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Example
The Role of Language and Culture in Technological Innovation

By

PEACEMAN NDODOXOLO SOPAZI

A thesis submitted in fulfilment for the Degree of Doctor of Philosophy in Engineering Management

Faculty of Engineering and the Built Environment UNIVERSITY OF JOHANNESBURG

Supervisor: Prof. T.N. Andrew

2013
PREFACE

The research work reported in this thesis was carried out mainly in South Africa, under the supervision of Professor TN Andrew.

This study represents original work by the author and has not otherwise been submitted in any form for any degree or diploma to any university or college. Where use has been made of the work of others, it is duly acknowledged in the text.

Signature

The Role of Language and Culture in Technological Innovation
ACKNOWLEDGEMENTS

I wish to acknowledge that I would not have been able to complete a thesis such as this one without the assistance and support of other people. Working on this project has been an awesome experience and, indeed, very enlightening. It gave me an opportunity to interact with people from very diverse backgrounds both culturally and academically and a sense of real appreciation for unity in diversity.

Due recognition goes to my promoter Prof. T.N. Andrew, not only for initiating this topic of study, but also for his guidance, encouragement and time (when there was actually no time). During consultations with him I confirmed the belief that I have always had, that knowledge is relative and not absolute. I really admired his skill when guiding me out of the problem areas that I encountered along the way, as well as his willingness to exercise flexibility in some instances rather than sticking to his opinions no matter what.

Financially, this research was supported by the University of Johannesburg as well as by Walter Sisulu University. I am indeed very grateful to all my colleagues in the Electrical Engineering Department of Walter Sisulu University for keeping things going while I was away. Dr Adéle Moodly from the Public Relations and Communication Department of Walter Sisulu University has provided me with invaluable support both from the content context and language aspects, and Dr Baba Tshotsho from the same department for her guidance and encouragement.

Uncle Cecil Cook (an anthropologist and a friend) was a great coach and inspiration during the writing process and I could always count on his expert advice on language issues even at short notice.

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Finally, I wish to thank all the Globelics colleagues for guiding me in the field of innovation, especially the following colleagues for their guidance and support: Dr Ulrich Schmoch from Fraunhofer Institute in Karlsruhe: Germany; Dr Kanes Rajah of the Centre for Entrepreneurship (cfe) at Greenwich University: London; Prof K. Joseph from Kerala: India; Prof Bengt-Åke Lundvall from Aalborg University: Denmark; and Dr Rasigan Maharajh from Tshwane University of Technology: South Africa.

To my family, I owe you a lot for your unspeakable patience and incredible support. I am forever indebted to you. May God bless you. The thought of my family has been an unspeakable inspiration both physically and spiritually.

After working on this project, I discovered some skills and abilities within me which have made me come closer to understanding the gifts with which I have been endowed by my CREATOR.

Peaceman N. Sopazi
2013
This thesis explores the association between language, culture, and technological innovation. This is accomplished by examining primary data, and literature that is based on empirical research on the interplay between language, culture, and technological innovation. Multi, intra, interdisciplinary and transdisciplinary perspectives are accordingly studied. The intent is to identify, assess and explicate language and cultural factors that support or act as barriers to technological innovativeness. The nature of the role played by these factors is also explored and explained.

The methodology employed incorporates both the indigenous and foreign experiences through literature, case studies and primary data. The aim of this study is to understand better how to assist those nations that aspire to be technologically innovative. This research considers the characteristics of the innovation process, and the views and/or characteristics of the innovator. In other words, despite that a historically innovative person or nation and a user or a process of innovation, may all not know precisely why there is an innovation, they can still contribute to the inquiry. Relevant literature, case studies and interviews are used to identify the distinctive patterns and behaviours that characterize innovative people and processes. The thesis creates a theoretical framework that is useful for identifying the intrinsic nature and the rate of influence at various stages during the role played by language and cultural factors in technological innovation.

The main contribution and conclusion of this thesis is that, language and/or cultural backgrounds do in fact positively contribute to technological innovation. However, when it comes to promoting and marketing the innovation, the business language plays a more significant role. It is further demonstrated that one’s national or primary culture, in response to needs, exposure, challenges, attitudes, beliefs, and values does play a critical role during the idea generation phase of the technological innovation process.
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3. (b) This paper was also selected and published under the theme: South-South Cooperation for Promoting Innovations in Developing Countries, 03 November 2010 by *Georgia Institute of Technology*, Atlanta, USA.

3. (c) An edited version of this paper was published in the *South African Innovator*, issue 4, 2007. pp. 18-19, ISSN:1814 - 1684


*The Role of Language and Culture in Technological Innovation*


OTHER NOTEWORTHY RESEARCH AND TRAINING ACTIVITIES

9. **ACTIVITY 1**

The author (PN Sopazi, 2007) was invited and participated at a conference organized by Centre for Public Sector Innovation in Midrand on 20 November 2007. The outcome of the conference was an Innovation Framework for The Public Sector of South Africa

10. **ACTIVITY 2**

The author (PN Sopazi, 2007) was appointed by the Innovation Fund organizers as an Adjudicator for the Institutional Innovation Competition at Walter Sisulu University in 2007. The outcome of the competition was an award ceremony for winners.

11. **ACTIVITY 3**


**ACTIVITY 4**

## Glossary of Terms and Abbreviations Used in This Research

### Abbreviations and Terms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>NIS</td>
<td>National Innovation System</td>
</tr>
<tr>
<td>ICT</td>
<td>Information Communication Technology</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>ITU</td>
<td>International Telecommunications Union</td>
</tr>
<tr>
<td>SAIT</td>
<td>South African Information Technology</td>
</tr>
<tr>
<td>NICI</td>
<td>National Information and Communication Infrastructure plan</td>
</tr>
<tr>
<td>DST</td>
<td>Department of Science and Technology</td>
</tr>
<tr>
<td>DoC</td>
<td>Department of Communication</td>
</tr>
<tr>
<td>DTI</td>
<td>Department of Trade and Industry</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
</tr>
<tr>
<td>S&amp;T</td>
<td>Science and Technology</td>
</tr>
<tr>
<td>EUR</td>
<td>Euro (European Currency)</td>
</tr>
<tr>
<td>USD</td>
<td>United States Dollar</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>DoE</td>
<td>Department of Education</td>
</tr>
<tr>
<td>DoH</td>
<td>Department of Health</td>
</tr>
<tr>
<td>BEE</td>
<td>Black Economic Empowerment</td>
</tr>
<tr>
<td>NEPAD</td>
<td>New Partnership for African Development</td>
</tr>
<tr>
<td>NGOs</td>
<td>Non Governmental Organisations (Non-profit making)</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>US(A)</td>
<td>United States (of America)</td>
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<tr>
<td>SMEs</td>
<td>Small and Medium-sized Enterprises</td>
</tr>
<tr>
<td>FDI</td>
<td>Foreign Direct Investment</td>
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<tr>
<td>QSR-NUDI*ST</td>
<td>Qualitative Solutions and Research – Non-Numeric Unstructured Data Indexing Searching and Theorizing</td>
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1.1 RESEARCH QUESTION AND BACKGROUND

The main research question around which this study is centered may be summarized as follows: What has language and culture got to do with technological innovation? The researcher argues that this study addresses an area of research that is still open for in-depth investigation. This argument is based on the researcher’s own engineering experience and interaction with other researchers, and it is subsequently confirmed by gathered data, as will be demonstrated in this thesis. Data is examined as it emerges. Answering the main question remains the beacon by which judgment is finally made as to whether there is sufficient data to justify firm conclusions.

This thesis is primarily concerned with empowering science and technology (S&T) practitioners to understand the impact and influence of language and culture on technological innovation. The practitioners referred to are engineers, technologists, and scientists working in the Physical or Natural, and Social Sciences. While it is acknowledged that in these individual disciplines there is already well established research on factors that encourage and/or suppress innovation, the author believes that it is useful to look into a transdisciplinary research mode for knowledge production, in addition to the existing multi, intra, and inter-disciplinary research and findings. The
The Role of Language and Culture in Technological Innovation

The proposed transdisciplinary research mode (i.e. non-discipline-specific but context-specific forms of cognition and knowledge production or ‘mode 2’) aims to explain some of the difficulties experienced in the innovation process, from conceptualization and conception to commercialization and utilization, in the value chain of technological innovation.

A comparative study of technological innovation from developed and developing countries is used to gain insight into any differences in the salient role players in the process of technological innovation. Contrasts and correlations identified in these studies are then studied and assessed in the South African context. Primary data gathered from different language and culture groupings in South Africa, as well as international literature reviews, are synthesized to test existing models and theories about the process by which technology is generated.

1.2 PURPOSE AND SIGNIFICANCE OF THE STUDY

The purpose of this study is to create a useful and practical framework that can be used by practitioners to identify, assess, and manage the critical language and cultural factors that influence the quantity, quality, and rate of technological innovation. Subsequent to determining these critical language and cultural factors, the purpose is also to examine and clarify the nature and extent of influence these factors have in the process of technological innovation. The distinctive characteristics and individual nature of
influences of the language and cultural factors will both be studied and characterized. The results from the analyzed critical factors will be compared to determine their combined and comparative relationship, as well as their influence, on technological innovation. One use of the language-culture-technology framework will be to point the way toward a sustainable process of technology generation, adaptation and transfer. It could also help ameliorate present day disparities between technologically advanced and technologically lagging nations and economies. The already well known barriers to technological innovation will be addressed in this study from a transdisciplinary perspective. While the researcher understands that a succinct but lucid explanation on the practical value this study will have is important, the researcher asserts that a better understanding of the value will only be acquired when the theoretical framework has been applied by the practitioners mentioned in the introduction (cf.1.1).

It is hoped that this research will provide a well explained understanding on why some nations are more successful compared to others in the area of technological innovation. Once empirically grounded insights are gained it should be possible to pass on important lessons about critical language and culture success factors and how to overcome language and culture barriers to technological innovation. Finally, the purpose of this research is to contribute towards critical thinking by scrutinising current studies on technological innovation and examining their assumptions and possible weaknesses. Motivation for this contribution stems from the desire to discover the impact it will have on technological innovation, as well as from the understanding that this is still an open area
for research. The guiding statements that follow were shaped by what emerged from the researcher’s interaction with innovation experts during phase 1 of this thesis (cf. 1.4.1).

1.3 GUIDING STATEMENTS FOR THE RESEARCH

The rationale behind the guiding statements is explained in the preceding sub-section (see 1.2). Furthermore, in Chapter 6 (6.2 - 6.11) these guiding questions or sub-problems are addressed, and the research interview guide used is designed in such a way that responses to each of these questions would be obtained. These statements are:-

- Relationship between language and technological innovation (see 6.2).
- Relationship between culture and technological innovation (see 6.3).
- Role of language in the cognitive processes involved in technological innovation (see 6.4).
- Role of culture in the cognitive processes involved in technological innovation (see 6.5).
- Roles of language and culture in general creative processes (see 6.6).
- Relationship between language and culture in technological innovation (see 6.7).
- Language and culture barriers to technological innovation (see 6.8).
- Language and culture opinions about technological innovation (see 6.9).
- Language ‘hybridity’ versus purity in technological innovation (see 6.10).
- Culture ‘hybridity’ versus purity in technological innovation (see 6.11).
1.4 METHODOLOGY FOR THE RESEARCH

In-depth ethnographic and ethnological case studies will be explored by considering a particular person and/or an entire group that are assumed to share a common culture. This refers to, fieldwork (ethnography) by way of data gathering and cross-cultural comparison (ethnology) by way of examining and comparing “the results of ethnography” (Kottak, 1991). The reason for this is that the focus of investigation is on the everyday behaviours such as, social interactions and ordinary language, with the intent to identify cultural norms, beliefs, social structures and other cultural patterns that possibly contribute to technological innovation (Leedy & Ormrod, 2005).

Finally, this research will follow a grounded theory approach. In other words this research will start with empirical data and then move to hypotheses and model building. This research does not begin from a particular theoretical framework (Glaser & Strauss, 1967). Rather, the empirical data that will be gathered from the case studies will precede and inform the development of the theory. Grounded theory studies are specifically useful when current theories about a phenomenon are inadequate or even non-existent as it seems to be the case in the current enquiry (Creswell, 2002). Literature in Chapter 2 supports this argument. Grounded theory refers to the understanding that the theory emerging from the study is derived from and grounded in the data gathered from the field, rather than from the research literature (Glaser & Strauss, 1967). This approach is particularly useful in this study, because of its transdisciplinary nature. Although existing
literature was perused before the study, it could not unduly influence the author’s theory because no model of language, culture and technological innovation interactions has been proposed. Therefore, the author proceeded to the next step without a preconceived theory or model in mind (Rodon & Pastor, 2007).

1.4.1 SELECTION AND DESCRIPTION OF THE SITE AND PARTICIPANTS

The participants were selected largely from South Africa during the second phase (phase 1 involved innovation experts not necessarily innovators themselves and phase 2 involved the actual innovators), after fine-tuning the approach. A German case study for a developed country is examined by interacting with German researchers and literature, and that culminated in a visit to South Africa by one of these researchers. A case study about India for a developing country was also explored, and it culminated in a visit to India by the author (researcher). These case studies are discussed in Chapter 4. Data emerging from these countries were compared with four language and culture groups in South Africa, namely English, Afrikaans, Xhosa and Zulu as already mentioned earlier (see, 1.4).

In chapter 3 (sub-sections 3.11, 3.12, and 3.13) there is a discussion about data collection strategies, data analysis strategies and the methods of achieving validity are discussed. Data was gathered by means of interviews (telephonic and face-to-face), and questionnaires conducted primarily in English being the main language for communication. Data analysis followed the strategies proposed by Strauss and Corbin (1990): Open Coding, Axial Coding, and Selective Coding followed by the Development
of Theory. These data analysis strategies are explained in sub-section 3.12 in Chapter 3.

With regard to the methods of achieving validity as explained by Melville and Goddard (1996), criterion-related validity, construct validity and content validity guided the process of achieving validity in this thesis. Additional background about the methods used in this thesis to assess validity is discussed in sub-section 3.13 in Chapter 3.

1.4.2 USE AND APPROPRIATENESS OF NUDI*ST, SPSS, AND MS. EXCEL SOFTWARE PACKAGES FOR THIS STUDY’S RESEARCH PROCESS

For data handling and code generation, computer research software is also used. This software is QSR-NUDI*ST (Qualitative Solutions and Research - Non-numeric Unstructured Data Indexing Searching and Theorizing) version 5.0. The author considered that although the use of computer research software is a great advantage for organizing large data sets- such as the one used in this research- it cannot be regarded a replacement for intuition, abstraction and judgment by the researcher (Hunter, Hari, Egbu, and Kelly, 2005). In some instances SPSS (Statistical Package for the Social Sciences) versions 16.0 and later 17.0 were also used for descriptive analyses, though SPSS is mostly used in quantitative research by most researchers. SPSS was particularly useful for analyzing and descriptively diagramming profile data of participants by tabulating frequencies, means and standard deviations. Data in Chapter 5 is presented using the Microsoft Excel 2003 package, rather than in the Nudi*st and SPSS formats. The author decided that converting to Excel made the data presentation less technical and therefore more accessible to a larger audience from various disciplines.
1.5 DELIMITATIONS AND LIMITATIONS FOR THIS STUDY

In order to remain focused on the present inquiry the author decided to impose the following discipline:

- Although language and culture are discussed, a broad and more in-depth coverage of these topics is deliberately avoided except in cases where such breadth and depth are deemed necessary for clarity and completeness.

