the appropriate cellphones from the manufacturers and the dealers to distribute their services to the end-users. As far as the introduction and diffusion of new innovations is concerned, service providers and cellphone suppliers are the two key role-players in this industry.

**2.4 Research problem and research questions**

The history of cellular communications in South Africa has been characterised by the successful introduction of frequent innovations and the rapid diffusion of the technology to a rapidly-growing subscriber base. This was achieved in a non-integrated industry where co-ordinated actions are required of a number of role-players. It is therefore a complex environment that presents many challenges to managers. The research questions that were addressed are the following:

- What are the main factors driving the rapid diffusion of new technology in the cellular communications industry?
- Is the relative importance of these factors different for the key role-players?

### 3. THEORETICAL FRAMEWORK

In this section the theoretical framework which was, used as the basis for the development of the research instrument (questionnaire) and for data analysis is presented.

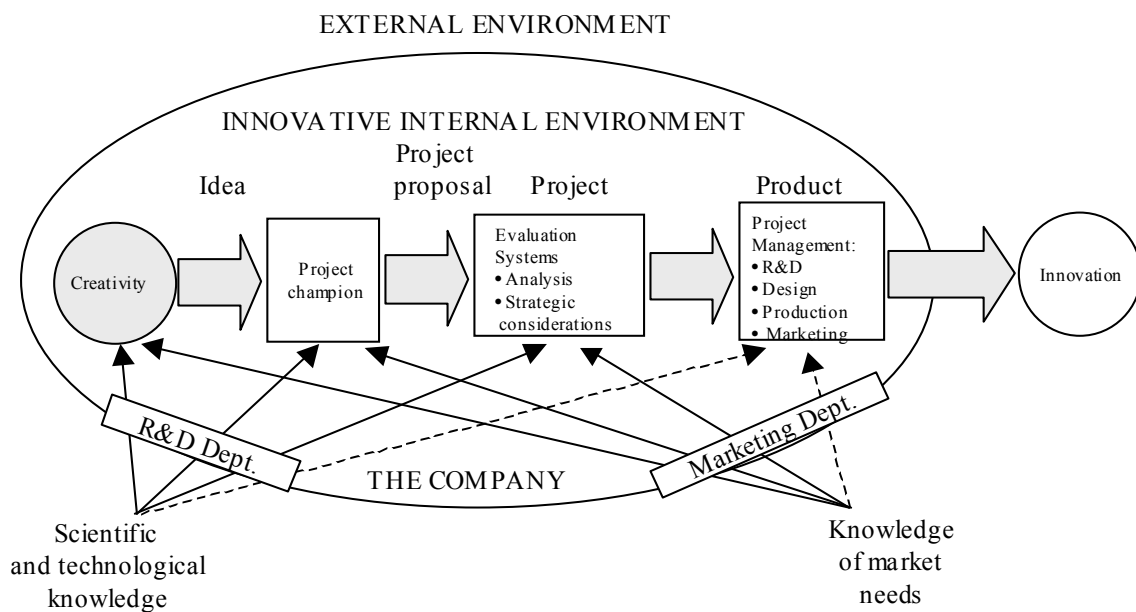
#### 3.1 Innovation and diffusion

Industrial innovation is defined as the introduction of new or improved products, services and production processes. Industrial innovation is widely accepted as the driving force of a nation's economic development and the improvement of the competitiveness of its firms (Freeman [4], Porter [5]). A technological innovation is considered to be successful when it has been adopted and diffused through the user population (Khalil [6]).

#### 3.2 Innovation management theories and models

##### 3.2.1 Organisational innovation management models

Organisational innovation management models view innovation management as an organisational process predominantly within the control of a single organisation. Such "autonomous entity models" are found in the work by Twiss [7], Betz [8] and Tidd, Bessant & Pavitt [9]. A typical model by Twiss [7] is shown in Figure 3. This model highlights four environments impacting on the innovation process: the internal environment, the external environment, the technological environment and the market environment. The rate of innovation and diffusion of innovations are driven by various factors within these environments.



**Figure 3: Organisational innovation management model by Twiss [7]**

Some of the factors driving innovation and diffusion in the internal environment that were considered in this study are board participation, corporate culture, technical expertise and organisational gatekeepers. Factors in the external environment that were considered are industry structure and regulations. Regulations are of importance since cellular communication is a regulated industry with competition and entry of firms regulated by government licenses. Factors in the technological environment that were considered are corporate research, technology transfer, technology conferences, expeditions and competing technologies. Factors in the market environment are price, convenience and advertising. Various advertising media were considered such as billboards, radio and newspapers.

