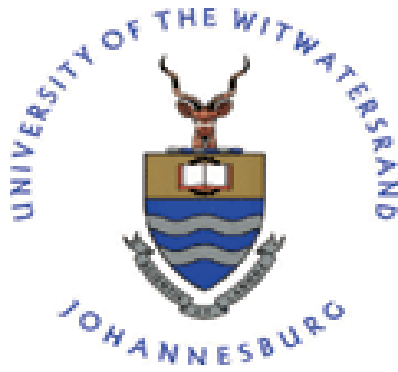




Using chaos and complexity theory to design robust leadership architecture for South African technology businesses

Vivashan Mogamberry Muthan

(Student number: 0211689M)

School of Mechanical, Industrial and Aeronautical Engineering

University of the Witwatersrand

Johannesburg, South Africa.

Supervisor:

Dr. Bruno Emwanu

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Declaration

I, Vivashan Mogamberry Muthan, Student Number 0211689M, am a student registered for the degree of Master of Science in Engineering in the academic year 2015.

I declare that this research report is my own unaided work. It is being submitted to the Degree of Master of Science in Engineering to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other University.

Signature of candidate

_____ day of _____, _____

Abstract

South African technology businesses are seeing an increasing number of young professionals from diverse backgrounds joining their ranks. Managing diversity in the workplace is perceived to be poorly handled in the South African business arena and may be responsible for the large turnover of employed professionals observed. There is a high rate at which young professionals are changing jobs, leaving the country and/ or becoming unproductive or complacent within relatively short periods of time. This situation is of serious concern due to the severe shortage of skills in the country, especially in the technology sector. On the one hand it creates a major upset or disruption for companies that invest significant resources in the training and development of these individuals. On the other hand, it leads to a vast knowledge gap within the industry since the time horizon of incumbents in specific positions or in companies is seldom long enough to fully develop specialist knowledge within the various technical niches.

Chaos and complexity theories are applied in the study to understand this problem better in the context of interactions between constituent parts of a dynamic system within itself and with the environment, and, specifically, to determine the degree to which the problem is influenced by leadership interactions. In the process a framework for designing leadership architecture was developed with the aim of helping business leaders better manage the problem.

A mixed method approach was used to conduct the research, in which a survey with over ninety respondents and focus group of selected individuals were used to obtain quantitative and qualitative data respectively. The data were then analysed to provide useful insight. The results showed that leadership, particularly the relationship between professionals and their direct managers, has a significant influence on the decision to stay or leave a company and/ or to change professions.

Dedication

I dedicate this work to my parents, Morgan and Shireen Muthan, who held my hand from my first step all the way through life, never letting me want for the feelings of love and encouragement. Thank you for giving me the one gift worth everything to me - the idea that love is worth more than any type or amount of material wealth.

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Nomenclature/ Definitions

Technology business – this refers to business operations whose core area of expertise is engineering of any discipline or information and communication technology (ICT).

Technology professional – this is taken to mean an individual with a tertiary qualification in a technological field of study at South African National Qualifications Framework (NQF) Level 5 or higher.

Leadership architecture – this is defined as the organisational management structures (management style, work environment and policies), processes and functions, both tangible and intangible, which enable and operationalise leadership transactions within the business (Gharajedaghi, 2011).

Shared Image – this refers to the collective set of intrinsic values (social, cultural, economic etc.) of an individual or group of individuals; the culture of a social system (Gharajedaghi, 2011).

Complex Adaptive Systems (CAS) –these are systems where relationships are not primarily defined hierarchically as they are in bureaucratic systems but rather by *interactions* among heterogeneous agents and across agent networks (Marion & Uhl-Bien, 2006).

Agents – this term refers to human elements of a social system; individuals as well as groups of individuals, who “resonate” through sharing common interests, knowledge and/or goals due to their history of interaction and sharing of worldviews (Marion & Uhl-Bien, 2006).

Pattern-able behaviour (as opposed to predictable behaviour)—this refers to non-linear system dynamics where linear, Newtonian models cannot be used to predict future states of the system, but there is a long-term pattern which emerges that can be identified and used to develop intuition about how the system is evolving over time. It is a hallmark of systems displaying chaotic behaviour. A famous example is planetary motion (Gleick, 1987).

Abbreviations

B-BBEE – Broad-Based Black Economic Empowerment

CAS – Complex Adaptive Systems

GST – General Systems Theory

SAI – Systemically Active Integration

SSM – Soft Systems Methodology

1. INTRODUCTION

1.1 Background

South African technology businesses¹ are seeing an increasing number of young professional incumbents from diverse backgrounds entering into the principally traditional and orthodox management structures which predominantly govern the country's businesses at large. Managing diversity in the workplace with due regard for the cultural and personal dimensions of these individuals is a challenge that is not effectively being handled by the majority of senior managers in the South African business arena (Jackson, 1999). Evidence of this is observed in the rate at which these young professionals are changing jobs, leaving the country for better prospects and/ or becoming unproductive or complacent within relatively short periods of time. Coetzee and Botha (2012) refer to an apparent languishing of commitment. This situation is of serious concern for the South African business sphere due to the severe shortage of skills in the country, especially in the technology sector (Hall & Sandelands, 2009; Kaplan & Charum, 1998). The number of individuals who frequently migrate between companies and/ or change their professions altogether (profession switch) has created a major upset for companies that invest significant resources in the training and development of these individuals only to have them leave. It also leaves knowledge gaps, since the time horizon of incumbents in specific positions or in companies is seldom long enough to fully develop specialist knowledge within the various technical niches (Toit & Roodt, 2008).

One factor that has been described as being the discrepancy indicator is the difference between the much higher remuneration rates of developed countries for technical professionals and the substantially lower rate offered by South African businesses. Kaplan and Charum (1998:10), for example, stated that the data suggests migration of engineering professionals is very sensitive to the economic climate. Therefore, individuals driven by monetary goals and seeking a lifestyle perceived as better would typically opt for a venture abroad, since the probability of securing a position in a local company that remunerates at an international rate is very low (Gauteng Business News, 2008). However other individuals not concerned with monetary gain and electively remaining in South Africa, indicate that they are not particularly concerned with

¹ A full definition of terms used in this section 1.1. and subsequent sections of the report is provided on page viii under "Nomenclature".

developing knowledge in their fields of practice for so long as they are in receipt of higher than average remuneration. They are content to hold positions lacking pressure for growth in either pure engineering knowledge or responsibility, provided they are paid a relatively higher salary than the market average (Hall & Sandelands, 2009). This has made sectors such as banking and sales more attractive. Another group of individuals initially choose to accept lower salaries and compensate by gaining a significant level of experience. However this is only for a limited time and until the experience was enough to trade in for a management position later on, even if this was a non-technical role (Terblanche, 2011).

The motivation of individuals who are constantly moving between companies therefore appears to fall into a fuzzy set (Zadeh, 1969) since this movement does not immediately appear to be driven solely by a choice between binary objectives such as financial incentive and experience. If this motivation is not properly understood in context, the shortage of technically skilled professionals in South Africa will at best remain at the current dire level which will in turn pose a significant threat to the country's long-term growth ambition (Sharp, 2011).

In light of this problem, the proposed study, motivated primarily by formal and informal discussions, held over a period of five years between January 2007 up to and including April 2012, with various engineering and ICT professionals around the subject of career development and anecdotal evidence, aims to explore further the motivation of technical professionals. Specifically, it will focus on analysing the interactions between these professionals and their organisations, how they are managed and the quality of the leadership they are exposed to, as their careers develop and their attitude to both their professions and their respective organisations over time. The network feedback effects generated by these interactions may offer an explanation for the seemingly erratic migrations and instability of sustainable technical knowledge transfer within what is effectively a knowledge-driven sector. The theories of chaos and complexity may offer a useful tool for the proposed analysis and this is elaborated on later.

South African technology businesses, whether fully local or locally managed entities of multi-nationals, in-line with a global trend, are transitioning from senior managers (40 - 60 year old) to younger (26 - 39 year old), culturally diverse professionals in leadership roles. This necessarily creates complexity at the higher organisational levels and requires active

adaptation (Jackson, 1994). There appears, however, to be a lack of leadership strategy that effectively manages and prepares both the senior managers and younger professionals for this process. Technical professionals, once appointed, must continually be motivated through their organisational careers, and motivating factors are not simplistic for them (Potgieter & Pretorius, 2009). The apparent inability of current management of the technology business sector to keep professionals motivated and their perceived unfair treatment of incumbents has created a lack of loyalty among technical professionals to their organisations. Professionals appear frustrated and display a lack of confidence in technology business leaders to mentor and guide their career development. This frustration leads to a lack of motivation and consequently a decline in productivity early in their careers, which either prompts a job/ company change or extinguishes their growth ambition altogether (Rothman et al., 2005).

A new generation with fresh perspectives is trying to work against a regime of established ideas within a managerial situation which neither rewards nor encourages creativity and is reluctant to pass the baton of leadership to the next generation. There is no recognition within the South African business environment of the 'whole life needs' of individuals and therefore no adaptive leadership strategy that can cope with the evolving needs of complex individuals within a complex environment (Karp, 2006). Senior managers remain focussed on the time tested management dictates to predict, control and stabilise (Burns, 2002). It is thus evident that these 'command and control' leadership frameworks have to evolve in order to enable organisational leaders to deal more effectively with the changing performance landscape of the South African business environment. Change will also allow leaders to develop the ability to create transactional spaces between organisational members where emergent, local leadership can occur (Lichtenstein et al., 2006). The question is: how do South African technology business leaders inspire, implement and manage change? What understandings are first needed?

Since leadership incorporates change management and is nowadays understood as being distinctively different from the conception of management in the orthodox hierarchical business sense, business leaders need to understand their role in the complex environment that the organisation has become and also to be able to adapt their style suitably and effectively. In the modern organisation leadership is not the sole function of some top-level executives, but is rather a company-wide activity requiring participation at all levels (Schneider & Somers, 2006).

To gain a better understanding of how the interactions between leaders and those whom they lead in the organisation influence the business sector at large, it is posited that chaos and complexity theory could proffer useful tools for analysis. These two theories are being used to study a diverse array of phenomena ranging from the evolutionary behaviour of natural systems to the effects of interactions between elements that have choice within social systems. Naturally, these studies lent themselves to the study of change in organisations and organisational behaviour, since an organisation is a purposeful assembly of members to fulfil a personal need while simultaneously fulfilling a need in the environment (Gharajedaghi, 2011).

An organisation is a social association based and run on choice at multiple levels. Marion and Uhl-Bien (2007: 299) propose studying the organisation as a complex adaptive system (CAS) defining CAS as neural-like networks of interacting, interdependent agents who are bonded in a cooperative dynamic by common goal, outlook, need, etc. They are changeable structures with multiple, overlapping hierarchies, and like the individuals that comprise them, CAS are linked with one another in a dynamic, interactive network. There is extensive literature on the application of chaos and complexity theory in the study of organisational dynamics and organisations as complex adaptive systems. However, not that much focus is given to the requisite complexity of leaders themselves who operate as fundamental change agents in these systems (Lord et al., 2010:105). Such studies may offer a better understanding of the turbulence in the current South African technology business arena and could perhaps be used to generate ideas about how to deal with the emergent characteristics of a rapidly transitioning system from within itself and in the way it relates to its environment with which it is co-evolving. As Osborn and Hunt (2007:322) have put it, "...it is not a matter of adjusting the ingredients to some known formula for success. It calls for a deeper understanding of both the context for leadership and leadership itself – an understanding we do not now have but argue we should seek."

1.2 Purpose of the study

The purpose of this study is to investigate the problem of job migration and changing of profession among young (26-35 years old) technology professionals in South Africa and determine whether chaos and complexity theory analogues could be applied to understanding how, if at all, South African technology business leaders influence the

problem through the role they play in creating, disseminating, reinforcing or redefining a firm's 'shared image' (Gharajedaghi, 2011) - the core of the organisation's systemic behaviour.

The research will aim to offer an understanding of how to bridge the perceived gap between business leaders and/ or mentors and young technology professionals within the context of a South African business environment. Through a detailed literature review of the research done to date on the application of chaos and complexity theories to leadership, as well the research done on general leadership theories, it is anticipated that a deeper understanding of the key concepts and implications of the theories for leadership will expose those core characteristics which are suited to the leadership of complex adaptive systems such as a technology business in a rapidly transitioning global environment. More specifically, these emergent characteristics are to be used to inform the development of a robust generic model which can be applied to design leadership architecture which could facilitate the transformation of the organisation and possibly manage the problem of job migration/ profession-switching by identifying gaps in a firm's current strategy for managing the careers of young technology professionals. This understanding could therefore potentially assist transitions in leadership which enable the future stability and sustainability of the organisation's knowledge investments.

1.3 Relevance of the study

By reviewing the research done to date on the application of chaos and complexity theories to leadership, as well the research done on general leadership theories, it is anticipated that a deeper understanding of the key concepts and implications of the theories for leadership will expose those core characteristics which are suited to the leadership of complex adaptive systems such as a technology business in a rapidly transitioning global environment (Uhl-Bien et al., 2007; Lichtenstein et al., 2006). More specifically, these characteristics are to be used in the development of a model for robust leadership architecture around which South African technology businesses can frame their leadership training and execution strategies, as well as managing their navigation through the changing performance landscape more effectively.

Gharajedaghi (2011) defines leadership architecture as the organisational management structures (management style, work environment and policies), processes and functions,

both tangible and intangible, which enable and operationalise leadership transactions within the business. Therefore, more robust leadership architecture would enable the functional execution of the organisation's leadership design to respond to dynamic changes in the performance landscape. As organisations move from one optimum to the next and navigate through strategic decisions and outcomes, a robust leadership design will use feedback to correct its path and move in the direction of seeking the next optimal solution rather than collapse as a result of the impact of change.

It will be discussed that South African technology business leaders could greatly benefit by understanding and appreciating:

- an organisation as a complex adaptive system;
- the role of leadership in this perspective and the need to cultivate current and future leaders who will foster the emergence of characteristics suited to such a system; and
- non-linearity and network feedback mechanisms within the organisation and the critical role these effects play in:
 - the success or failure of leadership strategies for managing the transition from senior managers to younger professionals;
 - the career guidance, mentorship and development of these younger professionals within a technology business environment; and
 - the dominant culture (shared image) of an organisation.

The benefit in understanding the above is relevant in that it could assist technology business leaders to design a leadership platform for more effective management of young technology professionals and to map out trajectories for its implementation and subsequent development. A leadership platform which has been thus informed has the potential to draw more potential from technology professionals and possibly to assist with the retention and motivation concerns faced by organisations today.

1.4 Problem statement

The research problem is to develop and determine whether a model for leadership architecture based on expedient chaos and complexity theory analogues could be applied to identify the influencing factors on the problem of job migration and changing of

profession among young (26-35 years old) technology professionals in the South African technology business context. The problem can be thought of as comprising three dimensions of enquiry which are set out below.

- a) What appear to be the main factors causing the problems of job migration and changing of profession among young technology professionals in South Africa?
- b) What is the degree of difference/ similarity between the perceptions of senior and young South African technology professionals, human resource (HR) managers and technology business leaders about these factors?
- c) In which way can system dynamics as described by chaos and complexity theory be used to develop a model for leadership architecture which better facilitates an organisation's goals in terms of leadership, human resource management, skills retention and organisational learning by design?

1.5 Research question

The research question is: *What are the key factors influencing job migration and changing of profession among young technology professionals in South Africa and how could insights from the theories of chaos and complexity be used to design leadership architecture which effectively copes with the influence of these factors?*

1.6 Research objectives

This study seeks to:

1. understand the context for the job migration and profession switching problem among young technology professionals and technology business leaders in South Africa;
2. evaluate the feelings, attitudes and beliefs of industry stakeholders about the influence of *leadership architecture* on young technology professionals;
3. apply understandings and analogies from the mathematical theories of chaos and complexity in order to analyse the relationship between the factors identified as most significantly influential on the problem and young technology professionals, senior technology professionals (including technology business leaders), and HR professionals; and

4. to use the insights generated from this analysis to help current business leaders design more robust leadership architecture which can effectively support the development of young technology professionals and manage the transitioning South African technology business performance landscape.

1.7 Hypotheses

With the preceding objectives in mind and in order to be able to address the research question, several hypotheses are proposed and these are presented below.

Hypothesis 1:

Ho: The impact of the direct management style on the decision to leave a company and/or switch professions is perceived similarly by young technology professionals and senior technology professionals.

Ha: The impact of the direct management style on the decision to leave a company and/or switch professions is perceived differently by young technology professionals and senior technology professionals.

Hypothesis 2:

Ho: Young technology professionals, senior technology professionals, technology business leaders and HR professionals perceive the impact of leadership on themselves similarly.

Ha: Young technology professionals, senior technology professionals, technology business leaders and HR professionals perceive the impact of leadership on themselves differently.

Hypothesis 3:

Ho: The South African technology business work environment and policy are perceived similarly by technology business leaders and young technology professionals.

Ha: The South African technology business work environment and policy are perceived differently by technology business leaders and young technology professionals.