- Language structures and other forms of culture that do not directly pertain to the current inquiry are not discussed.

- The focus is kept on technological innovation as understood in contemporary urban industrial society than on definitions of innovation that do not differentiate from techno-scientific forms of innovation.

- The case studies are limited to one developed and one developing country and then compared with the more familiar South African findings and context. The researcher decided to limit the data set to these three major case studies as it was deemed sufficient for this study.

- In South Africa, only English, Afrikaans, (Isi)Xhosa and (Isi)Zulu culture and language groups are included in the research.
1.6 ORGANIZATION OF THE THESIS

This thesis is structured to ensure that arguments, data, methodology and findings are logically organized and presented in chapters and under appropriate headings and sub-headings. These chapters are punctuated with figures, tables, conclusions, and summaries to assist the reader in following the arguments set forth. Chapter 1, as already discussed, deals with background to the study of the influence of language and culture on technological innovation. The process that has been followed to build the necessary theory has also been explained in this chapter (Chapter 1).

Chapter 2 examines and discusses relevant literature on language and culture. This is pursued by analyzing and evaluating other researchers’ arguments and findings on topics that are of relevance to this thesis. An overview of the selected contextual meaning of technological innovation is discussed. Definitions of related terms are critiqued, analyzed, and clarified.

The researcher engages in critical thinking to discriminate between different types of innovation and specifically technological innovation as a separate domain of innovation. Characteristics for innovation, invention, creativity, transfer and diffusion in the process of technological innovation are examined and critiqued. The role of language and cultural factors in the different facets of the technological innovation process are discussed and compared.
It is, however, generally found that after exploring literature from a number of disciplines there does not seem to be any transdisciplinary agreement about the causal role of language and culture in advancing or obstructing technological innovation. Despite the lack of agreement on these topics, Chapter two provides data that contributed to further refinement of the research methodology, as well as critical language and culture dynamics that need to be explored during the process of this enquiry.

Chapter 3 explains the methodological framework for identifying participants, collecting and analyzing data, drawing conclusions, and presenting findings. Chapter 3 further elaborates on the research methodology that is briefly outlined in chapter 1. Due to the complex nature of this inquiry, it has been necessary to use a combination of methodologies. Given that the approach used in this study is not discipline-specific, the researcher also concludes that the approach used for investigating the relationship between ‘soft issues’ and ‘hard-core’ engineering practices and concepts in this study, is relevant. Given that this is still a relatively new approach, as evidenced in the literature review section, expert opinions were also considered especially in the design of the research process and justification thereof.

In Chapter 4 a comparative study is conducted. Besides South Africa, which is also a developing country, this comparative study looks at an Indian case as a developing country and Germany as a developed country. In this chapter the researcher explores the critical success factors and barriers to technological innovation in these countries. Language and cultural factors, as well as influences, in the technological development of

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these countries are examined. National Innovation System (NIS) policies as well as national Information Communication Technology (ICT) innovation policies and development, are discussed and compared. As a result the researcher provides an illustration of NIS methodologies and literature found to be important in the process of technological developments according to the lessons learned in these countries. The South African case is primarily focused on ICT innovation and related policies, due to the fact that South Africa has been found to be strong in this area of technological development. While there are lessons to be learned in all these countries, it is also found that discussions on culture and language factors, in relation to technological innovation, lack coherent empirical data to conclude on the influences or impact these factors have in the process of technological innovation.

In Chapter 5 the researcher presents collected data. Critical analysis and discussion of the main findings of this thesis is conducted. This is conducted by using well explained methods such as diagramming and tabulation. This first hand data is compared with data from literature review with the aim to determine similarities where they exist as well as identify new information that emerges.

Chapter 6 deals with synthesis and interpretation of all the data, i.e. primary and secondary data. The approach used ensures that all the sub-problems that were indicated as guiding statements for this thesis have been dealt with. Sub-headings are therefore aligned with the wording used in the sub-headings provided in sub-section 1.3 of this chapter. At this point the researcher is satisfied that sufficient data collection and
discussion, analysis, synthesis and interpretation have all been examined and adequately explored in preparation for the final conclusion. The thesis contribution is reiterated and concluded in Chapter 7. Recommendations are made and possible future research suggestions are also provided. Further recommendations, based on lessons learned, with regard to research methodology in particular are articulated. Finally, as part of the End Matter, references and bibliographies, as well as relevant appendices, are included.
CHAPTER 2  LITERATURE DISCUSSION

“If language originated in gesture, and if gesture and tool making (the simplest form of technology) evolved together, this would imply that technology is an essential part of human nature, inseparable from the evolution of language and consciousness” The Hidden Connections: A Science for Sustainable Living - Capra (2002).

2.1 CHAPTER INTRODUCTION AND BACKGROUND

After carrying out an in-depth literature study on different systems of innovation and the impact of language and culture on technological innovation the author has concluded that it is more useful to focus on the potentially positive role of language and culture in fostering innovation. The reason is to avoid proliferating innovation literature with the negative impact of language and culture, –i.e. as barriers to innovation. Initially, different types of innovations are discussed in general and then a more specific connection is made with language and culture.

Culture as a barrier to innovation

Appropriate literature that demonstrates the impact of some types of cultures as barriers to innovation has been reviewed (see, among others, Loewe and Dominiquini, 2006; Balzarova, Castka, Bamber and Sharp, 2006). It is found that researchers generally concur on the notion that a good culture, -one that is appropriately configured for innovation-, is needed in order to create an environment that is conducive to technological and other types of innovations (see Pech and Slade, 2004; Martins and
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Terblanche, 2003; Knox, 2002; Miroshnik, 2002; Cameron and Quinn, 1999; Ahmed, 1998; Tushman and O’Reilly, 1997; Syrett and Lammiman, 1997; Judge et al., 1997; Robbins, 1996; Johnson, 1996; Dunphy and Herbig, 1994; Pheysey, 1993; Shaughnessy, 1988; Schuster, 1986; Rothwell & Wisseman, 1986). An appropriately configured culture can be organizational, national, regional, sectoral or even multinational (see also subsection 2.3.1 on cultural issues). It is the conclusion of this thesis that, though this position is widely held by the various researchers referred to in the preceding explanation, more empirical evidence would improve the arguments that support this position.

Language as an integral part of culture

Some authors consider language as an integral part of culture and do not see the need to single it out in their discourse (Rigg, 2005; Miroshnik, 2002; Herskovits, 1989; Grant, D., Keenoy, T. and Oswick, C., 2001; Ulijn, 2001; Watson, 2000; Checkland, 2000; Woodilla, 1998; Czarniaskwa, 1998). The few authors who deal with language in isolation show it as a barrier to innovation and also hypothesize that it must be configured and used correctly if innovation is to be encouraged. Once again, these authors, as in the case of culture, do not provide sufficient empirical evidence pointing to the success of trials.

In the light of what has been mentioned, the focus of this thesis then changes to literature that provides models for those who wish to do empirical research on how language and culture can be used when individuals, nations, regions, or organizations aspire to be...
innovative. A closer look at the specific aspects of language and culture that might be more responsible for their (language and culture) impact becomes a necessity. In this study, literature that corroborates and that which refutes the hypothesis of this thesis has been sourced from various fields, namely; general psychology, industrial psychology, engineering psychology, community psychology, philosophy, cognitive science, brain sciences, systems research, behavioral science, anthropology, language and human evolution, psycholinguistics, neuroscience of language, child language acquisition, human language processing, development of inflection, heredity, innovation promotion, creativity management and various cultural studies.

The reason for scanning across this broad spectrum (of fields) was not only motivated by the desire to gain various insights and perspectives, but also so that possibly the link could be found that could eventually lead to a break-through in this study. The author of this thesis has sought to come up with a conceptually rigorous and justifiable framework.

The goal is to discover a useful framework for the promotion of technological innovations, especially in countries where it is presently lacking, by studying the language and cultural traits that characterize the most technologically innovative nations and their organizations. Another aim of the discussion from these backgrounds, is to elucidate those aspects of culture and language that are unique to certain individuals, nations and organizations, and then to evaluate whether they potentially promote or stifle innovation.
The author acknowledges in this research that it is both generally accepted and proven that languages and culture are not static. They are dynamic and changing due to trends, environmental and psycho-cultural factors. This dynamic makes it difficult for researchers to securely isolate the unique characteristics of highly innovative individuals, nations and organizations.

Literature that separates endogenous aspects from exogenous ones is discussed so that there will be no equivocation about what is portable and belonging to phenotype (derived from culture and environment) and that which ‘runs through the blood’ (the genotype – bearing in mind that over an extended period of generations even the genotype can be modified). This is done so that the unique characteristics that enable an individual, nation, or organization to achieve higher levels of innovative behaviour, will eventually be elicited.

The existing literature on the role of language in innovation and creativity, typically answers questions such as, ‘is it in the way they speak – the kind of influence the words they choose to use have- or is it in the way the language itself is structured (morphology and mental lexicons)?’ Does the way the language is structured encourage more use of the left hemisphere of the brain or the right hemisphere? What impact does this have in a person? Is a person who uses more of the right hemisphere (synthesis)- due to the way his language is structured- more creative and therefore innovative than the one who uses more of the left hemisphere (analysis and logic)? Or does it not matter since the two
hemispheres co-operate and collaborate anyway according to some research? See Alder (1994).

Towards the conclusion, a theoretical framework for both diagnosing the language and cultural behaviour that is counter productive in the context of innovation, and predicting whether innovations will be successful or not, is provided. Case studies are provided from literature to enhance the likelihood of the correctness of the diagnosis and predictions. Another framework for testing language and cultural aspects and behaviour that are deemed necessary for the inculcation of the correct language use or structure, and culture for the enabling environment for innovation to be realized is given, and it is derived from the indicators emanating from the work done by other researchers to date.

Conclusions are drawn by discussing literature concerning new modes of innovation, how services can benefit innovation – why innovation in services is poorly understood, and other new developments in innovation, such as improvisation. For example, can we not pay attention to what people do when they improvise, and perhaps build up on that until we have an innovation? Literature that pertains to these questions is discussed in ways that are hoped will pave the way for new knowledge and ideas to be realized and contributed.

Different knowledge systems

For a long time European and Western systems, such as Western science and technology, and language and culture, dominated in the developing countries. Innovations have also
been thought about in the context of Western and European Systems of knowledge. The author argues that innovations, by way of altering or adapting the natural resources to suitably serve our perceived needs, have always existed in all groups of people. The tendency to lean more towards the Western knowledge systems has been the convenience, due to these systems having an explicit format in that they “can be articulated in formal language including grammatical statements, mathematical expressions, specifications, manuals, and so forth” (Rahman, 2000).

On the other hand, indigenous people have traditional knowledge, which is mostly tacit or hard to explain with formal language (Rahman, 2000). In other words, indigenous people can and may know more than they can tell (Polanyi, 1996). These two systems of knowledge (Western and traditional) could contribute to the betterment of living conditions through innovations, if they both gain equal recognition on the platform of creativity and knowledge transfer. It becomes necessary to pay attention to the cultures and different languages that are spoken in communities from which these knowledge systems originate since knowledge is best understood in the context of one’s culture and language.

*Sustainable innovation and technology transfer*

The author argues that sustainable innovation and technology transfer are possible if the transfer of technology between the donor and receiver is bi-directional, rather than a unidirectional process. The transmitting agent (or ‘donor’) must be able to switch to
'receive' mode sometimes, and thus be a ‘transceiver’. This creates room for innovation to come from both ends. If this process is viewed as being, or supposed to be, only unidirectional, then sustainability becomes an unrealistic goal or impossibility. Yu and Yang (2009) state, “...the success of innovation depends on the support from the culture it adapts to”. Sawatani, et al. (2007), conclude, “An innovation ecosystem includes events from social changes, as well as the impacts of the innovation on society”. The author further argues from experience, that there is a need for a process of mutual accommodation between donor and recipient in order to better manage the donor-recipient dynamic. The importance of this discussion stems from the understanding that, it is usually the case that those who see themselves as the ones transferring technology or knowledge, tend to outline certain prerequisites for access to their technology. Some of these prerequisites are that, the intended recipients must learn certain sciences, learn a new foreign language, acquire and master new and complex tools, and to some extent even adopt the culture of the place where the technology comes from. This usually has ethical implications on the communities for whom the new technology adoption is intended. According to the research by Uljin (2001) “Internet disrupts the physical environment” and “it is also culturally disruptive”. While acknowledging that “Internet can also be a powerful tool to build up social cohesion among people”, Uljin (2001) also states, “People of less widespread cultures and languages fear being overwhelmed by the predominance of just a few languages with their cultural content and assumptions”. 

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Innovation and society

It is the author’s view that time is spent on trying to align indigenous people with technology by changing them, instead of adapting the technology according to the needs and abilities of the intended recipients. Translation of all technology information into local languages must take place. The fear that translations will introduce an undesirable time factor into the equation must be dealt with, as it is already delaying the transfer of technology into indigenous communities, due to the prerequisites that have already been discussed. When this adaptation or translation is done, then not only will the process of technology transfer be faster, but there will also be an influx of innovations both from the transferring communities, and those that are meant to be receiving. This bi-directional process has potential to enhance the original thoughts and designs of that particular piece of technology. When people deal with concepts in their own languages and in the context of their own cultures, they not only understand them better, but also enhance them with their rich indigenous knowledge and systems, making the process sustainable, as everyone has a sense of ownership and responsibility (see also Sawatani, et al., 2007).

The author is well aware that in certain instances, the slow pace or non-existence of technology transfer was, and sometimes still is, a result of political and economic reasons. While this is true, the author argues that even when the political and economic climate is supportive and conducive, the barriers stated in this thesis continue to inhibit the process of innovation and technology transfer.
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**Information Communication Technology in technology transfer**

Information Communication Technologies (ICTs) have become one of the effective ways of transferring technology. However, the problem is that not everyone has access to them, especially the rural communities of developing countries, where the majority of the indigenous citizens live. To acquire even skills such as Mathematics, the growing trend is that schools must have computers with software packages for Mathematics. In addition to having computers, there are now expectations that there must also be Internet access and that the teachers must learn to use computers and the new packages in order to teach effectively. All of this adds to the list of barriers to information transfer. The reality however, is that even if people were to have such tools as computers, they would not be able to maintain them and remain on the cutting-edge of technological changes and advancements, due to socio-political challenges. These challenges include wars, health care, cost of software and licensing, and so on. The author’s view is that dependency on non-affordable means to technology should either be removed, and replaced with other creative ways, or ICTs must be free and open for all to use without constraints.

