

THE UTILISATION OF TECHNOLOGY IN ENTREPRENEURIAL ORGANISATIONS

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ABSTRACT

Over the past twenty years technology has advanced at a rapid pace, but this advancement has also coincided with a major, world-wide focus on entrepreneurial activity. A study was therefore launched to investigate the inter-relationship between entrepreneurial activity and technology utilisation in major organisations.

An organisational learning component was added to the entrepreneurial intensity construct, based on the results obtained from a literature study. A generalised technology blueprint was also developed for the entrepreneurial organisation of the 21st century. This blueprint was used as the foundation for the definition of the technology intensity construct that describes the degree to which technology is being made available and is being utilised to support organisational entrepreneurship.

An empirical study was subsequently launched to determine if a statistically significant correlation exists between entrepreneurial intensity and technology intensity within major South African organisations. The study revealed that a significant correlation exists between entrepreneurial intensity and technology intensity for the sample of South African organisations. A significant correlation between entrepreneurial intensity and organisational learning was also established, confirming the significance of organisational learning as a major business process in the entrepreneurial organisation of the future.

The study revealed that South African organisations place greater emphasis on the utilisation of technology to support the degree of entrepreneurial action, rather than utilising technology to identify new opportunities (as is indicated by a higher frequency of entrepreneurship). It is however proposed that greater emphasis should be placed on improving the frequency of entrepreneurship, as the empirical study revealed that the degree of entrepreneurship in the respondent sample is positively correlated to the frequency of entrepreneurship.

The importance of developing an integrated technology architecture, as is proposed in the newly developed technology blueprint for entrepreneurial organisations, has statistically been verified. Overall, it can be concluded that advanced technology, applied in an integrated environment, is a key enabler of entrepreneurial activity in organisations. Entrepreneurial organisations should therefore develop the ability and capacity to operate on the frontiers of technology to ensure competitiveness in the new competitive landscape.

DIE BENUTTING VAN TEGNOLOGIE IN ENTREPRENEURIESE ORGANISASIES

OPSOMMING

Tegnologiese ontwikkeling het gedurende die afgelope 20 jaar teen 'n hoë tempo toegeneem. Oor dieselfde tydperk het entrepreneuriese aktiwiteit ook toegeneem op 'n globale basis. 'n Studie is gevolglik geloods om die graad van die interverwantskap tussen entrepreneuriese aktiwiteit en tegnologie benutting in korporatiewe organisasies te ondersoek.

Die fasette van 'n lerende organisasie is geïdentifiseer vanuit 'n literatuurstudie en ingesluit as sleutel elemente in die definisie van entrepreneuriese intensiteit. 'n Generiese tegnologie bloudruk is vanuit die literatuurstudie ontwikkel om die voorgestelde tegnologiese infrastruktuur van entrepreneuriese organisasies in die 21^{ste} eeu te beskryf. Die voorgestelde tegnologie bloudruk vorm die basis waarop die konsep van tegnologiese intensiteit gedefinieer en gemeet kan word. Tegnologiese intensiteit beskryf die mate waartoe gevorderde tegnologie beskikbaar gemaak en benut word om intrapreneurskap te bevorder.

'n Empiriese studie is gevolglik geloods om vas te stel of 'n beduidende statistiese korrelasie bestaan tussen entrepreneuriese intensiteit en tegnologiese intensiteit in Suid-Afrikaanse organisasies. Daar is vasgestel dat tegnologiese intensiteit positief gekorreleer is met entrepreneuriese intensiteit vir die steekproef van Suid-Afrikaanse organisasies. Hierdie positiewe korrelasie is ook bevestig tussen entrepreneuriese intensiteit en die elemente van 'n lerende organisasie.

Daar kan dus afgelei word dat die vermoë om te leer 'n sleutel besigheidsproses sal verteenwoordig in die entrepreneuriese organisasie van die toekoms.

Die empiriese studie het ook aangetoon dat Suid-Afrikaanse organisasies meer klem lê op die benutting van tegnologie om die graad van entrepreneuriese aktiwiteit te verhoog, eerder as om tegnologie te benut om nuwe geleenthede te identifiseer. Die identifikasie van nuwe geleenthede word gereflekteer deur 'n toename in die frekwensie van entrepreneurskap.

Dit word aanbeveel dat organisasies eerder die frekwensie van entrepreneurskap moet verhoog, aangesien 'n positiewe korrelasie waargeneem is tussen die graad en die frekwensie van entrepreneurskap in die empiriese studie. Daar word dus verwag dat organisasies met 'n hoër entrepreneuriese frekwensie uiteindelik ook die graad van entrepreneurskap sal verhoog.

Die ontwikkeling van 'n geïntegreerde tegnologiese infrastruktuur, soos wat voorgestel word in die tegnologie bloudruk vir entrepreneuriese organisasies, is statisties bevestig. Die gevolgtrekking kan dus gemaak word dat gevorderde tegnologie 'n sleutel rol vertolk in die verhoging van entrepreneuriese intensiteit in organisasies. Entrepreneuriese organisasies moet gevolglik die vermoë ontwikkel om voortdurend op die voorgrond van tegnologiese ontwikkeling te bly, aangesien dit beduidende mededingende voordele kan skep in die toekoms.

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CHAPTER 1

NATURE AND SCOPE OF THE STUDY

1.1. INTRODUCTION

The past twenty years have been characterised by incredible technological advances, especially in the area of information technology and information management. The information revolution and its impact on businesses (and everyday life) are still receiving much attention at conferences, academic journals and business publications. At the same time the entrepreneurial revolution has gained tremendous momentum. Timmons (1999:3) refers to the new generation of entrepreneurs that has forever changed the economic and social structures of the world. The importance of entrepreneurship as a mechanism for economic prosperity is also advocated (Timmons, 1999:5).

The relationship between technological advancement and entrepreneurial action is evident, but many organisations still believe that the mere acquisition of advanced technology will provide avenues to competitiveness. The effective utilisation of advanced technologies by entrepreneurial organisations remains a question, which many company executives are battling with.

Chapter 1 provides the layout of the study, which was conducted to quantify the utilisation of modern technology to aid entrepreneurial processes in organisations. The objectives, as well as the reach of the study, will be detailed. An overview of the implemented research methods, as well as the limitations thereof, are also presented. Finally, a graphical presentation of the procedural structure of the study will also be presented.

1.2. PROBLEM STATEMENT

The importance of entrepreneurial organisations in the new competitive landscape has been well documented. Timmons (1999:4) refers to entrepreneurship as America's secret economic weapon. He also refers to the E-generation that created more than 95% of wealth in the current American economy (Timmons, 1999:4). There appears to be a direct link between the technology explosion and entrepreneurial activity in the American economy. The new competitive landscape forces organisations to identify new opportunities and invent new products, processes and services to gain competitive advantages, while technological advancements continuously redefine existing markets.

However, the strategic utilisation of advanced technology to gain competitive advantage remains a grey area. Companies engage in significant technology investments, hoping that the technology itself will provide a source of competitive advantage, but often these investments do not provide significant returns (Cooper, 1998). The ability to innovate is perceived as the essence of sustained competitiveness in the new competitive paradigm while the learning ability of an organisation is a direct result of entrepreneurial actions in an organisation (Sanderson, 1998).

Although entrepreneurial success has been linked to competitive advantage, the role that advanced technology can play in the creation and development of an entrepreneurial culture in an organisation has not been actively researched. The ideal technological infrastructure to support an entrepreneurial environment has also not been actively pursued. It is believed that a dynamic synergy between an entrepreneurial culture and a conducive technological environment can greatly improve an organisation's ability to be innovative and entrepreneurial, thereby improving its competitive position in the marketplace.

1.3. OBJECTIVES OF THE STUDY

The essence of the study is to determine how advanced technology can be utilised to support entrepreneurial activity in organisations. The study will therefore be focused on achieving the following objectives:

- Identification of the characteristics of entrepreneurial organisations.
- A general survey of the successful application of technology to support entrepreneurial actions in organisations.
- The definition of a generalised theoretical technology blueprint to support the entrepreneurial organisation of the 21st century.
- Determine if a statistical relationship exists between technology utilisation and entrepreneurial effectiveness in South African organisations.

It is hoped that the theoretical technology blueprint could serve as a roadmap to organisations that are interested in developing technology infrastructures capable of supporting innovation and ultimately competitive behaviour.

1.4. SCOPE AND REACH OF THE STUDY

Due to the generalised nature of the research topic, it is important to position the study in terms of the various functional areas of management science, as well as the geographical reach thereof.

1.4.1. Functional areas of management

The technology explosion in general, especially in the areas of information management and communication, is the direct result of entrepreneurial actions, but is also one of the primary drivers shaping the new competitive landscape in the business world (Hitt & Ireland, 1997). This interrelationship between

entrepreneurial activity and knowledge management automatically focuses the study within the following areas of management:

- Entrepreneurship
- The strategic management of information systems
- The strategic management of technology and innovation

The importance of entrenching the correct organisational culture to successfully manage any management intervention is a central focus of the study. Organisational behaviour is therefore an intrinsic part of the identified areas of management science that will be drawn upon in this study.

1.4.2. Geographical reach

An advanced technology infrastructure is currently a core characteristic of world class organisations. Therefore the theoretical boundaries of the study have to be drawn on an international scale, but the empirical analysis of the relationship between technology and entrepreneurial effectiveness will be approached from a South African perspective. The objective is to verify if technology effectiveness, as measured against a theoretical framework, can provide South African organisations with competitive advantages by actively supporting entrepreneurial competencies or by creating opportunities for organisational entrepreneurship.

1.5. RESEARCH METHODOLOGY

The following research method will be followed to determine the extent of the relationship between entrepreneurial activity and technology utilisation within organisations.

1.5.1. Literature study

A detailed literature study will be conducted, the main objectives being the following:

- Define global economic trends and the importance of corporate entrepreneurship within the new competitive environment.
- Determine the major characteristics of entrepreneurial organisations.
- Determine how the degree and frequency of corporate entrepreneurship can be measured.
- Examine practical examples of how advanced technology is currently applied to support entrepreneurial activity within organisations.

An international view will be applied to examine current entrepreneurial best practices and the application of technology within this environment. The information obtained will be utilised to define a generalised technology blueprint which entrepreneurial organisations can apply to support strategic entrepreneurial initiatives. The technology blueprint will provide a general implementation framework without focussing on detailed technicalities. The following aspects of advanced technology will be examined:

- Advanced communication technology (networks and infrastructure)
- Advanced manufacturing technologies
- Information technology (hardware, software, databases, networks and advanced automation technologies)
- The degree of integration required between these components to support corporate entrepreneurship.

1.5.2. Empirical research

The results of the literature study will be used to develop two sets of questionnaires, which will be distributed to South African companies to accumulate statistical data for correlation analysis.

The entrepreneurial intensity questionnaire will be used to determine the degree and frequency of entrepreneurial activity. An entrepreneurial intensity score will statistically be determined for each organisation. A technology questionnaire, measuring the utilisation and effectiveness of technology support for entrepreneurial activity within an organisation, will be distributed to the same target population of companies. The statistical results will be analysed to determine if a statistically significant correlation exists between entrepreneurial intensity and technology intensity within South African organisations.

1.6. LIMITATIONS OF THE STUDY

Technology is changing at a rapid pace, which makes it extremely difficult to predict what the technological infrastructure of an organisation should look like in the next five to 10 years. It will therefore be attempted to define a technology infrastructure based on existing technology. Multiple applications of technology in organisations exist, which widens the boundaries of technology application research. The study must therefore be pitched at the definition of a generalised infrastructure, which must integrate the value chain of the entrepreneurial organisation. Empirical research will also be conducted in South Africa – a country not known for technologically advanced organisations.

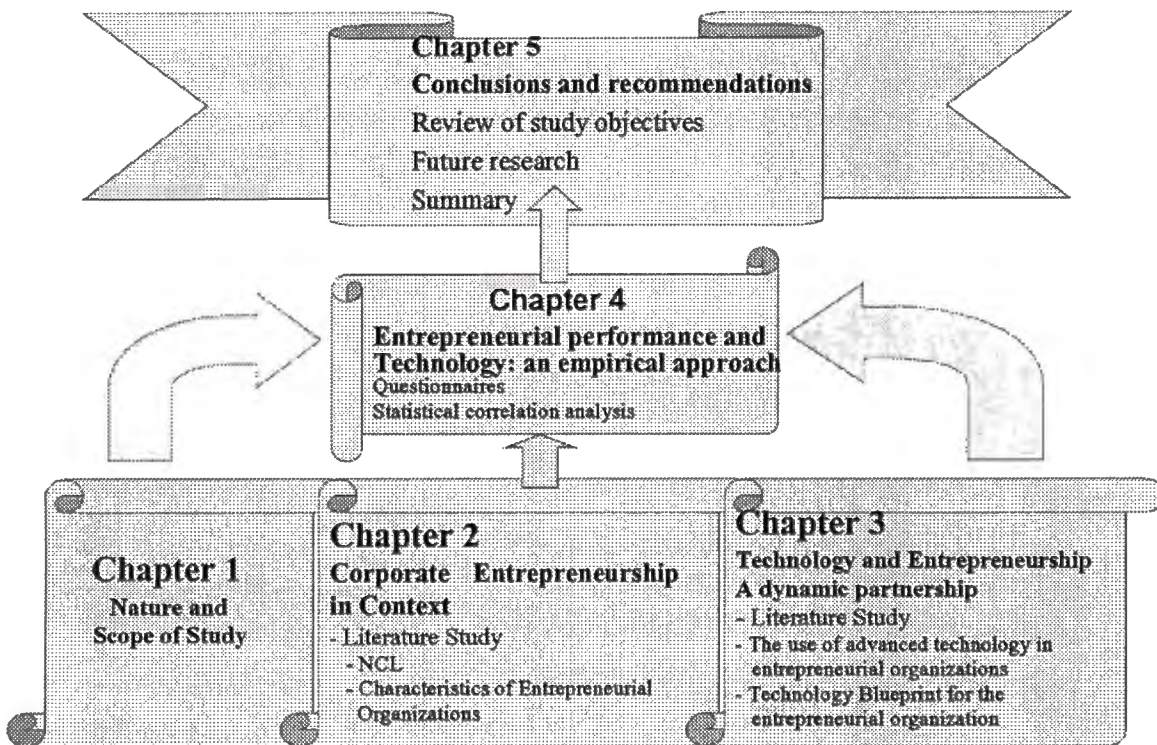
Due to time limitations it will also not be possible to expand the empirical survey as widely as possible, resulting in a smaller target population of organisations. The empirical results will therefore not be statistically representative of the South

African corporate environment, but it is expected that broad trends can be identified from the results.

1.7. LAYOUT OF THE STUDY

Figure 1.1 provides an overview of the interrelationships between the various sections of the study.

Figure 1.1: Layout of the study



Chapter 2 will focus on the new competitive environment in which organisations must compete, as well as the role and importance of corporate entrepreneurship in this new competitive landscape. The major characteristics of entrepreneurial organisations will be examined, as it will be used to develop a standardised questionnaire for measuring the entrepreneurial effectiveness of an organisation.

Chapter 3 will focus on the role of advanced technology in the new competitive environment, more specifically the role and utilisation of technology in entrepreneurial organisations. A theoretical technology blueprint for entrepreneurial organisations will be developed from literature and case studies. This blueprint will be used to develop a standardised questionnaire, which can be used to determine a technology intensity index for entrepreneurial organisations.

In chapter 4, the objectives and process for an empirical survey are developed. The purpose of the survey is to determine if a statistical correlation exists between entrepreneurial intensity and technology intensity in entrepreneurial organisations. The development of the entrepreneurial intensity and technology intensity questionnaires is also highlighted. A detailed account of the major results of the empirical study, as well as the discussion thereof, will be provided in this chapter.

Chapter 5 provides an overview of the major conclusions and recommendations that can be derived from this study. The major objectives of the study will be revisited to determine if they were successfully met. Future research areas, forthcoming from this study, will also be highlighted.

CHAPTER 2

CORPORATE ENTREPRENEURSHIP IN CONTEXT

2.1. INTRODUCTION

This chapter provides an overview of the major characteristics of entrepreneurial organisations. A generalised literature study was conducted to assess the importance of corporate entrepreneurship in the modern competitive business environment. The literature study was also aimed at identifying the major characteristics of entrepreneurial environments. The importance of these characteristics in achieving sustained competitive advantage within the new competitive environment was also investigated.

2.2. THE NEW COMPETITIVE LANDSCAPE

“eEnterprises conduct eCommerce in the eEconomy” (Melnicoff, 1999a)

A new competitive landscape is taking place in the economic world (Ireland & Hitt, 1997). This landscape is characterised by rapidly changing conditions and an ever-increasing unpredictability in the competitive pressures on organisations. The primary drivers of the business environment of the 21st century are the technological revolution and increasing market globalisation (Melnicoff, 1999a). Today, organisations must compete in an area of converging, yet rapidly changing technologies that require almost instantaneous responses to competitor actions (Ireland & Hitt, 1997).

The ability to produce goods and services of the highest quality, while incurring still lower manufacturing, distribution and service costs, is only regarded as entry level competencies in the modern business environment. We now live in an age

where anything can be produced and sold anywhere on the globe, which increases the degree of competition tremendously. The ability to innovate and implement innovation is regarded as a major basis of competitive advantage (Sanderson, 1998). Being able to "*think like the customer*" is viewed as the key source of competitiveness in the new competitive environment. It will enable organisations to respond to (and sometimes predict) changing customer needs and enable the utilisation of first mover competitive advantages (Sanderson, 1998).

Knowledge management will therefore be the key to strategic advantage and the basis of competitive success, as it will enable organisations to predict customer preferences, thus enabling them to be proactive with regard to product and process innovation (Baumgartner *et al.*, 1998). Entrepreneurial organisations are playing a major role in the definition of the business environment of the future, as these organisations are focusing on the identification or development of new markets, processes, products and services (Ireland & Hitt, 1997). Through careful consideration and analysis of ambiguous situations, entrepreneurial firms are able to isolate new product and process ideas, thus shaping industry conditions in their favour.

The abilities to innovate quickly and adapt to customer's changing demands are viewed as major characteristics on entrepreneurial organisations (Ahmed, 1998). The technological revolution has resulted in the convergence of computing, communication and intelligent control systems, which has spawned the electronic economy and forever changed the industrial economy paradigm (Melnicoff, 1999a). This technology explosion has created immeasurable opportunities for organisations that are competent to recognise and act on these opportunities. Entrepreneurial organisations are per definition focused on being proactive in the recognition of new opportunities, which will enable them to develop new products and markets through a process of managed innovation.

Corporate entrepreneurship should therefore be entrenched in organisational strategies and business practices. Peters and Waterman (1980:200) provide anecdotal evidence that more entrepreneurial organisations consistently exceed industry norms on key financial indicators. The importance of advanced technology in the new eEconomy is unmistakable, but technology should still be applied in an entrepreneurial context (Baumgartner *et al.*, 1998). This marriage between technology and entrepreneurial activity appears to be the determining factor between success and failure in the new competitive landscape.