Hypothesis 4:

Ho: Technology business stakeholders perceive B-BBEE and the management of diversity similarly.

Ha: Technology business stakeholders perceive B-BBEE and the management of diversity differently.

These four hypotheses correspond to non-linear, chaos-type factors, since the outcomes of interactive relationships between technology business stakeholders and the technology business environment are not predictable using traditional, linear models of management. While, at a high level, the factors referred to in the hypotheses appear to be typical management issues, they are related to emergent, systemic influences generated by localised interactions between agents in the system (the organisation). For example, Hypothesis 1 specifically considers the overall experience of leadership with regard for the role it plays in shaping an agent's decision to stay with or leave the organisation. There are inherent chaos/ complexity implications since leadership style is not directly measurable, nor are its effects on the organisation tangible or predictable using any linear system of analysis. These hypotheses will therefore also, indirectly, test the suitability and usefulness of chaos analogues in understanding the nature of the problem, if the results reveal leadership style and similar non-linear factors to be influencing the problem. Such an understanding will enable insight into the tags/ attractors around which the system is mapping its self-organising tendencies. These will be explained in later sections of this report.

1.8 Assumptions

The research effort will attempt to generalise the experiences of professionals within the broader context of the technology industry itself. It is assumed that these experiences will be consistent, regardless of the segment of the industry, individual companies and/ or whether this concerns an international company operating in South Africa or completely South African business entity. The study also assumes that experiences will be consistent across racial and gender demographics within the country. While the study will be confined to South African based companies only, not all respondents may be South African citizens. It will be assumed that all research respondents, whether South African

or not, will have adequate experience of the local business environment and leadership style in order to participate effectively in the research.

1.9 Limitations of the study

To study the full import of the relevance of chaos theory to business situations, computer simulation is a useful tool to plot data gathered over the long-time cycles during which chaotic effects are usually observed. The time limitation on this study does not allow for the use of simulation tools which could go a long way towards corroborating the data collected by more simplistic research tools. Moreover, the time constraint does not allow for a more detailed sampling process to filter respondents based on gender, race, company type, industry segment etc. – all of which are potential factors that could influence the system dynamics of the problem. It is also unclear what level of understanding of chaos/ complexity theory and its concepts managers and organisational leaders would have and therefore whether they would fully grasp the utility of the research in their businesses as there may be a significant knowledge gap to be covered first.

1.10 Structure of the report

The research will be discussed within the format of the following chapters.

- Chapter 1: Introduction – This chapter introduces the background to the research problem as well as the research question, objectives and hypotheses.
- Chapter 2: Literature Review – Here, relevant literature is surveyed with respect to research on leadership, organisational design, chaos and complexity science.
- Chapter 3: Development of Constructs – The results of the literature survey and the qualitative results of a focus group discussion are used to develop constructs to be further investigated in the study.
- Chapter 4: Leadership Architecture Framework Development – Combining the insights from Chapters 2 and 3, a framework for designing leadership architecture is proposed.
- Chapter 5: Methodology – Details of the research process and tests used for the quantitative portion of the study will be discussed.
- Chapter 6: Results – The results of the quantitative portion of the research will be presented.

- Chapter 7: Discussion and Analysis of Results – Results presented in chapter 6 will be discussed in more detail and within the context of chaos and complexity science.
- Chapter 8: Conclusion and Recommendations – Finally, the insights from Chapters 6 and 7 will be summarised and concluding remarks based on observations from the study will be presented. Recommendations for business and future research will also be put forward.

The diagram below illustrates the research process that was followed in the study.

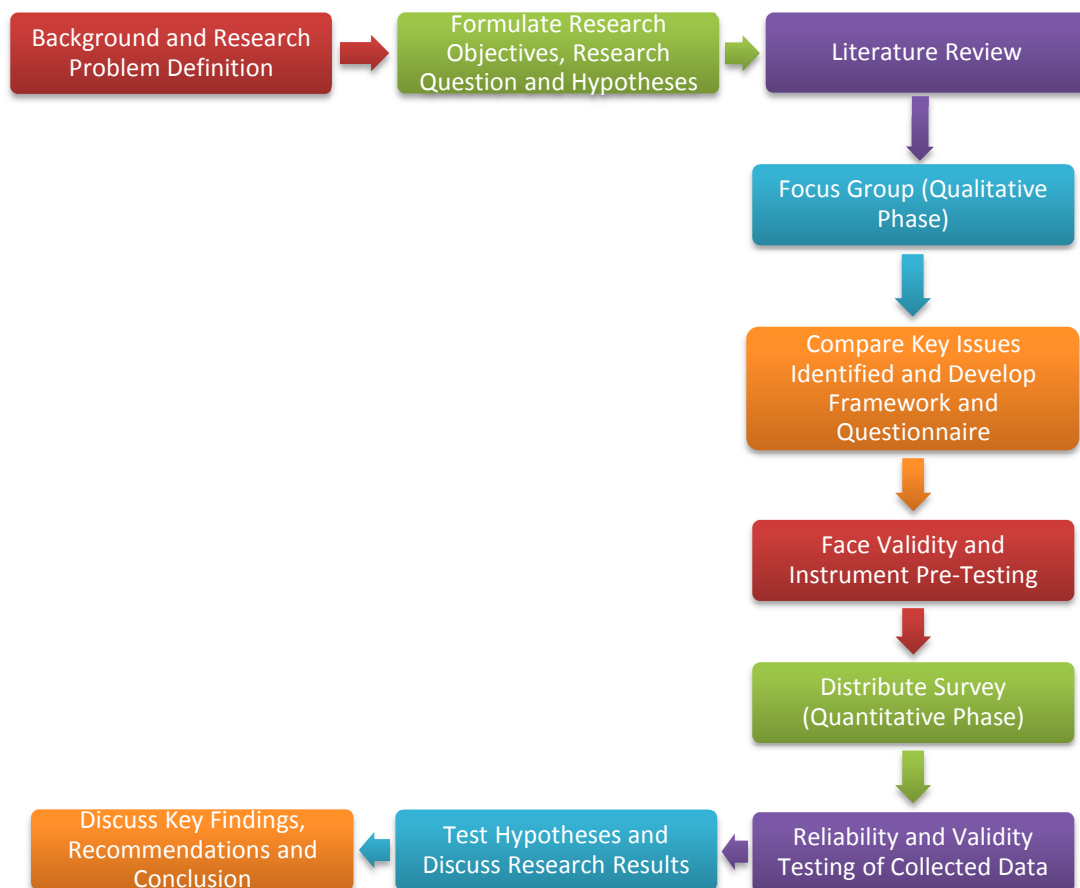


Figure 1.1: Overview of the research process used for the study

The preceding introduction has laid the foundation for the discussion of the problem and the development of the remainder of the study. The next chapter will present a detailed review of the literature.

2. LITERATURE REVIEW

2.1 Introduction

Based on the research objectives detailed in the preceding sections, the literature review seeks to filter the body of knowledge on leadership theory and also to focus specifically on those concerned with the implications of the research done in chaos and complexity theory for leadership in the context of a systems view of the organisation.

The literature suggests that, while there are several theories regarding leadership, organisational change and behaviour, these theories largely overlook their interdependencies at the level of individual members (Osborn & Hunt, 2007) whether leaders themselves, or those whom they lead. In addition, it is also noteworthy that behavioural characteristics of leaders and the psychological implications thereof for those whom they lead are not discussed in detail in orthodox leadership theory. The papers in this review aim to understand the specifics of the South African business environment, the dynamic relationship between leadership and organisational behaviour and the role of leadership within the modern organisation as a complex system.

2.2 The South African Technology Business Environment

In a joint study between the South African Qualifications Authority (SAQA) and Higher Education South Africa (HESA) it was stated that graduates and their prospective employers share a common misunderstanding about the role and attributes of each other (Griesel & Jan, 2009). Employers continuously express the opinion that graduates are under-skilled and ill-prepared for the workplace, while graduates strongly believe that their specialised skills and knowledge are under-valued by employers. The online power journal, ESI-Africa, in an interview with a leading reliability expert, noted that, while lack of skills is the foremost challenge within the engineering sector, a fundamental issue remains the large gap that exists in experience between young engineers and the average engineer aged about 54. The article goes on to describe the necessity for intervention with regards to bridging this gap, as well as retaining and developing skills. The lack of correlation between the number of engineers graduating and the number available to execute highly specialised tasks suggests a problem in the career development of graduates. Knottenbelt (2002:122) argued that most young engineers are

not allowed opportunities in their first years of work that would allow them to realise their full potential. The article also cites lack of mentorship as a cause for this and identifies that there is an extreme contrast between the realities of the initial training period and the expectations of graduates coming straight out of tertiary education. It is stated by the author, "These initial impressions of engineering as a profession result in large numbers of graduates leaving the industry at the earliest opportunity. This also impacts negatively on the image of engineering as a career. Many young and not so young engineers are incorrectly deployed in areas that do not suit their personality or interests. Successful members of the engineering team are invariably those that have found the right niche for themselves".

In many instances, the type of work engineers believed they would be doing after completing their studies, what they actually do, and the work assigned to them by mentors/ leaders in the early years of their careers, are at a high degree of variance (Reed & Case, 2003) which leads to initial disillusionment. Given these challenges, inherent in a developing country like South Africa, it becomes a strategic necessity for organisations to ensure that the ripple effects are properly managed by capable people executing proficient leadership and development strategies (Dockel et al., 2006). There are major questions around how to manage the transition of business from senior managers to younger professionals and, once employed, how are these professionals to be motivated and retained. One obvious indicator is the greater reward and recognition for technologists to transition into management positions (Petroni, 2000b). This discussion falls outside the scope of this research, but is important in that it highlights one key reason for technical professionals not staying in and building strong technical knowledge and that is a lack of incentive to do so (Petroni, 2000a). In addition, companies are more likely to hire people based on 'soft skills' or the ability to work and communicate with people than on 'hard skills' or purely technical knowledge (Crosbie, 2005). Engineering professionals already recognise the need to have better than average soft skills while still at the student level, citing the reason that, amongst others, it makes them more marketable (Ziegler, 2007).

South Africa has the additional challenge of being a relatively new democracy on the global stage and this is reflected strongly in the demographics of its workplace (Littrell & Nkomo, 2005). The country has inherited an outdated, largely negative legacy of management (McFarlin et al., 1999) which mostly has its roots in orthodox, military

hierarchical styles (Fletcher, 1999). Existing managers in place following the death of the apartheid regime have now had to cope with the attempts of the government-imposed broad-based black economic empowerment system (BBBEE). This policy has sought to rectify the mal-distribution of economic advantage by forcing companies to employ more representatively with respect to the country's population. The process, though well-intentioned, constantly has to fight corruption, is still abused by many, and has been poorly implemented to say the least in several companies (Juggernath et al., 2011). Global companies which do not fully understand the depth and breadth of BBBEE nevertheless understand that to secure business successfully (state business especially), there is a need to comply. They leave the implementation of BBBEE, however, to the 'old guard'. This does not help the situation; the South African black population (Indian, African, Coloured) account for 87.9% of the country's economically active population yet only 18.1% hold management positions. Whites, on the other hand, who account for 12.1% of the economically active population, hold 61.1% of the management positions. Implementation has been slow (Esserand Dekker, 2008 cited in Juggernath et al, 2011) and it appears that South African businesses are far from making BBBEE a real priority. This situation has therefore created a crucible in which there is a strong likelihood that network feedback amplifies the negative outcomes of interactions between orthodox management and young professionals in South African managed businesses, a large component of whom are black.

2.3 General Systems Theory (GST)

To assist in analysing the interactions within South African technology businesses, themselves, each a complex system within the wider business environment, systems theory is invoked. Evolving concepts within the broader Systems Theory such as chaos, complexity, feedback and cybernetics have become useful instruments for assessing organisational dynamics from the 'holistic' or systemic view (Minati, 2007). This approach contrasts the more traditional reductionist method, based on Newtonian physics. Reductionism forces managers to break organisations into parts, the underlying assumption being that the whole could best be understood by studying the characteristics and behaviour of the individual parts that make up the system (Plowman et al., 2007). Gharajedaghi (2011) has proven to be inadequate for dealing with the modern organisation, the models of which have transitioned through the mindless mechanistic to the uni-minded biological, to the currently held view of the organisation as a socio-cultural

multi-minded entity. Systems theory developed from the field of biology when Bertalanffy's 1968 work (cited in Gharajedaghi, 2011) showed considerable relevance for researchers in diverse fields outside of biology. Bertalanffy's work (cited in Gharajedaghi, 2011) *General Systems Theory* is now a quintessential work on systems theory and the basis for the discipline of systems thinking. After World War 2, systems concepts developed rapidly and found its way into the lexicon of management science (Jackson, 1994). Thinkers like Ackoff (1981), Checkland (1998) and Senge (1990) made strides in making the concepts practical and relevant to structuring complex organisational problems.

Checkland's (1998) Soft Systems Methodology (SSM), in particular, for the first time introduced the human (social and cultural) dimension into traditionally hard systems based operations research (OR) or management science. It allowed for problem owners to consider simultaneously the effects of obtaining different perspectives and accounting for the effects of decisions taken in one part of the organisation, and analysing the ripple effect on other parts of the organisation (systemic effects). Slowly but surely, managers began to see that their organisations were not closed systems as they had once believed, but open systems, dynamic systems which influenced, and were influenced by, their environment. This brought in a flood of new terminology, studies and research into the behaviour of open systems, with particular strands of this research focusing entirely on organisations.

For example, Katz and Kahn (cited in Schneider & Somers, 2006) delineated ten characteristics of open systems from an organisational perspective, stressing the important systems effects of inter-dependence, relationships and the influence of structure on behaviour. Although GST implies the openness of social systems, it also suggests system boundaries and stable patterns of relationships within boundaries (Schneider & Somers 2006). It is therefore useful to apply systems concepts in the study of social systems dynamics, but to keep in mind the limitations such as the Darwinian view that the survival of organisations (when framed within the organism analogy) within an economic 'ecology' depends on random mutation and 'survival of the fittest'. These concepts once again constrain the full strength of applying the systems perspective to understanding complex systems and may block out other interesting phenomena such as synergism (emergent properties and that the whole is more than just the sum of the

parts), multiple-goal seeking behaviour and purposefulness, all of which are characteristics of such systems (Ackoff, 1971).

Perhaps one of the most useful concepts of systems thinking is the mechanism of feedback. Feedback relates to the mechanisms by which information generated by system processes is fed back into the system in an iterative way. This information is then used to stabilise the system behaviour (negative feedback) or is amplified, decreasing system stability (positive feedback) with each iteration until the system breaks down into chaos (Gharajedaghi, 2011). It is due to the iterative nature of these feedback processes that the manifestations of chaos tend to materialise. Iteration and feedback introduce interesting phenomena in dynamic systems as a result of the influence they have on the critical point between system stability and instability. At this critical point, the probability of chaos exists and even an infinitesimal change in boundary conditions could cause the system to breakdown into chaos. As systems theory matured, researchers in the field began to study the effect of these influences at the boundaries of dynamic systems or at the “edge of chaos” in more detail. Researchers such as Edward Lorenz (1993) and Robert Shaw (1981) began studying the effects of changes in the starting values, or boundary conditions, of dynamic systems and observing the effects on the trajectory of these systems over time. Their results and continuing research led to a new branch of the study of complex systems which came to be categorised under the collective name of chaos theory (Gleick, 1987). This suggests the concept of chaos theory’s suitability for studying the instability in the South African job market as a function of the relationship between young professionals formulating a career path and leadership within a complex system. Setting goals in career development is an iterative process and the dynamic interaction with leadership and the organisation as a whole generates feedback (Hall & Richter, 1990).

2.4 Chaos theory

Certain systems, although they appear at a macro-level to be random and without order, are found to display micro-levels of order when they are simulated by myriad iterations. Systems that display random results may yet be carrying out simple rules which, when iterated several times, generate chaotic effects. For a good example of this type of behaviour, the reader is referred to the work of Benoit Mandelbrot (Mandelbrot, 1977). Chaos theory is concerned with non-linear systems – systems in which an external

change causes disproportionate effects, a phenomenon popularly known as the butterfly effect (Kaufmann, 1993) after the title of a paper by Edward Lorenz, who first encountered the effect while studying weather patterns (Wheatley, 1994), pointing to the inherent non-linearity of such systems due to the high degree of inter-relatedness between its parts (Anderson, 1999). The butterfly effect basically examines the sensitivity of complex systems to initial conditions (Kaufmann, 1993; Sterman, 2000) and the role played by path dependence and historical contingencies in influencing system states (Schneider & Somers, 2006).

There are copious amounts of information on the detailed explanation of chaos and the development of the theory. Those key elements of the theory which are most applicable to informing the development of a better understanding of leadership dynamics are summarised below.