**Indigenous knowledge and opportunities**

The opportunities that exist now are enormous, due to the recognition of the importance of not undermining indigenous knowledge that exists in the developing countries. Countries such as South Africa, Brazil and India are embarking on campaigns to bring about indigenous knowledge awareness to its citizens. Research in this area is encouraged.
by national institutions such as the National Research Foundation (NRF) of South Africa, and as well as by the South African Council for Scientific and Industrial Research (CSIR). The use of Free and Open Source Software (FOSS) and Ubuntu Linux, is now opening doors to more people to access, explore, use, change, adapt, modify and translate into other languages. This freedom relieves people of the fear of licensing litigation and being controlled by others, and instead allows flexibility and innovation.

The term ‘indigenous innovation’ has the same meaning as the following terms: traditional innovation, rural people’s innovation, farmers’ innovation, local innovation and community innovation, and indeed other related terms. The distinctions between these terms are subtle, but in general they refer to the same concept (Howes & Chambers, 1979; Mathias, 1994; Roach, 1994). Generally, the term innovation in this thesis refers to an idea that is new or perceived to be new or altered (Narayanan, 2001; Rogers, 1995). If this new idea or improvement of the resources is accomplished through traditional methods or knowledge systems, then it is called an indigenous innovation (Lewanika, 2001).

**Innovation and the environment**

It is often the case that indigenous innovations are environmentally sustainable when compared with scientific innovations. Research shows that scientific innovations such as CloroFluroCarbons (CFC), nuclear power plants, synthetic pesticides, and depleted Uranium have brought about destruction to both humans and the environment they live in. “Modern technology provides the means for the immediate destruction of world
civilization through nuclear weapons and for the long range destruction through the
depletion of natural resources and pollution of the environment” (Najafizadeh &
Mennerick, 1989). The irony is that scientific knowledge is usually well researched and
therefore predictable to a large degree, and yet sustainability of scientific discoveries is
always threatened. While this is true, it should also be acknowledged that “…modern
technology also provides potential means for greatly enhancing the standard of living for
the Third World (sic) as it already has done for the technologically advanced nations”
(Najafizadeh & Mennerick, 1989).

The indigenous communities have always been innovative but mainly not for commercial
reasons. These innovations have been in the areas of farming, traditional healing using
traditional herbs, and the making of domestic equipment, such as underground cold
storage systems, clay pots, grass mats, mud stoves, traditional musical instruments and so
on, all of which were and are environmentally friendly. For example, in Vietnam they are
applying indigenous knowledge on Upland Cultivation through experiments they have
evolved production systems that are quite efficient in terms of economic and
environmental considerations (Doanh & Tuan, 2004).

**Ethics and interdependence**

Both Hall (1997) and Meredith (1997), acknowledge the fact that scientists alone cannot
develop the necessary comprehensive knowledge base, although they are adding to our
knowledge through their discoveries. In order to ensure that innovations are sustainable it
is important to consider and recognize the roles that both the indigenous and scientific
knowledge systems could play. It is the author’s view that one system would compensate for the shortcomings of the other. In order for the concept of equal recognition to work, both systems and all the relevant stakeholders should be involved in the planning and design, and not one or the other being incorporated only afterwards. Rogers (1995) argues that innovators give little attention to consequences. Mulej, M., Kajzer, S., Potocan, V., Rosi, B. and Knez-Riedl, J. (2006), conclude that, “Lack of ethics of interdependence is equally problematic in science”. It seems that lack of ‘ethics of interdependence’ and not paying “enough attention to holism” (Mulej, et al., 2006) can suppress inventiveness and innovation, and make innovations unsustainable (see also McCann, J., Hurford, R. and Martin, A., 2005; Magnusson, 2003; Sandberg, 2007; Sollie, 2007; Yang, 2009; and Robbins, 2010).

2.2 AN OVERVIEW OF THE SELECTED CONTEXTUAL MEANING OF TECHNOLOGICAL INNOVATION

“Technology however, is much older than science... its origins in tool making go back to the very dawn of the human species when language, reflective consciousness, and ability to make tools evolved together” Capra (2002).

2.2.1 DEFINITIONS FOR INNOVATION

Innovation literature provides numerous definitions on innovation. According to Narayanan (2001) and Tidd, Bessant and Pavitt (2005), the word innovation seems to have its origins in the Latin word innovare, meaning “to renew, to make new, or to alter”. Some researchers define innovation in the context of pure technological developments
and others consider innovations from an economical angle, for example, as the first business application of the invention (see Schumpeter, 1950; Cooper, 1983; Moss Kanter, 1984; Drucker, 1998; Pérez-Bustamante, 1999; Poolton and Ismail, 2000; Narayanan, 2001; Davison, 2005; Dikmen, Birgonul and Artuk, 2005). These definitions are mostly about the first implementation of an idea that is, or at least perceived to be, ‘new’, and then executed, often assiduously, and in a way that leads to a broad-based extrinsic recognition to an individual, nation, organization or multi-national organization.

Furthermore, it is generally understood that the emphasis is not so much on newness of the idea than it is on the relevance of the novel idea to its unit of adoption (Aitken and Hage, 1971; Hage and Dewar, 1973; Rogers, 1983; Rogers, 1995).

It then becomes necessary to look at the adoption of a new idea so that it will become a real innovation. Man (2001) states, “… ideas are insufficient, only the successful implementation of those ideas can be regarded as true innovation”. Successful implementation depends on the adoption of the innovation by potential users.

2.2.2 CHARACTERISTICS FOR INNOVATION ADOPTION

In their concerns-based adoption model Hall and Hord (1987) state, “adoption is a process rather than an event, and is associated in any individual with a particular pattern of motivations, perceptions, attitudes and feelings.”
Authors such as Rogers (1983) have identified certain characteristics of innovation. These are: relative advantage, compatibility, complexity, trialability, and observability. Prior -one year earlier- to the publication by Rogers (1983), Tornatzky and Klein (1982) had conducted a meta-analysis of findings and published research in “innovation characteristics and innovation adoption-implementation”. In this research, Tornatzky and Klein (1982) highlighted the importance of complexity, compatibility and relative advantage in innovation adoption.

It must also be stated that there is also a view by Harrington and Ruppel (1999), when articulating about tele-working adoption, that trust between stakeholders is crucial. Wolfe (1994), provides other characteristics of innovation such as adaptability (flexible or inflexible), complexity (low or high), organizational focus (technical versus administrative), radicalness (low or high), and risk. The author’s observation is that most of the taxonomies on attributes that many researchers propose are mainly centered on the ones listed in Rogers’s book. For example, ‘results demonstrability’ is not different from ‘observability’. Moore and Benbasat (1991) however, in their perceived characteristics of innovations scale for the adoption of information communication technologies (ICTs), have added two characteristics; visibility and voluntariness. Visibility is the degree to which the innovation is seen to be used by others, while voluntariness is the degree to which use of the innovation is controlled by the user’s free will.
Narayanan (2001) identifies three major implications for the management of technology. These implications are:

- Innovation imitation (by competitors – supply side), and adoption (by consumers – demand side),
- The role of technology and market factors, and
- The centrality of learning.

Narayanan (2001), views innovation as both the process by which individuals or organizations arrive at a solution and the output in terms of product or service. Narayanan (2001) further provides four classifications of innovation which are; incremental innovations, modular innovations, architectural innovations, and radical innovations (refer to sub-section 2.2.3).

Weiss and Dale (1998), have the view that the attributes of technological innovation can be fused into two core constructs:

- Relative performance advantage – the extent to which the technology can perform better than what it replaces.
- Operational novelty – the extent to which the potential user has to learn new skills.
2.2.3 INCREMENTAL AND RADICAL INNOVATIONS VERSUS MODULAR INNOVATIONS

Explanations from various sources about incremental and radical innovations generally resonate (see Hill and Slater, 1998); hence it is deemed sufficient to quote from one source. Incremental innovations according to Narayanan (2001) refer to “minor improvements or changes of an existing product or organizational technologies and practices”. On the other hand Narayanan (2001) states that radical innovations “represent revolutionary changes that require clear departures from existing organizational practices and technologies”. Narayanan (2001) also explains that architectural innovations “…use existing organizational practices and technologies but reconfigure them in new or different ways”, whereas modular innovations “…refer to significant changes in elements of products, organizational practices, and technologies without significant changes to the existing configuration of the elements.”

2.2.4 INVENTION AND INNOVATION

“One of the problems in managing innovation is variation in what people understand by the term [innovation], often confusing it with invention” (Tidd et al., 2005). “In fact, some of the most famous inventions of the nineteenth century were invented by men whose names are forgotten; the names which we associate with them are of entrepreneurs who brought them into commercial use” (Tidd et al., 2005). Narayanan (2001) imputes the first distinction made between invention and innovation to Schumpeter (1950) who was an economist. This distinction asserts that an invention is a new combination of pre-existing knowledge, while an innovation is realized when there is a new technological
change that has diffused into the economy and has been adopted by potential users. Therefore, it could be said that “invention-if present- is part of the process of innovation” (Narayanan, 2001). This is supported by the statement that the British have an impressive track record for inventiveness, but have lost the knack for turning inventions into innovations (Rowe, 1986). Rowe also identifies the following reasons for the failure to transform inventions into innovations:

- The inability to link university research and industrial innovation;
- The low status typically given to engineers by management (and the country as a whole);
- Management hostility, suspicion, ignorance, and indifference towards technological innovation.

Narayanan (2001) recapitulates this discourse by declaring that, “innovation refers both to the output and the process of arriving at a technologically feasible solution to a problem triggered by a technological opportunity or customer need”. Invention and innovation are terms that surface often when dealing with the following types of innovation; product innovation, process innovation, organizational innovation, market innovations. Damanpour and Euan (1984), concur with the views mentioned by stating that, “…innovation is a practice, distinguished from invention by its readiness for mass consumption and from other practices by its novelty”.

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2.2.5 CREATIVITY AND INNOVATION

It is argued by Boden (1994) that, “one idea may be creative, while another is merely new” and she then asks, “What’s the difference?”. Boden (1994) describes two broad types of creativity; the improbabilistic (novel combinations of familiar ideas), and impossibilistic (generation and combination of ideas that seemed impossible to generate before). In the research on divergent thinking Williams (2004) argues that divergent thinking “is an important aspect of individual creativity”. Based on the findings Williams (2004) states, “factors relating to individual creativity include…personality, attitudes, ability, and motivation”. Creation, if it is understood to be about bringing into being or forming out of nothing, is impossible. What then, is creativity? And how does it differ or relate to innovation? They both are about new ideas and they are not supposed to be predictable, otherwise there will be nothing new or surprising about them. Kitsopoulos (1994) states, “Creativity is the ability to do something to which people respond that is original and unexpected and not obvious before it was done”. A clear phenomenon arising from this inquiry is that an innovation can be improved by employing creative techniques and ideas. The discussion that follows highlights some of the views on creativity and innovation.

There is an apparent tendency to view and use the terms creativity and innovation interchangeably (Man, 2001; Martins and Terblanche, 2003). Some researchers do not seem to be concerned about this tendency, while others are adamant that the difference exists and as such must be given its due attention. As a subterfuge, some authors simply use these terms together (e.g. creativity and innovation) most of, if not all the time. Man
(2001), argues that with regard to how these two terms are understood, there is a curious circular argument and he goes on to argue that creative solutions are a result of innovation which emanated from creativity. Research also shows that in order for an innovation to gain recognition and acceptance, it must at least be perceived to be adding value (Man, 2001; Knox, 2002).

2.2.6 TRANSFER AND DIFFUSION OF TECHNOLOGICAL INNOVATION

Once an innovation has been realized, it has to get out to the people in order for it to add value. In technological innovation research, this is known as technology transfer. After these technological innovations have been transferred from their place of origin to other places, they need to spread within the places to which they have been transferred. This spreading is called diffusion (see Rogers, 1995). However, there are numerous factors that can either support or inhibit technology transfer and diffusion (Martins and Terblanche, 2003; Chaudhuri, 1994). When arguing about the innovation adoption factors, Chaudhuri (1994), states that heterophilous (“heterophily” or “strength of weak ties” -extent to which individuals or groups are dissimilar with regard to certain attributes and other social factors) interpersonal networks are crucial to the flow of information because they enable ideas to permeate across boundaries such as values, beliefs, and social status. Chaudhuri (1994) further argues that homophilous (homophily- extent to which individuals or groups are similar with regard to certain attributes and other social factors) networks inhibit the spread of innovations or diffusion of innovations.
The view that diversity in terms of ethnography and cultural ethos in microcosm is a necessary ingredient for the adoption of an innovation is not, however, held by some researchers who believe it makes it difficult for communities of practice to develop a common language and shared patterns of meaning. Pérez-Bustamante (1999) highlights, that knowledge transmission to third parties may be restricted by the tacit and idiosyncratic nature of technological knowledge. Diversity can initially threaten the ability to develop common discursive resources and practices. However, it can be deduced from this discussion, that if diversity in terms of cultural ethos, is present in the innovation from conception, it can ultimately contribute positively towards technology transfer and diffusion. This is due to the fact that the innovation itself will have been developed from a multi-faceted perspective, which would make it possible for it to migrate from its locus and enter into other environments. Moreover, it should be pointed out that communities of practice with a common strong culture, as their subterfuge, tend to dominate to the point of suppressing views that are divergent.

In view of the discussion above the author needs to discuss the subject of technology in the context of developing countries and the transfer thereof. Developing countries are the ones where indigenous ways are still practiced to a larger degree, especially in the rural parts of these countries. It is important to define the terms, technology and transfer, as they are understood in the context of this discussion. Technology is sometimes defined in terms of its physical manifestation, that is, hardware or manufacturing (Zander, 1991).
Almost condescendingly, Eveland (1986), expresses a rather serene caveat that “…technology is not simply hardware or physical objects; rather, it is knowledge about the physical world and how to manipulate it for human purposes”. Eveland’s concern is perhaps addressed by the following definition adapted from Pérez-Bustamante (1999); a combination of technical expertise (technos) and knowledge bases (logos). It is argued by other authors that the human element cannot be excluded in the definition as these physical artifacts are made possible by human or tacit (Polanyi, 1996) development capabilities that reside in the minds of research and development (R&D) engineers (Autio & Hameri, 1995). Capra (2002) states,

“The meaning of ‘technology’, like that of ‘science,’ has changed considerably over the centuries. The Original Greek technologia, derived from techne (‘art’), meant a discourse on the arts. When the term was first used in English in the seventeenth century, it meant a systematic discussion of the ‘applied arts,’ or crafts, and gradually it came to denote the crafts themselves. In the early twentieth century, the meaning was extended to include not only tools and machines but also nonmaterial methods and techniques, meaning a systematic application of any such techniques”.