A major shortcoming of most of the organisational innovation management models is that they assume that the innovating organisation is an autonomous entity that acts on its own. These models are therefore inadequate to analyse a non-integrated industry such as the cellular communications industry. The innovation and diffusion model has to deal with the extensive interaction between the role-players in such an industry as already described.

### 3.2.2 Innovation network theory

A significant new innovation theory is the "economic network model", especially as developed by Håkansson [10][11][12][13]. Håkansson and Snehota [14], Pyka [15] and Rigby [16] provide a new theory to analyse technological innovation, especially in non-integrated industries. Håkansson's economic network model contains three main elements: actors, activities, and resources. *Actors* perform activities and possess or control resources. The two main types of *activities* are transformation and transaction activities. Transaction activities link the transformation activities of the different actors. These exchanges result in the development of economic (network) relations between actors. There are several types of *resources*: physical (machines, raw material, components), financial, and human (labour, knowledge, relations). Furthermore, resources can be classified according to the degree of organizational control. In the case of internal resources the firm has a hierarchical control. External resource providers control external resources. As a consequence, resources are heterogeneous, i.e., their (economic) value depends on the other resources with which they are combined [17].

Network relations between actors can either be formal contractual relations or less-formal cooperative relations. The contractual relations factors driving innovation and diffusion in the network environment that were considered in this study are outsourcing and long-term contracts. The cooperative relations factors that were considered are collaboration, joint ventures, partnerships and clusters.

## 3.3 Propositions

Based on the fact that the cellular communications industry is a non-integrated industry and in the light of the innovation network theory, the following propositions are offered for consideration:

- Industry cooperation is one of the most important factors that drive rapid diffusion of new technology in a non-integrated industry such as the cellular telecommunications industry in South Africa.

- Whereas the relative importance of diffusion factors could be different for the different role-players, industry cooperation is one of the most important factors for the two key role-players.

#### 4. RESEARCH METHODOLOGY

This section contains a short discussion of the research design and methodology followed in the study, including the presentation and discussion of the data collected and analysed in the study.

##### 4.1 Research design

The research design for this study was a single-case study. The rationale for selecting this research design was that it represents a *critical test of a significant theory*. The study utilised empirical data collected by one of the authors in 2000 [18]. The data was collected by conducting structured interviews with a selected group of senior managers in two service provider organizations (Vodacom and MTN) and two cellphone supplier firms (Nokia and Ericsson).

##### 4.2 Research instrument

A structured questionnaire was designed to establish the relative importance attached to the innovation management factors that propelled the rapid diffusion of cellular communications. The design of the questionnaire was based on the theoretical framework and the respondents were asked to indicate the importance of the 22 factors identified in the previous section using a 4-point Likert scale (4 – Excellent/Very Good, 3 – Medium, 2 – Low, 1 – Poor).

##### 4.3 Data analysis

The mean ratings of the 22 factors by managers in the cellphone supplier firms and service provider organizations are shown in Table 1. Mean values for the seven main groupings are also shown in the table.