2.4.1 Sensitive dependence on initial conditions

In the context of the organisation, sensitivity to initial conditions as displayed by chaotic systems alludes to the dependence of organisational culture on historical legacies (Thietart & Forgues, 1995). An organisation's current state can be linked back to those decisions made historically which have shaped the trajectory of the firm. These early 'initial conditions' become embedded in the shared image of the company and therefore keep the organisation bounded in familiar patterns. Although the system will not pass through the identical trajectory during periodic transition, familiar patterns of organisational behaviour will be observed. It is these historical assumptions which must be made explicit, challenged and measured for their ability to serve the organisation and its members.

2.4.2 Chaotic attractors and pattern formation

There are systems which at first glance appear totally random, but careful analysis of certain systems by iterative simulation has shown that they are chaotic but not random. Randomness implies no pattern, but chaotic systems display at the micro-level a pattern which forms within the basin of an attractor which brings about non-random behaviour at this scale. This attractor is the system's set of bounded preferences of microstates (Lee,

1997). Chaotic system patterns can be predicted, but not the paths taken, or their future states (Dooley & Van De Ven, 1999).

Patterns form around four fundamental attractors: point, cycle, torus and strange. Point attractors are responsible for the pattern of point-to-point searches for system states or singular objectives. Cycle attractors are observed in systems which oscillate between fixed states. Torus attractors can be described as organised complexity repeating itself, while strange attractors are said to be observed where unpredictable, complex patterns emerge over time. Attractors essentially define the self-organisational characteristic that a chaotic system exhibits. It is this aspect of chaos theory that creates a foundation for understanding complex system behaviour. Attractors map out the basin of trajectories that system states can assume and provide the self-referencing core around which complex systems self-organise. In this study, when this phenomenon is encountered in an organisational context, it is referred to as the shared image of that organisation.

2.5 Fractal behaviour, scaling and recursion

Another interesting feature of chaos theory is that the patterns generated by chaotic systems also exhibit self-similarity at different scales, or what is termed fractal behaviour (Shoup & Studer, 2010), from the word 'fractal' (Mandelbrot, 1977). An understanding of fractals and the concept of scaling is imperative to a chaos/complexity framework for understanding complex system behaviour, since there is propensity for complex systems to unfold in fractal dimensions. Part of the usefulness of the fractal concept is that information gained at one scale can be extended to gain insight into the structure of the macrocosm. If one is able to identify the recursive obedience of simple rules at one scale, management of what would otherwise be overwhelming detail is enabled (Kuhn, 2009). Fractals can be seen ubiquitously in nature from snowflakes to the architecture of leaves. This is an interesting phenomenon since it could offer insight into why patterns of leadership are found to be mimicked at department, organisation and industry levels.

2.6 Complexity

Strictly speaking, chaos theory and complexity theory are two separate, mathematical theories, the former nesting within the latter, however, they are complementary (Marion & Uhl-Bien, 2001), and for the purposes of this research their key concepts will be used

interchangeably. Both are concerned with non-linearity; however, complex systems are more stable and relatively more predictable than chaotic systems – owing largely to the phenomenon of self-organisation.

Complexity, from a systems perspective, is the measure of the degree to which elements of the system are interconnected and inter-related to each other and the system environment. A simple system is one with few interconnections and inter-relationships while a complex system has a richer network of these (Sterman, 1994). Complexity theory was developed around trying to understand phenomena in such complex systems which appeared unpredictable and random; phenomena where feedback effects due to the various inter-relationships are non-linear and of a network nature. In a worldview dominated by the reductionist approach, complexity has been shrouded in misunderstanding since it has to its credit such basic assumptions as the notion that the future states of complex systems may not be knowable until that future state actually happens, despite our best technologies and computing ability (Eve et al., 1997 cited in Schneider & Somers, 2006). If chaos is concerned with how a system behaves as it moves closer to the edge of instability (the edge of chaos), complexity is concerned with the self-organising behaviour of complex adaptive systems (CAS). It looks at the other side of the preoccupation that most organisational thinkers have with the idea that to be effective requires finer differentiation. Complexity suggests that the most adaptive organisation, not the fittest, is the one most poised for evolution by virtue of its self-organising capability which allows for the integration of the differentiated parts into an effective whole.

A complexity theory perspective further challenges the assumption of GST that all open systems tend toward states of equilibrium, decreasing activity and entropy production (Matthews et al, 1999), and subject to the Second Law of Thermodynamics (i.e. toward increasing entropy or disorder). The 'equifinality' view put forward by GST argues that goal-seeking systems can choose many ways (different means) to reach the same outcome in the same environment. This is a complementary perspective based on the Darwinian notion that evolution depends only on the force of natural selection which weeds out the unsuccessful elements of the population (e.g. individual organisations within a broader industry segment) in favour of the fittest (erroneously historically taken to mean the strongest). On the contrary, the complex adaptive system can adapt based on the emergent self-organising capabilities of its parts generated by their inter-

dependencies. This is not to say that environmental influences and selection are not important, but rather that systems themselves play a part in their adaptation and subsequent evolution. Furthermore, complexity theory suggests that equifinality may not apply to a non-linear system since its sensitivity to initial conditions allows it to attain a variety of unique states in the same environment i.e. multifinality, or different means as well as different ends. This could include varying degrees of adaptation or system obsolescence (extinction) and is effectively the heart of complex behaviour – balancing variety (differentiation) and order (integration). The highest expression of organisation is therefore organised complexity and the lowest, chaotic simplicity, as illustrated by the diagram below.

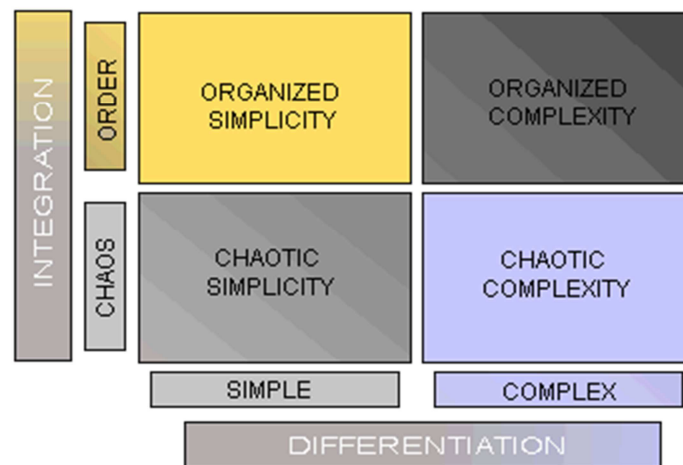


Figure 2.1: Modes of organisation (Gharajedaghi, 2011)

It is posited that the ideas of self-organisation which emerge from complexity theory can offer extensive insight into why businesses (more particularly technology businesses for the purposes of this study) exhibit the same brand of sub-optimal leadership behaviour that was inherited from their predecessors (the distorted shared image).

2.7 Self-organisation and the shared image concept

Chaos and complexity theory imply that, in order to self-organise, a system must possess a reference or an internal self-image of what it wants to be. Gharajedaghi (2011:33) has suggested that, just as in the way DNA is the source of this image for biological systems, culture is the shared image around which social systems self-organise and could possibly explain why behavioural patterns persist in socio-cultural systems, despite the best interventions to assist the process of change. By understanding how complex systems

move toward a pre-defined order and how the embedded shared subset of cultural codes affect them, insights can be derived about how to influence and change system behaviour, an idea that is central to this study.

It is in this context that the chaotic attractors described in the preceding sections offer useful parallels for the self-organising behaviour of social systems around shared images. If the shared image is thought of as the attractor, point attractors can be viewed as social beings pursuing their instinctive tendencies – fear, love, desire to share or self-interest. Cyclical attractors represent organisations which shift between apparently contradictory but complementary states resulting in a sub-optimal solution e.g. freedom and security, integration and differentiation. Torus attractors are more in accord with the behaviour of open systems which are goal seeking (equifinal, neg-entropic) and strange attractors would exemplify the social system which has the choice of both ends and means, and therefore displays unpredictable patterns based on the choices of purposeful members. Self-organisation may be a conscious act or a random result of iterative replication of ‘default values’. This is a commonly encountered situation in social systems and Gharajedaghi’s (2011:61) conception of the shared image offers here an explanation for why such systems display a tendency to replicate the same set of non-solutions with near perfect precision, even in the face of a wide variety of challenges and obstructions. The cultural codes implicit in a socially constructed shared image provide the default values for all decision-making and subsequent rule formations. These cultural codes make a social system behave the way it does and are more often than not considered sacred, making them tenaciously impervious to change. The shared image of a culture is a stronger filter than private filters and, although social systems learn through their members, social learning is not the sum of the independent learning of its members. Rather it is the collective, shared learning which creates the social operating system and explains why organisational inertia is greater than individual inertia (Minati, 2007). The shared image tunes the receptors for a certain kind of message only – those messages considered consistent with the operating system are absorbed and reinforced, while those considered contrary are discarded. To describe the process succinctly, consider the observation of the common practice of associating truth with simplicity. By that reasoning, anything that is not understood is considered to be false and is rejected. This reinforces the fear of rejection of individual members in a social group and therefore filters out attempts to break or challenge the status quo. The result is that the system replicates its familiar patterns *ad infinitum* if this distorted shared image is not altered.

2.8 The organisation as a complex adaptive system

The mathematical theories of chaos, complexity and self-organisation found their way into the social sciences and not long after this, organisational and leadership researchers proposed that an organisation is essentially a social system and therefore consists of dynamic interactions between agents who each display choice and are of themselves, purposeful (Burns, 2002). These individual purposes are brought together under, and hopefully align with, an overarching purpose, that of the organisation. The interactions between agents in the organisation are best characterised by non-linear network feedback loops. Each interaction contains within it the elements of choice, certainty and chance which are amplified by positive feedback or regulated by negative feedback. This introduces chaotic effects, which in turn necessitates organisational complexity. The effects of these interactions manifest in different ways at different system levels and at different times due to the non-linear nature of the system (Gharajedaghi, 2011).

Nonlinearity can often cause small changes to evolve into major consequences and therefore breaks any logical link between cause and effect, especially when time lags are involved. There is evidence of both positive and negative feedback loops within organisations; however, dominant management theories recognise negative feedback loops only, suggesting that the organisation responds to the feedback and thereby adapts to its environment (Stacey, 1995). The two most popular organisational models in contemporary management theory, the strategic choice model which implies that organisations choose long-term outcomes, and the ecological model, which suggests organisations adapt based on environmental events, are both based on negative feedback and do not recognise the effects of network feedback mechanisms.

From a system environment perspective, organisations must adjust to a performance landscape that is continuously changing (Lord et al., 2010:105). A performance or 'fitness' landscape is defined in complexity theory as the space of all possibilities within which an organisation can search for solutions, it being a part of this landscape itself. Also contained in the landscape are customers, suppliers, employees and various other stakeholders. The evolution of the performance landscape can therefore be seen as the co-evolution of the organisation and its environment (Lissack, 1999). To cope effectively with such change, many leadership theorists argue that organisations need a more fluid

approach that fosters emergent self-organisation throughout the organisation (Marion & Uhl-Bien, 2001). Most complexity theory when applied to the management sphere looks at the macro effects on the organisation and, at most, at localised structural emergence within the wider environments of the system (Marion et al., 2001; Uhl-Bien et al., 2007). A framework is thus required that pays particular attention and responds effectively to the dynamic challenge of leading individuals in organisations as complex adaptive systems or complex adaptive organisations (CAOs). This framework should recognise how organisations respond to both positive and negative network feedback loops and should also inform leaders on how to ensure they do not become trapped on local optima, by always searching for and striving toward a global optimum, while navigating the changing performance landscape. Ways to develop and test such a framework are also of importance (Schneider & Somers, 2006).

Such an adventurous search hints at moving from a historically founded comfort zone, where the organisation has established stability, to more unfamiliar territory which may at first appear chaotic. As the preceding sections have shown, however, chaotic behaviour is not necessarily chaos as implied by the everyday use of the word which depicts total anarchy. It is characterised by dynamic turbulence within a bounded pattern centred on an attractor between a zone of stability and a zone of instability. Research has shown that, if organisations are pulled completely into the zone of stability, their structures are frozen and leave no room for creativity and adaptation leading to eventual ossification (Lissack, 1999). Conversely, if they are pulled into the zone of instability by allowing too many inputs or too much differentiation without parallel integration, the system will break down into anarchy as a result of insufficient frozen/ stable elements. It must be realised that, for every level of differentiation, there appears to be a minimum level of integration, below which the system will disintegrate into chaos.

Between stability and instability, in the zone of the chaotic attractor, is where organisations balance order and diversity (Burns, 2002). As the system moves toward the edge of instability, it becomes more and more creative which makes this the zone in which organisations must strive to remain. Here at the edge of chaos, historical paradigms and legacies can be challenged as dynamic turbulence exposes the cultural codes implicit in the organisational culture which limit the organisation's development (Osborn & Hunt, 2007). True organisational creativity can be realised when the shared image which consists of these implicit cultural codes is made explicit and continuously re-

evaluated to assess whether it is still serving the organisation, its members and its environment effectively. Moreover if, as suggested by the literature, the most creative organisations are those which are critically poised at the 'edge of chaos' (or what complexity theorists call "self-organised criticality" (Shoup & Studer, 2010:19)), why are South African technology businesses not benefitting from the diversity inherent in the country's demographics to stimulate creativity in a sector where it is highly regarded as a necessity? Instead of an improvement in the quality and degree of innovation, there is a crisis in the employment sector in the form of skills shortages. The contradiction could potentially be explained by a deficit in leadership capability.

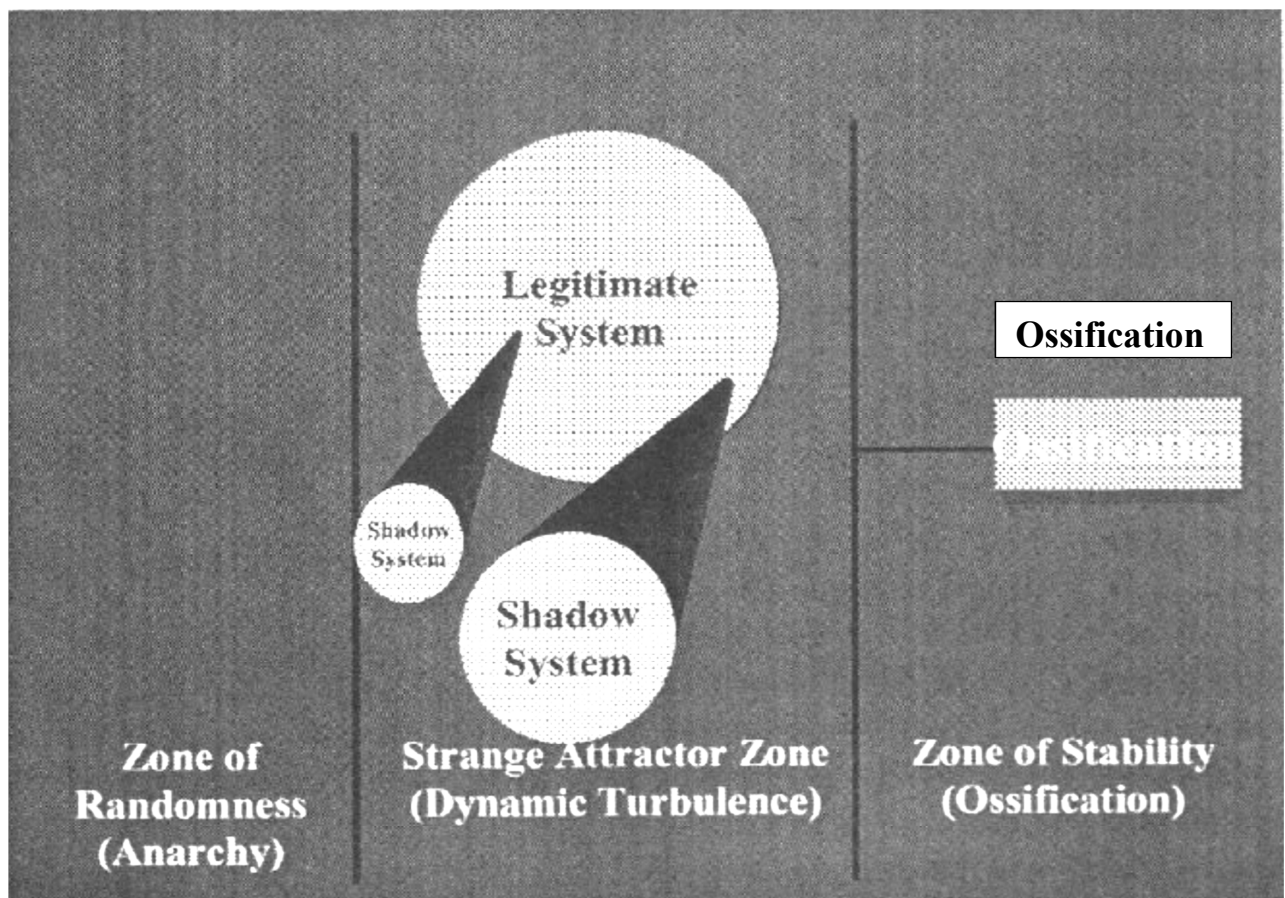


Figure 2.2: Model of the chaotic organisational environment (Burns, 2002)

2.9 Leadership within a complex adaptive organisation

The preceding sections allude to what the idea of leadership within an organisation, which is now understood as being a complex adaptive system, should essentially entail. In summary, it can be thought of as consisting of two major functions:

- 1) creating and maximising the transactional space between and within the organisation and its environment in order to enable the emergence of leadership; and
- 2) understanding and making explicit the attractors (shared image/cultural codes) which are dominant in the organisation in order to stay at the edge of chaos where creativity is maximised.