2.3. CHARACTERISTICS OF ENTREPRENEURIAL ORGANIZATIONS

In order to isolate the characteristics of entrepreneurial organisations it is important to explore the underlying dimensions of entrepreneurship. Ireland and Hitt (1997) define entrepreneurship as the gathering and integration of resources to take advantage of identified opportunities. Morris and Sexton (1996:5) define entrepreneurship as *“the process of creating value by bringing together a unique package of resources to exploit an opportunity”*. Although various interpretations of the definition of entrepreneurship exist, there appears to be growing consensus that entrepreneurship is a behavioural process and is opportunity driven (Morris & Sexton, 1996:5).

Corporate entrepreneurship (or intrapreneurship) is defined as *“the development of a spirit of entrepreneurship within and existing organisation”* (Hisrich & Peters, 1992:537). Dess and Lumpkin (1997) define an entrepreneurial organisation as one that *“engages in product market innovation, undertakes somewhat risky ventures and is first to come up with proactive innovations, beating competitors to the punch”*. They introduce the concept of entrepreneurial orientation to define a framework for researching entrepreneurial endeavours.

They also define an entrepreneurial orientation as key entrepreneurial processes that answer the question of how new ventures are undertaken, while entrepreneurship refers to the content of entrepreneurial decisions by addressing what is undertaken. The major components of an entrepreneurial orientation are the following:

- Innovativeness
- Risk taking
- Proactiveness
- Competitive aggressiveness

Morris and Sexton (1996:6) also identify the ability to innovate, the propensity towards risk-taking and proactive competitive behaviour as the key dimensions of corporate entrepreneurship. They introduce the concept of entrepreneurial intensity, which is a linear combination of the frequency and degree of entrepreneurship practised by an organisation. Hisrich and Peters (1992:38), as well as Ireland and Hitt (1997), also identified these elements as major components of corporate entrepreneurship.

The ability to manage knowledge via the process of organisational learning is also identified as a key dimension of entrepreneurial intensity (Sanderson, 1998). The profound impact of organisational learning on the entrepreneurial capabilities of organisations is confirmed by Sanderson (1998). These key components of entrepreneurship will be examined in more detail to provide insights into the key characteristics of entrepreneurial organisations.

2.3.1. Innovative marketing capabilities

Cooper (1998) acknowledges the crucial role that innovation plays in securing sustained competitive advantage, as most organisations seek to distance

themselves from the competition by developing new products, processes, services and procedures. Innovation is viewed as a continuous process, which is measured in terms of the deviation of an entrepreneurial concept from what is currently available on the market (Hisrich & Peters, 1992:39). Cooper (1998) identified the following dimensions of innovation.

◆ Types of innovation

Product innovation is the most noticeable outcome of entrepreneurial action and reflects the organisation's ability to develop new products or new combinations of features in existing products. It is regarded as the key entrepreneurial activity, since it reflects a market-orientated approach, which is paramount to remain competitive (Hisrich & Peters, 1992:39). Process innovation is defined as "*finding new and better ways to accomplish a task of function*". It involves changes to production processes, distribution processes, sales and marketing programs, purchasing techniques and improvements to administrative systems.

Process innovation can be a major source of competitive advantage (especially in established firms operating in mature industries), since it usually results in lower costs, faster delivery, improved quality and improved customer service (Cooper, 1998). Service innovation involves the development and improvement of customer service delivery systems, i.e. auto tellers and drive through restaurants. Technological innovation is encompassed in both product innovations and process innovations and will not be described as a separate dimension of innovation (Cooper, 1998).

◆ Degree of innovation

Innovations can be classified as incremental or radical, depending on the degree to which the underlying technology structure or organisational business

processes must be altered to accommodate the innovation. Innovations entail risky departures from existing business practices and markets as it becomes more radical or competence destroying (Cooper, 1998). It is therefore clear that the process of innovation encompasses activities across the entire value chain of the organisation and that it involves significant risks as it becomes more radical in nature.

◆ Key factors of innovation success

Ahmed (1998) identifies the following keys to innovation success:

- Effective linkages with suppliers, customers and external institutions and bodies of knowledge.
- Effective intra-firm communication across functional towers.
- A market orientation.
- Synergy between product development and technology to improve time to market.
- Strong top management leadership to entrench a culture of innovation and risk-taking in the organisation.

2.3.2. Risk-Taking

Risk-taking involves the willingness of an organisation to pursue opportunities that have a reasonable likelihood of producing losses or significant performance discrepancies (Hisrich & Peters, 1992:38). It does not imply that entrepreneurship involves reckless decision making, but rather, a calculated awareness of the risks involved in the process. It is reflected in the resource allocation decisions, as well as the targeted markets, products and services in which an organisation wishes to compete. Entrepreneurial organisations should therefore exhibit calculated risk-taking abilities.

There exists a direct relationship between risk-taking and innovation. The risk of losing market share is high if the degree of innovativeness in an organisation is low. The business risk associated with a high degree of innovativeness (discontinuous innovation) is also high, as the market might not accept new products. The objective is to actively manage the innovation process via calculated risk-taking by engaging more often in entrepreneurial activities (Hisrich & Peters, 1992:38).

2.3.3. Proactiveness

Morris and Sexton (1996:6) define proactiveness as "*doing whatever is necessary to bring an entrepreneurial concept to fruition*". According to Dess and Lumpkin (1997) proactiveness suggests a forward-looking perspective of a leader in the marketplace that has the foresight to act in anticipation of future demand, thereby shaping the business environment by introducing new products and technologies. Hisrich and Peters (1992:39) suggests that proactiveness can be operationalized in terms of an organisation's ability:

- To seek new opportunities that may or may not be related to current operations.
- To introduce new products and brands well ahead of the competition.
- To strategically eliminate operations that are in a declining stage of its lifecycle.

Proactiveness therefore refers to an organisation's ability to relate to market opportunities by seizing initiative and leading the marketplace. It therefore involves taking the initiative in an effort to shape the market environment to one's own advantage. Proactiveness is thus a reflection of an organisation's ability to

respond to opportunities across all activities of the value chain. Proactive organisations therefore emphasise growth, innovation and a market orientation.

2.3.4. Competitive aggressiveness

Dess and Lumpkin (1997) defines competitive aggressiveness as the intensity of an organisation's efforts to outperform industry rivals. It is characterised by strong offensive behaviour to dominate markets and may also be reactive to protect existing market share. Competitive aggressiveness therefore constitutes a response to competitive threats and a reaction to competitive trends that already exist in the market place (Dess & Lumpkin, 1997). Competitive aggressiveness is manifested in competitive actions, e.g. cost leadership, aggressive marketing and product diversification.

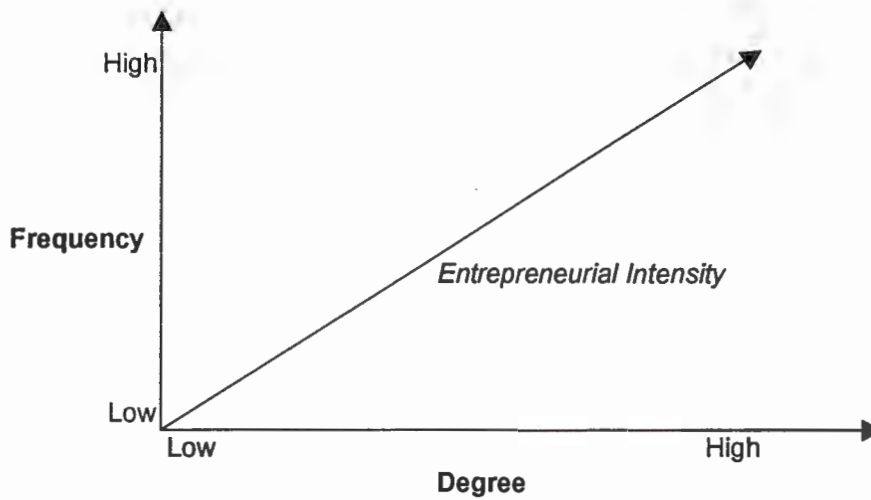
2.3.5. Entrepreneurial intensity

The variable nature of each of the above mentioned dimensions of entrepreneurship suggests that degrees of entrepreneurship is possible and that entrepreneurship occurs in varying degrees (Hisrich & Peters, 1992:42). Organisations can therefore be characterised in terms of both the degree and amount of entrepreneurship they produce, in short their *entrepreneurial intensity* (Morris & Sexton, 1996:6).

Entrepreneurial intensity is thus a linear combination of the degree to which organisations are innovative, risky, proactive and competitively aggressive and the frequency with which entrepreneurial events occur. This linear relationship is depicted in figure 2.1. Figure 2.2. emphasise the various classes of entrepreneurial organisations, based on the degree and frequency of entrepreneurial actions that these organisations undertake.

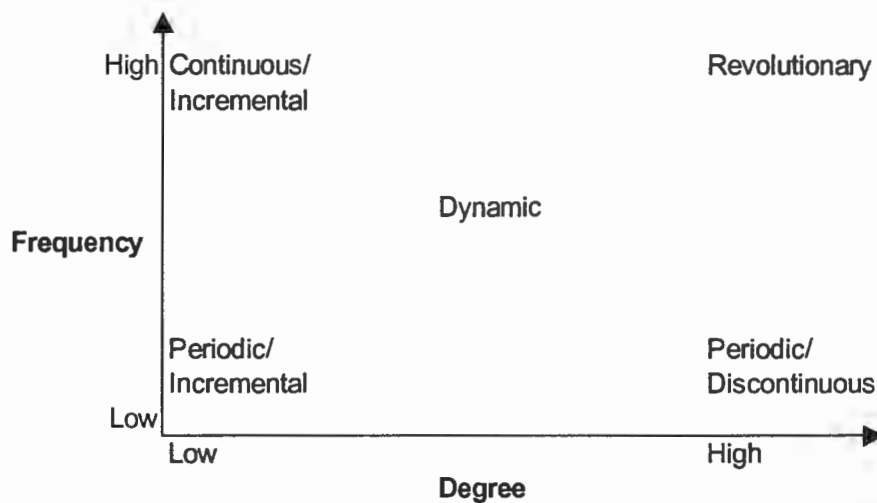
Both figures suggest that the dynamic organisation will balance both components of entrepreneurship to maintain entrepreneurial momentum, but that a truly revolutionary organisation will be characterised by a high entrepreneurial intensity score. The ability to continuously develop new products, services, markets and so forth is indicative of a highly entrepreneurial organisation.

Figure 2.1. The variable nature of entrepreneurship



Source: Morris and Sexton, (1996:7)

Figure 2.2. The entrepreneurial organisation continuum



Source: Hisrich and Peters, (1992:44)

The frequency of entrepreneurship can therefore be measured in terms of the number of process, product or service innovations, which were introduced over a specific period of time. The degree or extent of these innovative actions can be measured in terms of the extent to which it changed procedures, processes of products within the organisation and the marketplace. However, the degree of entrepreneurship within an organisation is also dependent on the extent to which an entrepreneurial culture is maintained within the organisation.

2.3.6. Entrepreneurial culture

The new idea either finds a champion or dies...No ordinary involvement with a new idea provides the energy required to cope with the indifference and resistance that major technological change provokes...Champions of new inventions display persistence of heroic quality – Edward Schon, MIT

It is difficult to be an intrapreneur, especially if the corporate environment does not support entrepreneurial action. Hisrich and Peters (1992: 547) concludes that large corporations must catch the “*entrepreneurial fever*” to simulate the same entrepreneurial spirit that exists in small entrepreneurial firms. It is viewed as a critical component of product and process innovation. Stuart and Abetti (as referred to by Morris and Sexton, 1996:7) examined a variable they termed “*organic emphasis*” to describe the extent to which a firm’s internal environment and culture are innovative, opportunistic and risk-taking. They also defined “*entrepreneurship level*” as the degree to which the top management of an organisation demonstrated entrepreneurial characteristics.

Hisrich and Peters (1992: 538) defines an intrapreneurial culture as one where visions, goals and action plans are developed, actions are rewarded, experimentation and creativity is nurtured and intelligent failure is also rewarded. Intrapreneurs are expected to take ownership and responsibility for their actions,

thereby stimulating them to create something new. Mentors and project champions (mostly senior members of the organisation) are appointed to coach entrepreneurial teams and streamline entrepreneurial efforts. The essence of an entrepreneurial culture is the commitment of senior management to pursue identified business opportunities and the willingness to take calculated risks in pursuing these opportunities. Table 2.1. summarise the major characteristics of an entrepreneurial environment:

Table 2.1. Characteristics of an entrepreneurial environment

Category	Characteristics
Strategic orientation	<ul style="list-style-type: none"> Top management is opportunity focused and take controlled risks Market leadership Entrepreneurship is part of corporate vision – a long term approach
Organisational structures	<ul style="list-style-type: none"> Functional structure – grouped by skill Multidisciplinary teams in flat matrix structures to promote cross-functional communication Authority is delegated to the lowest functional level Mentorship programs
Development approach	<ul style="list-style-type: none"> Operate on the frontiers of technology Top management encourage new ideas and experimentation and support it via resource allocation Intelligent failure is nurtured Project champions to provide entrepreneurial direction
Reward systems	<ul style="list-style-type: none"> Flexible, equity based reward system for intrapreneurs - based on achievement of goals

It is therefore impossible to determine the level of entrepreneurship (or entrepreneurial intensity) of an organisation without evaluating the corporate

culture and climate thereof. The degree of entrepreneurship is thus strongly related to the entrepreneurial culture of an organisation.

2.3.7. Organisational learning

In times of drastic change, it is the learners who inherit the future. The learned usually find themselves equipped to live in a world that no longer exists – author unknown.

Entrepreneurial organisations are seeking to improve existing products and services and innovate. This has resulted in plethora of initiatives, such as total quality management, business process re-engineering and many others. Experience has showed that these initiatives, by themselves, are often not successful (David Skyrme Associates, 1999). Something more is needed to:

- cope with a rapidly changing business environment.
- provide organisational flexibility to adapt to the changing environment.
- allow organisational members to innovate, based on customer needs.

Peters (as referred to by David Skyrme Associates, 1999) advocates that organisations must develop a capacity for fast-paced innovation by learning to embrace change. He concludes that the need to develop mechanisms for continuous learning and innovation is greater than ever. Garvin (as referred to by Anon., 1999) defines the learning organisation as *“an organisation skilled at creating, acquiring and transferring knowledge, and modifying its behaviour to reflect new knowledge and insights”*. Ross *et al.* (as referred to by David Skyrme Associates, 1999) defines the learning organisation as *“the continuous testing of experience, and the transformation of that experience into knowledge – accessible to the whole organisation and relevant to its core purpose.”*

Sanderson (1998) concludes that organisational learning is the key to innovativeness and that the learning organisation has to be an entrepreneurial organisation. Organisational learning per definition implies the ability to manage knowledge and intellectual capital successfully within organisational context. Boydell *et al.* (as referred to by Skyrme, 1999) proposed that *“the learning organisation facilitates the learning of all its members to continually transform itself.”*

Organisational learning should therefore be a key business process within entrepreneurial organisations, as it will enhance their ability to adapt to their changing external environment and continually enhance their capability to change via the process of collective and individual learning. The argument of de Gues (as referred to by David Skyrme Associates, 1999) that *“learning is the only sustainable competitive advantage”* appears to hold water. It refers directly to the ability of an organisation to anticipate and adapt to change via the process of entrepreneurship. David Skyrme Associates (1999) identified the following characteristics of a learning organisation.

◆ Learning Culture

The organisation has a future, external orientation by developing an understanding of their environment. External experts and consultants are widely used. The learning culture is characterised by a free exchange and flow of information via the networking of individuals across inter-organisational boundaries, as well as the development of external networks with customers and suppliers. Top management support learning at all levels of the organisation, as well as reward it. The notion of learning from mistakes is encouraged by top management, as long as it is intelligent learning. Mostly people are valued for their intellectual capital and their ability to be creative. Again the overlap between a learning culture and an entrepreneurial culture is very apparent.

◆ Tools and techniques

Learning organisations utilise methods that aid individual and group learning, such as creativity and group learning. Business processes, that encourage interaction across all boundaries, are developed. This includes infrastructure (information and communication systems) and management processes (i.e. participation, brainstorming).

◆ Key management processes

Management actively partakes in strategic and scenario planning to predict responses to changes in the competitive environment. Competitor analysis is a key management process, as it keeps the organisation in touch with its external or market environment, especially with regard to technological developments. Information and knowledge management is the basis from which information can be exploited as a key resource in the organisation. It is therefore regarded as a key business process in the learning organisation.

Reward and recognition systems recognise the acquisition of new skills, but is also used as a tool to strengthen the intellectual capital of the organisation. Capability planning involves a continuous evaluation and development of the competencies within the organisation to ensure future competitiveness.

2.4. SUMMARY

From the literature study it was established that organisational entrepreneurship is a key requirement for competitiveness in the new competitive environment. It is imperative to isolate the key characteristics and business processes of entrepreneurial organisations to evaluate the application and utilisation of technology therein.

The key dimensions of entrepreneurship, namely innovativeness, risk-taking, proactiveness and competitive aggressiveness were isolated and defined in a business context. It was concluded that the entrepreneurial nature of an organisation could be quantified in terms of the frequency and degree of entrepreneurship, which constitutes entrepreneurial intensity.

It was also established that a strong entrepreneurial culture is required for successful entrepreneurial activity, as measured by the degree of entrepreneurship in the entrepreneurial intensity construct. The key dimensions and characteristics of an entrepreneurial culture were also isolated.

It was determined that organisational learning is a key business process that supports entrepreneurial activity, especially the strategic ability to innovate. The key characteristics of the learning organisation were identified, including the importance of developing a learning culture to facilitate organisational learning and ultimately entrepreneurial activity.

The literature study verified that entrepreneurship has a direct influence throughout the organisational value chain and that it is the competitive lifeline of the modern organisation. A logical framework, that can be applied to evaluate the application and utilisation of advanced technology in the entrepreneurial organisation, has been determined. This framework will be applied to develop generalised technology blueprint for the entrepreneurial organisation of the 21st century.

CHAPTER 3

TECHNOLOGY AND ENTREPRENEURSHIP: A DYNAMIC PARTNERSHIP

3.1. INTRODUCTION

One of the characteristics of entrepreneurial organisations is the ability to operate on the frontiers of technology (see table 2.1.). But how do entrepreneurial organisations utilise advanced technology to support and, in many instances, spark entrepreneurial activity? Can technology play a significant role in improving an organisation's ability to be innovative, proactive, aggressive, as well as its ability to learn? Is there an ideal technology infrastructure that can be developed to encourage and support corporate entrepreneurship?