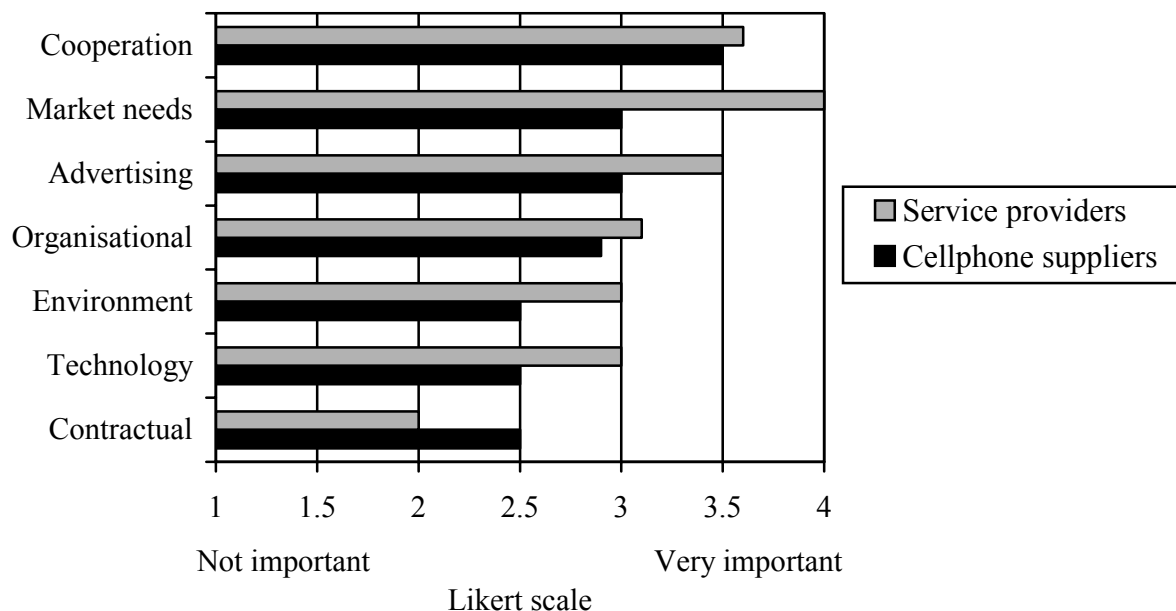
	Importance ratings (mean values)	
	Cellphone suppliers	Service providers
<b>Cooperation</b>	<b>3.5</b>	<b>3.6</b>
Collaboration	3.0	4.0
Joint ventures	4.0	3.5
Partnerships	3.0	3.0
Clusters	4.0	4.0
<b>Market needs</b>	<b>3.0</b>	<b>4.0</b>
Price	4.0	4.0
Convenience	2.0	4.0
<b>Advertising</b>	<b>3.0</b>	<b>3.5</b>
Billboard ads	3.0	3.0
Radio ads	2.0	3.5
Newspaper ads	4.0	4.0



<b>Organisational factors</b>	<b>2.9</b>	<b>3.1</b>
Board participation	2.5	3.5
Corporate culture	3.5	3.5
Technical expertise	2.5	2.5
Gatekeepers	3.0	3.0
<b>Environmental factors</b>	<b>2.5</b>	<b>3.0</b>
Industry structure	4.0	3.0
Regulations	1.0	3.0
<b>Technology factors</b>	<b>2.5</b>	<b>3.0</b>
Corporate research	2.5	3.0
Technology transfer	3.5	3.0
Technology conferences	3.5	3.0
Expeditions	1.0	2.5
Competing technology	2.0	3.5
<b>Contractual factors</b>	<b>2.5</b>	<b>2.0</b>
Outsourcing	3.0	2.0
Long-term contracts	2.0	2.0

**Table 1: Importance ratings of rapid diffusion support factors**

Figure 4 shows the mean ratings of the main rapid diffusion support factors of service providers and equipment suppliers.



**Figure 4: Importance ratings of main rapid diffusion support factors**

Figure 4 shows a clear correlation between the ratings of the two types of organizations. There is a high degree of correlation between the ratings (Spearman rank correlation

coefficient = 0.964), but due to the limited size of the sample it is not appropriate to test for significance. However, the rationale for a single-case study research design is not based on sampling logic but represents a *critical test of a significant theory* (See Yin [19], p.41).

Figure 4 shows that industry cooperation was judged to be the most important factor that drives rapid diffusion of new technology in the cellular communications industry in South Africa. The propositions that industry cooperation is one of the most important factors that drive rapid diffusion, and that this is the case for both of the two key role-players, are thus supported by the empirical data.

Figure 4 shows a very interesting pattern in terms of the importance of network relations. Contractual relations were judged the least important factor while cooperative relations are the most important factor driving innovation and diffusion in the cellular communications industry. Factors in the market environment such as price, convenience and advertising were awarded the second highest overall ratings. Market needs (price, convenience) received the highest rating by service providers.

Factors in the technological environment were considered relatively unimportant. This can probably be ascribed to the fact that most of the technology in this industry is procured from overseas. This could also be the explanation for the low rating of technical expertise amongst the organisational factors.

## 5. CONCLUSIONS

This study identified the main factors driving the rapid diffusion of new technology in the cellular communications industry. The main rapid diffusion support factors in order of priority as rated by the key role-players are cooperation, market needs, advertising, organisational factors, environmental factors, technology factors and contractual factors.