In other words, effective leadership fosters and facilitates the emergence of leaders while striking a balance between integration and differentiation, recognising the fundamental need for both. Based on the literature, the implications of complexity and network feedback effects for leaders lend themselves to a better understanding of system dynamics at the system/ organisational level and not at the level of the parts as advocated by the orthodox reductionist management models (Osborn & Hunt, 2007). Good leaders will challenge the shared image and will push the boundaries of creativity while being aware of the necessity of balance.

Under complexity theory, leadership remains about influencing others to operate above routine compliance (Schneider & Somers, 2006). Leadership is concerned with emergence and self-organisation (Knowles, 2001), properties which may not necessarily be correlated with traditional organisational hierarchies. Kaufmann's work (1991, 1993, 1995) suggests that four variables (three intra-organisational and one inter-organisational) affect an organisation's level of chaos or order and therefore its ability to adapt and evolve. These are P (shared schemata), K (the number of inter-relations – measured by the number of inputs to N), N (the number of subsystems) and C (inter-organisational linkages). Organisational identity, which can be thought of as the shared image that was described in preceding sections, is strongly linked to P and can be influenced by manipulating the other three. If this is the case, it follows that dimensions such as the 'flatness' of the organisational structure, flexibility of management systems and participation of organisations in forums where information is shared, all impact on how the shared image of the company evolves. A good example would be whether or not companies actively engage with educational institutions to help advance research and to develop best practices based on a collaborative effort with other industry players. Leadership in complex systems then, implies collaboration as opposed to competition.

Schneider and Somers (2006:358) consequently suggest studying social movements for examples of self-organising behaviour that is effective in this regard. In social movements, charismatic leaders serve as 'tags' around which purposeful members accumulate and begin to serve the system since their purposes are aligned with those of the movement. Tags are similar in concept to chaotic attractors and thus it could be surmised that the ideas of social leaders, and not necessarily the leaders themselves, serve as tags. If leaders are seen as enablers of leadership, they create the transactional space for leadership behaviour to diffuse, in the same way that chaotic attractors initiate and set up the bounded states of behaviour within which the system oscillates. Leaders like attractors will establish boundaries of behaviour and maintain the oscillation, in this case the percolation of the shared image, through the organisational system. Leaders who understand their role in this context can establish efficient ways to initiate and facilitate leadership behaviour within the basin of trajectories that emerge out of their leadership style. This could empower agents in the system to share the concept of leadership and create a dynamic double loop learning system – a positive loop, whereby the desired shared image is reinforced and embedded into the organisational culture, and a counteracting loop which regulates behaviour that is counter-productive, or is pulling the system too far away from the desired bounded state.

Social movements show this well since their leaders are the ones who keep the members aligned to the cause, as it were. Members who choose methods that are outside the core beliefs of the organisation are forced out of the system. A good example is the split within a political party, for example, when the leader of the party chooses to use non-violent methods to fight for freedom, while a deputy leader wants to use militaristic tactics. The goal/ shared image being the same, the methods are different as are the rates and condition of successes, but it is the responsibility of the leadership mechanism to keep the system bounded within acceptable states. The more a good leader has enabled the system to diffuse and reinforce the desired shared image, the more effectively the system will resist actions/ ideas which are contrary to it, or limit, its learning.

These tensions, when spread across a network of interactive and interdependent agents, generate system-wide emergent learnings, capabilities, innovations, and adaptability. Importantly, such elaborations are products of interactions among agents, rather than being caused by the specific acts of individuals described as leaders.

A complexity view suggests a form of 'distributed' leadership (Brown & Gioia, 2002; Gronn, 2002) that does not lie in a person, but rather in an interactive dynamic, within which any particular person will participate as leader or a follower at different times and for different purposes. It is not limited to a formal managerial role, but rather emerges in the systemic interactions between heterogeneous agents (Marion & Uhl-Bien, 2001). Leaders in the 'formal' sense can enable the conditions within which the process occurs, but they are not the direct source of change.

2.10 Conclusion

The literature review has shown that, while there exists exhaustive research on the application of complexity and chaos theory for managing organisations as complex systems, informing strategy and leadership, more research needs to be undertaken in applying some of the key concepts toward understanding how leaders themselves influence the individual behaviour of organisational agents in particular environments. The implications of complexity and chaos for leadership and organisational behaviour are being progressively studied and the emerging findings could be used as a framework for better understanding the interactions that take place between internally complex organisations when they are exposed to equally, or more complex, environments. Such a framework can further be used to design more robust leadership architecture, capable of helping leaders effectively manage the transition of future leaders into the organisation. The purpose of this research, therefore, is to determine the suitability of applying the concepts of chaos and complexity to gain an understanding the influence of technology business leadership on young South African professionals.

Very little is understood about why these younger professionals display what is largely considered to be erratic and disloyal behaviour, moving frequently between companies, leaving the country and/ or becoming complacent, non-productive members, despite being highly educated and skilled. In the next chapter, a qualitative approach is used with the aim of drawing out the key issues that appear to influence this problem and to compare these with what the literature has shown.

3. DEVELOPMENT OF CONSTRUCTS

This chapter combines the key issues identified in the literature with those obtained from the focus group and these are used to develop constructs for the study.

3.1 Key issues identified in the literature

From the literature review in Chapter 2, the key issues identified include those set out below.

3.1.1 Lack of effective management of diversity

Current technology business leaders are inadequately prepared to deal with a new generation of culturally and chronologically diverse young professionals who need to be groomed to inherit the mantle of leadership. Leadership frameworks are weakly developed and are based on militaristic, hierarchical models which are no longer relevant to the multi-minded, socio-cultural system into which the organisation has evolved (Fletcher, 1999).

3.1.2 The time horizon in roles/organisations is too short

The amount of time spent by incumbents within a specific job function, role or even the organisation itself is seldom long enough for the incumbent to develop the specialised knowledge which is critical to the continuation and growth of the industry (Toit & Roodt, 2008).

3.1.3 High remuneration rates offered by developed countries

Technology professionals are offered better benefits, quality of life, recognition and higher remuneration in foreign countries than those available in South Africa (Kaplan & Charum, 1998).

3.1.4 Desire of young technology professionals to enter a management role as quickly as possible

Management roles pay higher salaries and afford more recognition to individuals than traditional pure technical roles (Terblanche, 2011). Technology professionals acquire management or sales skills which they perceive as making them more marketable than developing specialised technical skills would.

3.1.5 Misunderstanding of roles and attributes

Graduates and their employers share a common misunderstanding about the roles and attributes of each other (Griesel & Jan, 2009). Employers perceive younger professionals as being disloyal 'hoppers' searching for more money and graduates perceive employers as not taking into consideration their 'whole life needs', personalities or their skill set.

3.1.6 Lack of mentorship

Development programmes are poorly constructed and are not stimulating enough nor do they effectively groom incumbents for future roles and responsibilities by dissemination of tacit and job-related skills from manager to the mentee (Knottenbelt, 2002).

3.1.7 Difference in work expectation

The types of work graduates believe they will be doing while still in university and what work they actually end up doing in their early years of employment are different (Reed & Case, 2003). This creates disillusionment early on in their careers and also creates a negative impression of the field itself.

3.1.8 Lack of incentives

There is no motivation of any kind for technology professionals to remain in a purely technical role and develop specialised knowledge in that particular role or field (Petroni, 2000a).

3.1.9 Poor implementation of B-BBEE

B-BBEE is poorly understood and has been slow both in terms of implementation and realisation of tangible results (Juggernath et al., 2011). There is a lack of commitment by organisations and the process has become maligned by corruption among opportunistic individuals on the one hand and ‘fronting’ practices by many firms who simply view the codes as a tick-the-box exercise in order to secure local business (especially from state-owned companies).

3.2 Key issues identified by the focus group discussion

The focus group that was selected on a convenience basis and expected to be affected by the problem convened to draw out key issues relating to technology professionals in South Africa. The discussion exposed several issues, and those issues perceived to have the greatest impact to the industry by the group are discussed below, in no particular order.

3.2.1 No mentorship

There appears to be a lack of mentors and palpable mentorship programmes within the technical industry in South Africa. Focus is not given to formal programmes and young professionals are often confused about their growth within the company and what the full scope of their responsibilities within a role should be. They often teach themselves, sometimes even being criticised for failure, despite not having been given the proper training.

3.2.2 Lack of incentives to become a technical specialist

There are no rewards, remuneration or otherwise, offered for staying in a technical role or developing specialised technical knowledge. Professionals perceive management as being the place to get to, since better salaries and status accompany these positions and not the purely technical ones.

3.2.3 BBEE strategy and implementation is not properly understood or executed

Young professionals sometimes feel as if they have been hired merely to improve the company's B-BBEE scorecard but that a genuine plan to improve the company's diversification and employment equity does not exist in reality.

3.2.4 Poor retention plans

Companies do not make their technology professionals feel valued. There is no incentive for, or recognition of, one's place in the company and this often makes individuals feel unneeded or not valuable to the company.

3.2.5 Traditional business leaders hold on to authority tenaciously

Young professionals are not afforded enough opportunity or the freedom to take critical decisions and develop their abilities in this respect. If they are, in most cases these decisions are micro-managed and therefore not entirely the young professionals'. This devalues self-worth and erodes confidence.

3.2.6 Lack of active engagement by human resource (HR) departments

Young technology professionals like to create new roles or new challenges but despite their drive and ambition, HR departments do not engage with them to make this a reality or at the very least, a possibility. It is perceived that the use of tools such as psychometric testing and other personality profiling instruments is only useful at the interview stage then never spoken of again. The new generation holds uniqueness and personality in high regard and are of the opinion that organisations generally appear to disregard these attributes.

3.2.7 Legacies of management

Young technology professionals perceive a marked difference in how they are managed by managers who have done an MBA for example as opposed to the 'legacy managers' who have simply inherited their management styles from their predecessors.

3.2.8 Technology business leaders do not trust young professionals

Managers appear to display a lack of confidence in investing in so-called 'hoppers' who simply jump from company to company in the pursuit of financial gain. Loyalty is favoured by senior managers but is no longer commonly encountered which leaves them feeling disillusioned about the cadre of individuals eligible for employment. Young technology professionals are under the impression that that a lack of trust is the reason that senior managers do not easily part with decision-making and authoritative control.

3.2.9 Opportunities for higher remuneration, growth and development

There is a perceived increase in opportunity, especially concerning management roles, and technology professionals feel that career progress takes much longer in a technical environment than in other environments into which technical professionals are typically recruited. The banking and consulting industries particularly were identified as offering better opportunities, pay structures and having better, more comprehensive and appealing recruitment strategies. There is also a perceived ability to increase wealth gain by moving between companies

3.2.10 Influence of networking

Connectivity through social media has advanced the way in which young professionals communicate with friends and industry peers. Negative employer reputations are quickly diffused through one's social and/ or professional networks as are favourable employer reputations concerning matters such as better salaries, treatment of people, consideration of whole life needs etc. Networking also assists recruiters, and more and more people are placed in companies as a result of headhunting as opposed to an active search by an employer.

3.2.11 Young technology professionals want flexibility, diversification of skills, roles and responsibilities and are not satisfied with the pace at which the nature of their work becomes more complex and challenging

The preference of young professionals is for leadership as opposed to management. They desire an environment where they and their leaders engage toward a better

understanding of each other. They want to perform more technical work, or work of a more challenging nature. There is also the desire for recognition of their degree and they want to work within a diverse knowledge base, learn as much as possible all the time and take on increasing responsibility for managing bigger projects requiring more critical decisions.

3.3 Summary

Comparing the two sources it is noted that there is an overlap of issues identified and the similarities can be integrated for the purposes of this study. The following table summarises the key issues identified by the literature and the focus group approach and compares these to analogous concepts within the chaos and complexity framework. The issues were also considered in the context of organisations as complex adaptive systems (CAS) in order to characterise the nature of the problem in systems terms, so that the corresponding chaos and complexity analogues could be identified. This allowed the researcher to contextualise the key issues identified in both cases within chaos and complexity analogues and to summarise the main constructs which were to be measured in the survey questionnaire.

Table 3.1: Comparison of issues identified by the literature and focus group

Key issues identified by Literature	Key issues identified by Focus Group	Perspective on the Organisations as a CAS	Analogous Element of Chaos/ Complexity Theory	Summary of Construct
Lack of effective management of diversity	Lack of active engagement by Human Resources (HR) departments	Introducing diversity into the organisation through employment of incumbents with different cultural backgrounds who are younger and come with different perspectives creates differentiation. Adaptive organisations effectively need to manage the integration of these elements simultaneously to determine if the result will move the system toward order or disorder.	Edge of chaos	B-BBEE & Diversity Management
	Poor retention plans	No understanding of the environment within which the organisation is functioning makes the system weak to external influence. System is not responding with capable plans to adapt to the changing purpose of its active elements (employees). Shared image is not communicated effectively.	Amplification of disturbances, non-linearity, shared image as an attractor	HR engagement
	Young technology professionals want flexibility, diversification of skills, roles and responsibilities	Rigidity in structure means the system cannot adapt to meet the needs of purposeful elements	Self- Organising characteristics of the system	Flexibility, diversification of skills, roles & responsibilities
Lack of mentorship	No mentorship	Lack of a shared image which serves the purposes of the organisation and its members	Shared image attractor, leaders as attractors	Mentorship
High remuneration rates offered by developed countries	Opportunities for higher remuneration, growth and development	The system is an organisation of purposeful members coming together to serve their own needs by serving a need in the environment. There must be clear understanding of what purposes attract members and what purposes align and keep them in the organisation.	Shared image as attractor	Remuneration
Lack of incentives	Lack of incentives to become a technical specialist	The organisation must create flatter structures with nested design cells that create a shared understanding of and appreciation for roles and purposes of different members. Reward system is weighted accordingly.	Self-Organising characteristics of the system, purposeful systems with purposeful elements	Incentives

Key issues identified by Literature	Key issues identified by Focus Group	Perspective on the Organisations as a CAS	Analogous Element of Chaos/ Complexity Theory	Summary of Construct
Desire of young technology professionals to enter a management role as quickly as possible Time horizon in roles/ organisations is too short		Non-linearity of systems as they evolve must be appreciated. Timelines evolve with the organisation, changing performance landscape and knowledge/ capability of members.	Non-linearity	Time to enter Management Roles
Misunderstanding of roles and attributes Difference in work expectation	Technology business leaders do not trust young professionals	Understanding or system attributes at individual and organisational level is an iterative process. Trust is earned through iterative decentralisation of decision making interventions. As the abilities of members improves, a new shared image which better serves the organisation replaces the distorted one. The self-organising mechanism of the system is engaged to define roles and using the purposes of members, align roles to expectations and the system wide shared image of the organisation's overall purpose.	Iterative nature of complex processes, shared image as attractor, leaders as attractors	Trust & Mutual Understanding
Poor implementation of B-BBEE	BBBEE strategy and implementation is not properly understood or executed	Balancing differentiation and integration	Self-Organising characteristics of the system	B-BBEE & Diversity Management
	Influence of networking	Network feedback will reinforce the shared image whether it is in fact distorted or perceived as such if not carefully managed. Organisations need to engage networking tools such as social media to effectively manage how their image is communicated through the intranetwork and to the environment (the industry)	Non-linearity, network feedback, shared image as attractor	Networking

The above summary was then used to inform the design of the research instrument for the quantitative portion of this project. A survey questionnaire was identified as being the most suitable instrument. The constructs summarised in Table 3.1 were further

scrutinised and reduced by combining them into single constructs which would be able to capture the spectrum of feelings, behaviour and perceptions associated with a particular construct. Table 3.2 below gives the list of final constructs obtained in this manner and the questionnaire items associated with each construct. The questionnaire itself can be found in Appendix A of this report.

Table 3.2 Summary of questionnaire constructs and items

Construct/ Key Variable	Questionnaire Item
Leadership, Management Style and the Shared Image	7.1, 7.3, 7.7, 7.9, 7.10, 8.3, 8.7
HR Engagement	7.4, 7.5, 7.11, 8.8, 8.9, 8.16, 9.12
Mentorship, Empowerment and Time Horizon to enter a management role	7.2, 8.4, 8.5, 9.9, 9.15
Flexibility, diversification of skills, roles and responsibilities	9.2, 9.4, 9.14
Remuneration and Incentives	9.1, 9.7, 9.10, 9.11, 9.13
Trust and Mutual Understanding	7.6, 7.8, 8.6,
B-BBEE and Diversity Management	8.1, 8.2, 9.3, 9.5, 9.6, 9.8
Networking	10.1, 10.2
Total: 8 Constructs	Total: 38 Questions

The remaining questions in the questionnaire, namely Questions 1-5 captured the demographic information to segment the respondents into the categories pertinent to the study and Question 6 measured the propensity of respondents to change companies and/or professions as a result of their experiences with their immediate manager – a point of crucial interest to this study. The main items in the questionnaire employed a 5-point Likert scale weighted from strongly negative (1) to strongly positive (5).