A literature study was conducted to review the application of technology throughout the organisational value chain and to investigate its impact on an organisation's ability to be entrepreneurial. The study also focused on identifying the key technology components, which are required integrate the identified technologies throughout the value chain. It was attempted to develop a technology blueprint for entrepreneurial organisations, based on the results of the technology literature study. The major outcomes of the study are reviewed in this chapter.

3.2. TECHNOLOGY – AN INTEGRATED OVERVIEW

“Technology, properly applied, can be used as a source of sustainable advantage to develop new products better, provide effective modelling tools to maximise revenues and profits, and create operating efficiencies” Rai (as referred to by Lynn *et al.*, 1999)

Chang (1997) defines technology as the “*cumulative sum of the organisation's knowledge and ability to produce quality goods and services*”. He concludes that technology is the key ingredient which multinational organisations utilise to adapt in the new competitive landscape, i.e. their ability to improve entrepreneurial actions. Information processing capability is viewed as the key to manage this adaptation process on a continuous basis. The following strategies are adopted by entrepreneurial organisations to remain competitive in the new competitive landscape:

- The formation of strategic alliances
- Innovative marketing
- Product and process innovation
- Global logistics

Technology should therefore be evaluated in context of its ability to support and integrate these adaptive strategies. The technology infrastructure should facilitate the successful accumulation of integrated knowledge about global business operations; i.e. integrated design, development, production and marketing. Chang (1997) suggests that technology integration will be the biggest determinant of innovation success, as it will facilitate the ability to create, develop and transfer knowledge within a global networked environment. It is thus evident that technology should not be viewed in isolation, but rather as a means of integrating the global business environment, as this is the key to effective corporate entrepreneurship.

3.3. TECHNOLOGY AND THE VALUE CHAIN

Successful intrapreneurship is only accomplished if the various processes in the organisational value chain can be integrated. It was therefore decided to

evaluate the application of advanced technology throughout the various segments of the value chain, as well as the role it plays in the enhancement of intrapreneurship. Specific emphasis was placed on innovative marketing, product and process innovation and global logistics:

3.3.1. Innovative marketing

“Firms that understand their customers’ problems, needs and wants, which can provide solutions to these problems, which can communicate those solutions to their target audiences and which can provide easy customer ordering will likely win the market place” (Lynn et al., 1999)

Fisher and Reuber (1995) view a market orientation as a key component of an entrepreneurial orientation and subsequently organisational performance. They propose that a market orientation is directly related to successful new product development and innovation in large organisations. Firms with advanced technology capabilities are also more likely to become market pioneers. Lynn *et al.* (1999) concludes that a market-orientated organisation has the best potential for success under any set of competitive environmental conditions. The following components of a market orientation have been proposed:

◆ Customer orientation

Emphasis is placed on the preferences, needs and wants as a basis for product innovation. Customer service is paramount to marketing success and is measured by various marketing tools, i.e. customer surveys and customer preferences tests.

◆ Competitor information

Effective analysis of competitor information is the key to being proactive and competitively aggressive in the market place, as it enables the organisation to achieve first mover advantages and target niche market more effectively.

◆ Intra-organisational communication

Communication transfer between functional units within the organisation (especially between marketing, manufacturing, and research and development) is regarded as the key to effective product innovation. The frequency of communication with partners, especially on the supply side of the value chain, has a substantial influence on process innovation capabilities and therefore customer satisfaction.

Lynn *et al.* (1999) refer to new marketing technologies that enable any organisation (large and small) to become market orientated due to substantial reductions in the cost of information technology. By using the Internet for global advertising and market research, low-cost electronic mail to communicate with customers and suppliers and mobile technologies (cellular telephones and mobile computers) for order-taking and field sales, organisations are now able to establish a global marketing presence at substantially lower costs. They define 2 major categories in which new marketing technologies can be divided.

➤ Web technologies

The World Wide Web (WWW) has caused a revolution in the way market research is being conducted. The Web provides an efficient channel for advertising, marketing, distribution and information services, but is far less costly. Verity and Hof (as referred to by Lynn *et al.*, 1999) concluded that it may

be up to 25% less costly to conduct direct marketing through the Internet than through conventional channels. The World Wide Web certainly increases the availability and reduces the cost of market information. Web technologies therefore enable organisations to be entrepreneurial by providing opportunities for electronic communication with customers and with obtaining information about customer preferences and attitudes via web-enabled market research, advertising and e-mail.

Gilbert *et al.* (1999) examined the use of the Internet as a relationship-marketing tool in the hotel industry. They defined relationship marketing as a “*customer centred approach whereby a firm seeks long-term business relations with prospective and existing customers*”. They claimed that web-based relationship marketing allowed the hotel industry to identify more about customer preferences through database analysis, improved customer knowledge about companies and helped hotels to improve products and services via the use of customised, online questionnaires. They conclude that the Internet is the most effective medium to interact with customers on a global scale.

➤ Internal services

Internal services refer to the processes that enable communication with internal company personnel and suppliers. The use of Intranets for internal communication, laptops for customised selling and cellular telephones for field sales, are improving the organisation's ability to be market orientated. Standardised software, or groupware (i.e. Lotus Notes, MS Office) is important to enable internal, client and supplier communication via the use of integrated Intranets and extranets. Multimedia (i.e. video conferencing and teleconferencing) is also used extensively to facilitate collaboration amongst organisations, enabling them to develop products and innovations quicker, thereby utilising first-mover advantages.

The key to successful market innovation is therefore the provision of a technology framework in which all the above-mentioned marketing technologies can be integrated into the entire business process.

3.3.2. Virtual logistics

Globally the physical logistics infrastructure is becoming more and more congested as the demand for goods and services continue to grow. Consumers expect goods and services to be delivered as conveniently as possible to avoid the physical constraints and frustrations of an overcrowded transport infrastructure (Crowley, 1998). He implies that consumer demand has to be accommodated on existing networks through increased levels of operational inefficiency by:

- absorbing delays on chosen routes (i.e. accepting higher transit costs).
- re-routing to indirect routes, resulting in higher transit costs.
- changing to inferior destinations.
- postponing travel to off-peak times, resulting in increased waiting/inventory.
- not travelling at all.

The incredible advances in communication technology has however resulted in possibilities for substituting physical mobility with electronic, or virtual mobility (Crowley, 1998). E-mail is substituting telephone conversations, printed paper mobility and various types of meetings (on-line collaboration). The Internet is substituting traditional forms of marketing and service-product distribution; i.e. holidays and conferences can be booked by using a combination of telephone, Internet and credit card systems. The convergence of telecommunication

technology and the physical transport system is culminating in the following entrepreneurial actions.

◆ Office innovation

Telecommuting (the substitution of virtual for physical commuting) is resulting in workers communicating with places of employment from home via information-communications technology (ICT), thereby reducing their need to travel to a central place (Kinsman, as referred to by Crowley, 1999). ICT is therefore resulting in the development of the virtual office concept, which allow employees to work from home, saving time and resulting in lower costs, due to:

- less fixed asset capital investment in office space and equipment;
- improved worker flexibility (especially for part-time contractors); and
- improved worker effectiveness, due to less stress and a reduced tendency to unionise.

The mobile office can however result in lower organisational effectiveness, due to a reduction in direct control over employees and issues of corporate culture and employee loyalty. Organisations also regard information as a strategic resource, resulting in concerns about information security and loss of intellectual property. ICT advances raise possibilities of partial telecommuting, which allows a worker to be physically at work for the “core attendance” components and do “information processing” from home. Advances in Multi-media technology (i.e. video conferencing) support this notion to an even greater extent.

Crowley (1999) reports that Rank Xerox encouraged employees to set up home-based limited companies, continuing to work for the company on a network contract basis. Xerox reported significant entrepreneurial successes of these home-based former employees. He claims that 12% telecommuting penetration

in Southern California has resulted in a 32% reduction in freeway congestion. *PC Week* (as referred to by Crowley: 1999) has found that 64% of the Fortune 1000 companies in the U.S.A. have implemented telecommuting programs, claiming reduced costs, improved productivity and a general increase in employee morale.

◆ Value chain integration

Developments in information technology have changed freight logistics completely (Crowley, 1999). Information technology has resulted in an integration of product supply chains via the use of enterprise resource planning systems (ERP). This is reducing inventory and costs, culminating from proactive inventory management. All the activities in the value chain (from raw materials procurement to the final distribution of products) are vertically integrated. In this scenario the firms along the value chain become partners, with information flowing freely between them to reduce uncertainty and the need for buffer volumes between the various production stages.

Standardised technology platforms and databases (i.e. ERP systems), which are electronically linked via TCP/IP networks (local area networks, Intranets, extanets and the World Wide Web) have resulted in tightly synchronised operations and distribution activities. These standardised information platforms are facilitating electronic data interchange (EDI) on a global scale, which results in the optimisation of the information/inventory relationship. Entrepreneurial organisations are therefore building technological capabilities in which information can substitute inventory.

It has resulted in the evolution of new organisational formats (virtual organisations) which are tightly integrated to improve product quality and delivery reliability and ultimately overall competitiveness. Technology

advancements are therefore blurring the distinction between manufactured produce and service delivery, as modern consumers are defining products as *“the combination of product quality and service delivery – on time at the correct location in the correct quantities”*. Entrepreneurial distribution organisations are realising that advanced technology offer various opportunities to innovate and be proactive, including the following (Crowley, 1999):

- Direct distribution from electronically triggered warehouses to home delivery services, thereby bypassing retailers.
- The utilisation of artificial intelligence systems to manage routes and load optimisation per vehicle, resulting in reduced costs via optimised transport network utilisation.
- The provision of links between customers and suppliers at various points in the value chain to minimise inventory.
- Value adding distribution, where the distribution organisation plays an integral role in the final stages of the production process to provide flexibility of destination choice, delivery timing and product presentation.
- Real-time delivery space booking, automatic monitoring of consignment status and automatic delivery confirmations.
- Onboard Transaction processing and information management facilities to improve distribution effectiveness.

Entrepreneurial organisations realise that a new equilibrium is evolving between physical and virtual mobility and that advanced information technologies play a critical role in the effectiveness of overall customer service delivery. The challenge lies in the integration of physical and virtual mobility paradigms via the development of standardised, integrated technology platforms, which integrate all the functions of the organisational value chain.

3.3.3. Manufacturing

Hisrich and Peters (1992:546) advocate that the utilisation of technology is imperative for the establishment of an entrepreneurial culture in an organisation. They identify manufacturing as the most critical area for change if intrapreneurship is to flourish. The drive towards flexibility, just-in-time delivery, and quality have resulted in manufacturing concepts, such as agile manufacturing, computer-integrated manufacturing and the vision of the virtual factory. The modern trends in manufacturing emphasise a simplification of shop-floor operations and electronically linking plant operations with all other aspects of the organisation, thereby creating a dynamic, responsive manufacturing environment. They identified the following characteristics of a responsive factory (see table 3.1.):

Table 3.1. Characteristics of the responsive factory

Characteristic	Technology application
Concurrent everything	Enterprise-wide computer integration, with electronic links to customers and suppliers. Computer-based transactions, automated routing of information to all departments and external partners
Fast development cycles	A Real-time production database, united with programmable logical controllers (PLC's) to give all development partners instant access to the latest information, thereby eliminating rework.
Flexible Production	Flexible machines, controlled by computers that co-ordinate work cells and factory-wide systems. Customised products can be produced with greater variety, with no cost penalties for small production runs, via automated batch production management.
Quick response	Dynamic, real-time factory scheduling systems can reduce inventory, as production will be scheduled on order.
Quality commitment	Ongoing quality programs lead to product and process

	innovation. Automated statistical techniques (statistical process control, quality function deployment) provide real-time quality information
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Source: Port, as referred to by Hisrich and Peters (1992: 548)

◆ Product development tools

Gunasekaran (1998) identified various advanced technologies, which can be utilised to improve the product development process. Computer-aided Design (CAD) has been used extensively in rapid-prototyping processes to reduce the development time, and therefore the time to market, for new products. Automated Engineering Analysis (AEA) involves the use of the CAD model of the product to plan the manufacturing process, assembly analysis planning and tolerance analysis.

Object Orientated Technology (OOT) results in the reuse of engineering code, design and analysis, thereby significantly reducing development cycles. It is regarded as an essential tool for product development (Gunasekaran, 1999). Solid Freedom Manufacturing (SFM) has emerged as a valuable tool for rapid prototyping, as it facilitated the automated development of prototype models, thereby significantly reducing the cost and time associated with developing a prototype of a new product.

The drive to improve customer value has forced engineering processes to evolve into an information system environment to speed up product development cycles and improve product quality. The main reason for this evolution process is the availability of three-dimensional geometry software on cost-effective platforms and effective database structures, integrated by communication management systems (Gunasekaran, 1999).

◆ Process control and automation

Donohue, as referred to by Gunasekaran (1999), claims that engineering systems will become more dependent on information systems and its technology, perhaps resulting in virtual machines as simulated prototypes of an actual product.

Burcher *et al.* (1999) claim that computer numerical controlled (CNC) machines account for biggest part of investments in advanced manufacturing technologies. Organisations are investing in CNC machines, as it results in improved product quality, reduced lead-time on new products, flexible manufacturing and the economical production of small product lots.

They claim that the successful utilisation of AMT requires an integrated approach to information systems, from production process level up to management information level. Production processes are controlled dynamically via industrial programmable logical controllers (PLC's), which are dynamically linked with one another via PLC networks. Process information can be transferred dynamically to plant operators via system control and data acquisition (SCADA), which improves the responsiveness of operating personnel to unexpected process or mechanical malfunctions (Winkelmann, 1999:11).

Advanced information and monitoring technologies are being used extensively to support maintenance management in the manufacturing environment (Du Preez *et al.*, 1999). The emphasis is placed on preventative and predictive maintenance technologies, including the following:

- Condition-based maintenance (CBM) involves the utilisation of technology to monitor the condition of manufacturing machines and warn the maintenance crew before failure occurs. Online vibration and temperature analysis, using built-in test equipment constitute real-time intelligence

technology that predicts machine component failure. A real-time manufacturing database is used to calculate the mean time between component failure and makes the information available to maintenance engineers via web-enabled technologies.

- Expert systems are extensively used for intelligent failure diagnosis. It also facilitates knowledge management and transfer.

These “intelligent” maintenance technologies lead to improved factory utilisation, as it improves responses to component failure. Intelligent maintenance systems and real-time maintenance databases are key sources of information, which can be utilised by design engineers to continuously improve production processes. Web-enabled maintenance systems allows the virtual pooling of spare parts, which provides instant access to spares around the world. It improves factory responsiveness and prevents expensive disruptions to continuous production processes (Du Preez *et al.*, 1999).

Virtual spares pooling can easily be accommodated via enterprise resource planning (ERP) systems, as it represent standard information platforms which can easily be integrated across organisational boundaries via TCP/IP network technology (*extranets*). The major challenge in manufacturing technology utilisation remains the integration of the various technologies to provide a seamless transfer of real-time information from process level right up to ERP level. This integrated framework, as well as its integration with other technologies throughout the value chain, will be discussed in more detail in section 3.5.

3.3.4. Technology application overview

Table 3.2. provides a summary of how advanced technologies are utilised to support and sometimes enable entrepreneurial activities throughout the value chain.

Table 3.2: Technology supporting entrepreneurial activity

Value Chain Activity	Technology Infrastructure	Entrepreneurial Advantages	Entrepreneurial Component
MARKETING & CUSTOMER SERVICE	HARDWARE Client servers Mobile computing (Laptops) Desktop computers SOFTWARE Groupware (Lotus Notes, MS Office) Shared customer databases Statistical analysis tools Image processing software Web Browsers (Netscape, Microsoft) NETWORKS & COMMUNICATION TCP/IP network components Intranets, Extranets, World Wide Web e-mail Cellular telephones Multimedia (video conferencing)	Understand customer needs Customized selling and order taking Collaborative computing with customers - Automated order taking - Web-enabled customer complaints - Market segmentation and analysis - Real-time market information - Industry-wide collaboration (extranets) - Internal collaboration across functional departments Global advertising (digital images and sound) Real-time market research (web-enabled Questionnaires) Remote sales management	Innovation Process innovation Process innovation Innovation Innovation Proactiveness Proactiveness & innovation Innovation, aggressiveness - lower costs Proactiveness, aggressiveness Proactiveness, innovation Proactiveness, innovation
LOGISTICS	HARDWARE Client servers Desktop computers Mobile computing (Laptops) SOFTWARE Groupware (Lotus Notes, MS Office) Integrated logistics database Scheduling software NETWORKS & COMMUNICATION TCP/IP network components Intranets, Extranets, World Wide Web e-mail Cellular telephones Multimedia (video conferencing) ARTIFICIAL INTELLIGENCE Expert systems Intelligent vehicles and road Infrastructure	Virtual office - lower costs - improved flexibility and effectiveness - Global reach Integrated product supply chains - reduced inventory - proactive inventory management - improved operations scheduling - Electronic data interchange - Direct links between supplier and customer Improved Flexibility - Onboard transaction processing - Optimized vehicle scheduling - Real-time space booking, automatic monitoring of consignment status and automatic delivery confirmation to provide improved response to customer needs	Process innovation Innovation Aggressiveness, innovation Proactiveness Proactiveness, innovation Proactiveness Innovation Innovation, aggressiveness Proactiveness
MANUFACTURING	PROCESS CONTROL & AUTOMATION PLC's Instrumentation CNC machines SCADA HARDWARE Real-time production client servers Desktops, graphics workstations SOFTWARE Groupware (Lotus Notes, MS Office) Real-time, Integrated production database CAD, AEA, OOT, SFM, Virtual machines CBM, NETWORKS & COMMUNICATION PLC network integration TCP/IP network components	Concurrency - Enterprise-wide information integration - Direct links between supplier and customer Fast Development Cycles - Real-time information available to all parties - Real-time process monitoring Flexibility - Automated batch management - Real-time process and quality management - Customized, small lot production Responsiveness - Real-time factory scheduling - Predictive maintenance - Virtual pooling of spares Quality Management - Real-time quality management and tracking	Innovation Innovation Innovation Innovation Proactiveness Proactiveness Innovation, aggressiveness Proactiveness, aggressiveness Aggressiveness Aggressiveness Proactiveness, aggressiveness

The infrastructure required for these technologies is divided into hardware, software, networks and communication functions. It is evident that the different technologies can only be utilised effectively if it can be integrated to encompass all the activities of the value chain. The importance of integrated, networks (operating on Internet protocols) is evident, as it enables inter-organisational and intra-organisational collaboration.

Table 3.2. also indicates that advanced technologies play a significant role in the entrepreneurial manufacturing environment, especially in supporting product and process innovation and flexible, responsive manufacturing. It is evident that ERP systems play a significant role in providing a standardised platform for transaction processing and industry-wide collaboration. It should therefore form the foundation of any integrated technology architecture in the entrepreneurial organisation.