In view of the foregoing discussion, in this thesis the term technology refers to both knowledge (Indigenous knowledge or foreign knowledge) and hardware (Autio & Hameri, 1995).
The author’s view is that the term *transfer* is defined in a limiting way by some authors. Autio and Hameri (1995) indicate that as a technology develops there is “cross-fertilization between technological systems…in the different evolutionary phases”. This is one reason why “factors affecting the transferability of technology become more important” (Autio & Hameri, 1995). The definition of technology transfer that views the process in a unidirectional way, as opposed to the bi-directional one, is limiting and does not allow enhancements from the side of the intended recipients. A result of this way of thinking is that, very little has been done to try to make the technology accessible in the context of the language and culture of indigenous communities. Technology transfer should not only be about transmission, but it should also be about absorption (that is, $\text{Transfer} = \text{Transmission} + \text{Absorption}$). This absorption is not easy if the people for whom the technology is intended have to first learn new skills in order to use and understand it.

Through an attempt to produce a synopsis that epitomizes an open-ended discourse in innovation research, the author asserts that the open-endedness of the deliberation about the meaning of the terms in innovation is in itself indicative of the mystery of creativity and innovation. It is for this reason that the author avoids drawing conclusions that could be construed as removing ambiguity. The author finds that researchers admit that creativity and innovation theories are about an ever-surprising subject (see Meyer and Goes, 1988). Paradoxically, a great attempt has, and continues to be made to try to harmonize and standardize the view points as shown through out this chapter. It is also
clear that the seeking of dominant views and eventually suppressing the non-dominant ones, even about the meaning of terms, is counter-productive to the generation of new ideas that may haply lead to new innovations being realized. This is not necessarily a dilemma more than it is a promising scenario for the continuation of the research towards the attainment of the unreachable goal of unraveling the mystery of creativity and innovation. The author’s view is that it is for these reasons that Meyer and Goes (1988) argue that there is still a lot that is not clear in terms of interpretation. They further refer to the ‘fragmentary’ and ‘contradictory’ manner in which innovation literature is presented. This points to the realization that both theoretical and practical knowledge about the reasons why and indeed how some organizations innovate is not yet adequate (Meyer and Goes, 1998).

Having stated all that, it must further be mentioned that the author’s intent by explicating the points, in the foregoing thesis, is to elicit a range of views and ambiguities for appreciation, rather than criticism. This exposition has been done by drawing on empirical studies.

The discussion that follows is mainly on the roles of culture and language in technological innovation. In this case, research that corroborates or refutes the impact and/or role of language and culture in technological innovation has been deliberately sought, due to the desire to evaluate the practicability of the direction of the hypothesis.
2.3 CULTURAL AND LANGUAGE ISSUES IN TECHNOLOGICAL INNOVATIONS

2.3.1 CULTURAL ISSUES

Wide-ranging research on various types of mores has been conducted by some researchers. These types include the following: family culture, national culture, organizational culture, universal culture, generalized culture and particular culture. In cultural anthropology, the anthropologists study society and culture from two perspectives. These are: ethnography and ethnology. All these are interrelated. Between different individuals, nations, and organizations there are cultural differences, and this is viewed as cultural diversity. Researchers agree that cultural diversity is not necessarily a negative phenomenon, but it must be appropriately managed so that we derive value from it. On the subject of managing cultural diversities, Miroshnik (2002), alludes to three types of what she calls “common responses to cultural differences as strategies to manage cultural diversities…” These types are:

- Parochial – “our way is [the] only way”.
- Ethnocentric- “Our way is the best way”
- Synergistic – “Our way and their way differ, but neither is inherently superior to the other”.

The synergistic type is deemed as an apt attitude for managing cultural diversity by Miroshnik (2002).
Diversity is considered to be an advantage when creating a new idea. It is also generally accepted by some researchers and managers that multicultural organizations are more flexible and open to new ideas. Adler (1983) discusses the understanding that multicultural organizations are better configured for the understanding of customers’ needs. When confronted with a complex problem, group thinking seems to provide the advantage of enhanced creativity, flexibility, and problem solving skills that would be a daunting exercise and experience for one person. In group thinking there is a blend of perspectives emanating from a fusion of cultural and other backgrounds. Furthermore, Adler (1983) admonishes that cultural diversity should not be made a liability to the organization, and that instead it should be recourse for problem solving. Another interesting dynamic about culture is that it is not static. The patterns of individual and group behaviour keep changing and this phenomenon has an influence on the society’s culture (see Adler, 1983).

**Definitions for culture**

Literature has many different definitions about culture (see Martins and Terblanche, 2003; Lundy and Cowling, 1996). Researchers seem to agree essentially, though different words are used that, basically, “culture is the way of life” (Foster, 1962). Tylor (1977) states that, “Culture is that complex whole which includes knowledge, belief, art, law, morals, customs and any capabilities and habits acquired by a man as a member of society”.

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Subsequent to sorting out more than a hundred definitions of culture in their book, Kroeber and Kluckholm (1952) presented the following comprehensive epitome and widely accepted definition:

“Culture consists of patterns, explicit and implicit of and for behavior acquired and transmitted by symbols, constituting the distinctive achievement of human groups, including their embodiment in artifacts; the essential core of culture consists of traditional (i.e. historically derived and selected) ideas and especially their attached values; culture systems may, on the one hand, be considered as products of action, on the other hand as conditioning elements of future action. Culture is something that is shared by almost all members of some social group; that the older members of the group try to pass on the younger members and something (as in the case of morals, laws and customs) that shapes behavior”.

The three definitions above demonstrate that there are wide ranging definitions, from the short (see Foster, 1962), to the slightly longer (see Tylor, 1977), and to the more elaborate (see Kroeber and Kluckholm, 1952). The more recent definitions that the author came across are all based on the same thinking as the ones demonstrated by these three definitions, hence the decision that these three will suffice. In other words, they are all about “the collective programming of the mind which distinguishes the members of one human group from another…the interactive aggregate of common characteristics that influences a group’s response to its environment” (Hofstede, 1980 p.25, cited by Miroshnik, 2002). While the author did glean through research by authors such as
Hofstede (1980) and Hofstede and Hofstede (2005) on differences in national culture, as well research by Shane (1990, 1993) on ‘why do some societies invent more than others?’ and ‘cultural influences on national rates of innovation’, it was found that their research does not quite address the current question of this thesis. As Shane (1993) concludes, their research “has a number of limitations” and these limitations include the inability to measure “cultural values and rates of innovation” while the findings indicate “that culture plays a part in the innovation process”. These researchers base their research on Hofstede (1980) research in which cultural differences among the studied societies are categorized according four quantifiable dimensions. According to Shane (1993), these dimensions are:

- **Uncertainty avoidance** which has to do with “preference for certainty”.
- **Power distance** which has to do with the “acceptance of inequality in power and authority between people”.
- **Individualism** which has to do with “preference for acting in the interest of a larger group in exchange for their loyalty and support”.
- **Masculinity** which according to Hofstede (1980) and in the words of Shane (1993) has to do with a “belief in materialism and decisiveness rather than service and intuition”.

These research by Shane (1993) concludes that, “Highly innovative societies have people who are individualistic, low in power distance and accepting of uncertainty”.

Finally, “cultures are integrated, patterned systems: when one custom, belief, or value changes, others change as well” (Kottak, 1991).
Against the background provided by the preceding discussion on the contextual understanding and definitions of culture, an attempt to demonstrate those aspects of culture that could promote technological innovations is made. As mentioned in the introduction, some researchers have identified certain cultural traits that impede the process of innovation. Moreover, the author argues that they have also speculated on the appropriate configurations of culture; for culture to be conducive for technological innovations with insufficient empirical evidence. In this thesis focus is on the positive impact of culture in technological, while the negative impact is not ignored.

The discussion that follows is placed in context of the understanding that various types of cultures are interrelated. An organizational culture for example, is made up of national cultures, made up of regional cultures, made up of family cultures, made up of individuals, and also that some cultures are universal, and/or generalised and/or particular (see also Burnes, Cooper and West, 2003). In view of this understanding, the author will therefore not separate the various types during this discussion. In other words, it does not matter what the type is, as long as it gives some indicators about a cultural trait that is conducive to creativity and innovation.

It is generally agreed by some researchers that organizational culture plays a significant role in determining the degree to which creativity and innovation are promoted and stimulated in an organization (Pech and Slade, 2004; Martins and Terblanche, 2003; Knox, 2002; Miroshnik, 2002; Cameron and Quinn, 1999; Ahmed, 1998; Tushman and
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O'Reilly, 1997; Syrett and Lammiman, 1997; Judge et al., 1997; Robbins, 1996; Johnson, 1996; Dunphy and Herbig, 1994; Pheysey, 1993; Shaughnessy, 1988; Schuster, 1986; Rothwell & Wiseman, 1986).

There is a general understanding that is propagated by these authors. It is that a culture that does not allow divergent thinking tends to stifle innovation (Williams, 2004; Paulus, 2000; McCrae, 1987). McCrae (1987) also demonstrated empirically the connection between openness to experience and divergent thinking. If for example, in a conservative and highly regulated culture, the policies, intellectual property rights and tax laws are very restrictive, the result is likely to be too much conformity which could lead to a lack of new ideas. This is partly the reason why people from highly conservative countries thrive when they arrive in the United States of America (USA). This is not to say that regulations such as intellectual property (IP) protection and rights should be abolished. Rather, as Fortino (2008) puts it, “Tailor the IP protection type and enforcement strategy…in the context of the business strategy being pursued”, so that there will be a “balance between weak and strong IP protection”. Fortino (2008) further argues, “…vigorous and even a strong legal defense of intellectual property rights for some classes of products and services may be inimical to successful business practices…”.

As mentioned in the introduction of this chapter, although many researchers agree on the reasons, the author could not find sufficient empirical research to support the arguments. These ideas seem to emanate from mere observations and heuristic in-house experiments, which cannot be generalized for a wider spectrum of culture. When tracing through the
pages of publications on this topic, the issue that seems to be most prominent is the freedom and ease or restriction in communicating about new ideas.

It appears that certain cultures are more welcoming to new ideas, and this necessarily also depends on whether there is shared meaning during conversations or not. A common culture would be ideal for ‘meaning making’ during a discourse, as it would enable communicators to understand both the tacit and explicit meanings of the language used. This view is corroborated by Herskovits (1989) who, cited by Miroshnik (2002), states, “Language is probably the most difficult cultural element that a global manager must study, because it is more than the ability to speak a foreign language, but also the competency to recognize idiomatic interpretations”.

Using the translation theory, Holden (2002), defines three major language obstacles in international knowledge transfer. These are:

- **Ambiguity** – intended knowledge may be misinterpreted by a receiver due to constraints of language or sender,
- **Interference** – when words in different languages look or sound the same, but mean something else, and
- **Lack of equivalence** – when the context of one language is imperfectly transferable into another.
This then brings us to the question of language. Does shared language make it easier for those who are sharing ideas to better understand one another, than would be the case had the language not been common? If yes, would this continue to be helpful towards the articulation of new ideas, even if the culture is conservative and restrictive? Man (2001) states, “… language used is vital in opening the side of the brain that begins innovative inquiries”.

People use language to express their culture, and culture also determines how people will use their language. Miroshnik (2002) states: “Culture enables us to communicate with others through a language that we have learned and that we share in common”. This suggests that language and culture are intrinsically linked. The author’s view is not that one is embedded within another, but that they influence each other notwithstanding the fact that one might suffer without the other.

The section following is an attempt to define language as it is understood in this thesis. Singling it out is not motivated by the thinking that it exists and potentially can lead to innovation alone (regardless of the cultural configuration), but by the desire to contextualize it for the purpose of clarity in this thesis. In fact, the author views language as an integral part of culture, though sometimes it can be singled out for the purpose of in-depth examination on its role.
2.3.2 LANGUAGE ISSUES

According to reviewed literature, as can also be seen in this subsection, substantial research on language has been conducted. In view of this understanding it is felt that for the purpose of this thesis it will suffice just to consider those aspects of language and its definition that seem more applicable to the current inquiry. It would be outside the scope of this research to cover the entire breadth and depth of the language topic. In view of this understanding the author decided to study the various fields of inquiry with the intent of detecting strong indicators that could be rewarding in the current expedition through literature. Particular attention is paid to the links between language and intelligence, intelligence and inventiveness, inventiveness and cognitive skills, as well as whether or not there is any correlation between intelligence and innovation.

At this point, the author’s view is that at the core; language, culture, technology, and innovation are essentially and foundationally, intrinsically connected. A person may do one of the following: (i) say, ‘I want you to be happy’ (spoken language), (ii) or ‘give you what makes you happy’ (cultural gesture), or (iii) ‘make a tool or produce a product that makes you happy’ (technology and innovation).

All of these are expressions of and about the same thing, and the only difference is that they are communicated in different forms (‘languages’). Capra (2002) states,

“Our hominid ancestors must have communicated with their hands, just as their ape cousins did. Once they began to walk upright, their hands were
free to develop more elaborate and refined gestures. Over time, their
gestural grammar would have become more and more complex, as
gestures themselves evolved from gross to more precise movements.
Eventually, the precise movements of their hands would have triggered
precise movements of their tongues, and thus the evolution of gesture
produced two important dividends: the ability to make and use more
complex tools, and the ability to produce sophisticated vocal sounds”.

An overview and definition of language

For some time it was believed that language abilities were inputs and learning from the
environment and other sources. In this context, it makes sense to find the languages that
would trigger innovativeness better than others. With the arrival of Chomsky’s (1959)
theory of innate language acquisition device, there was a major shift in thinking.
Language could now no longer be thought of as a tool for thought but rather as a tool that
attempts to explain thought. In other words thinking does take place without the
language. According to Weiskrantz (1988), when we know what we want to say, but
unable to ‘put it into words’, it is an example among many indicating that thought can
take place without language.

This refutes the understanding that language defines how we see the world. Language
seems to be merely a tool, though insufficient in some respects, that we use to a limited
extent to describe our thoughts. The thinking or innovative ability of someone cannot be
ascertained only through the language he uses. According to Vernon (1967), deaf
children with limited verbal language ability score in the normal range on standardized tests of cognitive performance. Moreover, Furth (1971) states that the cognitive skills and thinking abilities of the deaf children develop relatively normally. What these studies did not look at, is whether or not these children were using non-verbal forms of language for their thinking derived from the innate human program for language. An interesting dynamic here is the one brought by Vernon and Koh (1971), and Stuckless and Birch (1966), when they argue that some studies suggest that deaf children who have sign language skills do better in cognitive and thinking tasks than those without the sign language skills.