The constructs thus summarised in Table 3.2, combined with an understanding of complex adaptive systems, chaos and complexity theory will be used to inform the design of a robust leadership framework and this forms the basis of the next chapter. While traditional management philosophies have typically fought against the self-organising behaviour of social systems, the proposed framework offers suggestions to make potentially beneficial use of this natural tendency.

4. LEADERSHIP ARCHITECTURE FRAMEWORK DEVELOPMENT

4.1 Introduction

This chapter draws on information generated by the literature review in Chapter 2 and qualitative data from the focus group presented in Chapter 3. The aim is to obtain insight from the information with a view to developing a framework for analysing leadership architecture for the organisation as a complex adaptive system.

4.2. A proposed framework for designing leadership architecture based on chaos/ complexity insights

At the qualitative stage of the study more than one leadership-related variable emerged as a key issue impacting the job migration/ profession switching problem and these factors are known to exhibit a large degree of non-linearity since there is no predictable way to analyse the interactions between the system (i.e. technology companies) and the agents of that system. Chaos theory therefore appears to be suitable as a framework for understanding the system dynamics related to the research problem. It follows that good leadership architecture could help organisations become more effective in managing the afore-mentioned problem. Based on this, a framework is proposed, borrowing ideas from throughout the literature. This framework which combines what the researcher considers the most appropriate chaos/ complexity insights into a coherent design platform. Again it should be stated that a foundational notion of chaos theory itself is that non-linear processes are always going to be ‘un-predictable’ in the sense that emergent properties as a result of interacting elements of a system (especially when those elements have choice), can never be isolated into a well-defined future state. However, it teaches that an understanding of the system dynamics over time could be used to identify pattern-able behaviour which can or could create intuition about how the system is self-organising. This in turn helps system designers and system managers better prepare for future ‘potentialities’. Any chaos/ complexity based design will have the essential characteristics listed below.

- It will account for sensitive dependence on initial conditions (historical contingencies) (Osborn & Hunt, 2007).
- It will follow a few simple rules recursively with feedback (Burns, 2002).

- It will show scale independence (self-similarity) (Schneider & Somers, 2006).
- It has to create intervention points where there is a propensity for the system to bifurcate (split-up) and breakdown into chaos (Gleick, 1987). This is where the design cell concept (Gharajedaghi, 2011) is particularly useful as will be explained further.

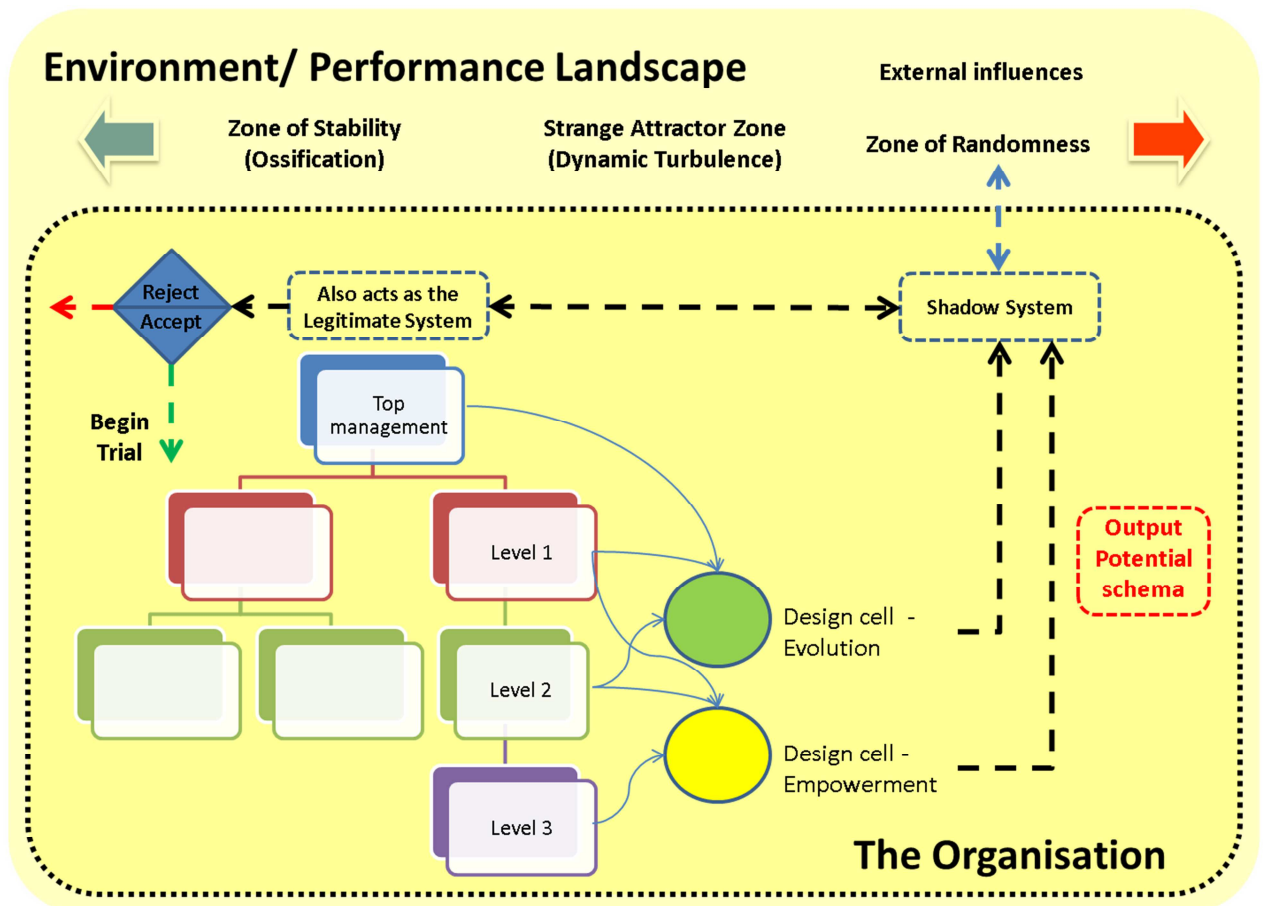


Figure 4.1 A chaos based platform for designing leadership architecture – Systemically Active Integration (SAI)

Figure 4.1 demonstrates a possible chaos-based framework for leadership architecture design. It combines the design cell concept of Gharajedaghi (2008) with the chaos model of the organisation proposed by Lissack (1999) and Burns (2002), as well as accounting for external influences which occur as a result of the organisation's interaction with the environment/ performance landscape. A design cell is essentially an informally drafted cross-functional team outside the day-to-day operations of the company that integrates horizontal business functions (i.e. at the same hierarchical level of the firm) and vertical business functions (from different hierarchical levels). The concept was first introduced by Ackoff (1981). Design cells are nested, organisational vehicles for participative design

activities. Each design cell regards its superior design cell as its environment and aims to redesign its activities in this context (Gharajedaghi, 2010).

Using design cell methodology helps give quality and meaning to the essentially recessive shadow system which is the informal system of communication within the organisation (Lissack, 1999) – usually just responsible for rumours and ruin. If left unchecked and without positive intervention, the shadow system can create a negative organisational culture, mistrust, a breakdown in communication and other problems.

A design cell is encouraged for each layer of the hierarchy in the organisation for three reasons:

- There is an opportunity for the desired shared image to be reinforced at more and deeper levels of organisation allowing it to fully permeate more agents of the system while maximising the transactional space for localised leadership interactions.
- The business risk of new schema is minimised because the design cell acts as an incubator – it allows the company to begin trials and manage the implementation of new ideas which could potentially yield better results than current schema, internally first, therefore limiting exposure to external influences. In the same vein, those schemas which would detract the system from the desired shared image or which are simply bad ideas in the context of the organisation, its suppliers, customers and markets can be rejected also with minimal risk.
- Design cells are scale-independent. They can be reproduced at all levels of the organisation but will be self-similar (fractal), consisting of the same fundamental organising principles which allows them to be nested at hierarchical levels of the organisation where there is usually a tendency for the system to bifurcate and breakdown into the informal shadow system.

At any level of the hierarchy, the design cell on that level draws agents from one level above and one level below. This gives any level access to management two levels higher – not typical (or sometimes even possible) during the day to day operations of the business. This creates an informal ‘team’ of system agents wherein ideas and insights can be shared without prejudice from several different business functions at different levels. It empowers agents at operationally lower levels in the organisation to take

leadership action by thinking about the goals of oneself and the company and how these could better be aligned. The researcher has therefore introduced the term 'Design for Empowerment' modules to refer to design cells at the lower organisational levels. As design cells go higher up, the technical and managerial skill and insight potentially increase and these design cells nurture the possibility of transforming the organisation. The researcher thus introduced the term 'Design for Evolution' modules to describe design cells at the higher organisational levels. Design modules can select favourable schemata (action items/ policies/ rules/ innovation ideas) and forward to the legitimate system (top management). In this way the shadow system acquires visibility and attention and becomes a participative leadership function at the local and global levels of the firm. The shadow system already exists in firms. It is just a matter of whether it can be purposefully engaged to provide meaningful input.

4.3 Systemically Active Integration (SAI) and key functions of the framework

Once design cells are active and begin to channel the flow of information from the shadow system, engaging different business functions and collecting diverse, differentiated perspectives, the shadow system is given 'texture', setting the design process in motion. This is a purposeful move toward design based on a coherent framework for designing leadership architecture that can provide *Systemically Active Integration (SAI)*. In Figure 2 under Chapter 2, it was shown that the highest mode of organisation occurs when there is both conscious differentiation and intelligent integration – i.e. self-organised complexity. SAI is a framework which enables differentiation through regulated idea creation in order to move the organisation away from ossification and toward the zone of the strange attractor. When new schemas are escalated from the shadow system, there is a pre-screening of schemas by a regulatory legitimate system which minimises the risk to the firm. Schemata identified as favourable can therefore be integrated and tested in real time. The top management of the firm is engaged to serve as this legitimate system and functions to separate noise from useful information and to ensure that the organisation's trajectory is pulled and maintained in the basin of the desired attractor (self-organising around the core values and ultimate purpose of the organisation). Part of its management function is to review historical decisions and assess the business impact of the adopted strategic course as a result of such decisions. This would further extend to schemas imported from the shadow system and tested in the organisation where the legitimate is

the mechanism to delete schemas which could throw the organisation into the zone of randomness.

SAI is a dynamic, interactive, iterative framework for designing leadership architecture, based on the 'edge of chaos' theory that an optimal system is one which is 'poised' i.e. able simultaneously to foster diversity and ensure that all radical and new ideas are still reasonably within the bounds of the company's core values and ultimate purpose (Burns, 2002). Since multiple new, competing ideas are bound to arise, such a system also checks that external influences are positively being interpreted, converted into information and used to respond in appropriate ways to the dynamic performance landscape.

SAI can also be used as an analytical framework for understanding the organisational system dynamics as well as to ensure that the system is actively and iteratively seeking the next optimal solution as it co-evolves with its environment by capitalising on the emergent results of a more networked leadership transactional space.

It is worth noting that both the shadow system and the legitimate system are necessary and must communicate with each other (represented by the dual direction arrows connecting the two systems). Without the legitimate system to maintain new schema within the desired basin of the attractor (core values and ultimate purpose) the system would bifurcate at each new idea, as agents choose sides one after the other until chaos results, since there are no regulating mechanisms – chaotic simplicity. Without the shadow system, the organisation would become stagnant, moving deeper into the zone of stability until all creativity, new ideas, new thinking and innovation stop. The two keep each other in balance at the edge of chaos, working against and with each other, balancing diversity with integration, all the while taking the systemic influences of interactions into account. This combination creates the self-organised complexity and higher order structure, demonstrating the principle that one system does not exist in spite of, but rather because of, the other.

This chapter has shown that the SAI framework offers a robust approach for analysing leadership architecture and designing for the influence of leadership on the research problem suggested by the literature and qualitative data. The next chapters seek to quantify this influence and present the quantitative phase of the study.

5. METHODOLOGY

The research approach used to investigate the problem will be discussed in this chapter.

5.1 Introduction

The hybrid or mixed-method approach, which combines the quantitative and qualitative data collection approaches, was selected as the method most suitable to this research effort. Data were collected using both approaches to achieve triangulation and hence improve validity. The development and use of mixed designs (hybrid) have increased in recent years as researchers have realised that the best approach to answering research problems is to combine the qualitative and quantitative approaches, or that using solely either one is insufficient in providing complete answers that meet the purpose of the study (McMillan & Schumacher, 2010).

5.2 Use of focus group

In order first to refine the issues to be investigated, a focus group meeting was used to record the feelings, perceptions and attitudes of respondents selected on a convenience basis. The researcher acted as an observer and recorded the session using a digital recording device while an assistant (Assistant HR Manager at the firm from which the focus group was selected) facilitated the discussion. The assistant was given a guideline (Appendix C) to steer the discussion. The researcher took notes during the discussion. This provided qualitative data which were compared with the key issues identified in the literature in order to develop constructs for the study. The results and subsequent development and refining of constructs for the research instrument were provided in Chapter 3. The focus group was constituted as follows:

- three Young Engineers (26 – 39 years old);
- one Senior Engineer (>39 years old);
- one Human Resource Manager; and
- one Technology Business Senior Manager.

This group was asked to discuss the broad topic of organisational challenges facing the technology industry in South Africa. The discussion was facilitated by the researcher who

ensured that participants freely contributed their ideas and shared their experiences regarding the topic.

5.3 Data collection

For the second phase of the study, the online survey tool *Survey Monkey* was used to design and distribute the questionnaire. An online survey was chosen as it was believed that such a method would offer participants anonymity and allow the researcher access to a wider sample without the limitations of geographical distance (Mouton, 2008). To enhance the purposive filtering of participants, the researcher engaged the services of the Engineering Council of South Africa (ECSA) and selected technology recruitment professionals to distribute the survey to their networks of registered HR and technology professionals on their respective databases. This ensured that only engineering and Human Resources professionals within technology companies would receive the survey.

5.4 Data analysis

The questionnaire was developed to make use of data capturing in a categorical, ordinal format using the weights assigned by the Likert scale as given in Table 5.1 below. The raw data were firstly subjected to an editing process to identify and remove inconsistencies. For example, the internal logical consistency mechanisms were checked for their effectiveness in ensuring participants answered consistently when the same question was phrased differently. This was achieved by a simple arithmetic validation using weights assigned to responses. Data were then filtered and coded using an alpha-numerical system in order to use this in further calculations using the statistical computer program *SPSS*. After coding, the data were run through several tests which are discussed hereafter.

Table 5.1: Likert scale weighting used in survey questionnaire

Response	Weight
Strongly disagree	1
Disagree	2
Not sure	3
Agree	4
Strongly Agree	5

5.5 Sample description

The survey was distributed to technology and HR professionals within South Africa. Purposive sampling was achieved by targeting respondents in known technology companies and using the services of the Engineering Council of South Africa (ECSA) as well as specialist technology recruitment agencies to forward the survey to registered HR and technology professionals on their respective databases. In total 99 responses were received. The data were put through an initial analysis and cleaned for instances where sections had been skipped and/ or the response did not meet the research criteria. Eight responses were excluded as they belonged to the category younger than 26 years and there was no literature support to include this demographic in the study. The remaining 91 responses all passed the screening for completeness and the sample size was therefore 91.

Constituent categories were created according to the responses to the introductory questions. “Do you have a technical qualification?” and “Do you have people reporting to you?” identified technology business leaders. “What is your age?” identified the demographics of interest to the study and the question “Are you a Human Resources Manager or employed in the HR division of your company?” filtered out the HR participants. The resultant categories are listed below.

- *Young technology professionals* – these were respondents who checked the 26-39 age category, are in possession of a technical qualification and may or may not have people reporting to them
- *Senior technology professionals*—these were respondents who checked the 39-49 years and 50 years or older age category, are in possession of a technical qualification and may or may not have people reporting to them.
- *HR professionals*—these were respondents who checked any of the age categories, are not in possession of a technical qualification and may or may not have people reporting to them

Respondents who checked the younger than 26 years option were excluded from this study since there was no literature or qualitative support to include this age category in the analysis.

The data presented represents only those responses where the questionnaire was completely answered i.e. without skipping questions/ items.