3.4. ORGANIZATIONAL LEARNING

Organisational learning and knowledge management has been established as two key processes of any entrepreneurial environment (see chapter 2.3.7.). Sieloff (1999) provides a detailed account of how Hewlett Packard (HP) built an integrated technology environment to universal connectivity for all employees. He expands on the use of information technology that facilitates global communication and knowledge sharing (multimedia for video conferencing) via the Internet.

The development of a standardised desktop environment, using groupware (i.e. Lotus Notes, Microsoft Office) is proposed to facilitate inter-and intra-organisational communication and knowledge sharing across all the activities of the value chain. Web-enabled, shared *document repositories*, which are located

on standardised databases, provide centralised pools of knowledge within the organisation.

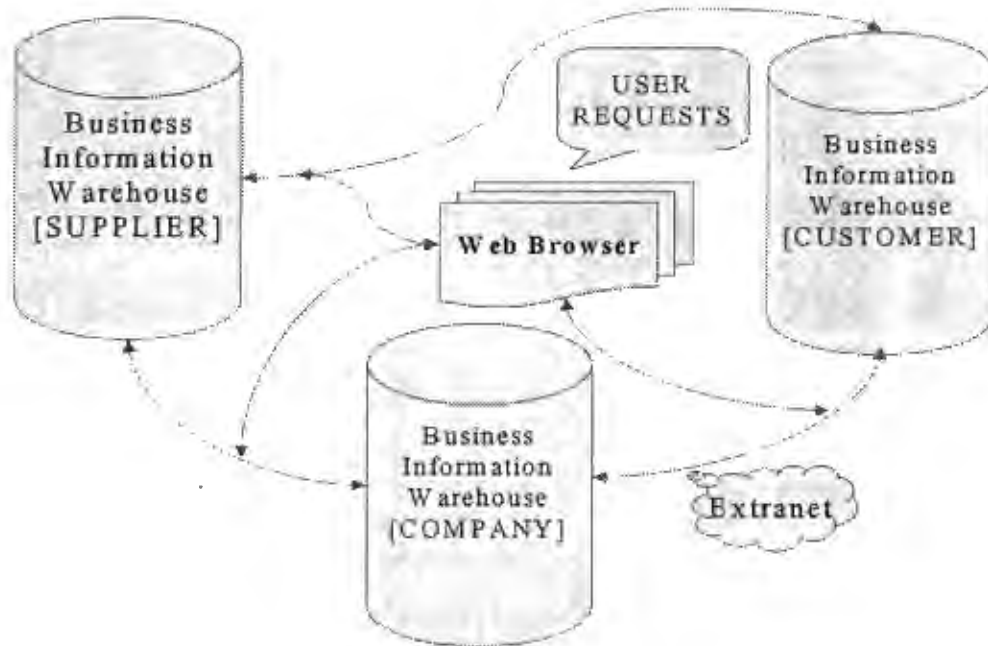
He refers to the development of an online “*electronic yellow pages*” which directs employees to personnel with specialist knowledge. HP developed sophisticated databases of product problems and solutions at their customer response centres, replacing time-consuming trouble shooting activities of support engineers. This greatly improved customer service and reduced service costs significantly. The transfer of knowledge between business partners can be facilitated via extranets. Passive video monitoring equipment greatly enhances knowledge sharing among the members of globally distributed teams, as it provides “*casual proximity*”, thereby improving the speed and effectiveness of new product development.

McDonald and Winch (1999) examine the use of information technology as a strategic management-training tool. Computer Aided Visioning (CAV) represents a “management flight simulator” which can be used to develop the abilities of key managers to manage change. CAV is a strategic management simulation tool, which simulates new business paradigms (as predicted by senior management) and allows key managers to gain experience in managing the “new enterprise” via simulation exercises. It improves organisational responsiveness to changing business conditions.

The current revolution in knowledge management is the facilitation of knowledge absorption by restricting the flow of information to employees, using inter-and intra-organisational search engines and filters (Todd, 1999). The objective is to integrate all knowledge repositories and databases within the organisation by creating a web-enabled business information warehouse per organisation. By developing a standardised technology environment, business partners can exchange information by conducting intelligent information searches, using

browsing technology on extranets. Figure 3.1. provides a schematic overview of this integrated environment:

Figure 3.1. Integrated knowledge management process



Literature confirms that advanced technology can play a significant role in the knowledge management process of any organisation. Entrepreneurial organisations should therefore invest in the establishment of a standardised technology infrastructure that supports the formation of integrated business information warehouses and that facilitates global collaboration and knowledge sharing.

The learning organisation should therefore operate on the frontiers of technology. The role that technology plays in the learning organisation is directly related to the support of entrepreneurial activity. Table 3.3. provides an overview of this dynamic relationship:

Table 3.3. The role of technology in the learning organisation

Technology Infrastructure	Entrepreneurial Advantages	Entrepreneurial Component
HARDWARE Client servers Desktop computers (standardized) Mobile computing (Laptops)	Global Collaboration - Shorter product development times - Access to industry and global knowledge - Global communication - Virtual project teams	Product & Process Innovation
SOFTWARE Groupware (Lotus Notes, MS Office) Integrated information databases	Inter-organizational Communication - Improved learning - Company "yellow pages" - improved responsiveness to customer needs	Innovation, Proactiveness Competitive aggressiveness
NETWORKS & COMMUNICATION TCP/IP network components Intranets, Extranets, World Wide Web e-mail Cellular telephones Multimedia (video conferencing) Passive video monitors Web search engines	On-line Document Repositories - Integrated business information warehouse to protect knowledge as strategic resource - Easy access to the latest knowledge throughout the organization - Improved knowledge retention via proper information management	Innovation, Proactiveness
ARTIFICIAL INTELLIGENCE Expert systems	Management "Flight Simulators" - Improved change management and adaptiveness - Improved management responsiveness	Proactiveness

The importance of a standardised hardware and software architecture, which can be integrated via TCP/IP networks, is highlighted in table 3.3. This integrated environment is critical to the formation of business information warehouses and organisational learning repositories. A standardised, integrated environment also enables global collaboration and inter-organisational communication. It is thus evident that advanced information technologies can be utilised to support organisational learning, and eventually entrepreneurial activity, i.e. innovation, proactiveness and competitive aggressiveness.

3.5. TECHNOLOGY BLUEPRINT

The literature study on the utilisation of technology in entrepreneurial organisations revealed that the various technologies have to be integrated to enable the formation of a single business information warehouse, which spans the entire business value chain. This integrated approach will aid inter-and intra organisational collaboration and knowledge management, as information and knowledge can be shared via information networks supporting Internet protocols.

The importance of real-time information was also highlighted, together with the establishment of a standardised desktop environment (using groupware as operational medium).

It was established that technology could also be applied to aid product and process development by intelligently automating the most time consuming phases of the development process (Jiao & Tseng, 1999). It is predicted that artificial intelligence systems (robotics) will play a significant role in the manufacturing environment of the 21st century.

A theoretical technology blueprint, which can be used as a roadmap for the development of a technology infrastructure of entrepreneurial organisations, should therefore be developed. A standardised technology infrastructure must be developed that supports electronic data interchange in the business-to-business and business-to-consumer cycles (Anon., 1999:78).

The entrepreneurial organisation must therefore attempt to support communities of users and businesses in an integrated manner to support all activities in the value chain. It is suggested that the major components of this technology blueprint should be the following:

- A standardised, enterprise-wide transaction processing and planning system that incorporates all the activities of the business value chain.
- Automation of manufacturing processes and machine control to accommodate cost-effective, flexible manufacturing.
- Real-time manufacturing information management and integration into the enterprise-wide planning system.
- The integration of all information and knowledge sources into a single business information warehouse.

- The development of an integrated information *superhighway* of *digital* local area and wide area networks, based on Internet protocols (TCP/IP).
- A standardised desktop environment

This infrastructure can encourage the formation of an information economy *ecosystem*, consisting of clusters of information economy firms that create a synergy to grow ideas and encourage corporate entrepreneurial actions (Metropolitan Chicago, 1998). Each of these components of the technology blueprint will now be examined in more detail.

3.5.1. Enterprise-wide transaction processing and planning

The notion of enterprise-wide transaction processing and planning culminated into the development of enterprise resources planning (ERP) systems, such as SAP/R3, Baan, etc. These integrated systems incorporate all the transactional and planning activities of the business value chain to create a standardised organisational information database. ERP systems (i.e. SAP/R3) consist of a centralised transaction processing database in which tables are allocated for each of the functions of the value chain, including:

- Purchasing to Procurement (PtP)
- Financial Controlling and Management (FI and CO)
- Materials Management (MM)
- Production and Quality Management (PP/PI and QM)
- Maintenance Management (PM)
- Human Resource Management
- Project Management
- Investment Management

ERP systems provide a standardised platform that enables the entrepreneurial organisation to re-engineer internal business processes to be more cost competitive, but it also enables the formation of standardised business information warehouses per organisation (Anon., 1999:80). The ERP databases collate all inter-organisational transactions for management and planning purposes. It provides a standardised basis for intra-organisational transaction processing and value chain activity management.

Such a standardised information-processing platform facilitates electronic data interchange (EDI), as electronic linkages via digital *extranets* can easily be achieved. Due to its standardised configuration, ERP systems provide the foundation for industry-wide value chain management and should therefore be regarded as the foundation for the management of an information economy ecosystem.

3.5.2. Manufacturing automation and information management

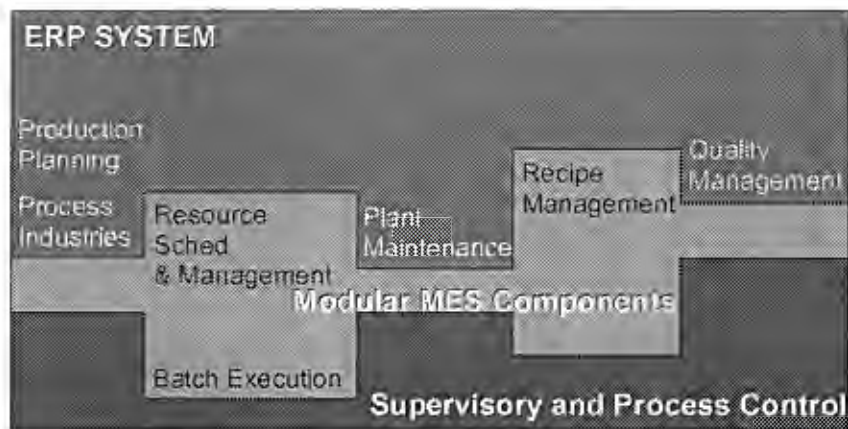
The characteristics of technology application in an entrepreneurial manufacturing environment were summarised in table 3.1. The focus of the manufacturing technology blueprint should be placed on enterprise-wide computer integration, automated, flexible manufacturing equipment, real-time information management to facilitate dynamic operations scheduling and also real-time quality tracking and maintenance management. Organisational learning is of paramount importance in the manufacturing environment and should therefore be accommodated via a centralised document management system. All these components should be integrated via digital networks.

According to McBreen (1999:3) the technology infrastructure of the modern responsive manufacturing environment consists of three layers, namely:

- Supervisory and process control
- A manufacturing execution system (MES) architecture, which facilitates dynamic production scheduling and batch execution according to fixed recipes and real-time production information management.
- ERP, facilitating inter-and intra-organisational value chain management.

Figure 3.2. summarises the integrated nature of the proposed architecture. The process control layer and the MES layer are plant-specific, while the ERP systems are enterprise specific, but should also facilitate industry-wide information management.

Figure 3.2. Technology architecture for the responsive factory



Source: McBreen, (1999:3)

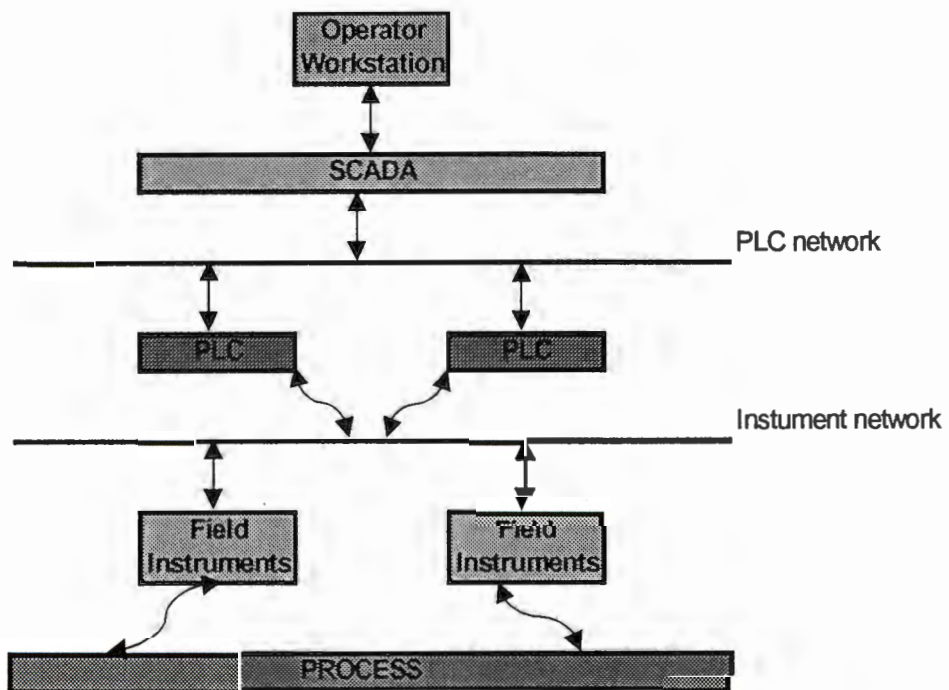
◆ Automation, supervisory and process control

The manufacturing supervisory, automation and process control layer represents the foundation of manufacturing technology architecture. It consists of computer numerical control (CNC) machines, which is controlled by programmable logical controllers (PLCs). Manufacturing processes are sequentially controlled by a networked PLC architecture that facilitates the execution of production recipes for batch, as well as continuous production processes (Moorby, 1999:41).

Field instrumentation and inputs and outputs are directly linked to programmable logical controllers and process equipment. The role of instrumentation is to dynamically monitor process variables. The information is transmitted as a digital signal to PLCs where it is compared to variable setpoints. The PLCs then transmit output information to the field instruments, thus automatically manipulating the process.

Systems Control and Data Acquisition (SCADA) technology allows real-time reporting of process variables on operator control stations. It allows the process operator to remotely control the process by manipulating process equipment. This digital technology architecture improves responsiveness and provides a source of real-time information, which can be utilised, for continuous process innovation. Figure 3.3. provides an overview of a modern digital control architecture.

Figure 3.3. Digital process control architecture



◆ Manufacturing execution systems architecture

The sole purpose of manufacturing execution systems (MES) architecture is to accommodate flexible, automated process management and real-time manufacturing information management. It provides the link between the ERP environment and the automated process control environment, thus creating a real-time, integrated operations management system. This architecture supports more cost-effective manufacturing, as well as improved process innovation.

Winkelmann (1999:12) describes the design of a manufacturing execution system (MES) architecture for a flexible manufacturing facility. He identifies the following components of the MES architecture:

- Operations scheduling, including the functionality to dynamically optimise production resources and schedules and develop prioritised production schedules per manufacturing route.
- Dynamic recipe management that provides the manufacturing process standards for integrated process (or batch) management.
- Dynamic process management is possible, where a standardised manufacturing recipe can be executed automatically. The recipe is digitally transferred into PLC programs and thus executed precisely according to standards.
- Real-time production information management is achieved by recording process and materials information directly into a production information database via a standardised digital communication (TCP/IP) network. This production local area network (LAN) links the process control and automation architecture with the production database.

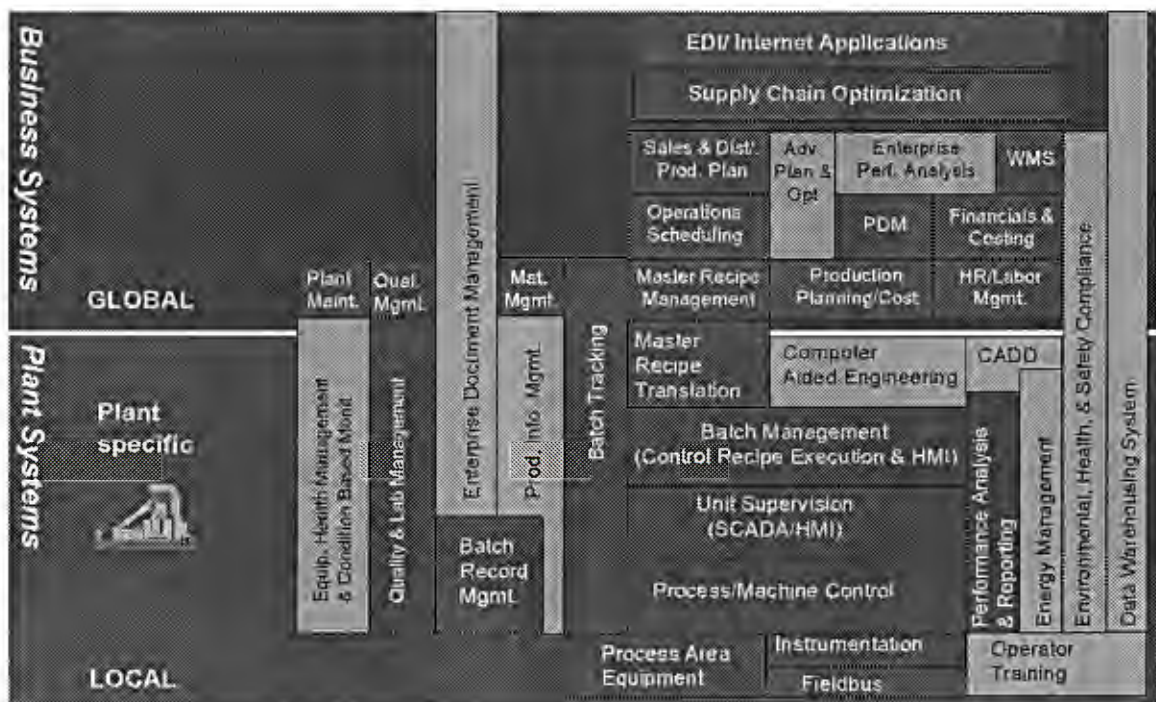
Process history, including materials and quality tracking information, is stored for future reference purposes. Management reports can be prepared automatically

in real-time and immediately be distributed to all interested stakeholders via the Internet. Manufacturing is regarded as the most fertile area for intrapreneurship to flourish in (Hisrich & Peters, 1992:547). It is however necessary to interface the MES architecture with the ERP environment to create a standardised business information warehouse (McBreen, 1999:12).

Suppliers will therefore be able to know what the stock status is of the manufacturer. The manufacturer will be in a position to dynamically schedule production runs according to customer preferences as orders are placed. Process management functionality will allow the manufacturer to produce non-standard orders precisely to customer demands.