For a long time the study of language has largely been the domain of linguists (see Gross, 2001). Linguists tend to define language in terms of its structure (its grammar). A new trend in the study of language has recently developed. This trend is about looking at language both from the perspective of linguists and that of psychologists, psycholinguistics. This includes the study of perception, understanding, and production of language, as well as their development.

“The normal use of language is innovative, in the sense that much of what we say in the course of normal language use is entirely new [and] not a repetition of anything that we have heard before” (Chomsky, 1968). If this is true, then at least, it means that all human beings have an element of creativity. Could this also mean that someone who has good language skills is also good in creativity? An interesting phenomenon here would be to know whether this creativity (or innovation) is translatable into technological
innovations. It has already been discussed, that innovation is about new ideas and that these new ideas are communicated to others through language. Moreover, it has also been stated that a common language is vital in ‘meaning making’ and technology transfer. There is clear evidence that language is useful for the communication of new ideas which could lead to innovations, but still it would be of interest to know whether or not some languages are better than others in the communication of new ideas. Psycholinguists have done some work on language and thinking. In the next paragraph a brief account and summary of some of their pertinent contributions is made.

The view of the author is that language is more than just a convenient set of symbols for the communication of our thoughts. This view was earlier explained by Whorf (1956). Whorf (1956) argues that higher levels of thinking require language and that the characteristics of a particular language shape the ways that the users of the language think about things. In the hypothesis of linguistic relativity (Whorf, 1956), the view is that the particular language that people speak determines how they will see the world. It seems that the level of precision in thinking about something depends on the relevance of the phenomenon to the thinker, otherwise, why would the thinker bother. For example, someone who lives near the North- Pole will tend to have more words that describe snow than someone who lives in a different environment. In English, for example, the word would be just snow, whereas the Eskimos are said to have four different words (see Morgan et al., 1986) and Inuit Eskimos have twenty different words (see Gross, 2001) for snow. This greater precision must not necessarily be attributed to flexibility of the language used by the Eskimos but to the demands and triggers of the environment.
The theory of *linguistic relativity* has recently come under attack due to the experiments that were done on color perception. It has been found that the fact that certain languages do not have names for certain colours does not mean that the people who use these languages cannot perceive those colours (see Rosch, 1973). Rosch (1973) did experiments with the Dani people of New Guinea who had only two focal-colour names in their language, *mili* for black or dark and *mola* for white or bright. It was found that the thinking of the Dani people was influenced by even the focal colours for which they did not have names. Similarly, in IsiXhosa and in IsiZulu languages, *luhlaza* is the word used to refer both to the colours green for grass and blue for the sky. When necessary, clarification is provided to avoid ambiguity. This does not imply that IsiXhosa and IsiZulu-speaking people cannot see the difference between the two colours.

Initially, the author had sought out to investigate the relationship between language and thought. If for example, it was found that thought depends on language, it would then make sense to look at which language has which kind of influence on thought and then also to look at its structure. However, research so far indicates that though language learning from the environment and other cultural sources seems to play a role in one’s language development, it is not the only factor responsible for language development. This conclusion is deduced from the experiments done with the primates for example such as chimpanzees where attempts to teach them human language were not conclusively successful. At least, these experiments made researchers believe that there must be some innate abilities in humans that primates do not have.
It seems that the components of language structure such as phonology, morphology, lexicons, semantics, and syntax require that innate ability of a human being to use them. By themselves they cannot do much. Kottak (1991), an anthropologist, after a careful study on the various hypotheses on the relationship between language, thought and culture, offers the following conclusion, “According to the principle of linguistic relativity, all dialects are equally effective as systems of communication, which is language’s main job. Our tendency to think of particular dialects as better or worse than others is a social rather than a linguistic judgement”.

The following literature on language and thought was also reviewed: Watson’s (1913) ‘peripheralist approach’- that language and thought are the same, Sapir (1929) and Whorf (1956) -a student of Sapir, in their Sapir-Whorf linguistic relativity hypothesis, Brunner (1983) arguing that thought is dependent on, or caused by language, Vygotsky (1962), - thought and language are initially quite separate activities, and Piaget (1950), - language is dependent on, and reflects thought. Subsequent to this review, the author determined that the best way to conclude is by the following quotation from Gross (2001):

“While there are many examples indicating that thought can occur without language, the exact relationship between thought and language remains unclear. What is certain, however, is that no one account of this relationship is true and all others false; several theoretical perspectives can claim some support from the
experimental literature. However, since language represents such a central feature of culture, both shaping it and being shaped by it, any theory which fails to take account of cultural factors is likely to be inadequate”.

On the basis of the foregoing discussion, the author opines that this discussion cannot be closed without also looking at the functioning of the brain and innovation. Though not many, there are some researchers, especially the neuropsychologists, who have offered some insights about the relationship between the brain hemispheres and innovation. Ornstein (1986) gives the following explanation about the major differences between the left and right hemispheres:

- The left is specialized for *analytical* and *logical thinking* (breaking things down into their component parts), especially in verbal and mathematical functions, processes information *sequentially* (one item at a time), and its mode of operation is primarily *linear* (straight line).

- The right is specialized for *synthetic* thinking (bringing different things together to form a whole), particularly in the area of spatial tasks, artistic activities, crafts body image and face recognition, processes information more *diffusely* (several items at once), and its mode of operation is much *less linear* (more holistic).

Though this explanation by Ornstein (1986) is widely accepted, it is argued by many that it is not as simple as saying some tasks are for one side of the brain and others for
another. It is argued that the difference is only in the processing style, and therefore the two sides of the brain may work together on the same task and their different processing styles are complimentary in the process more than anything else. Morgan, King, Weisz, and Schopler, (1986). Morgan, et al., (1986), concur with Ornstein (1986), by stating that language understanding is usually the domain of the left hemisphere and that the right hemisphere is usually specialized to deal with spatial relationships, pattern recognition and images. Morgan, et al., (1986), also state that “the specializations of the hemispheres are matters of degree”. It does appear that there is cooperation between the two hemispheres rather than that one hemisphere is solely responsible for particular tasks. Gross (2001), maintains that, “a ‘smart’ mind is one that responds in both ways” and he continues by quoting McCrone (1999) as saying, “…whatever the story about lateralization, simple dichotomies are out. It is how the two sides of the brain complement and combine that counts”. Artists, composers, architects and so on are said to be right brained, and physicians, scientists, accountants and so on, are on the other hand said to be left brained. Certain atypical individuals, such as Leonardo da Vinci, are cogitated to be both right and left brained. This is why Morgan, et al., (1986) conclude by saying, “to be more conservative, we may simply say that there seems to be some hemispheric specialization of function”.

Notwithstanding the trend in the discourse on the two hemispheres Alder (1994), claims to be involved in the research that has managed to identify a few points. Alder (1994) eulogizes De Bono’s (1977) ‘lateral thinking’ as having been instrumental in explaining that each of us is inherently creative, but it is just a matter of releasing or stimulating that
part of our brains that brings forth new perspectives, or the occasional “eureka”. Alder’s views are discussed in brief below:

- We have enormous untapped resources of thinking power, as the right side of the brain, which is associated also with the sub-conscious intuition, hunches and so on – is so under-utilized in Western society.

- Our education systems major on logic (logic as we understand it with the left brain) rather than the feelings and spontaneous “insights” associated with the right side of the brain.

Based on the research with, and the training they offer to British business leaders, Alder (1994) highlights a few methods that work, when trying to evoke the right side of the brain. Some of them are summarized below:

- *Don’t try too hard* - the right brain can do its best work when you are relaxed. The harder you try, or the more conscious you are of a problem, the harder it is to get a result.

- *Make space* – this is somewhat related to the previous one, in that it is also about finding time and space to relax. For example, in the research and discussions that were done with chairpersons and chief executives of leading British companies, it was found that the most important ideas came to them outside of office hours, during times of relaxation and pleasure.
• **Sleight of Mouth** - this great skill of applying different perspectives to any problem comes with practice. In short, this is about looking at a problem from many angles and coming up with metaphors for it and this will eventually unblock an intractable problem

• **Chunking** - “The process of chunking maintains some link with an original concept or issue, but introduces new associations; seeing things, if you like, both from a bird’s eye and a worm’s eye view, with many different vantage points. The randomness and subjectivity introduce the lateral thinking needed to open up an issue”.

Other methods highlighted by Alder are reversals, chunked reversals, metaphors, meta-model and visualization. Alder again asserts that, “Our own more recent research shows that the whole range of right brain thinking attributes are a factor in top business leadership, and tend to separate the real leader from the manager”. What is interesting is that in this same research by Alder, it is acknowledged that the secret is in the partnership with and the mutual respect for, the two different thinking processes during problem solving. This discussion is supported by Man (2001), when he states, “technological growth is evident when:

• Brain or knowledge-based work increases;

• Body stress and strain is eliminated;

• Quality of work life is enhanced;

• Tangible savings are evident.”
Moreover, Man (2001) argues that the language used is crucial to opening the side of the brain that triggers innovative inquiries. He then goes on to mention innovation triggers, including the language of the right brain.

If there was strong indication from the research on language and thinking that indeed, language alone is responsible for triggering new ideas in the brain during the thinking process, then it would be worth investigating deeper into the relationship between the hemispheres and language.

The author further concludes that it seems as if language is a component of culture and if it is viewed in the context of culture, its influence on an individual’s innovation will be clear, otherwise outside this context its relationship with innovation remains unclear. The discussion that follows does not separate language from culture, but pays attention to the language aspects in culture. The author then illustrates that the way people use any language is what matters more than what language it is and how it is structured. This use of language is a phenomenon that is inseparable from the culture of the individual, nation, and organization, hence it is deemed necessary to look at language in the context of culture.
An attempt to look at heredity and environmental factors is also made, as well as an investigation and discussion on (Wittig and Belkin, 1990):

- Industrial Psychology- application of psychological principles to the solution of work-related problems.
- Engineering Psychology- the relationships of people to machines with the intent of improving such relationships.

Heredity and environmental factors as well as the ‘nature-nurture’ debates could also not be concluded. It is still not clear whether, naturally, certain individuals are born innovative, or through being nurtured appropriately almost anyone can be innovative. This is similar to the debate on whether entrepreneurs are born, or created by society. Based on the foregoing discussion, the author concludes that both the nurturing and natural aspects of innovation need to be considered.

2.4 CONCLUSION ON LANGUAGE AND CULTURE ROLES IN TECHNOLOGICAL INNOVATION

Thus far, as evidenced in the preceding discussion, the author has avoided formulating any thesis, due to the fact that the hypotheses that were considered seem to necessitate further investigation. However, for the purpose of this thesis, different views are considered from the angle of culture and language within culture. Ulijn and Campbell (2001) concluded in their research that, “Culture affects language, even when people of different cultures use the same language”. 

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A more recent study on innovation and entrepreneurship views the role of language in the context of culture, but more specifically as a tool for the necessary discourse for triggering innovation (see Grant, D., Keenoy, T. and Oswick, C. (2001); Rigg, 2005; Checkland, 2000; Watson, 2000; Czarniaskwa, 1998; Woodilla, 1998). These researchers all emphasize the importance of ‘talking’ regardless of the language (at a technical and structural level). It is also generally agreed by them, that “Organizational discourse as a field of enquiry has been attracting increasing attention in recent years, but, …there are still very few empirical discursive analyses of organization and managing” (Rigg, 2005; see also Grant et al., 2001). These researchers are motivated by the constant play that they see between talk, meaning and action, both at the level of an individual as well as at the level of an organization (that is, collectively). They are also interested in the discursive practices or resources used by managers when they persuade, encourage, cajole, and sometimes even coerce other members to adopt new working practices, and in working out new solutions.

The next chapter deals with the research methodology that was used in this research. In this chapter, the research approach that was used is explained. Chapter 3 also explains the importance of not separating social issues from natural science as there exists between them what Capra (2002) describes as, hidden connections.
CHAPTER 3 RESEARCH METHODOLOGY

“Good qualitative research studies can offer people a new insight on issues that they take for granted” (Silverman, 2006).

3.1 CHAPTER INTRODUCTION

This chapter outlines the methodological process followed in order to gain information and to generate knowledge. The nature of the research question (i.e. what has language and culture got to do with technological innovation?) led the researcher to consider views from a range of empirical research disciplines and topics. Some of these topics are discussed in the research conducted by linguists, anthropologists, psychologists, technologists, engineers, scientists and managers.

In trying to find answers to the main research question, the researcher interacted with researchers and practitioners from the fields within the identified areas of study (see Burden & Roodt, 2007). The researcher interacted with these researchers and practitioners at conferences, seminars and at their work places.
3.2 BACKGROUND

In order to address the real world question about the relationship between language, culture and technological innovation the researcher was confronted with having to find a mode of knowledge production as well as a relevant overall methodological approach. This mode of knowledge production had to be compatible with the overall research methodology employed in the study.

Finally, this study aims to suggest a useful research framework that can be used to understand the relationship between language, culture and technological innovation. The main question that is asked in this study requires a process of data gathering, analysis and explanation in which the researcher asks; what is the relationship between language, culture and technological innovation?

The researcher argues that this research question is a qualitative research question. The reason is that this question is asked so that we can know what the relationship is, if any. Subsequently, if the relationship exists, the aim is to explain the nature of the relationship. From gathered data, focus will be on trying to understand the characteristics of behaviour, rather than on measurements. It is for this reason that this study follows an inductive research process which employs a qualitative research approach.

Grounded theory (GT) is chosen as the relevant form of qualitative methodology that can also follow an inductive research process. Gibbons, et al., (1994) describe an alternative to traditional forms of knowledge generation which is called ‘mode 2’. ‘Mode 2’ (also
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known as a transdisciplinary research mode) is explained next and is used to complement GT due to its similarities with the GT approach. The sub-sections that follow aim to define, justify, and explain the relevance and applicability of the research approaches and methods employed in this study.

3.3 METHODOLOGICAL PROCESS FOR GAINING INFORMATION

In this sub-section the researcher explains the relevance of mode 2 (transdisciplinarity) and GT methodology in this study. The challenge here is to figure out the best way to address both questions about the ontological nature – or the ultimate reality- of innovation and also about the epistemology of how knowledge is generated about the technological innovation process.

The researcher decided to use the ‘mode 2’ research approach advanced by Gibbons et al. (1994) because it allows transdisciplinary knowledge to be generated across a diverse range of different contexts of application. The researcher accepted the distinction by Gibbons et al. (1994) between the traditional modes (‘mode 1’) that rely on discipline specific approaches of knowing and a new mode of knowledge production (‘mode 2’) that is inherently transdisciplinary. Gibbons et al. (1994) explain that Mode 1 is a traditional discipline based mode of knowledge creation.
In contrast Mode 2 is not discipline specific because it seeks to transcend disciplinary boundaries and to become transdisciplinary. Therefore Mode 2 knowledge production is not confined to a particular paradigm, or disciplinary format, methodology or view of reality.