The study has found that industry cooperation is the most important factor that drives rapid diffusion of new technology in a non-integrated industry such as the cellular telecommunications industry in South Africa. The study also found a high degree of correlation between the ratings of the diffusion factors by service providers and cellphone suppliers, the two key role-players. The findings of this single-case study therefore support the propositions based on the innovation network theory, and can thus be seen as a critical test of this significant theory.

The findings have important implications for the management of innovation and diffusion in a non-integrated industry such as the cellular communications industry in South Africa:

- Managers should promote and foster industry cooperation by setting up appropriate cooperation mechanisms.
- In the interest of further rapid diffusion, the continuance of all the different types of cooperation is very important. However, cooperative relations such as collaboration, joint ventures, partnerships and clusters, are more important than contractual relations such as outsourcing and long-term contracts. The requirement is therefore for managers with less formal cooperative networking skills rather than formal contracting skills or technical expertise.

- Market initiatives and innovation such as the regular introduction of new or improved products and services, were drivers of rapid diffusion, and their continuance is therefore very important.

Generalisation of this study is limited by the fact that this is a single-case study. Questions that can be addressed in future studies are:

- Does the conclusion of this study hold for other non-integrated industries?
- Are there cases where diffusion has failed due to insufficient cooperation?

## 6. REFERENCES

- [1] **Cellular Online**, 2004. Latest African Mobile and Cellular Statistics, [www.cellular.co.za/stats/stats-africa.htm](http://www.cellular.co.za/stats/stats-africa.htm), visited on 15 June 2004.
- [2] **Gruber H. and Verboven F**, 2004. The diffusion of mobile telecommunications services in the European Union, <http://netec.mec.ac.uk/WoPEc/data/JEL/L1.html>, visited on 15 April 2004.
- [3] **GSM World**, 2004. Subscriber Statistics, <http://www.gsmworld.com/news/statistics/substats.shtml>, visited on 15 June 2004.
- [4] **Freeman C**, 1986. *The Economics of Industrial Innovation*. Massachusetts: MIT Press.
- [5] **Porter M E**, 1990. *The Competitive Advantage of Nations*. New York: MacMillan Press.
- [6] **Khalil T M**, 2000. *Management of Technology*. McGraw Hill, Boston.
- [7] **Twiss B C**, 1992. *Managing Technological Innovation*, 4th edition, Pitman.
- [8] **Betz F**, 1993. *Strategic Management of Technology*, McGraw-Hill.
- [9] **Tidd J, Bessant J and Pavitt K**, 1997. *Managing Innovation*, Wiley.
- [10] **Håkansson H (Ed)**, 1987. *Industrial Technological Development: A Network Approach*. London: Croom Helm. Håkansson H, 1989. *Corporate Technological Behaviour: Co-operation and Networks*. London: Routledge. Håkansson H, 1992. *Evolution Processes in Industrial Networks*. In: Axelsson B & Easton G (Eds.), *Industrial Networks: A New View of Reality*. London: Routledge. Håkansson H, 1993. *Networks as a Mechanism to develop Resources*. In: P. Beije, J. Groenewegen, O. Nuys, eds., *Networking in Dutch Industries*, pp. 207-223. Leuven/Apeldoorn: Garant/Siswo.
- [11] **Håkansson H and Snehota I (Eds.)**, 1995. *Developing Relationships in Business Networks*. London: Routledge.
- [12] **Pyka A**, 2002. *Innovation networks in economics: From the incentive-based to the knowledge-based approaches*. *European Journal of Innovation Management*. Bradford: 2002. Vol. 5, Iss. 3.
- [13] **Rigby J**, 2003. *Innovation Networks Theory and Practice*. *R & D Management*. Oxford: Nov 2003. Vol. 33, Iss. 5.
- [14] **Oerlemans L A G, Pretorius M W, Buys A J and Rooks G**, 2004. "Industrial Innovation in South Africa 1998-2000", University of Pretoria, ISBN 1-86854-520-2.
- [15] **Malebo L M**, 2000. *The Analysis of the Diffusion of Personal Telecommunications in South Africa*, Master of Science (Technology Management) Thesis, University of Pretoria.

- [16] **Yin R K**, 2003. Case Study Research Design and Methods. Third Edition, Applied Social Research Methods Series, Volume 5, SAGE Publications, Thousand Oaks, London, New Delhi, Newbury Park, CA.