The availability of historical and real-time information provides a fertile environment for intrapreneurship to flourish, given that an entrepreneurial culture exists within the organisation. Figure 3.4. displays the different components of an MES in an entrepreneurial manufacturing environment:

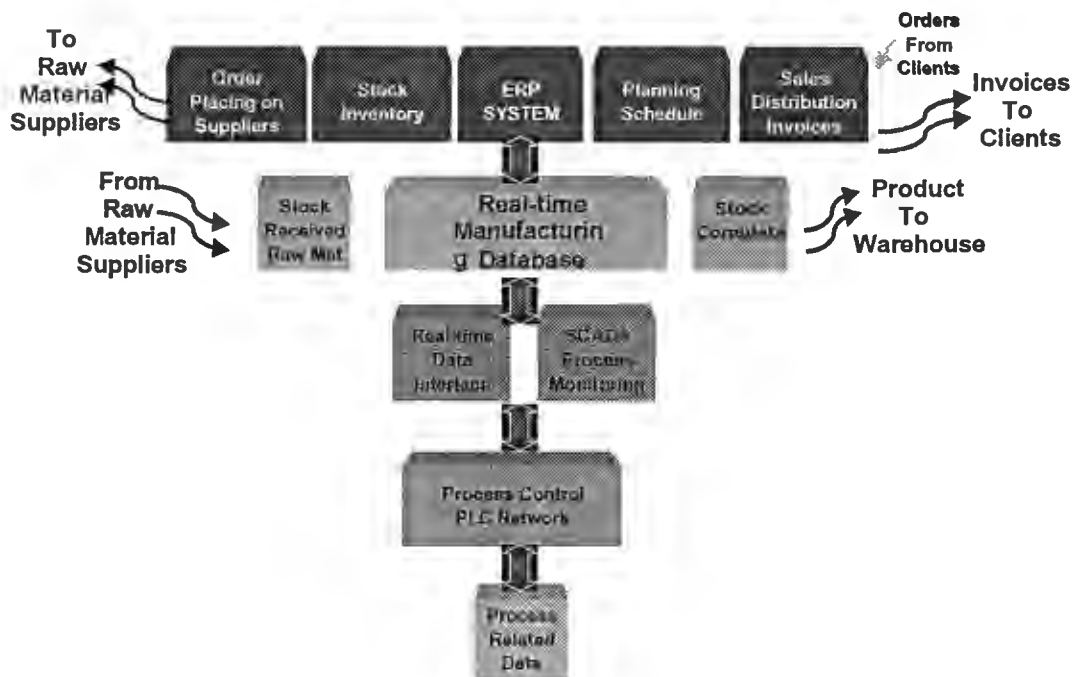
Figure 3.4. Components of a business information warehouse



Enterprise documentation management, as well as computer-aided engineering is critical components of the proposed MES application portfolio (as is depicted in figure 3.4.). The integration of the MES environment (which is plant specific) into the global ERP environment is clearly noticeable, as well as the ability to accommodate Internet applications.

This entire integrated knowledge management environment constitutes the proposed business information warehouse. Global collaboration and knowledge sharing can be achieved between business partners, as well as customers, through standard Internet browsing technology. Figure 3.5. provides an overview of this business information management process:

Figure 3.5. Business information management



3.5.3. The organisational information super highway

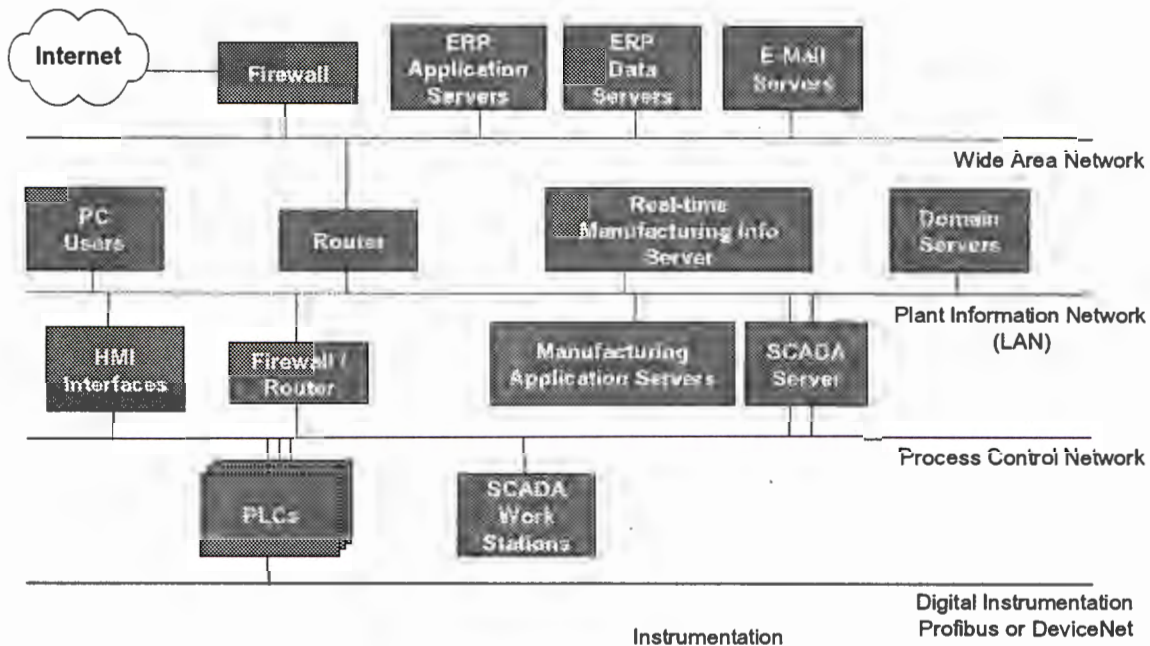
Advanced digital communication networks provide the backbone of any integrated technology infrastructure and are obvious requirements for electronic

data interchange and global information management. The Internet has enabled organisations to form virtual partnerships with suppliers and customers around the globe. Suppliers and customers can collaborate directly with the organisation via wide area networks (extranets) operating on Internet protocols (TCP/IP). Internal collaboration is achieved via Intranets, which are used to convey essential organisation-specific information (Melnicoff, 1999b).

Intranets can be configured to allow a large degree of autonomy on how this information is managed. The technology blueprint for the entrepreneurial organisation should accommodate a network architecture that accommodates the formation of virtual organisations and virtual strategic alliances, but also provides adequate protection to confidential information within the organisation. The information-intensive requirements of the manufacturing environment should also be accommodated via plant-specific (and even function-specific) local area networks (McBreen, 1999:14).

McBreen (1999:18) proposes digital network architecture consisting of four separate digital networks, which are connected network routers. He suggests that firewalls should be positioned to restrict access to sensitive information and automated business management processes. Figure 3.6. provides an overview of the proposed high level technical infrastructure that will allow connectivity throughout the entrepreneurial enterprise up to global alliance partners.

Figure 3.6. High level technical infrastructure



Source: McBreen (1999:18)

This integrated technical infrastructure allows the transfer of information directly from a process control level through to an enterprise planning level. Virtual collaboration between business partners (in *virtual business communities*), as well as inter-organisational collaboration and knowledge sharing, is therefore accommodated. This architecture also allows for the sharing a real-time manufacturing information, which is a prerequisite for effective product and process innovation (Moorby, 1999:19).

3.5.4. Standardised desktop environment

A standardised desktop environment is the final requirement for the creation of a technology architecture in entrepreneurial organisations (Sielhoff, 1999). It implies the use of groupware (i.e. MS Office of Lotus Notes) to facilitate information exchange between users inside and outside the organisation. Most existing multimedia software is also included in advanced groupware application suits. Groupware therefore supports collaboration between members of virtual

development teams and is thus a key component of the technology blueprint for entrepreneurial organisations.

3.6. SUMMARY

In the literature study it was established that advanced technology is extensively utilised to support (and sometimes stimulate) entrepreneurial activities in corporate organisations. Technology is mainly applied to improve inter and intra-organisational collaboration and knowledge sharing, but advanced process control and automation technologies are widely applied to reduce manufacturing costs, improve product quality and provide real-time information that is used to stimulate process innovation.

Advanced telecommunication, information and networking technologies are increasingly utilised to integrate business processes across the entire business value chain, substantially reducing product development times. Marketing information can be made available to everybody in the organisation, while customer and supplier business information can be integrated to reduce inventory and distribution costs. Artificial intelligence technologies are mainly applied to reduce costs and improve manufacturing efficiencies.

Effective organisational learning, a key business process in entrepreneurial organisations, can only be achieved if advanced information and communication technologies are fully utilised to provide a knowledge management framework throughout the organisation.

A technology blueprint, which is based on available technology applications, has been designed to facilitate entrepreneurial business processes in corporate organisations. The blueprint is based upon ERP systems, process control and automation infrastructures, as well as MES architectures, which are integrated

by digital networks to form integrated business information warehouses. A standardised desktop environment is regarded as a key component of the technology architecture of entrepreneurial organisations.

CHAPTER 4

ENTREPRENEURIAL PERFORMANCE AND TECHNOLOGY: AN EMPIRICAL APPROACH

4.1. INTRODUCTION

Chapter 2 elaborates on the characteristics of entrepreneurial organisations, while chapter 3 expands on the utilisation of advanced technology to support (and sometimes enable) entrepreneurial activity within an organisation. It was concluded that technology and entrepreneurship constitute a dynamic partnership, implying that entrepreneurial organisations usually operate on the frontiers of technology. The remaining objective is to quantify, via an empirical study, whether the relationship between entrepreneurial intensity and technology utilisation is statistically significant.

A detailed account of the empirical research method being applied is presented in this chapter. The rationale behind the design of the entrepreneurial intensity and technology intensity questionnaires will be explained, as well as the sampling procedure and statistical techniques that were followed. Chapter 4 will also focus on the interpretation of the results of the empirical study, specifically examining the following relationships:

- The nature and extent of the relationship between entrepreneurial intensity and organisational learning.
- The relationship between the degree and frequency of entrepreneurship.
- The relationship between organisational learning, product introduction, service introduction and process innovation.
- The significance of the relationship between technology availability and technology utilisation.

- To what extent there exists a statistical relationship between technology intensity and entrepreneurial intensity in South African organisations.

A detailed account will be provided of the statistically significant relationships.

4.2. MEASURING ENTREPRENEURIAL INTENSITY

In chapter 2 it was concluded that organisational entrepreneurship could be quantified by determining the entrepreneurial intensity of organisations. Various researchers have reported successes in measuring the entrepreneurial intensity of an organisation and positively linking it to organisational performance parameters (Hisrich & Peters, 1992:71).

The two dimensions of entrepreneurial intensity, frequency and degree of entrepreneurship can be measured via self-report questionnaires in which managers are asked to provide responses that best describe operations within their organisations over the past 2 years. The weighted sum of the average frequency and the degree components then constitute the entrepreneurial intensity of the organisation. Equation 4.1, which was deduced from research conducted by Morris and Sexton (1996:9), portrays this relationship mathematically.

$$\boxed{a.F_{ave} + b.D_{ave} = EPI} \quad (4.1.)$$

Where:

- a = fractional weight of the frequency factor in the EI construct
- b = fractional weight of the degree factor in the EI construct
- F_{ave} = normalised composite mean scores for the frequency components
- D_{ave} = normalised composite mean scores for the degree components

EPI = entrepreneurial performance index

and: $a + b = 1$

The entrepreneurial performance questionnaire was constructed as follows.

4.2.1. Frequency of entrepreneurship

To assess the frequency of entrepreneurship, individual questions were included where respondents reported the absolute number of new products, new services and new production or operational processes. Respondents were asked to skip any questions, which were not applicable to their organisations.

4.2.2. Degree of entrepreneurship

The degree of entrepreneurship was measured in three ways. Miller and Friesen (as referred to by Morris & Sexton, 1996:9) developed a 13-item questionnaire in which respondents indicate on a five-point scale their agreement, or disagreement, with a series of statements. These statements characterise the extent to which company philosophy and top-level decision-making are innovative, risk-taking, and proactive. Reliabilities reported for this scale have ranged from 0.79 to 0.88 (Morris & Sexton, 1996:9).

Secondly, respondents were also asked to indicate (on a five-point scale) to what extent the number of new products, services and processes were:

- New to the world
- New to their markets
- Modifications or extensions of things the company was already doing.

Organisational learning has been identified in chapter 2 as a key business process in the entrepreneurial organisation of the 21st century. The dimensions of the learning organisation were therefore included in the questionnaire, as part of the determination of the degree component of entrepreneurial intensity. The inclusion of organisational learning in the questionnaire deviates from the questionnaire that was designed by Hisrich and Peters (1992:52), but it was decided that organisational learning represents a key dimension in the degree component of the entrepreneurial intensity construct.

The extent of organisational learning in the organisations (which responded) was measured by asking respondents to rate learning processes in their organisations against the identified organisational learning dimensions. Again a five-point scale was used for measuring purposes. Cumulative mean scores of these categories were combined and normalised to determine the degree of entrepreneurship in organisations which responded to the questionnaire. The design of the questionnaire is depicted in appendix 1.

4.3. MEASURING TECHNOLOGY INTENSITY

A similar approach has been adapted to measure the utilisation of technology to support entrepreneurial activity. Technology intensity is the variable that has been defined for this purpose. It is determined by multiplying the degree of technology availability (as identified by the technology blueprint) with the degree of technology utilisation to support entrepreneurial activity within the organisation. Equation 4.2 represents this relationship:

$$\boxed{A_i \times U_i = TI} \quad (4.2.)$$

Where: A_i = availability index, calculated as the normalised, mean composite score of the technology availability components.

U_i = Utilisation index, calculated as the normalised, mean composite score of the technology utilisation components.

TI = Technology intensity index

The technology intensity questionnaire was constructed to measure the various technology components that were identified in the technology blueprint.

4.3.1. Technology availability

The technology blueprint guidelines were used to measure the availability of the various recommended technologies, as well as the integrated nature of these technologies. Respondents were asked to rate the availability of technologies on a five-point scale within the following categories:

- entrepreneurial marketing
- integration of the business value chain
- manufacturing
- organisational learning

4.3.2. Technology utilisation

The same procedure was followed to determine the utilisation component of the technology intensity index. Respondents were asked to rate the degree to which the technologies (identified in the technology blueprint) were being utilised to promote entrepreneurial actions within the categories identified in section 4.3.1. Again a five-point rating scale was used in the questionnaire.

The design of the technology intensity questionnaire is presented in appendix 1.

4.4. EMPIRICAL RESEARCH

This section provides an overview of the research methods that were employed to determine the statistical significance of the relationships between technology components and the components of organisational entrepreneurship.

4.4.1. Sampling procedure

The sampling frame consisted of South African industrial and blue chip organisations with more than 500 employees, which were randomly selected. A total of 40 surveys, consisting of both an entrepreneurial intensity and a technology intensity questionnaire, were mailed to senior executives of selected organisations, operating in the mining, industrial, financial, information technology, and fast movable consumable goods industries in South Africa.

To encourage participation, respondents were promised an executive summary of the findings. E-mail reminder messages were also sent to respondents 7 days after the initial surveys were mailed. Where possible, direct interviews were conducted with senior executives to discuss the impact of technology on their organisations. Eight questionnaires were completed in this manner. A total of 19 responses were received, which represents a response rate of 47.5%. Table 4.1. provides a summary of the composition of the responses received.

Table 4.1. Industry distribution of respondents

INDUSTRY	RESPONSES	%
FMCG	2	10.53
Information Technology	3	15.79
Mining	2	10.53
Insurance	2	10.53
Banking	4	21.05
Chemicals	5	26.32
Electricity	1	5.26
Total	19	100.00

The response sample represented a combination of organisations within the major industries in the South African economy, but a higher response rate would have been preferred to provide a more representative view of the statistical relationship between entrepreneurial intensity and technology intensity. Information in the questionnaires was organised to enable the calculation of an entrepreneurial performance index, as well as a technology intensity index, for each organisation that responded.

4.4.2. Quantifying statistical relationships

Product introduction, service introduction and new process introduction were established as major indicators of entrepreneurial performance. The conducted literature study (see chapters two and three) indicates that organisational learning is perhaps the most significant component of an entrepreneurial culture. It was decided to statistically evaluate the inter-relationships between these variables to determine if general conclusions can be drawn, based on the South African sample of organisations.

According to Benade *et al.* (1996:23) a correlation coefficient indicates the degree of the linear relationship between two variables and it can range between -1 and +1. If the correlation coefficient falls between these absolute values, the degree of the linear relationship between the two variables is not trivial. The determination coefficient, which is the square of the correlation coefficient, provides the answer.

It provides an indication of the extent to which a change in the dependent variable can be measured in terms of a corresponding change in the independent variable. The determination coefficient is therefore a true reflection of the relationship between two variables.

The aim of the study was to determine if statistical relationships exist between the different variables that define the entrepreneurial intensity and technology intensity constructs. Statistical correlation and determination coefficients were therefore determined for the different sets of variables to quantify these inter-relationships.

4.5. RESULTS AND DISCUSSION

Table 4.2. provides a summary of the major correlation results. A detailed account of the results per survey is provided in appendix 2.

Table 4.2. Statistical relationships for the entrepreneurial intensity construct

Correlation group	R	R ²
Frequency/degree of entrepreneurship	0.653	0.426
EPI/new product introduction	0.826	0.683
Product innovation/organisational learning	0.579	0.335
Service innovation/organisational learning	0.572	0.327
Process innovation/organisational learning	0.403	0.162
EPI/organisational learning	0.799	0.639

The statistical results portrayed in table 4.2. should be seen in a general business context, where numerous variables can have an influence on the measured components of entrepreneurial performance. Morris and Sexton (1996:12) reported determination coefficients of less than 30% between entrepreneurial performance and organisational performance, but still hypothesised that entrepreneurial performance has a strong influence on overall organisational performance (given the complex nature of the business environment).

It is thus suggested that determination coefficients in excess of 0.35 should be viewed as statistically significant for the purpose of this study, as the major aim

of the study is to identify statistical patterns that can be investigated in more detail to develop new hypotheses. The results in table 4.2. suggest that the frequency and degree of entrepreneurship is correlated and that entrepreneurial intensity is strongly correlated with organisational learning. The significance of these statistical relationships will be discussed in more detail in the following sections.

4.5.1. Entrepreneurial performance

An entrepreneurial performance index was calculated for each component of the organisational performance construct to determine if any patterns can be recognised. Table 4.3. provides a summary of the major results that were captured from the entrepreneurial performance questionnaires.