Table 5.2: Summary of sample constituency

Initial Categories		Unmarked	Marked	Total
Category 1: Young Technology Professionals	Count	55	44	99
	Row N %	55.6%	44.4%	100.0%
Category 2: Senior Technology Professionals	Count	90	9	99
	Row N %	90.9%	9.1%	100.0%
Category 3: Technology Business Leaders	Count	69	30	99
	Row N %	69.7%	30.3%	100.0%
Category 4: HR Professionals	Count	93	6	99
	Row N %	93.9%	6.1%	100.0%

The category “Senior Technology professionals” was initially split into “Senior Technology Professionals” and “Technology Business Leaders” (identified as those aged 39 years and older and having people report to them) however it was decided that the senior technology professionals category did not capture significant responses to measure any considerable effects. The distinction of interest to this study was, in any case, the difference in perception between the ‘younger’ and ‘senior’ categories and for this reason, the senior technology respondents were combined with the technology business leaders category to form the new category “Senior Technology Professionals” which would adequately represent the sub-sample of interest to the research.

The number of HR respondents relative to the total sample size was also found to be too low for significant statistical analysis. This category could therefore not be included in the statistical analysis portion of the study. There were therefore only two constituent categories remaining which were used in the further analysis, namely Young Technology Professionals and Senior Technology Professionals

Table 5.3: Final constituent categories

Analytical Categories	Frequency	Percent
Young Technology Professionals	44	53.0
Senior Technology Professionals	39	47.0
Total	83	100.0

5.5.1 Validity testing

Validity testing is a measurement framework used to assess the degree to which a measurement instrument actually measures what it purports to measure. Hair et al., (2006) show that validity is present in many forms and the five most widely accepted forms of validity are content, construct, convergent, discriminant and nomological validity.

Content validity (or face validity) is the extent to which, on the surface, an instrument looks like it is measuring a particular characteristic (Leedy & Omrod, 2010). The objective is to ensure that the selection of scale items extends past merely empirical issues to include also theoretical and practical considerations. The survey questionnaire was first sent to six (6) typical participants selected on a convenience basis for the purposes of face validity testing, and to test the functional reliability of the online survey technology.

This pilot test phase also assessed the overall structural fitness of the instrument to collect the data of interest. Pre-testing the instrument allowed for identification and resolution of ambiguities so that a clearer interpretation of the content by all respondents would be enabled. Grammatical errors and repetitions were addressed and questions were re-framed to better affirm that the context for the study was South African leadership. A cover page was also added at the front of the questionnaire to remind participants to bear this context in mind while answering the survey. Phrases which were also unnecessarily lengthy, and which therefore might introduce confusion in the minds of participants, were refined and re-phrased in simpler language.

Construct validity is the testing of the ability of the items to represent underlying latent theoretical constructs (McMillan & Schumacher, 2010) they were designed to measure. This was investigated by means of a factor analysis. Factor analysis is particularly useful as a tool for examining the validity of tests or the measurement characteristic of attitude scales (Robinson et al., 1991). The actual analysis will be discussed further in the sections which follow.

Convergent validity assesses the degree to which two measures of the same concept are correlated (Leedy & Omrod, 2010), and this was also determined through a factor analysis of the various items which made up the instrument.

Discriminant validity refers to the degree to which two conceptually similar concepts are distinct. This was argued in the previous chapter relative to the development of the final constructs and thus the researcher is satisfied with the resultant level of discriminant validity.

Nomological validity refers to the degree that the summated scales of each construct make accurate predictions of the other concepts in a theoretically based model. Theoretical relationships were established in the previous chapter and these are tested on a practical level as described in the following sections.

5.5.2 Factor analysis

This technique was incorporated to assist in establishing the reliability and validity of the measuring instruments used in the study. Hair et al., (2006) describe factor analysis as an interdependence technique, whose primary purpose is to define the underlying structure among the variables in the analysis. The general purpose of factor analytic techniques is to find a way to summarise the information in a number of original variables into a smaller set of new composite dimensions with the smallest loss of information. Norusis (2005) further adds that it is a statistical technique used to identify a relatively small number of factors that explain observed correlations between variables.

The interpretation and labelling of the outcome factors is a subjective process. To enable a meaningful interpretation, certain guidelines would be appropriate as postulated by Hair et al., (2006). These are presented below.

- Factor analysis should most often be performed on metric variables. In the case of the study, the 5-point Likert scale makes this appropriate.
- The analysis should strive to have at least five variables for each proposed factor. All dimensions in this study are more than sufficiently above this level.
- The sample must have more observations than variables; whilst the minimum absolute sample size should be 50 observations.
- Maximise the number of observations per variable, with a minimum of five and at least 10 observations per variable.
- A statistically significant Bartlett's test of sphericity ($p\text{-value} < 0.05$) indicates that sufficient correlations exist between the variables to proceed.

- Measure of sampling adequacy (MSA) values must exceed 0.50 for both the overall test and each individual variable; variables with values less than 0.50 should be omitted from the factor analysis one at a time, with the smallest being omitted with each iteration. Although 0.50 is considered to be the bare minimum, Hair et al., (2006) describe that particular cut-off point as 'miserable'. Thus a stronger cut-off point of 0.6 was enforced in the factor analysis for this study.
- Several stopping criteria need to be used to determine the initial number of factors to retain:
 - factors with eigen values greater than 1.0 (unity);
 - enough factors to meet a specified percentage of variance explained, usually 60% or higher; and
 - a predetermined number of factors based on research objectives and/ or prior research. This particular rule will only be enforced if there is any uncertainty concerning the structure resulting from the above two rules.
 - A common rule of thumb is that each factor should have at least three factors that load highly on it (Norusis, 2005). Should this not be the case the factor would then be considered undefined.
- Although factor loadings of ± 0.30 to ± 0.40 are accepted as the bare minimum, values greater than ± 0.50 are generally considered to be necessary for practical purposes.
- Variables should generally have extracted commonalities of greater than 0.50 to be retained in the analysis. However, values as low as 0.30 are generally accepted.

With regards to the determining an extraction method, there are two factor analytic approaches – Principal Component Analysis and Principal Axis Factoring. In Principal Component Analysis, it is assumed that all variability in an item should be used in the analysis, while in Principal Axis Factoring, only the variability in an item that it has in common with the other items is used. In most cases, these two methods usually yield very similar results. However, Principal Component Analysis is often preferred as a method for data reduction, while Principal Axis Factoring is often preferred when the goal of the analysis is to detect structure. Although data reduction is one of the aims of the factor analysis in this study, a more pertinent aim is to determine whether any underlying clear structure is present within the data per the questionnaire. Thus Principal Axis Factoring was adopted. Furthermore, an oblique rotation method, which is best suited to

the goal of obtaining several theoretically meaningful factors or constructs, was selected for the factor analysis carried out in this study.

5.5.3 Reliability testing

Hair et al., (2006) describe reliability as being considered an assessment of the degree of consistency between multiple measurements of a variable. It represents the consistency with which an instrument measures a given performance or behaviour. A measurement instrument that is reliable will provide consistent results when a given individual is measured repeatedly under near-identical conditions.

In order to test the reliability of the survey questionnaire instrument used in this study, the diagnostic measure of Cronbach's alpha was used on the groups of items per each key factor identified following the factor analysis process. Cronbach's alpha is a statistical technique for validating internal consistency which appears best suited to data resulting from the attempted measurement of intangible phenomena (feelings, emotions, attitudes, behaviours etc.). The theoretical value of alpha can take on a value between 0 and 1 and professionals typically use 0.7 or higher as the criteria for justifying the use of a given instrument (Nunnally, 1978) although this may decrease to 0.60 in exploratory research (Hair et al., 2006).

Chapter 5 has described the methodology used for the study including the reliability and validity tests which were used. Chapter 6 will present the details of the results which were found from the study.

6. RESULTS AND ANALYSIS

This chapter presents the results of the quantitative phase of the study as collected by the online survey questionnaire. These results, in the context of the research objectives and research question, will be discussed in greater detail in Chapter 7.

6.1 Sample description

The sample constituency by professional category was shown in Chapter 5. The sample distribution according to the age of respondents was as follows:

Table 6.1: Number of respondents per age category

Age Category	Frequency	Percent	Valid Percent
26 to 39 years	46	50.5	50.5
39 to 49 years	14	15.4	15.4
50 years or older	31	34.1	34.1
Total	91	100.0	100.0

In addition to the above, another point of interest was the resultant years of tenure of the respondents.

Table 6.2: Number of years of tenure of respondents

Tenure	Frequency	Percent	Valid Percent
Less than 1 year	9	9.9	9.9
1 to 3 years	14	15.4	15.4
3 to 5 years	13	14.3	14.3
5 to 10 years	17	18.7	18.7
10 years or longer	38	41.8	41.8
Total	91	100.0	100.0

Tables 6.1 shows that the number of respondents was an almost even split between those who were younger than 40 years of age and those who were 40 years of age and older. The latter group had a total of 45 respondents with 31 being older than 50 years of age. Furthermore, from Table 6.2, 38 of the 91 respondents (41.8%) have been at their company for longer than 10 years. In total, about 75% of respondents have spent more than three years in their companies which is typically long enough in the technology industry for one to gain a fair impression of the organisational culture and environment.

6.2 Statistical responses by theme

All items in the questionnaire were grouped according to a theme which they represented. Responses were then analysed to determine the statistical spread of feelings relative to each theme.

Table 6.3: Experience of direct leadership style (overall)

Option		Unmarked	Marked	Total
1. Leadership style: Made you consider moving overseas.	Count	76	15	91
	Row N %	83.5%	16.5%	100.0%
2. Leadership style: Made you consider moving overseas but within the same company.	Count	81	10	91
	Row N %	89.0%	11.0%	100.0%
3. Leadership style: Made you consider changing professions or industries.	Count	58	33	91
	Row N %	63.7%	36.3%	100.0%
4. Leadership style: Had no notable effect on your career decisions.	Count	41	50	91
	Row N %	45.1%	54.9%	100.0%

The above question (Question 6 in the survey questionnaire) was the first question aimed at capturing the sentiment of respondents toward their direct manager's leadership style. The question was asked directly and not as part of a broader theme as in the case of the rest of the questions which followed. It identified the propensity to consider leaving a company and/ or changing profession based on that experience. Respondents had the option to mark (choose/ select) more than one option, therefore, for all the options that one could select based on one's experience of direct leadership style, there was a 'Marked' and 'Unmarked' column. 'Marked' represented the count of times the option was selected and 'Unmarked' represented the count of times an option was not selected. For ease of analysis, the above responses were then consolidated to combine responses where more than one option was chosen i.e. if a respondent selected option 1, 2 and/ or 3; it indicated that their consideration to move either by changing profession or moving overseas. If a respondent selected option 4, it indicated that there was no consideration of taking action. If all 4 responses were selected, the response was invalid. There were no instances of such responses. In summary, respondents either considered a change or no change as shown in Table 6.4:

Table 6.4: Consolidated response to “Experience of Direct Leadership Style”

Action Considered	Frequency	Percent	Valid Percent
No Change	45	49.5	49.5
Change: Considered Moving Overseas/Changing Professions	46	50.5	50.5
Total	91	100.0	100.0

There is an almost perfectly even split in responses to the above question regarding the experience of leadership style. In the questions which followed, responses were weighted using a 1-5 Likert scale were used as shown in Chapter 5, Table 5.1.

Groups of items were used to capture broadly the feelings, perceptions, attitudes and beliefs regarding a theme based on the constructs described in Chapter 3. The standard deviations presented refer to the original data.

Table 6.5: Summary of responses to “Workplace Experiences” questions

Question	Mean	Std. Deviation
I am or was previously motivated to leave a company as a direct result of my relationship with my direct manager.	2.84	1.500
I feel empowered by my manager to take decisions which contribute to the business direction of my division.	3.63	1.082
My direct manager openly and regularly communicates with me so that learning and knowledge transfer can take place.	3.34	1.288
The HR department adds no value to the organisation.	2.90	1.280
Our local leadership does not give due importance to mentorship and does not provide any sort of mentorship programme.	3.07	1.207
Loyalty is a word that is unheard of among younger technology professionals.	3.47	1.041
My direct manager constructively helps me identify my areas of development without undermining me.	3.14	1.204
There appears to be a lack of trust from the management with respect to young technology professionals.	3.06	1.108
Despite the best efforts of the company to educate managers on the latest thoughts on leadership, local managers at all levels still use the outdated methods of their predecessors.	3.47	1.072
I often feel like I know more about our technologies or core business than my manager.	3.21	1.172
HR regularly communicates with me to understand where I am in my career and whether I still feel fulfilled in the role I have.	1.94	1.122

Most of the responses shown above, to questions which aimed to record the feelings of respondents with regard to their workplace experiences, showed a neutral tendency. The exception was the ranking of the statement “HR regularly communicates with me to

understand where I am in my career and whether I still feel fulfilled in the role I have” which showed a negative response tendency.

Table 6.6: Summary of responses to “Managers at my company” questions

Question	Mean	Std. Deviation
Managers at my company: Effectively deal with intercultural conflicts within the organisation.	3.02	1.033
Managers at my company: Appreciate the injection of "youngsters" into the management team.	3.31	.972
Managers at my company: Challenge and debate the management styles and assumptions of their predecessors.	3.01	1.123
Managers at my company: Encourage input from young professionals in the company toward business decisions and strategy.	3.13	1.068
Managers at my company: Are objective in evaluating young professionals' eligibility for management positions and make the decision based on competence, rather than on prejudiced factors such as age, race, gender, sexual orientation or others.	2.95	1.174
Managers at my company: Are always clear about what is expected of me in my job.	2.93	1.136
Managers at my company: Insist on referring to "the good old days" and "how we used to do it".	2.73	1.146
Managers at my company: Add no value to my career since I do not learn any new skills from them.	2.91	1.274
Managers at my company: Ensure that I am provided with access to, and encourage interaction with, a competent team of formal and/ or informal mentors.	2.99	1.123
Work environment and policies: Remuneration is a primary reason professionals leave the company.	3.21	1.127

Table 6.6 demonstrates that the responses to statements relating to how respondents felt about the general management in their companies showed a neutral tendency.

Table 6.7: Summary of responses to “Work environment and Policies” questions

Question	Mean	Std. Deviation
I am allowed flexibility, within well-defined boundaries, to execute my role in ways that best suit my strengths and abilities.	3.49	1.073
The company recognises the need for and appreciates diversity as a basis for creativity and innovation.	3.21	1.000
Cross-functional teams are encouraged and my job exposes me to a wide variety of skills, roles and responsibilities which I have to master.	3.43	1.071
We try very hard to reflect the country's demographics in our management structures.	3.39	1.224
The company consistently and constantly makes efforts to understand, implement and communicate a meaningful BBBEE strategy to all company stakeholders.	3.49	1.164

The HR department is abreast of the latest thinking on strategic HR management and innovates ways to recruit and retain diverse talent.	2.67	1.091
Remuneration in the organisation is not based on race, gender or other prejudices.	3.13	1.281
It feels to me like the company engages in BBBEE "fronting" and employs non-white people in non-critical, non-decision-making roles only.	2.41	1.090
Being a technology professional enables one to get into a management role within a short period of time.	2.76	1.074
The company encourages becoming a technical specialist.	3.16	1.096
I do not have to go into a management role since the rewards are just as high for becoming a technical specialist.	2.60	1.189
If for any reason I experience a lack of motivation, I am confident that HR will engage with my manager and myself to plan an intervention to assist me.	2.35	1.207
Remuneration in the company is fairly determined based on qualification, experience and the type of work one does.	2.93	1.185
The job I currently hold is routine and leaves no room for creativity or innovation.	2.37	1.146
Technology professionals in the company, many of whom have been with the company for a long time, often complain that they still do not hold a management position.	3.14	1.087

Responses to questions regarding respondents' immediate working environment and the associated policies showed a neutral tendency. A significant deviation toward the negative took the form of the response tendencies for ranking of the statements "I do not have to go into a management role since the rewards are just as high for becoming a technical specialist", and "If for any reason I experience a lack of motivation, I am confident that HR will engage with my manager and myself to plan an intervention to assist me".

Table 6.8: Summary of responses to "Networking" questions

Question	Mean	Std. Deviation
I have felt like leaving a company after speaking to other colleagues within the company who had expressed an interest to leave.	2.54	1.129
My colleagues and I are not influenced by views and opinions about an employer which are shared through social media, email and/or conversations.	3.46	1.018

Two questions were asked on the theme of 'Networking'. Responses showed a positive tendency when asked in both a positive and negative sense.

6.3 Validity testing

Validity testing was carried out in two parts as described below.

- Face validity – this was used as pre-testing of the data collection instrument and to identify errors which could have caused the erroneous interpretation of the items. This was described in the Methodology chapter.
- Construct validity – this was carried out to assess the suitability of the items to capture the data of interest. This was also a refinement process to determine whether the constructs which had evolved from the literature and the qualitative data captured during the focus group meeting were sufficient as overall factors that influenced the research problem. A factor analysis technique was used.

6.3.1 Factor analysis

Data collected from the 91 respondents were initially put through the Cronbach's alpha test using the dimensions (constructs) derived from the literature and focus group discussions (described in Chapter 3). Those original eight factors failed the initial reliability tests therefore implying that they were too broad to capture the specific detail of the most pertinent underlying issues.