The Grounded Theory (GT) approach by Glaser and Strauss (1967) has been chosen as the main research methodology in this study. The GT approach is considered to be compatible with the transdisciplinary ‘mode 2’ knowledge generation. Both mode 2 management research and the GT approach emphasize the need to avoid the use of pre-existing and discipline bounded frameworks (see also Partington, 2000). Both GT and mode 2 have the capacity to deal with tacit knowledge that has not yet been codified. This is a major point of convergence between these two research approaches. The GT approach addresses the challenge of dealing with tacit data by explaining the process to be followed in identifying and transforming tacit data into codified knowledge. The history of GT helps explain its relevance for innovation research.

Grounded theory (GT) has its origins in the work by Glaser and Strauss (1967). Like many approaches and their applications, GT has gone through an evolutionary process. Today there is a split between the originators and practitioners of the GT approach. On one side is Glaser’s method that is believed to have maintained the original version of GT methodology. On the other is the Strauss and Corbin (1990) methodology which has modified the original GT approach in response to critical feedback from practitioners that identified shortcomings in the original (classical) GT approach. Glaser (2010) maintains
that GT as a general methodology can be used in part or in its entirety. Traditionally GT strongly emphasized that literature review was to be avoided at the initial stages of the GT process (Glaser and Strauss, 1967). It was later stated by Glaser (1998) that past literature could be “woven into the theory as more data for constant comparison”. Strauss & Corbin (1990) developed an extensive coding system to assist researchers build up theories from data. These observation, organizing and data handling procedures were insufficient in the original work by Glaser and Strauss (1967).

The author came to the conclusion that GT is used by researchers mainly because it introduces space for qualitative interpretation within the framework of inductive data gathering. However, Glaser (2010) maintains that GT was conceived of as general method that could employ both qualitative and quantitative methods. Strauss and Corbin (1990) in turn argue that both inductive and deductive thinking are involved in the analytical process. The reason for the use of both deductive and inductive reasoning is that during analysis there may be situations where there is the need to hypothesize about possibilities until one proves or disproves one’s hypothesis. In their original work, Glaser and Strauss (1967) also argue that both forms of data can be used in the same research project.

What follows is an account of how the GT approach can be combined with the guiding principles driving mode 2 research. The overall approach employed in this study of technological innovation draws both its inspiration and rigor from the rational combination of the GT methodology with Mode 2 methodology for transdisciplinary

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research. The following sections also address the matter of what questions, issues, and complexities were deliberately avoided during the research process (see also Graziano and Raulin, 1993; Martella et al., 1999; Silverman, 2006).

3.3.1 AVOIDANCE OF RESEARCH JUSTIFICATION BY PERSISTENCE

The temptation and propensity to regard an idea as valid knowledge, because it has been accepted for a long time, is an approach that has been consistently avoided in this research. This acceptance of a belief on the grounds of its persistence or tenacity, as some may call it, requires no further substantiation except that the belief is already accepted. Tenacity may explain why there are so many prejudices that are resistant to change, even when there is abundant evidence that our prejudices are unfounded. The author avoided this approach because of its evident stubbornness.

3.3.2 AVOIDANCE OF HUNCH - BASED FINDINGS

The author argues and believes that scientific enquiry must necessarily transcend a sixth-sense type of approach to scientific research, which may be common in implicit traditional practices, religious philosophy, and psychic practices, and yet inadequate for scientific discourse. The author’s approach in this study is that language and culture issues on technological innovation also need to be also scrutinized in a more rigorous manner, rather than as soft intangible belief-based variables.
3.3.3  BOND BETWEEN MATERIAL AND RULES OF BEHAVIOUR

This study focuses on connections and interactions between language and culture (communication and rules of behaviour) on one hand, and technological innovation (material) on the other. Technology shapes culture and culture is shaped by technology, and language is used to facilitate both the feed-forward and feed-back communication processes about the resulting changes. According to the author the constant interplay between natural and social structures and systems is proof that in fact, Social Sciences and Natural Sciences are intrinsically linked and are not parallel with one other. In other words, natural systems (that deal with material) and social systems (that deal with rules of behaviour) must and do work together.

In the words of Fritjof Capra (2002), “In the future, this strict division will no longer be possible, because the key challenge of this new century – for social scientists, natural scientists and everyone else – will be to build ecologically sustainable communities, designed in such a way that their technologies and social institutions – their material and social structures – do not interfere with nature’s inherent ability to sustain life”.

3.3.4  APPLICATION OF SCIENTIFIC REASONING

As mention in 3.3.2 above, the author guarded against drawing conclusions on an unscientific basis. However, scientific reasoning in the context of this study is used in a broader sense. Science is a way of thinking that involves a continuous and systematic interplay of rational thought and empirical observation. Alternatively, it is
a continuous interplay of facts and rational thought. The scientist remains curious, skeptical, and committed, using processes that identify or discover facts and that integrate those facts into coherent predictions, explanations, and general principles (see Graziano and Raulin, 1993; Martella et al., 1999). This was deemed appropriate for this research.

### 3.4 QUALITATIVE RESEARCH

The understanding used for the qualitative research methodology is the one described by Denzin & Lincoln (1994). Denzin & Lincoln (1994) explain that qualitative research makes use of many methods and involves an interpretive approach. They further argue that a selection of empirical materials such as case studies, personal experience and interviews can be used.

### 3.5 QUANTITATIVE RESEARCH

Some quantitative research approaches are used to enhance the analysis of the findings, particularly those suggested by King, Keohane, & Verba, (1994) when they state, “Quantitative research uses numbers and statistical methods. It tends to be based on numerical measurements of specific aspects of phenomena; it abstracts from particular instances to seek general description or to test causal hypotheses; it seeks measurements and analyses that are easily replicable by other researchers”.

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According to Thomas (2003), “The simplest way to distinguish between qualitative and quantitative may be to say that qualitative methods involve a researcher describing kinds of characteristics of people and events without comparing events in terms of measurements or amounts. Quantitative methods, on the other hand, focus attention on measurements and amounts (more and less, larger and smaller, often and seldom, similar and different) of the characteristics displayed by the people and events that the researcher studies.

### 3.6 TRIANGULATION

Triangulation is used, amongst other reasons, for drawing comparisons between the different kinds of data, but not as the main methodology.

“Triangulation involves comparing different kinds of data (e.g. quantitative and qualitative) and/or different methods (e.g. observations and interviews) to see whether they corroborate one another” (Silverman, 2006).

### 3.7 TRANSDISCIPLINARITY ON LANGUAGE AND CULTURE

As a term, ‘transdisciplinarity’ is a research mode of knowledge production that seeks to emphasize that the definitive potency of knowledge necessarily surpasses the generally accepted discipline-specific methods without devaluing their individual strengths. It is a new mode for seeing nature and reality. “Transdisciplinarity does not strive for mastery
of several disciplines but aims to open all disciplines to that which they share and to that which lies beyond them” (Charter of Transdisciplinarity, 1994).

Research on language and culture, as a basis for discussing technological innovation is aimed at discovering the influence each one has on the other – influence which can be described from a point of view that is outside of their individual disciplines. For the purpose of this study, ‘mode 2’ research is used as opposed to ‘mode 1’ research.

Gibbons et al., (1994) state,

- “Mode 1 is disciplinary while Mode 2 is transdisciplinary”.
- “Mode 1 is characterised by homogeneity, Mode 2 by heterogeneity”.
- “Organisationally, Mode 1 is heterarchical and transient.”
- “In comparison with Mode 1, Mode 2 is more socially accountable and reflexive”.

Briefly, ‘Mode 2’ research “corresponds to a movement beyond disciplinary structures in the constitution of the intellectual agenda, in the manner in which research is organized, results communicated and the outcome evaluated” (Gibbons et al., 1994).

Next is a further description of ‘mode 2’ methodological philosophy, as applied in this study.
3.7.1 DISTINCT BUT EVOLVING FRAMEWORK

(Mode 2; See Gibbons et al., 1994)

This research required creativity in that the process followed was evolving in accordance with emerging pointers from data. Yet this non-preconceived direction remained comprehensible due to attained contextual theoretical consensus at every stage. Determining where to go next –and how to go there- is something that was necessarily dependent on emerging data both from literature and phase 1 participants.

3.7.2 EMPIRICAL AND THEORETICAL SOLUTION PROCESS

(Mode 2; see Gibbons et al., 1994)

The constant interplay between empirical and theoretical processes enriched knowledge contribution and formulation of this non-discipline specific direction. This complementary role played by empirical data and theoretical data assisted in the emergence and development of a distinct theoretical framework and how to use it. This entire process was attuned with its grounded theory (GT) co-process.

3.7.3 TRANSDISCIPLINARITY IS DYNAMIC

(Mode 2; Gibbons et al., 1994)

The ability to predict long in advance how the research process would be executed was not possible, due to dynamism within the process, and yet confidence about the
correctness of the direction was always revived and confirmed by the contextual
theoretical consensus reached. When using a dynamic process such as this one, it
becomes more difficult to predict when theory saturation will be reached. However, when
theory saturation is eventually attained, there is usually more data for analysis, something
which ensures undeniable contribution. For this process to yield valuable insights,
patience is required.

3.8 GROUNDED THEORY, LANGUAGE, CULTURE,
& TECHNOLOGICAL INNOVATION

Against this background on research methodology, the author has decided to use
grounded theory (GT) (see Glaser, 1967). GT explains what is actually happening in real
life and practical life, rather than describing what ought to happen. The author wanted to
use a method that would yield insights about the relationship between language, culture
and technological innovation, in a way that would conclude that something is highly
probable rather than that it is certainly so. While most researchers view GT as a
qualitative approach, it is felt by the author that in this research, triangulation -which is a
mixture of qualitative and quantitative, is a justifiable and appropriate method, especially
for analysis.

Furthermore, GT has been applied here in an adapted manner by not strictly following the
rule of not doing any preliminary literature review. The reason for this adaptation is that
the author wanted to get some direction, about how to approach the first group of
participants or experts. Other requirements of GT, such as allowing theory to develop and emerge along the way have been followed. The sampling method has taken the form called *snowballing* (see Cooper and Schindler, 2001). In this research, while *Snowballing* was taking place, fine-tuning was also taking place. The reason is that, at first experts in the field of innovation and creativity were interviewed using unstructured interviews to facilitate interactive conversation, -and this part is referred to as phase 1. These experts assisted in finding the correct target (fine-tuning) populations for further interviews, and the first group of targets (after the experts) also assisted in finding the second group of targets, and so on. This therefore assisted in focusing the study and finding the core variables, without increasing the range of possible targets, hence the author refers to this process as fine-tuning. As more ground was covered, the sample became focused unlike snowball sampling that “gathers… as it rolls along” (Cooper and Schindler, 2001). Also, the process could not be called a funnel approach, as the narrowing was not necessarily converging towards the centre, but instead it was taking an unpredictable shape, but certainly a much narrower and focused one.

### 3.8.1 THEORETICAL SAMPLING

According to Glaser (2004), “theoretical sampling is the process of data collection for generating theory whereby the analyst jointly collects, codes, and analyses the data and decides what data to collect next and where to find them, in order to develop the theory as it emerges”. In this research, the author has followed exactly this method as suggested by Glaser (2004).
When the preliminary research was done, it was done in order for it to guide the researcher about what to collect next and where to find it, as guided by the suggestions made by the first line of participants or experts from phase 1. The author applied the general principle of qualitative research, which is that one should continue to sample until there is no new information and no new insights being gained any longer, which is what happened in the case of this study.

In general, the following process was followed, in which data analysis is fundamental:

Adapted from: Glaser and Strauss (1967), Glaser (2004), and Rodon & Pastor (2007)

*Figure 3.1, The Process of Building a Grounded Theory (GT)*
3.8.2 WRITING UP

This is the stage of the research process where theory is articulated and everything is put together in preparation for publication. Here established categories are collated, memos are incorporated, relevant linkages are made with the core variable, descriptive sentences are generated, and the general flow and interrelatedness of ideas is formulated and communicated. Conclusions, as well as suggestions about the discovered theory and its contribution to the body of knowledge, are discussed and presented. Presentations and discussions are enhanced by the use of tables and figures to improve readability (Glaser, 1998, 2004).

3.9 PHASE 1: PRELIMINARY INVESTIGATION ON THE VIEWS OF THE EXPERTS

The main purpose of the study was to investigate whether or not language and culture play an influential role on technological innovation and if so what kind of role and to what degree. During phase 1 of the research process, 20 experts in the field of technological innovation, creative design, and engineering management were interviewed to gain insights and opinions about the study. These experts were from countries such as, Germany, India, United Kingdom, United States of America, Sweden, Nigeria and South Africa. They assisted the researcher in terms of finding an appropriate sample of participants as well as in fine-tuning the research framework and methodology for data
collection. Extensive networking was done by the researcher at the conferences, workshops, and seminars attended both nationally and internationally. Attendance at these research events assisted also in terms of improving the research approach.

3.9.1 PRE-RESEARCH LITERATURE REVIEW VERSUS NO PRE-RESEARCH LITERATURE REVIEW

Glaser (2004) states, “A good GT analysis starts off with regular daily data collecting, coding and analysis. The start is not blocked by a pre-conceived problem, a methods chapter or a literature review. The focus and flow is immediately into conceptualization using the constant comparative method.” Further, Glaser states, “the best way to do GT is to just do it”. In the case of this thesis formulation, the author had to interact with experts.

One way to do this was to engage them with ideas at conferences. In order to produce conference papers literature reviews had to be done. Incidentally some of this literature ended up forming part of the literature review of this thesis. The aim of this literature review was not to formulate preconceptions *per se*, rather it was used merely to attract some audience with the purpose of using data emerging from the audience’s experiences for the first round of theory formulation and also in preparation for the second round of data collection.
3.9.2 ‘NO TAPING’ *(no electronic voice recorder-, see Glaser, 2004)*

Experts from various fields of specialization, such as Psychology, Engineering and Technology Management, technological innovation, general innovation and creativity, leadership and creativity, language and communication, and project management, were interviewed. No taping was done during these preliminary semi-structured interviews but field notes were taken. The questions asked were also not highly structured. The result of this exercise proved useful in assisting the author towards designing an improved interview schedule and a questionnaire in preparation for the second phase of interviews.

In GT, it is commonly a deliberation by many practitioners, that taping and transcribing interviews though common in qualitative research, is counterproductive and a waste of time. It is proposed that, instead the researcher should compile field notes and soon after, generate concepts that fit with data and which are relevant and useful in explaining the phenomena under investigation. But in this research, taping and transcribing interviews was done, and on the contrary it proved to be worthwhile for the enrichment of data for analysis.