Table 4.3. Entrepreneurial performance index results

Company/Industry	Frequency Score	Degree Score	Weighting		Total EPI	Product EPI	Service EPI	Process EPI	Organisational learning
			(a)	(b)					
FMCG	0.900	0.783	0.5	0.5	0.842	0.87	0.80	1.00	0.76
Chemicals	0.350	0.338	0.5	0.5	0.344	0.50	0.40	0.50	0.28
Electricity	0.500	0.525	0.5	0.5	0.513	0.40	0.77	0.50	0.57
Banking	0.550	0.679	0.5	0.5	0.615	0.67	0.67	0.80	0.70
Mining	0.667	0.436	0.5	0.5	0.551		0.50	0.80	0.38
FMCG	0.800	0.658	0.5	0.5	0.729	0.70	0.67	1.00	0.62
Chemicals	0.400	0.467	0.5	0.5	0.433	0.50	0.47	0.60	0.42
IT	0.700	0.792	0.5	0.5	0.746	0.83	0.70	0.80	0.78
Banking	0.850	0.804	0.5	0.5	0.827	0.80	0.77	0.80	0.84
Chemicals	0.550	0.638	0.5	0.5	0.594	0.43	0.60	0.70	0.73
Insurance	0.750	0.775	0.5	0.5	0.763	0.80	0.70	0.80	0.83
Insurance	0.650	0.692	0.5	0.5	0.671	0.80	0.70	0.80	0.71
Banking	0.450	0.713	0.5	0.5	0.581	0.60	0.53	0.60	0.83
IT	0.650	0.800	0.5	0.5	0.725	0.73	0.50	0.90	0.82
Chemicals	0.700	0.750	0.5	0.5	0.725	0.63	0.60	0.90	0.82
Mining	0.800	0.624	0.5	0.5	0.712			0.90	0.63
Chemicals	0.750	0.633	0.5	0.5	0.692	0.73	0.60	0.90	0.63
Banking	0.550	0.646	0.5	0.5	0.598	0.63	0.47	0.60	0.70
IT	0.800	0.850	0.5	0.5	0.825	0.77	0.83	0.80	0.88
Average	0.651	0.663			0.657	0.671	0.626	0.774	0.680
Standard deviation	0.156	0.139			0.134	0.143	0.128	0.152	0.168

The results indicate that the average degree and frequency scores are closely related for the sample of South African companies and that the organisations in the sample have above average entrepreneurial characteristics and performance. The normalised EPI scores range from a minimum of 0.34 to a maximum of 0.84. It is also evident that entrepreneurial performance, as portrayed by new process introduction, is significantly higher than that of new process or service introduction. This difference might be a result of the focus that many South African organisations are placing on business process re-engineering, in order to become globally competitive.

The results also indicate a 65.3% positive correlation between the frequency and degree of entrepreneurship and a subsequent determination coefficient of 0.426 (see table 4.2.). This implies that 42.6% of the change in the degree of entrepreneurship can be attributed to a change in the frequency of entrepreneurship for the statistical population.

It can therefore be deduced that organisations that engage in entrepreneurial actions more frequently eventually increase the degree of entrepreneurial action, as frequent entrepreneurial action stimulates the evolution of a culture of entrepreneurship within these organisations. Morris and Sexton (1996:13) made the same observation, but did not provide any statistical information to support it.

It is proposed that the extent of the relationship between degree and frequency of entrepreneurship should be examined more thoroughly to determine if a general hypothesis could be constructed to describe this relationship. The role that technology can play in enabling entrepreneurial action will be examined in detail in section 4.5.3.

An 82.6% correlation coefficient and a corresponding 0.683 determination coefficient were calculated for the relationship between new product introduction

and entrepreneurial performance for the South African sample of organisations. This result emphasises the importance of new product development and product introduction for entrepreneurial organisations. It is expected that technology utilisation should be strongly correlated with new product introduction. The extent of this relationship will also be examined in section 4.5.3.

4.5.2. The significance of organisational learning

The importance of organisational learning in the creation of an entrepreneurial culture within an organisation was advocated in chapters two and three. Organisational learning was therefore identified as a major focus area in the empirical study, as a strong correlation was expected between organisational learning and entrepreneurial performance in major organisations.

An average normalised organisational learning score of 0.68 was calculated for the sample population on the entrepreneurial performance questionnaire (see table 4.3). The standard deviation of the sample is 0.168. The distribution of normalised organisational learning scores for the surveyed population is presented in figure 4.1.

Figure 4.1. Distribution of normalised organisational learning scores

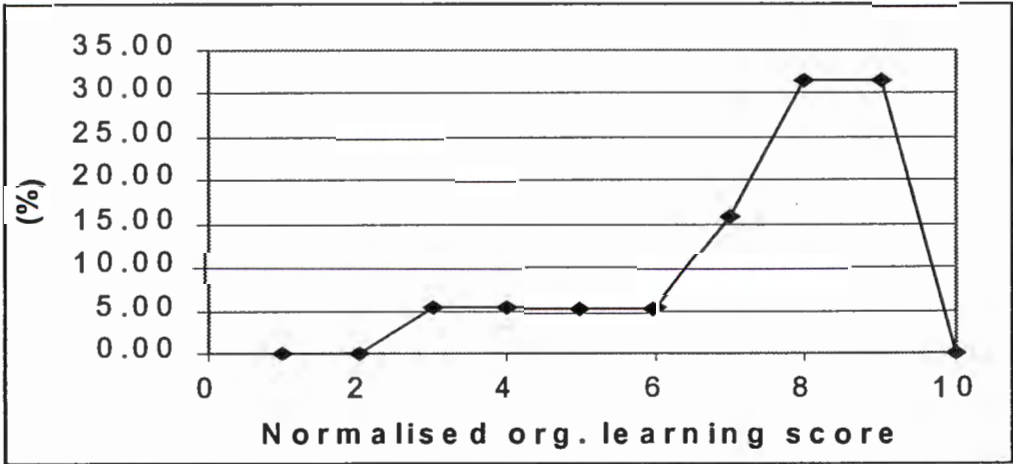
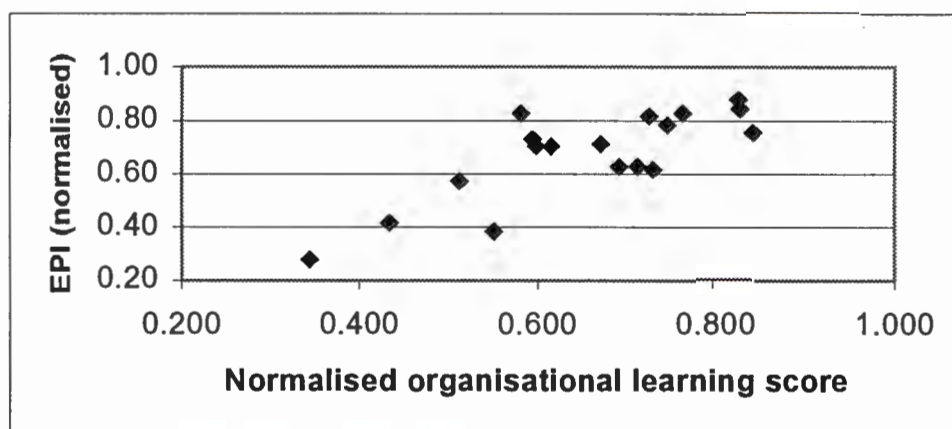


Figure 4.1. indicates that the distribution of normalised organisational learning scores is skewed to the right for the South African sample of organisations and that these major organisations all place above average emphasis on organisational learning. The above average organisational learning scores coincide with above average entrepreneurial intensity scores (see table 4.2.).

It was decided to determine the extent of the relationship between the organisational learning component of the EPI questionnaire and the overall EPI index in an attempt to evaluate the significance of organisational learning in the entrepreneurial performance construct. Figure 4.2. provides a graphical representation of this relationship.

Figure 4.2. The relationship between entrepreneurial performance and organisational learning



The linear correlation between organisational learning and entrepreneurial performance is 79.9% for the sample of organisations, indicating that 63.9% of the variation in entrepreneurial performance can be accounted for by the variation in organisational learning effectiveness (see table 4.2.). The degree of the relationship between organisational learning and overall entrepreneurial performance is thus significant and warrants further investigation in future studies.

Correlation coefficients were also determined to quantify the statistical relationships between organisational learning and new product, process and service introduction (see table 4.2.). The determination coefficients range from 0.16 between organisational learning and process introduction and 0.34 between organisational learning and new product introduction. These results are not viewed as statistically significant.

It is suggested that these relationships should be investigated in more detail, as the sample of organisations on which the results are based is small. It is expected that organisational learning should have a significant influence on new product, service and process introduction.

In general it can be concluded that a learning culture is a crucial component of successful organisational entrepreneurship and that organisational learning components should be included in the determination of an organisation's EPI. The inter-relationship between advanced technology and organisational learning will be examined in section 4.5.3.

4.5.3. Technology utilisation

It has been proposed in this study that advanced technology can be utilised extensively to support and enable entrepreneurial activity in organisations. A technology utilisation questionnaire was developed to determine the technology intensity of major South African organisations and simultaneously determine if a statistically significant correlation exists between entrepreneurial intensity and technology intensity. The following results were obtained from the empirical survey.

◆ Technology intensity

The major results obtained from the technology intensity questionnaire are summarised in table 4.4.

Table 4.4. Technology intensity of major South African organisations

Company/Industry	Availability	Utilization	TI	TI (Org. Learning)
FMCG	0.850	0.765	0.650	0.40
Chemicals	0.390	0.259	0.101	0.06
Energy	0.870	0.694	0.604	0.35
Banking	0.508	0.450	0.228	0.12
Mining	0.695	0.500	0.347	0.09
FMCG	0.740	0.647	0.479	0.09
Chemicals	0.580	0.482	0.280	0.10
IT	0.700	0.636	0.445	0.20
Banking	0.867	0.820	0.711	0.42
Chemicals	0.522	0.453	0.237	0.12
Insurance	0.900	0.855	0.769	0.56
Insurance	0.817	0.673	0.549	0.30
Banking	0.783	0.691	0.541	0.14
IT	0.917	0.745	0.683	0.70
Chemicals	0.790	0.741	0.586	0.40
Mining	0.656	0.569	0.373	0.20
Chemicals	0.700	0.624	0.436	0.24
Banking	0.700	0.636	0.445	0.15
IT	0.900	0.691	0.622	0.45
Average	0.731	0.628	0.478	0.268
Standard deviation	0.149	0.147	0.183	0.181

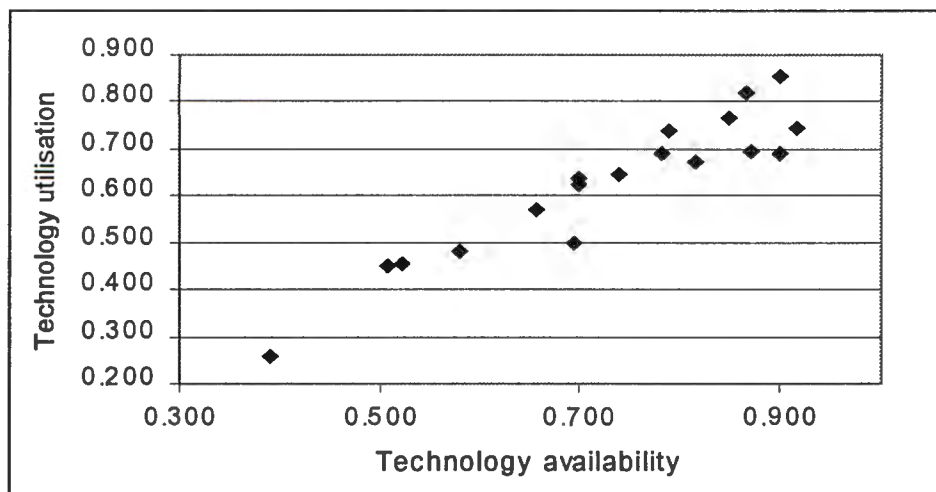
The average normalised technology intensity score for the sample of South African organisations is 0.478 with a standard deviation of 0.183. The scores range between a minimum of 0.101 and a maximum of 0.769. The results in table 4.4. clearly indicate that advanced technology is made available to a significant extent in major South African organisations, as the average availability score is 0.731 for the sample. However, the technology is not utilised to its full potential (average utilisation score of 0.628).

The survey also indicates that the major South African organisations have to date not focused on the development of integrated knowledge repositories to

support organisational learning as a key business process. The average recorded technology intensity score for the organisational learning component is only 0.268, with a standard deviation of 0.181. The low scores can be attributed to the fact that an integrated approach to technology infrastructure design has only been made possible by significant technological advances in recent years. Organisations are only beginning to understand the significance of the business information warehouse concept.

Table 4.4. also indicates that the technology availability and utilisation scores might be dependent on each other. The correlation and determination coefficients were therefore calculated to determine the significance of the statistical relationship between technology availability and utilisation. Figure 4.3. provides a graphical representation of this relationship.

Figure 4.3. The relationship between technology availability and utilisation



A 93.7% correlation was determined between technology availability and technology utilisation, with a corresponding determination coefficient of 0.879. This result implies that the extent to which technology is utilised is directly related to the extent to which it is made available in organisations. This is hardly surprising if the enormous costs involved in technology investments are

considered. It can therefore be expected that senior management will emphasise the maximum utilisation of technology investments, as these investments become more significant.

It can also be argued that an optimum investment in technology exists, where any additional investment will not translate into a corresponding utilisation increase. This relationship provides another fertile area for management research, given the enormous emphasis that is currently placed on investment in advanced technologies (Melnicoff, 1999b).

◆ The relationship between technology and entrepreneurial performance

The major focus of the empirical study was to determine if a statistically significant relationship exists between entrepreneurial intensity and technology intensity. Figure 4.4. provides the comparative distributions of normalised technology intensity and entrepreneurial intensity scores for the sample of South African organisations (see appendix 2 for numerical results).

Figure 4.4. Technology Intensity and Entrepreneurial Intensity distributions

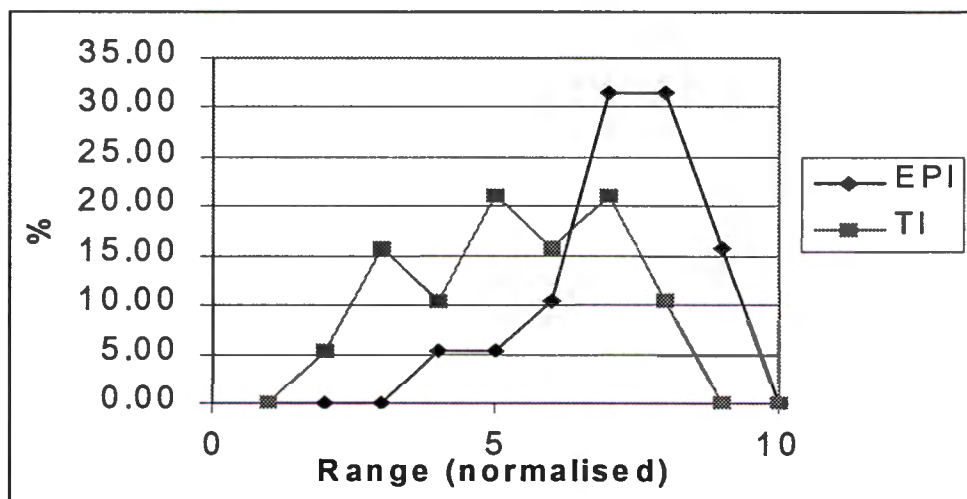


Figure 4.4. indicates that the technology intensity scores are normally distributed, while the distribution of entrepreneurial intensity scores is skewed to the right. It provides an indication that the organisations in the sample place more emphasis on entrepreneurial activity than technology intensity, but the distributions do not indicate if a statistically significant relationship exists between the two variables.

Form the literature study (as described in chapters two and three) it is expected that the relationship between entrepreneurial intensity and technology intensity should be statistically significant. Figure 4.5. provides a graphical representation of technology intensity as a function of entrepreneurial intensity, as is measured by the entrepreneurial performance index.

Figure 4.5. Entrepreneurial intensity as a function of technology intensity

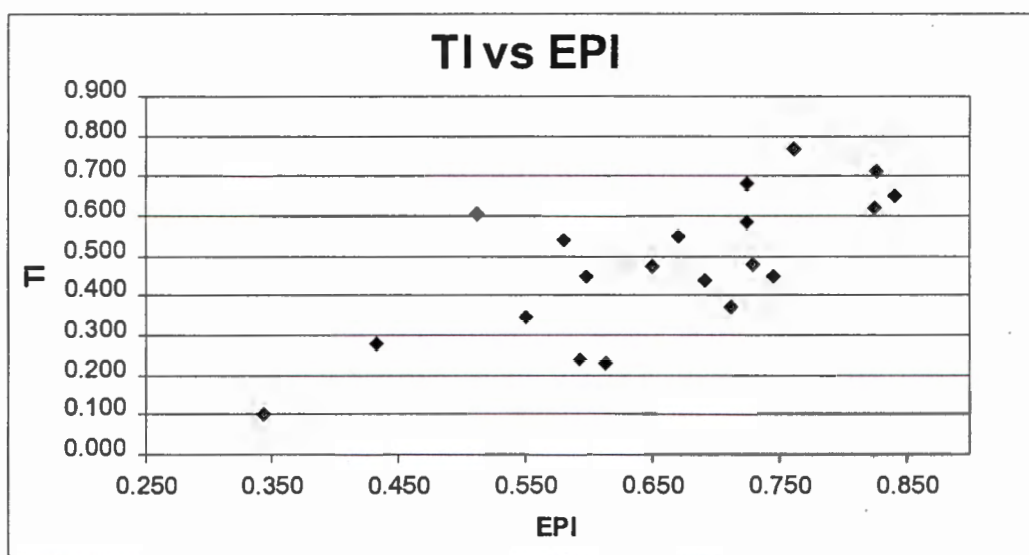


Figure 4.5. indicates that entrepreneurial intensity is positively correlated with technology intensity, as was expected. There exists a 73.6% correlation between the two variables. The determination coefficient of 0.542 indicates that 54.2% of the changes in entrepreneurial intensity can be attributed to corresponding changes in technology intensity for the sample of South African organisations.

The correlation between entrepreneurial intensity and technology intensity is therefore regarded as statistically significant, but more comprehensive research is required to develop a hypothesis about the relationship between the two variables.

The relationship between technology intensity and entrepreneurial intensity was examined in more detail to determine if statistically significant correlations exist between the sub-components of each of the two constructs. Emphasis was placed on the relationships between organisational learning components of both technology intensity and entrepreneurial intensity, as well as the relationship between entrepreneurial intensity and the integrated value chain component of the technology intensity construct. The major results are summarised in table 4.5.

Table 4.5. Statistical relationships between entrepreneurial intensity and technology intensity components

Correlation group	R	R ²
Degree of entrepreneurship and TI	0.745	0.555
Frequency of entrepreneurship and TI	0.655	0.429
TI (integrated value chain)/EPI	0.772	0.597
TI (marketing)/EPI (product introduction)	0.657	0.431
TI (org. learning)/EPI (org. learning)	0.623	0.388
EPI and TI for all categories	0.736	0.542

From table 4.5. it is evident that the correlation between the degree of entrepreneurship and technology intensity is significantly higher than the correlation between the frequency of entrepreneurship and technology intensity. Both correlation coefficients are however regarded as significant in the context of this study. A possible explanation for this difference might be centred on the utilisation of technology.