The full data set was then put through a factor analysis process to determine the organic grouping of items. The results were as follows:

Table 6.9: Results of factor analysis with original dimensions indicated

Factor			Original Dimension				
1	2	3					
.794			Leadership, Management Style and The Shared Image				
.767	.161		Leadership, Management Style and The Shared Image				
.732		-.245	Mentorship, Empowerment and Time Horizon To Enter A Management Role				
.706	.162	.210	HR Engagement				
.653			Flexibility, Diversification Of Skills, Roles and Responsibilities				
.647	.121	-.206	B-BBEE and Diversity Management				
.612	-.257	.160	Flexibility, Diversification Of Skills, Roles and Responsibilities				
.608	-.545	.242	Mentorship, Empowerment and Time Horizon To Enter A Management Role				
.599	.149	-.510	Remuneration and Incentives				
.584	-.489	.155	Trust and Mutual Understanding				
.556	-.354	.183	Mentorship, Empowerment and Time Horizon To Enter A Management Role				
.550	.113	-.413	B-BBEE and Diversity Management				
.510	.405	.140	B-BBEE and Diversity Management				
.266	.645	.284	B-BBEE and Diversity Management				
.221	.469	.452	B-BBEE and Diversity Management				

Following the rules described in Chapter 5, several iterations (20 in total) of the Principal Axis factoring analysis were run on the questionnaire items to identify organic groupings of items. With each of the subsequent iterations, an item was removed with the aim of improving refinement. Table 6.10 shows the final grouping of items which provided a reliable result.

This being the case, the items comprising the three new factors were each combined into new themes which were then used to rename the factors. These formed the basis for the remainder of the analysis. The new factors were:

Factor 1: Leadership Experience;

Factor 2: Business Culture Experience; and

Factor 3: B-BBEE and Diversity Management.

A Rotated Factor Matrix was also calculated to assess the theoretical strength and practical meaningfulness of the three new factors with respect to their ability to represent the research objectives. The rotation converged in four iterations.

Table 6.10: Results of rotated factor analysis with extraction indicated

	Factor			Extraction
	1	2	3	
Leadership Experience	.843	.107		.468
Leadership Experience	.757	.166		.725
Leadership Experience	.664	.160		.604
Business culture experience	.630	.237	.115	.444
Business culture experience	.509	.372	.201	.614
Business culture experience		.795		.603
Business culture experience	.119	.686		.634
Leadership Experience	.328	.684	.169	.466
Business culture experience	.263	.608	.191	.438
Leadership Experience	.486	.575	.260	.569
Leadership Experience	.406	.545	.390	.473
Business culture experience	-.118	.136	.731	.567
Business culture experience			.685	.641
Leadership Experience	.135	.343	.555	.476
Business culture experience	.447	.366	.485	.485

Each row in the output table above represents items (questions) from the survey questionnaire that was associated with each factor (not shown). Importantly, the eigen values calculated in Table 6.12 are a further test of the 3 factor solution. The factors should all have eigen values which exceed the cut-off criterion (eigen values greater than 1). The percentage variance is an indication of how much of the variability, in all of the three factors, each individual factor contributes i.e. Factor 1 account for 36.898 of the variance and so on.

Table 6.11: Extraction sums of squared loadings

Eigenvalues	% of Variance	Cumulative %
5.535	36.898	36.898
1.643	10.956	47.854
1.031	6.873	54.726

As an additional validity check, the following tests were done:

Table 6.12: Summary of KMO and Bartlett's test results

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	MSA	.788
Bartlett's Test of Sphericity	Sig. (p-value)	.000

Measures of MSA exceed the requisite 0.50 overall, and the p-value for Bartlett's Test of Sphericity is significantly lower than 0.05, indicating sufficient factor correlations.

6.4 Reliability testing

The three factor solution described above was subjected to the Cronbach's alpha test for internal logical consistency as described in Chapter 5. Table 6.14 below shows the results that were calculated for each of the factors:

Table 6.13: Summary of Cronbach's alpha test

Factor	Cronbach's Alpha	N of Items
1 Leadership Experience	.838	5
2 Business Culture Experience	.867	6
3 B-BBEE and Diversity Management	.715	4

The alpha measurements for all three of the factors exceed the minimum requirement of 0.7. It should be noted that, given the nature of the study, 0.6 would have also been an accepted minimum value as explained in Chapter 5.

6.5 Hypothesis testing

The overall results of the mean and standard deviation calculations per each factor are set out below.

Table 6.14: Summary of statistical results per factor

Category		Leadership Experience	Business Culture Experience	B-BBEE and Diversity Management
Young Technology Professionals	Count	44	44	44
	Mean	3.42	2.89	3.31
	Std Deviation	.86	.91	.81
Senior Technology Professionals	Count	39	39	39
	Mean	3.30	2.95	3.51
	Std Deviation	.97	.91	.73
HR Professionals	Count	6	6	6
	Mean	3.60	3.28	3.58
	Std Deviation	.63	.82	.63
Total Sample	Count	91	91	91
	Mean	3.33	2.91	3.35
	Std Deviation	.91	.91	.81

Table 6.15 shows the overall comparison of responses by category. It can be seen that the responses displayed an approximately neutral tendency, with Factor 1 and 3 having a slightly more positive bias.

6.5.1 Statistical testing

Statistical tests were performed on the three factors with the aim of addressing the research hypotheses proposed in Chapter 1 as a critical part of the research objectives. The results of the tests are first presented and the implications regarding the hypotheses are then analysed.

Table 6.16 was drawn up to show the results of a cross-tabulation test whereby the responses of young technology professionals were compared to the responses by senior technology professionals.

Table 6.15: Cross-tabulation test of experience of direct leadership style (specific)

		Young Technology Professionals	Senior Technology Professionals	Total
No Change	Count	16	25	41
	% within Leadership Style	39.0%	61.0%	100.0%
Considered Moving Overseas/ Changing Professions	Count	28	14	42
	% within Leadership Style	66.7%	33.3%	100.0%
	Count	44	39	83
	% within Leadership Style	53.0%	47.0%	100.0%

A Fisher's Exact test, which is a customised version of the Pearson Chi-Square test was also done since this is a way of determining the significance of deviation from the null hypothesis. Table 6.17 gives the result of the test:

Table 6.16: Fisher's exact test result

Fisher's Exact test	
Exact Sig. (2-sided)	0.016

6.5.2 Results for hypothesis 1

Hypothesis 1:

Ho: The impact of the direct management style on the decision to leave a company and/or switch professions is perceived similarly by young technology professionals and senior technology professionals.

Ha: The impact of the direct management style on the decision to leave a company and/or switch professions is perceived differently by young technology professionals and senior technology professionals.

Table 6.16 summarises the results of cross-tabulation testing of the responses related to the direct experience of the immediate manager's management style on technology business stakeholders, specifically the difference in perception between the two demographics of critical interest to this study: Young Technology Professionals and Senior Technology Professionals (which included technology business leaders).

From the test data it can be inferred that the majority of young technology professionals actually considered moving overseas or changing their professions/ industries as a direct result of their immediate manager's management style. The number of young technology professionals who felt this way was also double the number of senior technology professionals who shared the same feeling.

Conversely, the majority of senior technology professionals indicated that the impact of their manager's style had no influence on whether they wanted to leave or change professions/ industries.

6.5.3 Results for hypotheses 2, 3 and 4

These results have been grouped together and separated from Hypothesis 1 since they relate to questions which were not directly asked, but formed part of a broader theme related to each of the factors. It was therefore considered of interest to compare the results of asking questions directly versus asking as part of a theme and how this would influence the overall result.

Hypothesis 2:

Ho: Young technology professionals, senior technology professionals, technology business leaders and HR professionals perceive the impact of leadership on themselves similarly.

Ha: Young technology professionals, senior technology professionals, technology business leaders and HR professionals perceive the impact of leadership on themselves differently.

Hypothesis 3:

Ho: South African technology business work environment and policy are perceived similarly by young technology professional and senior technology professionals.

Ha: South African technology business work environment and policy are perceived differently by young technology professional and senior technology professionals.

Hypothesis 4:

Ho: Technology business stakeholders perceive B-BBEE and the management of diversity similarly.

Ha: Technology business stakeholders perceive B-BBEE and the management of diversity differently.

Table 6.17: Summary of Results for T-test and Levene's test for equality of variances

Factor	t	DoF	Sig. (2-tailed)
Factor 1: Leadership Experience	.576	81	.567
Factor 2: Business Culture Experience	-.320	80	.749
Factor 3: B-BBEE and Diversity Management	-1.176	80	.243

Table 6.17 shows the result of two tests - Levene's test for equality of variances and the t-test, both of which can be applied if a sample containing two or more groups of interest needs to be tested. Both tests were used to compare the three factors and to determine whether there was a significant variance across the response data in order to test the null hypotheses of research hypotheses 1.5.2, 1.5.3 and 1.5.4. For a variance to be significant, a p-value (sigma 2-tailed) of less than 0.05 is required. DoF (degrees of freedom) is an indication of the number of the responses which were used in the calculations. The table draws a comparison of the variances between responses received from young and senior technology professionals. The sigma values calculated were all well above 0.05 indicating no significant variances.

Chapter 6 has presented a review of the results. This will be followed by a detailed discussion of the results in the context of the research question and hypotheses in Chapter 7.

7. DISCUSSION OF RESULTS

In this chapter, the results presented in Chapter 6 are considered in greater detail, with particular reference to the research question, objectives and hypotheses. In addition, insights from chaos and complexity theory are sought in discussing the findings. In Table 1 of Chapter 3 it was shown how studies which analysed organisations as complex adaptive systems (CAS) could offer a link between chaos and complexity theory and modern leadership/ management theory by allowing the researcher to contextualise the issues identified by the literature and the qualitative data, using chaos analogous elements of the two theories. The factor analysis in Chapter 6 produced three new factors (Leadership Experience, Business Culture Experience and B-BBEE and Diversity Management) which could also be classified using the same theoretical framework in Table 1 and this will be discussed in more detail in the sections which follow.

7.1 Overview of results from a chaos/complexity science perspective

An analysis of all the final results positions the direct management style as the factor which emerged as potentially the most significant influence on the problem of job migration/ profession switching. This is in line with the theory, at least from the standpoint that leaders act as chaotic attractors or tags around which the system self-organises (Schneider and Somers, 2006). A company's core values or the vision and mission may similarly act as the attractors (and in a good organisational design, it is necessary that they do), but ultimately it is the leadership which makes explicit and disseminates the shared image which reaches into the wider organisational system (Gharajedaghi, 2011).

The data from this study has significant inferences in that a telling result occurred between the initial reliability testing and the final factor analysis. As was described, the original eight factors were too broad to capture the essence of the situational dynamics which appeared to be creating the problem. Running the factor analysis to check for organic grouping of items was insightful since it revealed a stronger argument for chaos implications. Just three factors emerged as being strong enough to represent the research ideas in terms of collecting the information of interest which is, in and of itself, an evident sign of chaotic behaviour. The natural grouping together of the three new factors, represented by only approximately 40% of the original questionnaire items, demonstrates

a fundamental chaos principle - recursion of simple rules producing emergent, complex behaviour.

7.2 Discussion of results for hypothesis 1

1 Ho: The impact of the direct management style on the decision to leave a company and/ or switch professions is perceived similarly by young technology professionals and senior technology professionals.

1 Ha: The impact of the direct management style on the decision to leave a company and/ or switch professions is perceived differently by young technology professionals and senior technology professionals.

The data showed that 66.7% of young technology professionals considered moving overseas or changing their professions/ industries as a direct result of their immediate manager's management style. This is two thirds of the category, while the number of senior technology professionals who also felt that they were influenced to make a change only accounted for a third (33.3%) of the senior technology professional category.

Sixty-one per cent of senior technology professionals adopted the disposition that their feelings toward their direct manager's style had no influence on their propensity to stay or leave. Therefore, based on the data summarised in Table 6.16, there were significant differences in perception between young and senior technology professionals regarding the impact of the direct management style on their motivation to stay with, or leave, the company/ industry/ profession and the alternate hypothesis (Ha) is accepted.

The factor, "Leadership Experience" was created to combine items which organically grouped together following the factor analysis. These items can be traced back to their original constructs in Table 1 during the initial development based on the qualitative data and the literature. The leadership-related variables had three associated chaos/ complexity elements. These were sensitivity to initial conditions, lack of a shared image which serves the purposes of the organisation and its members, and understanding the self-organising mechanism of the system. Leadership plays a critical role in iteratively analysing and making explicit the shared image of the firm so that it is tested for its ability to serve the firm's goals (Marion & Uhl-Bien, 2001). Leaders must also consider historical influence (initial conditions) on the leadership pattern evolution over time and must

examine the pattern of replication to determine what qualities (good or bad) have become part of the dominant culture (shared image) around which the firm is self-organising. The fact that a leadership-related variable emerged in this study as the most significant influence on the problem further supports the idea that organisations could benefit from a more robust chaos/complexity theory-based framework for leadership architecture design. Such a framework (SAI) was proposed in Chapter 4 and has the ability to provide new dimensions of analysis, capable of identifying pattern-able behaviour to potentially add value through understanding the organisation's system dynamics.

A point of interest for future research may be to exploit the data in Table 20 further in order to determine whether the split of responses is based on age difference, gender difference, race difference or some other demographic. This may provide greater insight into the problem.

7.3 Discussion of results for hypotheses 2, 3 and 4

The test results referred to in the discussions below with regard to the hypotheses 1, 2 and 3 make reference to Table 6.18 in Chapter 6.

7.3.1 Discussion of the similarities/ differences in perception of the experience of leadership between young and senior technology professionals

Hypothesis 2:

2 Ho: Young technology professionals, senior technology professionals, technology business leaders and HR professionals perceive the impact of leadership on themselves similarly.

2 Ha: Young technology professionals, senior technology professionals, technology business leaders and HR professionals perceive the impact of leadership on themselves differently.

A 95% confidence interval was used in the Levene's test for variance to compare the responses received from young and senior technology professionals. The sigma value

was 0.567, indicating no significant variance. The null hypothesis (H_0) is therefore accepted.

The results of the testing of Hypothesis 2 appear to contradict the results of Hypothesis 1 where the direct management style was identified as having a significant influence on young technology professionals' future actions. However, this apparent discrepancy could be due to the fact that the items which were used to collect data relative to the first hypothesis were more direct and pointed in phrasing, whereas those related to the broader theme of the experience of leadership were more generic and referenced the entire organisation's leadership. Respondents could have interpreted the latter to refer to the leadership encountered in their organisations in totality. In some cases, this could refer to global companies where the leadership style could possibly vary from region to region and the aggregate experience of leadership was therefore positive. Further analysis, which is outside the scope of this project, would be required to gain better insight.

The variability of emotions must also be considered, since a positive or negative experience just before the time of answering the survey could very well have influenced the way a respondent answered the broader questions as opposed to how he/ she answered the more direct questions and vice versa. This introduces complexity in the form of each individual respondent's self-organisation at a personal level. At any given time, agents in the system are self-organising around a shared image which may or may not be aligned to their manager's, the company's or the environment. Their personal shared image will also contain elements of their own culture, creating a multi-variable, fractal dimensioned phase space within which their individual state could be mapped.

Notwithstanding this, the inferences drawn from the data relative to Hypothesis 1 offers a stronger indication that leadership style, particularly the style of an individual's direct manager, does influence the research problem. This is due to the fact that the questionnaire items linked to Question 6 were more direct and specific and did not leave room for ambiguous interpretation. Again, it would be of interest to filter the results by other demographics such as age and gender to gain more insight into the neutral tendency of the overall result for Hypothesis 2 and to determine along what denominations the results are split.

7.3.2 Discussion of the similarities/ differences in perception of the experience of the business culture between young and senior technology professionals

Hypothesis 3:

3 Ho: The South African technology business work environment and policy are perceived similarly by senior technology business professionals and young technology professionals.

3 Ha: The South African technology business work environment and policy are perceived differently by senior technology professionals and young technology professionals.

A 95% confidence interval was used in the Levene's test for variance to compare responses received from young and senior technology professionals. The sigma value was 0.749, indicating no significant variance. The null hypothesis (Ho) is therefore accepted. When the factor analysis was complete, a new factor, Experience of Business Culture, was generated. This factor comprised items relating to (in the original dimensions) remuneration and incentives, mentorship, B-BBEE, trust and mutual understanding and empowerment among others. These, although diverse, can broadly be considered to describe the policy-making and general working environment of a firm, and in Table 3.1, the chaos/ complexity elements related to the working environment and policy variables were self-organising characteristics of the system, purposeful systems with purposeful elements, operating at the edge of chaos and the shared image as an attractor. Although the absence of variance between the categories suggests that, at least operationally, the policy systems and overall work environment seem to be working, the result could be due to the lack of more pointed items in the questionnaire. This would require deeper analysis along the more specific lines of a working climate type analysis. In the context of the profession switching/ job migration problem, this study has shown that the business culture (in so far as its operational architecture is concerned) does not appear to be an influential factor.