3.9.3 ‘NO TALK’ *(see Glaser, 2004)*

The author avoided talking a lot about the theory, and kept an open mind on the views that were shared by the participants. A challenge was that most participants wanted to be clear about the subject and purpose of inquiry and therefore insisted on being given upfront explanations about the intended direction of the research. In such cases,
the author shared a few wide-ranging ideas about the broad-spectrum purpose, while
wary of the fact that the participants should not be influenced in any way and also that
they should also not influence the researcher’s ultimate verdict.

3.10 PHASE 2: RESEARCH ON TECHNOLOGICAL INNOVATORS

3.10.1 IDENTIFICATION OF THE KNOWN AND BEST TECHNOLOGICAL INNOVATIONS IN SOUTH AFRICA

During phase 2 of the research process the study was conducted mainly in South Africa’s nine provinces. Twenty-one (i.e. 88%) of the 24 participants were from four major provinces in South Africa namely, Gauteng (Pretoria and Johannesburg), Western Cape, Eastern Cape and KwaZulu Natal. Three (12%) of the 24 were from the United Kingdom, Germany and India, respectively. Face-to-face interviews were used though in some instances telephone interviews were also used. 22% of participants collectively from India, the United Kingdom and Germany were interviewed telephonically. Previously, face-to-face informal interactions had happened between the author and these international participants. More than 70% of the participants were from the following industries: Software Technology Design or Information Communication Technology (ICT), electronic engineering design, and the rest from mechanical manufacturing and design, as well as science, and technology research and development firms, and institutions. Both males and females of various races, age groups, education, beliefs and
societies, and language and cultural backgrounds were used in this study. The analysis chapter provides further information about this diversity.

The South African sample that was used was primarily from a list of South Africa’s Top Technology One Hundred (TT100) individuals and firms as identified by the Department of Science and Technology of South Africa. The researcher carefully chose the participants according to their profile. This profile was based on the diversity of language, culture, gender, education level, geographical location and race. These were the innovation award winners that had been identified through a rigorous process of novelty judgment and testing by appointed innovation experts who were mandated by the South African Department of Science and Technology (DST) in partnership with other innovation institutions in South Africa.

3.10.2 AVOIDANCE OF ANECDOTALISM

This refers to “… research reports that appear to tell entertaining stories or anecdotes but fail to provide an analytical or a methodological framework with which to convince the reader of their scientific credibility” (Silverman, 2006). These stories were avoided in this study.

3.10.3 USE OF EMIC AND ETIC ANALYSES

Both emic and etic analyses were used in the research process on language, culture, and technological innovation concepts, as well as in the analysis of the findings. Silverman
(2006) states, “Emic analysis is a term mainly used by anthropologists to describe culture based on subjects’ own concepts and descriptions”, On the other hand, etic analysis is described as, “a term used mainly by anthropologists to describe concepts and descriptions based on the researcher’s own concepts (as apposed to those of research subjects)” (Silverman, 2006).

3.10.4 ATTENTION TO DIACHRONIC ANALYSIS

During phase 1, the author found that the meaning of words to different people is not something to be overlooked. This further motivated the use of interviews, rather than posted questionnaires, in order to ensure that the participants and the researcher had a similar understanding of the concepts, or at least where necessary share understanding of terms for meaning-making. This was done carefully so as not to contravene the no talk (cf. 3.9.3) concept. This proved to be quite useful, more especially because participants did not have similar backgrounds- linguistically, culturally, and field-wise.

Silverman (2006) states, “Diachronic analysis is a linguistic method concerned with historical changes in language”. This method is related to the concept etymology which “…is the study of historical changes in the meaning of words” (Silverman, 2006).
3.10.5 CONCENTRATING ON THE RICHNESS OF THE STUDY AND NOT ITS LONGITUDINAL ASPECTS

“Ultimately, everything will depend on the quality of your data analysis rather than upon the quality of your data. Just make sure you have the time and the ability” (Silverman, 2006). When the author asked the first line of participants (phase 1 participants), what they thought should be the emphasis of this study, they unanimously, though in different words, highlighted the significance of concentrating on the richness of the study- that is rich and intense data, and subsequent in-depth analysis.

3.10.6 CONSIDERING AS MANY LANGUAGE AND CULTURAL GROUPS WITHIN SOUTH AFRICA AS POSSIBLE

Literature shows in chapter 2, that cultural diversity constitutes one of the critical success factors in the process of innovation (Adler, 1983a; and Miroshnik, 2002). Similarly, language plays a critical role as it is deemed an integral part of culture as demonstrated in chapter 2. “Language is probably the most difficult cultural element that a global manager must study, because it is more than the ability to speak a foreign language, but also the competency to recognize idiomatic interpretations” (Herskovits, 1989). Consideration of participants from various backgrounds proved to be useful as it assisted in also identifying participant’s from different racial groups as well. However, the
African language group was limited to the Nguni language group as there were no other African language groups identified from the selected sample.

3.10.7 TAKING GENDER FACTORS INTO CONSIDERATION

Phase 1 participants referred to the importance of paying attention to gender issues with regard to technological innovation due to historical reasons, religious beliefs and other cultural practices that contributed toward various gender biases (see also Hofstede, 2003). Research on phase 2 participants confirmed that gender issues were part of the determinants with regard to the participation or lack of participation in technological innovation. It must be mentioned that from the list of top technology innovators (during the year 2006), women innovators were fewer, and the author made sure to involve all of them in the research in an attempt to strike a balance.

3.11 DATA COLLECTION METHODS

Glaser (1998) on Grounded Theory (GT):

Data collection was mainly field-based, flexible, and adapted during the course of the research. Though interviews (telephonic and face-to-face) and questionnaires typically played a major role in data collection, other forms namely; documents, historical records, observations and any other sources that seemed to be of relevance, were also used. All the interviews were conducted by the researcher. English was the main language used during data collection, though for clarity sometimes the IsiXhosa and IsiZulu languages
were used with those who speak and understand these languages. Transcriptions were
done by the author (researcher) who was also the interviewer, usually on the same day of
the interview.

GT discourages the use of literature review in doing research, though in this study this
practice was not strictly adhered to. GT practitioners feel that literature reviews create
preconceptions which are not good when doing field work, as the theory must necessarily
emerge from (or be grounded in) collected data.

3.11.1 ‘ALL IS DATA’

According to Glaser (1998), “All is data is a fundamental property of GT which means
that everything that gets in the researcher’s way when studying a certain area is data…”.

The dynamic nature of problem solving or, “problem solving on the move” (Gibbons et
al., 1994) attests to the idea that all is data. In addition, Gibbons et al. (1994) state, “a
particular solution can become the cognitive site from which further advances can be
made, but as to where this knowledge will be used next and how it will develop is
difficult to predict”.

Participants were selected from developed and developing countries which are largely
distinctly cultural and in which indigenous knowledge is mainly used. Case studies in
Germany for a developed country and in India for a developing country were used. Apart
from the fact that these countries largely have rich indigenous cultures and languages,
they also are evidently technologically innovative in their own rights. Data emerging from these countries was then compared with four language and culture groups in South Africa, namely English, Afrikaans, Zulu, and Xhosa.

### 3.12 DATA ANALYSIS STRATEGIES

The process of data analysis was mainly guided by the following concepts as described by both Silverman (2006) and Strauss and Corbin (1990), and Glaser (2004):

#### 3.12.1 CONTENT ANALYSIS

According to Silverman (2006), the concept of content analysis “involves establishing categories, and systemic linkages between them, and then counting the number of instances when those categories are used in a particular item of text”. This method proved to be quite useful.

#### 3.12.2 OPEN, AXIAL, AND SELECTIVE CODING (Glaser, 2004)

The author examined collected data line by line and in the process created labels and generated categories. Data was disintegrated by asking questions such as, what does this mean, when does it happen, who does it, and how does it happen? After comparing and finding similar incidents, data with similar incidents was then grouped together to form categories. This process essentially constituted what is known as open coding. Glaser
(2004) states, “Open coding allows the analyst to see the direction in which to take the study by theoretical sampling before he/she has become selective and focused on a particular problem”. Again according to Glaser (2004), “The process begins with line-by-line open coding of the data to identify substantive codes emergent within the data”.

The process of linking categories with their sub-categories to generate main categories is referred to as axial coding. Nudi*st software was useful in this process, as the researcher was dealing with large amounts of data. Development of a theory became the next step and it was done by using selective coding.


Subsequent to conducting selective coding, momentum builds up as the analyst by now has delimited the study. Development of a theory is then realized, by using the constant comparative method and field notes or memos. Glaser and Strauss (1967), explain the constant comparative method by highlighting four stages, namely; “(1) comparing incidents applicable to each category, (2) integrating categories and their properties, (3) delimiting the theory, and (4) writing the theory. Glaser (2004) states, “Selective coding means to cease open coding and to delimit coding to only those variables that relate to the core variable in sufficiently significant ways as to produce a parsimonious theory. Selective coding begins only after the analyst is sure that he/she has discovered the core variable”.

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3.13 METHODS FOR ACHIEVING VALIDITY

The process of achieving validity was guided by content validity (Melville and Goddard, 1996). Melville and Goddard (1996) explain *content validity* by stating that if there is no existing related instrument expert opinion on each question must be used to verify whether or not each question tests what it is supposed to test. Expert opinions were used, as explained in Chapter 1, by constantly contacting the experts who were interviewed during phase 1 to determine whether the questions were actually testing what was intended. This non-linear feedback and feed-forward approach assisted in terms of refining and redefining the research process.

3.14 DESIGN AND JUSTIFICATION FOR QUESTIONS

3.14.1 SECTION 1: PARTICIPANTS’ PROFILE *(refer to questionnaire in appendix)*

Literature is coherent about the importance of the background of an innovator so that to some extent one can categorise innovators. (Sopazi and Andrew, 2008) state that anthropologists, in cultural anthropology, study society and culture based on two perspectives which are ethnography and ethnology and that cultural diversity needs to appropriately managed in order to derive benefits. It is considered important to know about the profile of a participant and particularly so, because of the transdisciplinary nature of this enquiry.
3.14.2 SECTION 2: OPINIONS AND EXPERIENCES

Research questions under section 2 were motivated by the following authors and literature review (cf. 2.3.1 in Chapter 2):

QUESTIONS 11B & 11C
(Refer to questionnaire in appendix)

With regard to questions 11B and 11C, many researchers agree that organizational culture plays a significant role in determining the degree to which creativity and innovation are promoted and stimulated in an organization. The following is a list of the ones referred to:


Having read through the works of the researchers listed above, the focus of this study had to be more on home or indigenous culture and less on organizational culture. Another important aspect of this research is its focus on the interplay between not just culture and innovation but between language, culture and technological innovation,

Chapter 2 (cf. 2.3.1) outlines in detail information about what these researchers have written.
QUESTIONS 11E- 11J
(Refer to questionnaire in appendix)

Narayanan (2001) identifies three major implications for the management of technology, and these are:

- Innovation imitation (by competitors – supply side), and adoption (by consumers – demand side);
- The role of technology and market factors; and
- The centrality of learning.

Narayanan (2001) views innovation as both the process; -process by which individuals or organizations arrive at a solution-, and the output ;– product or service, and further provides the following four classifications of innovation: incremental innovations; modular innovations; architectural innovations; and radical innovations.

Weiss and Dale (1998) have the view that the attributes of technological innovation can be fused into two core constructs:

- Relative performance advantage – the extent to which the technology can perform better than what it replaces.
• Operational novelty – the extent to which the potential user has to learn new skills.

**Incremental and Radical innovations; Architectural and Modular innovations**

Explanations from various sources about incremental and radical innovations generally resonate, hence it is deemed sufficient to quote from one source. Incremental innovations refer to “minor improvements or changes of an existing product or organizational technologies and practices”. On the other hand radical innovations “represent revolutionary changes that require clear departures from existing organizational practices and technologies” (Narayanan, 2001). Narayanan (2001) also explains that architectural innovations “…use existing organizational practices and technologies but reconfigure them in new or different ways”, whereas modular innovations “…refer to significant changes in elements of products, organizational practices, and technologies without significant changes to the existing configuration of the elements”.

Regarding the relationship between thought and language in the context of invention and innovation (cf. subsection 2.2.4 in Chapter 2), questions 11D, 11H and 11I (see appendix C) were asked during the interviews. The main aim was to further understand the relationship between thought and language according to the views of participants. It is stated in chapter 2 (subsection 2.2.4) that Gross (2001) asserts that there are many examples pointing to the fact that thought can occur without language. In the same exposition Goss (2001) argues that language represents a central feature of culture. In other words language shapes culture and it is also shaped by culture.
Another important argument is the one made by Man (2001). Man (2001) argues that language is crucial to opening the side of the brain that triggers innovative inquiries (see also in subsection 2.2.4). In designing the questionnaire these arguments were taken into account. The participants were also afforded the opportunity to provide more explanations if they chose the option ‘other’ instead of the given options from which to choose in the questionnaire.

It was also stated in Chapter 2 (subsection 2.2.4) that Rowe (1986) identified the reasons for failure to transform inventions into innovations. Among the reasons identified by Rowe (1986) is the inability to link university research with industrial innovation. A comparative study between Germany and India in Chapter 4 (sub-section 4.6.1) also highlights the importance for collaboration between industry and public institutions.

On the issue of the need for collaboration between industry and public institutions, Herstatt et al. (2008) indicate that in India the situation of good links between industry and academia would help by providing the needed support for innovation. According to Herstatt et al. (2008) this lack of good links between industry and academia results in a more academic orientation. This means that the focus of government funded educational institutions is more on research publications rather than on cooperation with industry. Another failure that is highlighted by Rowe (1986) is the fact that managers give low status to engineers.
Finally, Rowe (1986) further argues that management is hostile, suspicious, ignorant as well as indifferent towards technological innovation. Furthermore, on the issue of failure to transform invention into innovations, Damanpour and Euan (1984) argue that innovation is a practice that differs from invention because of its readiness for use by the masses and that its novelty differentiates it with other practices.

In order to explore the reasons for failure to transform inventions into innovations questions under ‘your opinions and experiences’ sections in the questionnaire were asked. These are questions 2, 3, 4, 5, 6 and 7. These questions are formulated in such a way that regardless of the understanding of the participant about the difference between an invention and innovation there would still be a response which will fall into one of the identified categories in this study. Question 11 of the questionnaire would also yield insights into the participant’s understanding of the terms.

3.14.3 SECTION 3: PARTICIPANTS’ OWN ASSESSMENT OF THE ROLE PLAYED BY LANGUAGE AND CULTURE IN INNOVATION

In this section, the researcher provides the participants with the opportunity to evaluate and provide their own assessment of the role played by language and culture in innovation. The participant’s own assessment will then be compared with the researcher’s own findings and assessment.
The author understands, as can be seen in discussion in Chapter 7 (see subsection 7.6) about the limitations of this study and possible future research, that technological innovation is a complex and a multi-dimensional process. This implies that it technological innovation is a product of many sub-processes which are not easy to observe in action.