It was established that the organisations being reviewed do not optimise the utilisation of available technology. The results in table 4.5. might indicate that these organisations utilise technology more effectively to support entrepreneurial action (i.e. higher degree of entrepreneurship), compared to utilising it to identify new opportunities for entrepreneurial action (i.e. more frequent involvement in entrepreneurial action). It is suggested that technology should be utilised to identify new opportunities for entrepreneurial action, as this should eventually result in a higher degree of entrepreneurship (see section 4.5.1.).

This inter-relationship provides a fertile area of future management research, as the utilisation of advanced technology to identify new opportunities for organisational entrepreneurship can be developed into a major competitive advantage in the electronic economy.

Throughout the study emphasis has been placed on the importance of utilising technology to integrate organisational value chains as a means to stimulate entrepreneurial activity in organisations (Melnicoff, 1999b). Table 4.5. indicates that the integrated value chain component of the technology intensity construct is strongly related to entrepreneurial performance (correlation coefficient of 0.772).

Again this relationship should be verified in more detail via an extensive research effort, as theory suggests that the key to successful organisational entrepreneurship is an integrated value chain (Gilbert *et al.*, 1999). This result also indicates that advanced technology is perhaps the key enabler of integrated business value chains, providing a major source of future competitive advantage.

Table 4.5. indicates that the identified entrepreneurial marketing and organisational learning technologies (see chapter 3) are positively correlated with entrepreneurial marketing and organisational learning activities. The recorded correlation coefficients again indicate that advanced technology can

support entrepreneurial marketing and organisational learning activities. More extensive research is however required to formulate a general hypothesis in this regard.

It can be concluded that a statistically significant relationship exists between entrepreneurial intensity and technology intensity, but that more extensive research is required to develop general hypotheses that describe the extent of this relationship.

4.6. SUMMARY

A general empirical research method has been developed and applied to determine if a statistically significant correlation exists between entrepreneurial intensity and technology utilisation in organisations. The empirical study indicated that a statistically significant correlation exists between technology intensity and entrepreneurial intensity. Statistically significant relationships were also established between the various components of both the entrepreneurial intensity and technology intensity constructs. Detailed conclusions and recommendations about these relationships will be provided in chapter 5.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1. INTRODUCTION

In chapter 4 it was established that the relationship between technology intensity and entrepreneurial intensity is statistically significant in major South African organisations. The major conclusions of the study are summarised in chapter 5. These conclusions provide the foundation for numerous suggestions that can be implemented by South African organisations to improve entrepreneurial effectiveness by utilising advanced technology to a greater extent. Finally, future research opportunities will be highlighted.

5.2. CONCLUSIONS

The following conclusions can be drawn from the empirical survey that was designed to evaluate the extent to which advanced technology is utilised to support entrepreneurial activity in major South African organisations.

- It was established that South African organisations represented in the response sample exhibit above average entrepreneurial intensity, but place greater emphasis on the degree of entrepreneurship, rather than the frequency of entrepreneurship.
- A statistically significant relationship was observed between the degree of entrepreneurship and the frequency of entrepreneurship for the sample of South African organisations.

- A statistically significant relationship was established between organisational learning and entrepreneurial intensity for the group of respondents. The inclusion of the organisational learning components in the entrepreneurial intensity construct has been justified, but it is proposed that the inter-relationship between organisational learning and entrepreneurial intensity should be studied in greater detail.
- Major South African organisations place above average emphasis on organisational learning, but have not yet developed the required technology infrastructure to facilitate effective organisational learning.
- The empirical study revealed that the responding organisations exhibit average technology intensity scores, which are mainly determined by above average technology availability scores. It can therefore be concluded that advanced technology is not optimally utilised to enable and support entrepreneurial activity in the responding organisations.
- Statistically significant correlation coefficients were determined for the relationship between technology intensity and the degree of entrepreneurship, as well as the relationship between technology intensity and the frequency of entrepreneurship. The correlation between technology intensity and the degree of entrepreneurship was higher for the sample of respondents.

It might indicate that South African organisations utilise advanced technology to a greater extent to increase the extent of entrepreneurial activity, rather than to identify new opportunities for organisational entrepreneurship.

- A significant statistical correlation was established between entrepreneurial intensity and technology intensity for the sample of South African organisations. The significant role that advanced technology plays in enabling entrepreneurial activity, and thereby ensuring future competitiveness, has thus been verified.
- The proposed technology blueprint for entrepreneurial organisations of the 21st century emphasises the importance of integrated technology architecture to enable and support the creation of integrated raw materials and product supply chains between customers and suppliers. It was established that the correlation between the integrated value chain component of the technology intensity construct and overall entrepreneurial intensity is statistically significant. The importance of integrated technology architecture for entrepreneurial organisations has thus been verified.
- It has been established that advanced technology, as defined in chapter 3, is positively correlated new product introduction and organisational learning. The crucial role that advanced technology plays in improving inter-and intra-organisational collaboration has been verified. Improved collaboration manifests in improved idea generation and product development efforts.

Overall, it can be concluded that advanced technology, applied in an integrated architecture, is a key enabler of entrepreneurial activity in organisations. Major South African organisations realise the importance of investing in advanced technologies, but these investments are not leveraged to its full potential. South African organisations have also not focused on developing integrated knowledge repositories to support the organisational learning business process. It is however proposed that integrated knowledge repositories form the foundation of

effective organisational learning, which in turn provides the key to entrepreneurial effectiveness.

5.3. RECOMMENDATIONS

A significant correlation has been identified between various components of the entrepreneurial intensity construct and technology intensity. The response sample of South African organisations should however be greatly expanded before general hypotheses can be constructed around the inter-relationships between advanced technology and organisational entrepreneurship. The following recommendations can however be made based on the results of the study.

- It is suggested that South African organisations should more frequently engage in entrepreneurial activity, as it is expected that a higher frequency of entrepreneurship will result in a corresponding increase in the degree of entrepreneurship. More detailed research is however required to verify this expectation.
- South African organisations should invest in the development of integrated information and telecommunication technology architectures to enable effective organisational learning, as organisational learning is regarded as a key business process in the entrepreneurial organisation of the future.
- Technology integration provides the key to effective value chain management and opportunity recognition for organisational entrepreneurship. South African organisations should therefore focus on the development of integrated business information warehouses, as is proposed in chapter 3.

- It is suggested that the ability to utilise advanced technology effectively for the identification of new entrepreneurial opportunities will provide significant competitive advantages in the new competitive landscape. South African organisations should therefore develop the capacity to operate at the frontiers of technology to ensure competitiveness in the 21st century.

5.4. REVIEW OF STUDY OBJECTIVES

In general, it can be concluded that the major objectives of the study, as were determined in chapter 1, were all achieved. The major characteristics of entrepreneurial organisations were identified via the literature study. The literature study, and subsequently the empirical study, confirmed the importance of organisational learning as a major business process in entrepreneurial organisations. The dimensions of entrepreneurial intensity were isolated and utilised for the construction of an entrepreneurial intensity questionnaire.

Various advanced technologies, that are successfully utilised to enable and support entrepreneurial activities across the value chain, were identified via a literature survey. These technologies provided the foundation for the definition of a generalised, integrated technology architecture for the entrepreneurial organisation of the 21st century. This technology blueprint was also successfully utilised for the definition of the technology intensity construct.

An empirical research method has been designed to evaluate if a statistically significant relationship exists between entrepreneurial intensity and technology intensity. The empirical study confirmed that a strong correlation exists between these two variables. The design of the technology blueprint has also been verified statistically. Various focus areas have been identified that need to be

addressed by South African organisations to ensure that advanced technology is effectively leveraged to improve entrepreneurial performance.

5.5. FUTURE RESEARCH OPPORTUNITIES

The following opportunities for future research have been identified.

- The results from this initial empirical study indicate that a higher frequency of entrepreneurship correlates with a higher degree of entrepreneurship. It is proposed that the extent of the positive correlation between the degree and frequency of entrepreneurship should be examined more thoroughly to determine if a general hypothesis could be constructed to describe this relationship.
- The degree of the relationship between organisational learning and overall entrepreneurial performance warrants more detailed research in future studies, especially since organisational learning is regarded as a key business process in the entrepreneurial organisation of the 21st century.
- Future research emphasis should be placed on the relationship between technology availability and utilisation, as an optimum utilisation rating is expected above which additional investment in technology will not provide significant financial returns. Many major organisations are currently debating this issue (Melnicoff, 1999b).
- The inter-relationship between the frequency of entrepreneurship and technology intensity provides a fertile area of future management research. It is suggested that the utilisation of advanced technology to

identify new opportunities for organisational entrepreneurship be depicted in a general increase in the frequency of entrepreneurship.

- More detailed research must be conducted to develop a hypothesis about the relationship between technology intensity and entrepreneurial intensity.
- Finally, it is recommended that the composition of the technology blueprint should be updated on an annual basis to reflect the increasing rate of technological advancement. It is however believed that the creation of an integrated technology environment will remain the foundation of the blueprint for the next decade.

5.6. SUMMARY

The significance of the relationship between technology intensity and entrepreneurial performance has statistically been verified in this study. It can be concluded that entrepreneurial organisations should develop the ability to operate at the frontiers of technology, as it enables and supports opportunity recognition and entrepreneurial effectiveness. Advanced technology can provide sustainable competitive advantage if it is effectively leveraged to improve entrepreneurial effectiveness.

The important role that advanced telecommunication and information technology can play in supporting the organisational learning business process has been verified statistically. The dynamic relationship between technology and entrepreneurship should be investigated to a greater extent, as this partnership represents a potent source of sustainable competitive advantage in the new competitive landscape.

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APPENDIX 1.
DESIGN OF QUESTIONNAIRES FOR EMPIRICAL RESEARCH

**Table A1.1. The entrepreneurial performance index questionnaire
(applied to South African Companies)**

A. NEW PRODUCT INTRODUCTION					
	Significantly Less	Same			Significantly More
1. What is the number of new products your company introduced during the past 2 years? _____	1	2	3	4	5
2. How does the number of new product introductions your company made compare with those of your major competitors?	1	2	3	4	5
3. To what degree did these new product introductions include products that had not previously existed anywhere before (<i>new to the world</i>)?	1	2	3	4	5
4. To what degree did these new product introductions include products that had not previously exist in your markets (<i>new to South African markets</i>)?	1	2	3	4	5
5. To what degree did these new product introductions represent modifications to current products or extensions of current product lines?	1	2	3	4	5
B. NEW SERVICE INTRODUCTION					
	Significantly Less	Same			Significantly More
1. What is the number of new services your company introduced during the past 2 years? _____					
2. How does the number of new service introductions your company made compare with those of your major competitors?	1	2	3	4	5
	Not at all				To a great extent
3. To what degree did these new service introductions include services that had not previously existed anywhere before (<i>new to the world</i>)?	1	2	3	4	5
4. To what degree did these new service introductions include services that had not previously exist in your markets (<i>new to South African markets</i>)?	1	2	3	4	5
5. To what degree did these new service introductions represent modifications to current products or extensions of current product lines?	1	2	3	4	5
C. NEW PROCESS INTRODUCTION					
1. Estimate the number of new production or operational processes your company implemented during the past 2 years. Examples of process innovation? New inventory management systems, an improved accounts payment process, major new sales and distribution approaches, etc. _____					
	Significantly Less	Same			Significantly More
2. How does the number of new production or operational process introductions your company made compare with those of your major competitors?	1	2	3	4	5
3. To what extent did these new process improvements represent a minor or major modification or existing processes?	1	2	3	4	5
D. COMPANY ORIENTATION					
<i>Our company is characterized by:</i>	Strongly Disagree				Strongly agree
1. A high rate of new product/service introduction, compared to our competitors (including new features and improvements)	1	2	3	4	5
2. An emphasis on continuous improvement in methods of production and service delivery	1	2	3	4	5
3. Risk-taking by key executives in seizing and exploring chancy new opportunities	1	2	3	4	5
4. A "live and let live" philosophy in dealing with competitors	1	2	3	4	5
5. Seeking of unusual, novel solutions by senior executives to problems via the use of "idea people" brainstorming, consultants, etc.	1	2	3	4	5
6. A top management philosophy that emphasizes proven products and services, and the avoidance of heavy new product development costs.	1	2	3	4	5
7. A charismatic leader at the top	1	2	3	4	5

**Table A1.1. The entrepreneurial performance index questionnaire
(continues)**

At our company, top level decision making is characterized by:					
8. Cautious, pragmatic, step-at-a-time adjustments to problems	1	2	3	4	5
9. Active searches for big opportunities	1	2	3	4	5
10. Rapid growth as a dominant goal	1	2	3	4	5
11. Large, bold decisions, despite uncertainties of outcomes	1	2	3	4	5
12. Compromises among the conflicting demands of owners, government, customers, management, employees, suppliers, etc.	1	2	3	4	5
13. Steady growth and stability as primary concerns	1	2	3	4	5
E. KEY BUSINESS BEHAVIOURAL DIMENSIONS					
The following questions relate to the situational factors that face individuals in your organizations on a day-to-day basis. Please circle the number that best represents the emphasis your company places on the given criteria: 1 implies more emphasis on the left and 5 places more emphasis on the right.					
1. When it comes to the company's current strategic orientation, we are:					
Influenced primarily by the resources we currently control	1	2	3	4	5
2. When it comes to your company's approach to new opportunities, we tend to:					
Commit fairly quickly, capitalize and move to the next opportunity	1	2	3	4	5
3. Our company's approach to investing resources in new opportunities tends to involve:					
Multiple stages with minimal commitment at each stage	1	2	3	4	5
4. When it comes to the way we manage and control our resources, we prefer:					
Episodic use, renting, leasing contracting and outsourcing	1	2	3	4	5
5. Our company's management structure can be characterized as:					
A flat structure with multiple informal networks	1	2	3	4	5
6. Our company's compensation and reward system is:					
Value based and team based with unlimited earnings potential for employees	1	2	3	4	5
Influenced primarily by the perception of untapped opportunity					
Approach with an evolutionary commitment that tends to be of long duration					
A single stage with complete commitment upon decision					
Ownership, purchase, control and employment of the resources we use					
A hierarchical structure with clearly defined authority and responsibility					
Resource based, driven by short term performance with limited earnings potential					
F. ORGANIZATIONAL LEARNING					
<i>Please encircle the number most applicable to your organization:</i>					
Our leader has a clear vision	1	2	3	4	5
This vision is clearly communicated	1	2	3	4	5
The leader is admired by employees	1	2	3	4	5
Leaders "walk the talk" when it comes to organizational learning	1	2	3	4	5
There is a clear plan to transform our vision into reality	1	2	3	4	5
We effectively measure our processes, progress and results	1	2	3	4	5
Results of our metrics are shared rapidly and widely	1	2	3	4	5
External and internal customer requirements are clearly understood	1	2	3	4	5
We routinely learn from the best practices of our competitors or colleagues locally and internationally.	1	2	3	4	5
We avoid the problem of "not invented here" by using the good ideas of others	1	2	3	4	5
We rapidly identify and share organizational best practices	1	2	3	4	5
We seek to help employees to identify changing needs in the workplace and provide learning opportunities to meet these needs	1	2	3	4	5
Training is actively supported throughout the organization	1	2	3	4	5
We accept challenges, even if we are not sure how to meet them	1	2	3	4	5
We hold people accountable	1	2	3	4	5
We do not punish intelligent failure or mistakes	1	2	3	4	5
We find work fun	1	2	3	4	5
Learning is planned and purposeful, rather than accidental	1	2	3	4	5
Personal growth is encouraged and rewarded	1	2	3	4	5
Leaders serve as learning role models	1	2	3	4	5
We provide challenging jobs that stretch employee abilities	1	2	3	4	5
People show a passion for personal and organizational growth	1	2	3	4	5
We are flexible in making organizational changes that reflect changing job skill sets and requirements	1	2	3	4	5

**Table A1.2. Technology intensity questionnaire
(Applied to South African Companies)**

A. ENTREPRENEURIAL MARKETING	Not at All					To a great Extent
<i>Please rate your organization on the following criteria.</i>						
1. Have the sales force in your organization been issued with mobile technology I.e. cellular telephones, laptops, mobile transaction processing tools?	1	2	3	4	5	
2. How effectively is this mobile technology (as specified above) applied to enable customized selling and automatic order taking?	1	2	3	4	5	
3. Does your company operate with standardized computer software, I.e. MS Office, Lotus Notes, etc.?	1	2	3	4	5	
4. Does your organization have a website on the internet?	1	2	3	4	5	
5. To what extent is internet marketing applied in your organization?	1	2	3	4	5	
6. To what extent do your organization partake in web-enabled, real time market research (I.e. online questionnaires?)	1	2	3	4	5	
7. To what extent have your organization developed databases in which customer information is stored and analyzed?	1	2	3	4	5	
8. How effectively are these databases utilized to analyze customer needs, evaluate customer complaints and do market segmentation and analysis?	1	2	3	4	5	
9. Have your organization developed an intranet?	1	2	3	4	5	
10. How effectively is the intranet utilized to promote internal communication across functional departments, as well as with customers and suppliers?	1	2	3	4	5	
B. INTEGRATED VALUE CHAIN	Not at All					To a great Extent
<i>Please rate your organization on the following criteria.</i>						
1. Has your organization invested in and enterprise resource planning (ERP) system (e.g. SAP, BAAN)?	1	2	3	4	5	
2. Is the ERP system in your organization linked to similar systems of customers via TCP/IP networks) to enable electronic transaction processing?	1	2	3	4	5	
3. Have your organization developed legacy systems that enables electronic data interchange via TCP/IP networks?	1	2	3	4	5	
4. How effectively are the above systems utilized to facilitate the integration of product supply chains (suppliers and customers)?	1	2	3	4	5	
5. How effectively are these systems utilized to proactively manage inventory, improve operations scheduling and improve logistics management between suppliers and customers?	1	2	3	4	5	
6. Have your organization invested in automated logistics scheduling systems?	1	2	3	4	5	
7. How effective are these artificial intelligence systems in improving logistics management and reducing distribution costs?	1	2	3	4	5	
8. Does your organization have the required information systems infrastructure to enable personnel to operate from home (I.e. wide area networks, integrated information databases, multimedia for communication purposes)?	1	2	3	4	5	
9. How effective are virtual office workers?	1	2	3	4	5	
10. Does your organization employ information and communication technology to enhance relationships with international partners (global collaboration)?	1	2	3	4	5	
11. How effective are these virtual partnerships in supporting the development of new products and processes, reducing costs and anticipating market trends?	1	2	3	4	5	