7.3.3 Discussion of the similarities/ differences in perception of B-BBEE and diversity management between young and senior technology professionals

Hypothesis 4:

4 Ho: Technology business stakeholders perceive B-BBEE and the management of diversity similarly.

4 Ha: Technology business stakeholders perceive B-BBEE and the management of diversity differently.

A 95% confidence interval was used in the Levene's test for variance to compare the responses received from young and senior technology professionals. The sigma value was 0.243 indicating no significant variance. The null hypothesis (Ho) is therefore accepted.

Concerning Hypotheses 4, the absence of variance between young and senior technology professionals appears to be counter-intuitive to the understandings gleaned from the literature and qualitative portions of the study. Based on the data collection and sampling, one reason for this could be the fact that the focus group participants were all selected from within the same organisation.

B-BBEE and Diversity Management was also one of the original factors that passed through into the final analysis. From the perspective of an organisation as a CAS, it was stated that introducing diversity into the organisation through employment of incumbents with different cultural backgrounds, who are younger and come with different perspectives creates differentiation. Adaptive organisations effectively need to manage the integration of these elements simultaneously to determine whether the result will move the system toward order or disorder. Therefore, another reason for the absence of variance could be that the items specifically related to B-BBEE described factors which, in the respondents' views, are showing positive future trends as companies are forced to acknowledge the importance of B-BBEE for doing business in South Africa. Recent government initiatives and the pressure (especially on parastatal companies) to enforce policies related to Preferential Procurement, Supplier Development and Enterprise Development could all be contributing to a more positive future outlook.

The original intention was to compare the perceptions of all technology business stakeholders including HR professionals, and therefore the items were broader in scope, possibly increasing the probability that more than one interpretation could emerge. Additionally, the fact that HR professionals were excluded as a constituency could have removed possible valuable information since HR divisions typically have access to the hard data regarding a company's commitments and progress to B-BBEE and transformation.

It would have been of value to have had access to a wider population from which more HR respondents could have been drawn. The relegation of the HR professional category due to the low response rate has imposed limitations on information that could be inferred from the study. More research and further analysis where a larger sample of HR professionals can be accessed is definitely required. Furthermore, the 60% of items rejected after the factor analysis may have contained insightful data related to the final factors used in the testing phase of the study. If, perhaps, these had been refined and phrased in a way that could have better been understood by respondents, different insights could have emerged. The fact that the responses to a more direct-type question, on leadership for example, showed a different result to the more generic type questions is evidence that the preceding sentence could have import. It can therefore be inferred that, unless future research can show otherwise, B-BBEE is not a significantly influential factor on the research problem.

7.3.4 Discussion of results with respect to the research objectives

Research Objective 1:

The most significant result from this study has been to show the impact of the direct management style of a technology professional's manager on the propensity to stay or leave an organisation. Particularly, this factor has more influence on the younger constituent which provides an initial context for the job migration/ profession switching problem. In this way, objective 1 of the research was fully met. To understand further the context further research would be required to understand the extent to which leadership has impact on the context and to investigate other variables which could potentially be adding deeper layers of complexity to the context such as the difference in axiological perspectives between generations.

Research Objective 2:

The results also showed sensitivity to the directness of the questions such that a wide range of feelings, attitudes and beliefs were expressed on influences of leadership architecture on young technology professionals and key factors were identified. A comprehensive evaluation of these, however, could not be done as it requires better understanding of feelings, beliefs and perceptions (intangible qualities), which require the use of psychometric tools and possibly design instruments which have less sensitivity to interpretation and which employ more direct questioning to draw out the information of interest. In addition, the HR professionals who participated were few and not representative enough so that not all stakeholders' opinions were fully represented. Objective 2 was therefore partially fulfilled.

Research Objective 3:

The literature survey was useful in identifying the key elements of chaos and complexity theory which were relevant to the analysis of the research problem. The insights from this phase of the research were used extensively in the development of the leadership architecture framework. In this way, objective 3 was fully met.

Research Objective 4:

With respect to using insights from this study to better assist businesses, the framework developed in Chapter 4 can be used as a conceptual basis for engaging business leaders on factors they should consider in order to effectively support development of young technology professionals and managing their career transitioning process. However, the framework needs to be tested and validated within one or more organisations as a truly robust leadership architecture tool before it can be fully implemented. As validation of the tool has not yet been done, its robustness has not been confirmed and therefore objective 4 of the research was partially met.

Chapter 7 has discussed the findings in detail and with specific reference to the research question, hypotheses and research objectives. It has discussed how the results relate to each of the research objectives laid out in section one and whether the objectives have

been fully or partially met. Chapter 8 will present the concluding observations as well as recommendations for future research.

8. CONCLUSION AND RECOMMENDATIONS

This chapter correlates the key findings of the study with the research problem and objectives as described in Chapter 1 toward understanding the context for the present situation of job migration/ profession switching among young technology professionals. Recommendations based on the research findings are presented for the consideration of young technology professionals, technology business leaders and HR professionals. Finally, suggestions for future research are also presented.

8.1 Key findings

8.1.1 Most significant factors

The results have shown that the experience of the leadership style of a young technology professional's direct manager is the most significant factor influencing his/ her decision to remain at a company or leave and/ or change profession. From the detailed review of the literature to the qualitative research data, in the form of issues raised by the focus group, and finally to the quantitative phase in the form of survey questionnaire results, leadership and leadership-related factors persisted in being pertinent. From this, it can also be inferred that the role of leadership in creating the context for the problem is significant and that technology business leaders would do well to understand the far reaching implications of their actions on other agents in the system and on the industry itself. The South African technology sector is already at a stage where there is a serious decline of the critical mass of future professionals who can plan and execute complex technical and management work. Such skills are highly expedient, not only for industry, but also for the country's growth ambition which is intimately linked to infrastructure development and therefore to the knowledge-based economy.

8.1.2 Perception of factors affecting the problem between young and senior technology professionals

According to the results of the study, there were no significant differences in perception between young technology professionals and senior technology professionals with regard to the two other factors which were considered to be potentially responsible for influencing the problem, namely – Experience of Business Culture and B-BBEE and Diversity

Management. However, the literature and qualitative research suggest otherwise. It is the researcher's belief that further research and more analysis are needed on these two factors in respect of the role they play in shaping the problem. A different approach may be needed and also, owing to the fact that these aspects are regarded as being particularly sensitive in South Africa, a wider-reaching, more quantitative approach may be more prudent where respondents are not necessarily concerned with being 'politically correct'. It is also possible that, because of the sensitivity of these issues, some respondents may have felt that there was not sufficient anonymity to answer freely or perhaps, as discussed in the previous chapter, the workplace and the perception of diversity are both moving into a more positive paradigm.

8.2 Limitations of the study

The preferred unit of analysis for this type of study would be the technology business organisations (companies) themselves since the systemic effects and patterns are potentially best identified at this level of analysis. However, the categorisation of data received was generic from the company perspective, even though captured in the context of the individual participant's experience within his/ her specific company. Major limitations on the study were the time period within which to collect data as well as the ability to filter data into different groups or sectors within the technology industry.

The access to more HR professionals was a further limitation. The resulting low number of respondents meant the exclusion of the HR demographic from the study. It would actually have been very useful to compare HR perspectives with those of young and senior technology business leaders.

The variability of human emotion also needs to be taken into account where one is attempting to measure feelings, attitudes and beliefs. The questions and statements are subjective and the way respondents chose to answer at the time of taking the survey could have been influenced by a variety of factors. Such is the nature of complex systems. Non-response bias was not considered due to the limitations on time which did not allow for a thorough non-response follow-up as a check. Future research will need to take this into consideration and investigate whether better insight is generated.

Chaos and complexity theory can typically be used to develop analytical models using longitudinal data. This was not feasible given the time constraint on this project. Furthermore, the overall sample size was limited. The larger the sample, drawn from within more segments of the technology industry, the better the observation of emergent trends could be. The number of companies within which the data required for the study could be accessed generally affects the replication and generalisation of the observed results, although for the purposes of this study, the data is sufficient to gain an initial understanding of the key variables influencing the problem. More detailed analyses of a broader data set would be desirable for further work.

8.3 Recommendations for young technology professionals

More and more emphasis is being placed on systemic thinking as a quality which is desirable in a leader. In the South African environment, there is a strong emphasis on youth and youth development being driven by government, and initiatives such as Supplier Development and Enterprise Development, which are significant components of a company's B-BBEE scorecard, specifically mention employment and skills development targets for youth (16-35 years of age). While this ushers in significant opportunity for young people, it is best accompanied by responsibility in terms of taking the initiative to expand one's academic, technical and interpersonal skills in order to communicate to businesses that their investment in this demographic will show good future yields.

A sense of ownership and a willingness to learn from experienced business leaders is key to young people's success. As was indicated in the literature, learning and development is an iterative, interactive process and young people should not underestimate the importance of the smallest of actions which, when amplified by organisational feedback, could result in unexpected and often disproportionate results. The nature of such results, of course, could be positive or negative, and the trajectory is in large part influenced by the individual.

8.4 Recommendations for technology business leaders

The purpose of a chaos/complexity paradigm is, as Gleick (1987) suggests, creating intuition about complex systems rather than specifically predicting what the outcomes will be. South African technology business leaders, arguably, have the greatest responsibility

in the context of the country's current shortage of specialised engineering and management skills. The onus falls upon them to train and mentor the next generation of leaders that will carry the innovative and creative potential of the country into the future. Leaders can benefit immensely from understanding that the organisation has transitioned significantly since the Industrial Revolution, and so has the management perspective. From once being viewed as mechanistic and having no mind, organisations are now viewed as interdependent, complex adaptive systems with a multi-minded operating system. This has significant implications for the way organisations need to be managed, given that there will also be daily interaction throughout a firm's value chain, each link of which is itself a complex adaptive system.

Understanding the importance and taking advantage of fractal behaviour and how the structure of the wider systems can be inferred from understandings gained at the local scale, leaders are better prepared to navigate the ever-changing and evolving performance landscape which incorporates their entire value chain. Shoup and Studer (2010:17) put it succinctly, "Leaders do well to vigilantly buffer and nurture the system so that the right patterns emerge consistent with the system's dominant values. As systemic thinkers, leaders also do well to anticipate the intended and unintended consequences of their decisions." The shared image, which is at the core of an organisation's dynamic trajectory, is critically affected by leadership, since leaders play a major role in disseminating and shaping an organisations core values, vision, mission and guiding principles (culture). It is therefore imperative that leaders themselves first have a clear understanding (which they themselves can easily articulate) of what they want that trajectory to look like. Mere strategic planning is not enough.

8.5 Recommendations for future research

A great deal of research has been done on the applicability of chaos and complexity theories to organisational learning and leadership and therefore it would be of value for future research efforts to delve deeper into the specific topics of the research already done and test their applicability using real organisations as the sample space. With regards to taking this particular study further, future research could probe deeper into the data to look for patterns in the responses between finer demographics for example, between race, gender, and company type. The insights could be used to refine the leadership architecture design and to give feedback to HR divisions in companies which

would strengthen the intuition about how to balance the firm's diversity. The unit of analysis could be increased to individual firms to analyse the influence of organisational culture on the problem and study the variance between companies across different technological degrees of products (high, medium, low technology) and/ or industry segment (automotive, ICT, manufacturing, rail etc.). Questions that are still of interest to the research are set out below.

- What role, if any, does historical contingency play on the current shared image (culture) of South African technology businesses?
- How is the future of South African technology innovation being influenced by the current skills shortage and job migration/ profession switching problem?
- Is the leadership style changing and what is the future state of South African technology business leadership?
- To what extent has leadership knowledge transfer and empowerment of young technology professionals been carried out in South African technology industries?

A question which may be of particular interest to the industry itself could be, "How can the net present value (NPV) and the loss on investment (LOI) associated with intellectual capital investments be quantified/ calculated?" in order to assess the potential revenue impact of the job migration/profession switching problem.

Concerning chaos and complexity applications in the domain of management and leadership, the ideas themselves are not new, but there are still several sub-topics within these domains which could be investigated further and which could potentially increase the insights into the dynamic evolution of organisations. Some of these that the researcher considers to be potentially promising are suggested below.

- The concept of phase space – the complete state of a system, representing all possible knowledge of that system, can be plotted into what is called 'phase space'. Phase space is multi-dimensional, with the various axes and planes representing different measurable dimensions of the system being studied. The state of the system is then represented by a single point in phase space and the trajectory of the point is tracked as it evolves over time. This is typically how the system's attractors are identified when, as the point moves through phase space, it shows the system's propensity to accumulate trajectories within one, or basins, of

attraction. Future research could use numerical modelling techniques to model the relationship between the number of agents, average number of years at the company and the rate of innovation, for example, with the values being plotted in three-dimensional phase space. This could provide further insight into how job-migration/ profession switching has impacted (or not impacted) the South African technology industry's rate of innovation.

- Information Theory – Work done by Shaw (1981) proposed the intriguing idea that chaotic systems generate information. The premise is that, the more a system behaves chaotically, the higher the propensity that it will generate data which can be filtered to produce information, which if one knows what to look for, can be helpful in understanding the dynamic evolution of the system. In the current example, when masses of people start migrating at a high rate between companies and/ or switching professions, the technology business system (the industry) is breaking down into chaos from the perspective of associate turnover, but this situation is also communicating data about the system. Getting into the 'physics' of the problem means adopting a chaos/ complexity perspective to analyse the problem similar to what has been done in this research effort. The idea could be expanded upon by investigating further the influence of the type of company (locally represented multinational, or fully South African, high, medium or low-technology products), the sub-segment of the industry, and the size of the organisation. More useful information could potentially exist which could inform the response of technology business stakeholders.
- Fuzzy Situational Maps – Fuzzy logic and fuzzy set theory have become useful tools in designing and analysing the behaviour of complex systems. A fairly recent development in the field is the idea of fuzzy situational maps (FSM) and fuzzy decision trees. This show the evolution of a communication process when there is learning taking place (feedback). A possibility exists to extend this as a metaphor in the business environment. In the implementation of B-BBEE, government and industry could work jointly on the development of a common *codebook* which could allow for the fluid communication of ideas relative to B-BBEE. Certain companies could be identified as leads (carriers and transmitters of the codebook) and the fuzzy communication process and resultant decision trees could be modelled and analysed in terms of their accuracy in depicting how other companies in the lead company's network learn and modify their own behaviour in order to adapt.

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Appendix A: Online survey introduction

Dear Colleague

I am a part-time Masters student in the School of Mechanical, Industrial and Aeronautical Engineering at the University of the Witwatersrand, under the supervision of Dr Bruno Emwanu. My MSc title is: **“Using chaos and complexity theory to design robust leadership architecture for South African technology businesses”**

As part of my research, I would like to ask you to kindly assist by completing a short questionnaire which aims to gain some insight into your opinion of and interactions with technology business leadership in South Africa.

I would advise completing it immediately as the questionnaire will take no longer than 15 minutes of your time and is very important for me to complete my research. Please click on the link below to access the survey.

<https://www.surveymonkey.com/s/SNGTB7S>

Although your response is of the utmost importance to my research, your participation in this survey is entirely voluntary and you may withdraw at any time without penalty. Information provided by you remains confidential and will be reported in summary format only. Please note that by submitting the completed questionnaire your agreement to participation in the research is assumed.

Thanking you,

Vivashan M. Muthan
Student No.: 0211689M
Contact No.: 011 741 3800

Supervisor: Dr. Bruno Emwanu
University of the Witwatersrand – Faculty of Engineering
Contact No.: 011 717 7437

Appendix B: Focus group guidelines

Introduction

As partial fulfilment of the Master of Science in Engineering degree, every student is required to undertake a research project and compile a dissertation based on the results. My background and training in the technology sector led to the development of my topic, “Using Chaos and Complexity Theory to Design Robust Leadership Architecture for South African Technology Businesses.” This discussion is to gain your perspective on leadership, organisational learning and the situation of young technology professionals (explain terminology) within the South African technology environment as you perceive it.

Questions

- In your opinion, are South African technology business leaders adequately prepared and willing to train a new generation of culturally diverse young professionals?
- How has the leadership style in your organisation evolved to meet the needs of the transitioning South African socio-political environment?
- Based on your observations, does the leadership style in your organisation vary significantly between hierarchical levels?
- Do you think that BBBEE is a necessary strategy in the South African technology industry and do you believe that technology business leaders fully understand and embrace the rationale?
- What steps has your company taken to develop a diverse management team and do you believe that your management team is adequately representative of the country's BBBEE requirements?
- How actively do leaders in the industry empower and guide your young technology professionals to make critical strategic and technological decisions?
- How is training and development in the industry geared toward organisational learning, creation of opportunities for growth, diversification and innovation?
- Is job migration and/ or profession switching (explain) a problem in the technology industry and what is the extent to which it affects the industry?
- What would you say are the main reasons for the problem?

- How do you think industry is attempting to remedy the situation and what have been the results of the intervention/s?
- Have you observed the role that networking between industry colleagues plays with respect to switching employers and/ or professions? What have been your observations?

APPENDIX C: SURVEY QUESTIONNAIRE