**Table A1.2. Technology intensity questionnaire
(continues)**

C. MANUFACTURING	Not at All				To a great Extent
<i>Please rate your organization on the following criteria. Ignore this section if your organization does not manufacture any products.</i>					
1. Does your organization utilize machinery that is automatically controlled by programmable logical controllers (PLCs) in its manufacturing processes?	1	2	3	4	5
2. Are the manufacturing processes automatically controlled via sequenced PLCs which are linked via plant networks?	1	2	3	4	5
3. Have your organization invested in system control and data acquisition systems (SCADA) to enable real-time process management by operators?	1	2	3	4	5
4. Is process information captured in real-time (via PLCs) in a centralized production database to produce real-time, automated process management reports?	1	2	3	4	5
5. Is this real-time production information database interfaced into the ERP system?	1	2	3	4	5
6. How effectively are process automation systems in improving manufacturing flexibility, quality management and production costs?	1	2	3	4	5
7. How effective are real-time production information management systems in improving operations scheduling, process management, quality management and process innovation in your organization?	1	2	3	4	5
8. Have your organization invested in artificial intelligence systems for manufacturing purposes, i.e. (neural control systems, robot technology, etc.)?	1	2	3	4	5
9. How effective are intelligent control and manufacturing systems in improving manufacturing flexibility, process management and innovation, and production cost control in your organization?	1	2	3	4	5
10. How effectively is real-time process information management systems utilized to improve maintenance management in your organization?	1	2	3	4	5
11. Have your organization invested in product development tools, i.e. computer aided design (CAD), automated engineering analysis (AEA), object oriented technology (OOT), etc.?	1	2	3	4	5
12. How effectively are these tools (Q11) utilized to reduce product development times, improve product functionality and enable product innovation?	1	2	3	4	5
D. ORGANIZATIONAL LEARNING	Not at All				To a great Extent
<i>Please rate your organization on the following criteria.</i>					
1. How effective are local area and wide area networks (LAN, WAN and Internet) in facilitating inter-and intra-organizational communication in your organization?	1	2	3	4	5
2. Have your organization developed documentation and information databases, which can be accessed by networks, to store and manage information?	1	2	3	4	5
3. How integrated are information repositories (databases) to enable direct access to the latest information in your organization?	1	2	3	4	5
4. How effective is communication and information technology utilized to enable the formation of remotely distributed (or virtual) project teams in your organization?	1	2	3	4	5

APPENDIX 2.
RESULTS OF THE ENTREPRENEURIAL INTENSITY AND TECHNOLOGY
INTENSITY EMPIRICAL SURVEYS

Table A2.1. Results of the entrepreneurial performance survey

PARAMETER	FREQUENCY			DEGREE			WEIGHTING		EPI (Normalized)
	Maximum Score	Actual Score	Normalized Score	Maximum Score	Actual Score	Normalized Score	Frequency (a)	Degree (b)	
Product Introduction									
FMCG	5	4	0.8	15	14	0.93	0.5	0.5	0.87
Chemicals	5	2	0.4	15	9	0.60	0.5	0.5	0.50
Energy	5	1	0.2	15	9	0.60	0.5	0.5	0.40
Banking	5	3	0.6	15	11	0.73	0.5	0.5	0.67
Mining	0	0	(-)	0	0	(-)	0.5	0.5	(-)
FMCG	5	3	0.6	15	12	0.80	0.5	0.5	0.70
Chemicals	5	2	0.4	15	9	0.60	0.5	0.5	0.50
IT	5	4	0.8	15	13	0.87	0.5	0.5	0.83
Banking	5	4	0.8	15	12	0.80	0.5	0.5	0.80
Chemicals	5	2	0.4	15	7	0.47	0.5	0.5	0.43
Insurance	5	4	0.8	15	12	0.80	0.5	0.5	0.80
Insurance	5	4	0.8	15	12	0.80	0.5	0.5	0.80
Banking	5	3	0.6	15	9	0.60	0.5	0.5	0.60
IT	5	3	0.6	15	13	0.87	0.5	0.5	0.73
Chemicals	5	3	0.6	15	10	0.67	0.5	0.5	0.63
Mining	0	0	(-)	0	0	(-)	0.5	0.5	(-)
Chemicals	5	4	0.8	15	10	0.67	0.5	0.5	0.73
Banking	5	3	0.6	15	10	0.67	0.5	0.5	0.63
IT	5	4	0.8	15	11	0.73	0.5	0.5	0.77
Service Introduction									
FMCG	5	4	0.8	15	12	0.80	0.5	0.5	0.80
Chemicals	5	2	0.4	15	6	0.40	0.5	0.5	0.40
Energy	5	5	1	15	8	0.53	0.5	0.5	0.77
Banking	5	3	0.6	15	11	0.73	0.5	0.5	0.67
Mining	5	2	0.4	15	9	0.60	0.5	0.5	0.50
FMCG	5	3	0.6	15	11	0.73	0.5	0.5	0.67
Chemicals	5	2	0.4	15	8	0.53	0.5	0.5	0.47
IT	5	3	0.6	15	12	0.80	0.5	0.5	0.70
Banking	5	4	0.8	15	11	0.73	0.5	0.5	0.77
Chemicals	5	3	0.6	15	9	0.60	0.5	0.5	0.60
Insurance	5	3	0.6	15	12	0.80	0.5	0.5	0.70
Insurance	5	3	0.6	15	12	0.80	0.5	0.5	0.70
Banking	5	2	0.4	15	10	0.67	0.5	0.5	0.53
IT	5	2	0.4	15	9	0.60	0.5	0.5	0.50
Chemicals	5	3	0.6	15	9	0.60	0.5	0.5	0.60
Mining	0	0	(-)	0	0	(-)	0.5	0.5	(-)
Chemicals	5	3	0.6	15	9	0.60	0.5	0.5	0.60
Banking	5	2	0.4	15	8	0.53	0.5	0.5	0.47
IT	5	4	0.8	15	13	0.87	0.5	0.5	0.83
Process Introduction									
FMCG	5	5	1	5	5	1.00	0.5	0.5	1.00
Chemicals	5	1	0.2	5	4	0.80	0.5	0.5	0.50
Energy	5	3	0.6	5	2	0.40	0.5	0.5	0.50
Banking	5	3	0.6	5	5	1.00	0.5	0.5	0.80
Mining	5	4	0.8	5	4	0.80	0.5	0.5	0.80
FMCG	5	5	1	5	5	1.00	0.5	0.5	1.00
Chemicals	5	2	0.4	5	4	0.80	0.5	0.5	0.60
IT	5	3	0.6	5	5	1.00	0.5	0.5	0.80
Banking	5	4	0.8	5	4	0.80	0.5	0.5	0.80
Chemicals	5	3	0.6	5	4	0.80	0.5	0.5	0.70
Insurance	5	4	0.8	5	4	0.80	0.5	0.5	0.80
Insurance	5	3	0.6	5	5	1.00	0.5	0.5	0.80
Banking	5	2	0.4	5	4	0.80	0.5	0.5	0.60
IT	5	4	0.8	5	5	1.00	0.5	0.5	0.90
Chemicals	5	4	0.8	5	5	1.00	0.5	0.5	0.90
Mining	5	4	0.8	5	5	1.00	0.5	0.5	0.90
Chemicals	5	4	0.8	5	5	1.00	0.5	0.5	0.90
Banking	5	3	0.6	5	3	0.60	0.5	0.5	0.60
IT	5	4	0.8	5	4	0.80	0.5	0.5	0.80

Table A2.1. Results of the entrepreneurial performance survey

(continue)

Company Orientation									
FMCG	5	5	1	60	54	0.90	0.5	0.5	0.95
Chemicals	5	2	0.4	60	23	0.38	0.5	0.5	0.39
Energy	5	1	0.2	60	30	0.50	0.5	0.5	0.35
Banking	5	2	0.4	60	45	0.75	0.5	0.5	0.58
Mining	5	4	0.8	60	30	0.50	0.5	0.5	0.65
FMCG	5	5	1	60	44	0.73	0.5	0.5	0.87
Chemicals	5	2	0.4	60	32	0.53	0.5	0.5	0.47
IT	5	4	0.8	60	47	0.78	0.5	0.5	0.79
Banking	5	5	1	60	47	0.78	0.5	0.5	0.89
Chemicals	5	3	0.6	60	35	0.58	0.5	0.5	0.59
Insurance	5	4	0.8	60	46	0.77	0.5	0.5	0.78
Insurance	5	3	0.6	60	41	0.68	0.5	0.5	0.64
Banking	5	2	0.4	60	39	0.65	0.5	0.5	0.53
IT	5	4	0.8	60	46	0.77	0.5	0.5	0.78
Chemicals	5	4	0.8	60	42	0.70	0.5	0.5	0.75
Mining	5	4	0.8	60	37	0.62	0.5	0.5	0.71
Chemicals	5	4	0.8	60	39	0.65	0.5	0.5	0.73
Banking	5	3	0.6	60	42	0.70	0.5	0.5	0.65
IT	5	4	0.8	60	49	0.82	0.5	0.5	0.81
Business Behaviour									
FMCG	-	-	-	30	16	0.53	0	1	0.53
Chemicals	-	-	-	30	7	0.23	0	1	0.23
Energy	-	-	-	30	11	0.37	0	1	0.37
Banking	-	-	-	30	10	0.33	0	1	0.33
Mining	-	-	-	30	11	0.37	0	1	0.37
FMCG	-	-	-	30	15	0.50	0	1	0.50
Chemicals	-	-	-	30	11	0.37	0	1	0.37
IT	-	-	-	30	23	0.77	0	1	0.77
Banking	-	-	-	30	22	0.73	0	1	0.73
Chemicals	-	-	-	30	14	0.47	0	1	0.47
Insurance	-	-	-	30	17	0.57	0	1	0.57
Insurance	-	-	-	30	14	0.47	0	1	0.47
Banking	-	-	-	30	14	0.47	0	1	0.47
IT	-	-	-	30	25	0.83	0	1	0.83
Chemicals	-	-	-	30	20	0.67	0	1	0.67
Mining	-	-	-	30	17	0.57	0	1	0.57
Chemicals	-	-	-	30	17	0.57	0	1	0.57
Banking	-	-	-	30	11	0.37	0	1	0.37
IT	-	-	-	30	26	0.87	0	1	0.87
Organisational Learning									
FMCG				115	87	0.76	0	1	0.76
Chemicals				115	32	0.28	0	1	0.28
Energy				115	66	0.57	0	1	0.57
Banking				115	81	0.70	0	1	0.70
Mining				115	44	0.38	0	1	0.38
FMCG				115	71	0.62	0	1	0.62
Chemicals				115	48	0.42	0	1	0.42
IT				115	90	0.78	0	1	0.78
Banking				115	97	0.84	0	1	0.84
Chemicals				115	84	0.73	0	1	0.73
Insurance				115	95	0.83	0	1	0.83
Insurance				115	82	0.71	0	1	0.71
Banking				115	95	0.83	0	1	0.83
IT				115	94	0.82	0	1	0.82
Chemicals				115	94	0.82	0	1	0.82
Mining				115	72	0.63	0	1	0.63
Chemicals				115	72	0.63	0	1	0.63
Banking				115	81	0.70	0	1	0.70
IT				115	101	0.88	0	1	0.88

Table A2.2. Results of the technology intensity survey

PARAMETER	TECHNOLOGY AVAILABILITY			TECHNOLOGY UTILIZATION			TI (Normalized)
	Maximum Score	Actual Score	Normalized Score	Maximum Score	Actual Score	Normalized Score	
Entrepreneurial Marketing							
FMCG	25	25	1.00	25	19	0.76	0.76
Chemicals	25	14	0.56	25	7	0.28	0.16
Energy	25	25	1.00	25	14	0.56	0.56
Banking	25	14	0.56	25	8	0.32	0.18
Mining	20	14	0.70	20	8	0.4	0.28
FMCG	25	24	0.96	25	17	0.68	0.65
Chemicals	25	18	0.72	25	10	0.4	0.29
IT	25	20	0.80	25	16	0.64	0.51
Banking	25	25	1.00	25	22	0.88	0.88
Chemicals	25	13	0.52	25	7	0.28	0.15
Insurance	25	25	1.00	25	20	0.8	0.80
Insurance	25	25	1.00	25	17	0.68	0.68
Banking	25	22	0.88	25	19	0.76	0.67
IT	25	23	0.92	25	20	0.8	0.74
Chemicals	25	22	0.88	25	18	0.72	0.63
Mining	15	14	0.93	5	3	0.6	0.56
Chemicals	25	22	0.88	25	13	0.52	0.46
Banking	25	19	0.76	25	16	0.64	0.49
IT	25	23	0.92	25	21	0.84	0.77
Integrated Value Chain							
FMCG	30	24	0.80	25	18	0.72	0.58
Chemicals	30	12	0.40	25	5	0.20	0.08
Energy	30	22	0.73	25	17	0.68	0.50
Banking	30	15	0.50	25	16	0.64	0.32
Mining	30	19	0.63	25	11	0.44	0.28
FMCG	30	17	0.57	25	17	0.68	0.39
Chemicals	30	17	0.57	25	13	0.52	0.29
IT	15	11	0.73	20	14	0.70	0.51
Banking	25	21	0.84	15	12	0.80	0.67
Chemicals	25	11	0.44	20	11	0.55	0.24
Insurance	25	22	0.88	20	19	0.95	0.84
Insurance	25	19	0.76	20	14	0.70	0.53
Banking	25	23	0.92	20	12	0.60	0.55
IT	25	22	0.88	20	14	0.70	0.62
Chemicals	30	23	0.77	25	17	0.68	0.52
Mining	30	18	0.60	25	13	0.52	0.31
Chemicals	30	19	0.63	25	15	0.60	0.38
Banking	25	20	0.80	20	14	0.70	0.56
IT	25	22	0.88	20	12	0.60	0.53

Table A2.2. Results of the technology intensity survey

(continue)

Manufacturing							
FMCG	35	31	0.89	25	20	0.80	0.71
Chemicals	35	11	0.31	25	7	0.28	0.09
Energy	35	33	0.94	25	23	0.92	0.87
Banking	0	0	(-)	0	0	(-)	(-)
Mining	35	30	0.86	25	18	0.72	0.62
FMCG	35	30	0.86	25	18	0.72	0.62
Chemicals	35	21	0.60	25	13	0.52	0.31
IT	0	0	(-)	0	0	(-)	(-)
Banking	0	0	0	0	0	0	0
Chemicals	30	20	0.67	20	12	0.60	0.40
Insurance	0	0	(-)	0	0	(-)	(-)
Insurance	0	0	(-)	0	0	(-)	(-)
Banking	0	0	(-)	0	0	(-)	(-)
IT	0	0	(-)	0	0	(-)	(-)
Chemicals	35	29	0.83	25	20	0.80	0.66
Mining	35	23	0.66	25	16	0.64	0.42
Chemicals	35	25	0.71	25	19	0.76	0.54
Banking							
IT							
Organisational Learning							
FMCG	10	5	0.50	10	8	0.80	0.40
Chemicals	10	2	0.20	10	3	0.30	0.06
Energy	10	7	0.70	10	5	0.50	0.35
Banking	10	4	0.40	10	3	0.30	0.12
Mining	10	3	0.30	10	3	0.30	0.09
FMCG	10	3	0.30	10	3	0.30	0.09
Chemicals	10	2	0.20	10	5	0.50	0.10
IT	10	4	0.40	10	5	0.50	0.20
Banking	10	6	0.60	10	7	0.70	0.42
Chemicals	10	3	0.30	10	4	0.40	0.12
Insurance	10	7	0.70	10	8	0.80	0.56
Insurance	10	5	0.50	10	6	0.60	0.30
Banking	10	2	0.20	10	7	0.70	0.14
IT	10	10	1.00	10	7	0.70	0.70
Chemicals	10	5	0.50	10	8	0.80	0.40
Mining	10	4	0.40	10	5	0.50	0.20
Chemicals	10	4	0.40	10	6	0.60	0.24
Banking	10	3	0.30	10	5	0.50	0.15
IT	10	9	0.90	10	5	0.50	0.45

Table A2.3. Correlation between entrepreneurial intensity and technology intensity

Company/Industry	EPI	TI
FMCG	0.842	0.650
Banking	0.827	0.711
Insurance	0.763	0.769
Chemicals	0.725	0.586
IT	0.746	0.445
FMCG	0.729	0.479
IT	0.725	0.683
Mining	0.712	0.373
Chemicals	0.692	0.436
Insurance	0.671	0.549
Banking	0.615	0.228
Chemicals	0.594	0.237
Banking	0.581	0.541
Mining	0.551	0.347
Electricity	0.513	0.604
Chemicals	0.433	0.280
Chemicals	0.344	0.101
Banking	0.598	0.445
IT	0.825	0.622
Average	0.651	0.472
Standard deviation	0.131	0.185
Correlation	0.736	
Determination	0.542	

Table A2.4. TI and EPI distributions

RANGE	(%) EPI	(%) TI
0-0.1	0.00	0.00
0.1-0.2	0.00	5.26
0.2-0.3	0.00	15.79
0.3-0.4	5.26	10.53
0.4-0.5	5.26	21.05
0.5-0.6	10.53	15.79
0.6-0.7	31.58	21.05
0.7-0.8	31.58	10.53
0.8-0.9	15.79	0.00
0.9-1.00	0.00	0.00
Total	100.00	100.00

Table A3.5. Correlation between technology entrepreneurial intensity components

Company	Organisational learning		Marketing		Integrated value chain	
	EPI(o/l)	TI(o/l)	EPI (product)	TI (marketing)	EPI(t)	TI (ivc)
FMCG	0.76	0.40	0.87	0.76	0.76	0.58
Chemicals	0.28	0.06	0.50	0.16	0.28	0.08
Electricity	0.57	0.35	0.40	0.56	0.57	0.50
Banking	0.70	0.12	0.67	0.18	0.70	0.32
Mining	0.38	0.09	(-)	0.28	0.38	0.28
FMCG	0.62	0.09	0.70	0.65	0.62	0.39
Chemicals	0.42	0.10	0.50	0.29	0.42	0.29
IT	0.78	0.20	0.83	0.51	0.78	0.51
Banking	0.84	0.42	0.80	0.88	0.84	0.67
Chemicals	0.73	0.12	0.43	0.15	0.73	0.24
Insurance	0.83	0.56	0.80	0.80	0.83	0.84
Insurance	0.71	0.30	0.80	0.68	0.71	0.53
Banking	0.83	0.14	0.60	0.67	0.83	0.55
IT	0.82	0.70	0.73	0.74	0.82	0.62
Chemicals	0.82	0.40	0.63	0.63	0.82	0.52
Mining	0.63	0.20	(-)	0.56	0.63	0.31
Chemicals	0.63	0.24	0.73	0.46	0.63	0.38
Banking	0.70	0.15	0.63	0.49	0.70	0.56
IT	0.88	0.45	0.77	0.77	0.88	0.53