The researcher will then attempt to identify, assess and comment on the disparities or similarities.

**OWN ASSESSMENT**

A. Does *language* play a role in innovation?  

B. Does *culture* play a role in innovation?  

Do you have any other comments on this study? If yes, please write them below:
3.15 CONCLUDING REMARKS

Triangulation is used in the data analysis. This combination of a qualitative and quantitative approach assisted with regard to identifying core variables that emerge from data and which relate to language and culture.

Most of the participants during phase 1 believe that richness of data collection and analysis would be a good contribution in itself. They declared that this belief is based on their experiences.

Their experiences made them realize that the issue of innovation is a matter of luck and continuous trial and error, and that it is also highly situational. They further argue that it is not possible to find a person or organization that is always and consistently innovative, but that rather various situations (for example; wars, political changes and other survival needs) have given rise to innovations.

Therefore, if one can analyze these situations deeply and be able to link them with language and culture that would be a valuable contribution. Furthermore, they believed this study could be conducted within the South African context with as many cultures and people as possible, and then also compared to two case studies from abroad.

Chapter 3 dealt with the methodological process as well as the framework for identifying participants, data to be collected, collection of data, data to be analyzed, data analysis,
drawing of conclusions, and presentation of findings. Chapter 4 is hereafter going to deal with case studies that have also contributed to the formulation a theory in this research.
CHAPTER 4

NATIONAL INNOVATION SYSTEM (NIS) AND INFORMATION COMMUNICATION TECHNOLOGY (ICT) INNOVATION SYSTEMS

GERMANY, INDIA AND SOUTH AFRICA - CASE STUDIES

4.1 INTRODUCTION AND BACKGROUND

This chapter discusses technological innovation data on two cases, namely; India—a developing country, and Germany—a developed country. The South African case for a developing country (Baskaran and Muchie, 2006) is also briefly discussed in the context of information communication technology (ICT) as it is the place where this study was predominately conducted. In this chapter the author conducts a comparative study of technological innovation in these countries. This comparative study is conducted by examining culture and language data. A comparative analysis on post war Germany and post colonial India is conducted in the light of reviewed literature, in relation to technological innovation and research methodologies as applied in these countries.

When the research for this thesis was conducted, the author observed that 68 percent (17 out of 25) of the South African participants and their firms were mostly involved in Information and Communication Technology (ICT) innovations. The rest of the participants were involved in mechanical engineering, marketing of technologies and the medical field. Specifically what was observed is that within ICT, most industries are involved in software development innovations rather than hardware and this has
been found to be the case in India (Chandrasekhar, 2000) and Germany (ITU, 2006), as well. In addition this prompted the author to also consider ICT developments and policies of the studied cases. Here, the broader context of ICT definition has been employed, namely, Information Technology (IT) and telecommunication (Telecoms) - both hardware and software. Carter (1993) states, “Information Technology is the use of technology to perform…information processing tasks”. Further, Carter (1993) concludes that, “Computer systems, telecommunications systems, audio, video systems, and modern control systems are all part of IT”. According to Carter (1993), “The IT revolution is founded on the microprocessor, which can be used for storing and processing information. Today, microprocessors are used to control every type of appliance and industrial process, and they lie at the heart of modern computers”. This may also explain why the majority of technology innovations are in the ICT discipline.

4.1.1 Motivation for Choosing Germany and India as Case Studies:

- Germany and India share a common business language- which is English. This statement is supported by the participants of this study who are independently of German and Indian origins, as well as by Paelmke & Erwee (2007). Referring to Germany, Paelmke & Erwee (2007) state, “…the extensive use of English in business, as well as in various societal contexts, is increasingly emerging as a discriminating issue for older and non-professional employees”.
- One is a developing country (India) and the other is a developed country (Germany). As South Africa consists of better developed and less developed
parts within the same country, lessons from both a developed and a developing country are considered to be relevant by the author.

- Both Germany and India show evidence of technological innovation activity as indicated in the literature that is subsequently discussed (see also 4.3.1 and 4.3.2).
- Both Germany and India have rich indigenous languages and cultures, despite their respective post-war and post-colonial positions. This statement is supported by both Germans and Indians living in these countries who were interviewed by the author as part of the group of experts in phase 1 of the interview process.

Lessons learned in these countries are discussed by drawing from the work done by other researchers with the aim to corroborate arguments articulated by the author. Emphasis is on the developments of the present decade (2000-2009). These lessons contributed positively towards the development of the research approach used in this thesis.

### 4.2 GEOGRAPHIC, ECONOMIC AND SOCIETAL METRICS

Table 4.1 provides some demographic data for the Indian and the German cases that have been used in this study. The demographic data is given here for ease of reference, so that when the individual cases are presented and discussed the reader will have a relative idea of some demographic factors for these countries. According to the South African Department of Land Affairs (1996) and South Africa Year Book (2008 and 2009), South Africa has a surface area which is 1,219,090 km². On the other hand, India has about 3,287,263 km² (wikipedia.org/wiki/Geography_of_India).
2 March 2012; Indian Economic Survey, 2002 -2003 and Indian Chamber of Commerce and Industry, 2003) and Germany about 357, 023 km² (Statistisches Jahrbuch, 2003 or Statistical Year Book, 2003). Further information on demographic factors in Germany and in India is provided in table 4.1.

Table 4.1 Geographic, economic & societal metrics of Germany & India

<table>
<thead>
<tr>
<th>Demographic Factors</th>
<th>India</th>
<th>Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geographic Area (km²)</td>
<td>3 287, 263</td>
<td>357,023</td>
</tr>
<tr>
<td>Total Population (Million)</td>
<td>1027</td>
<td>82.4</td>
</tr>
<tr>
<td>Working Population (Million)</td>
<td>363.75</td>
<td>40.6</td>
</tr>
<tr>
<td>Unemployment Rate (%) *</td>
<td>7.32</td>
<td>4.1</td>
</tr>
<tr>
<td>Rate of literacy (%) *</td>
<td>65.4</td>
<td>94.7</td>
</tr>
<tr>
<td>Gross Domestic Product (Bill. Euro)</td>
<td>528.6</td>
<td>2108.2</td>
</tr>
<tr>
<td>Per Capita Income (Euro)</td>
<td>487</td>
<td>25500</td>
</tr>
<tr>
<td>Economic Growth (%)</td>
<td>5.6</td>
<td>0.2</td>
</tr>
<tr>
<td>Exports (Bill. Euro)</td>
<td>48.2</td>
<td>648.3</td>
</tr>
<tr>
<td>F D I – inflow (Bill. Euro)</td>
<td>4.2</td>
<td>44.5</td>
</tr>
<tr>
<td>National Language</td>
<td>15+</td>
<td>1</td>
</tr>
<tr>
<td>Religion</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

Adapted from: Paelmke (2007) and Paelmke and Erwee (2007).

*Based on the year: 2000.

Other sources: Indian Economic Survey 2002-2003; Statistisches Jahrbuch 2003; Federation of Indian Chambers of Commerce and Industry 2003
4.3 NATIONAL SYSTEMS OF INNOVATION IN GERMANY AND INDIA

The concept of national systems of innovation or national innovation systems (NISs) is not new as it has been used by different researchers from as far back as 1856, by Friedrich List. Baskaran and Muchie (2006) state that according to Freeman (1995), “List (1856) and his concept of ‘national production system’ may be seen as the historical origin of the national system of innovation”.

Similarly, Joseph (2005) states, “While the historical roots to the concept innovation system could be traced back to the work of List (1841), the modern version of this concept was introduced by Lundvall (1985) in a booklet on user-producer interaction and product innovation”. Elsewhere, Joseph (2005) further states, “Freeman (1987), while analyzing the economic performance of Japan, brought the concept to an international audience. Since then there has been burgeoning literature (Lundvall 1992, Nelson 1993, Freeman 1995, Edquist 1997 to list a few earlier works), focusing on different dimensions of innovation system”. The statement by Joseph (2005) is corroborated by Baskaran and Muchie (2006) when they affirm that according to Bengt-Åke Lundvall, the modern version of the concept of NIS first appeared in an unpublished contribution by Freeman (1982) and that “some years later Lundvall (1985) used the concept in formulating the importance for innovation of the concept of producer-user interaction and feedback for learning”.

Following the research on the concept of NIS, according to the author, the definition that is contextually relevant in this thesis, and which also appropriately summarizes definitions by other researchers, is the one in which Metcalfe (1995) states,
“…that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which Governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefact which define new technologies”.

Following, is a discussion on national innovation systems (NISs) in Germany and India and ICT innovation systems for Germany, India as well as South Africa. When discussing the case of South Africa, emphasis is on ICT rather than general innovation systems, owing to the fact that the author observed ICT to be the focal area for technological innovation in South Africa, as will further be demonstrated in subsequent chapters (Chapters 5 and 6).
4.3.1 Innovation System of Germany

“Germans are too specialized...which makes them very good at doing things in their own domain of specialization but it also makes them more inflexible” (Herstatt et al, 2008).

Adapted from: Frietsch and Kroll, 2008

Figure 4.1, A Simplified German Innovation System

Fundamentally, the NIS in Germany is primarily driven by the role players indicated in Figure 4.1, according to Frietsch and Kroll (2008). These three main role players, namely; (i) Political & Administration, (ii) Intermediaries, (iii) Industrial System and Research & Education System, work together to achieve technological development in Germany. The intermediaries act as bridges for the ministries to support co-operations between industrial systems on one hand, and research and education systems on the other (see Cuhls and Wieczorek, 2008).
Research conducted by Trompenaars and Hampden-Turner (1993) indicates, that the German industrial culture is hierarchical and highly task oriented. According to Paelmke and Erwee (2007), “German organisations operate in relatively stable and low risk conditions and German society is classified as more individualistic than Indian culture”. These authors also indicate that German and Indian managers have different perceptions about the impacts of language diversity. However, the author could not find research that explains evidently, the nature and extent of the impact of language and culture, on technological innovation.

The author found that emphasis is placed on general diversity issues rather than specifically on language and culture. Paelmke and Erwee (2007) state, “… majority of the Indian managers clearly negate language based productivity problems, [while] only half of the Germans managers do so”. Again, the context for this statement does not exactly correlate with the one the author is focusing on, but rather on understanding instructions. “Instructions are often misconstrued due to the fact that there are many migrant workers, who are both linguistically and culturally different, working in Germany” (Paelmke and Erwee, 2007).

It is stated by Herstatt et al. (2008) that most of the developed economies are now involved in innovation offshoring. The United States is one of the leading economies in the field of innovation offshoring. The concept of innovation offshoring seems to be motivated by factors such as, lack of skilled labour and some legal restrictions (see Herstatt et al., 2008). Based on this offshoring practice, the author posits that use of a common language when communicating with people from places outside one’s
environment would be advantageous. Herstatt et al. (2008), using data from the research by DIHK (2005), state, “In the case of Germany, one third of all firms are reportedly engaged in R&D activities outside of the home base”. In the same report by Herstatt et al. (2008) it is stated, “The stock of foreign direct investments (FDI) in R&D foreign affiliates by German firms increased [to] over 2000% between 1995 and 2003 from a mere USD 43.2 million to an accumulated USD 891.4 million, according to a United Nations Conference on Trade and Development report based on the Bundesbank data (UNCTAD, 2005c)”. This discussion clearly shows that the focus is on “R&D activities taking place outside of the home base” Herstatt et al. (2008), rather than on the internal language-culture dynamics in technological innovation.
4.3.2 Innovation System of India

“Indians are good in technical and handyman work- even better than Chinese...The Chinese are however better in mass production” (Herstatt et al., 2008).

Figure 4.2, Three Major Features of Indian National Innovation System

Research according to Baskaran and Muchie (2008) illustrates that in India, after colonization, the innovation system was inward looking. India concentrated on promoting indigenous knowledge and trying to meet domestic demands (see Figure 4.3.1). Herstatt et al. (2008) state, “After years of self-imposed seclusion, principally
motivated by post-colonial India’s insistence on the ‘development of indigenous technology’, India finally seems to have joined the global mainstream of innovation”.

Furthermore, Worgat (2008) states, “Until the end of the 1980s, the Indian government was restrictive to inward FDI flows, based on the idea of technological self-sufficiency, and imports of foreign technology embodied in capital goods were only admitted if the country needed those goods and could not produce them itself”.

Recently, India is outward-looking and increasingly becoming one of the major destinations for export performance and innovation offshore opportunities (Baskaran & Muchie, 2006; and Herstatt et al., 2008). This recent development is attributed to the “availability of skilled labor and produced in world-class elite institutions”, (Herstatt et al., 2008). This change from restrictive, towards more open policies has brought about remarkable positive benefits for India towards its technological development (Wogart, 2008). It is argued that while the restrictive ‘inward –looking’ policies were in place in India, technological development was minimal (Wogart, 2008) and that “Immediate goals, such as reduction in collaboration and fees were accomplished” (Wogart, 2008) but “they were not successful in achieving their most important aim, namely a significant increase in technological generation by the firms”(Alam, 1988).
4.4 ICT INNOVATION SYSTEMS

ICT policy is innovation Policy (ITU, 2006)

4.4.1 The Case of Germany

The German ICT market is reported to be critical to technological development and doing relatively well. According to the ITU (2006) report on the German ICT market, the “ICT industry is one of German’s most important industries, employing around 750,000 people generating revenue of EUR 134 billion and accounting for exports worth more than EUR 50 billion”. In the same report it is stated that Germany enjoys a strong position in many technological areas including application software, software engineering, security cards and chip-card technologies. Furthermore, in this report it is mentioned that “while in 1994, ICT [in Germany] contributed only 4.7 percent to the GDP, this figure amounted to 6.8 percent in 2004” and that “As far as gross value is concerned, ICT with its EUR 87 billion has surpassed mechanical engineering and the automobile industry and now occupies the top rank”. This trend, according to the report, is expected to continue in the future “since the ICT sector is clearly growing more strongly than the economy as a whole, and thus remains the driving force for business activities”.

While it is acknowledged that ICT innovation is doing relatively well in Germany, it is however stated by ITU (2006) that, “Sufficient use has not yet been made of the potential offered by the ICT market for growth and prosperity in Germany”. This success story of the German ICT industry is attributed to Germany’s National
Innovation System (NIS) policies that take into account what is discussed on literature and methodology in section 4.6.

4.4.2 The Case of India

The statement, “ICT policy is innovation Policy” (ITU, 2006) seems true for India. In India NIS policy directly affects ICT policy and in turn ICT policy directly affects NIS policy. It can be argued that these two policies are not only inseparable but that one is shaped by the other and therefore at a glance they are one and the same. Literature on ICT policy and innovation in India highlights the need for ‘industry-academia’ collaboration or what other researchers refer to, as ‘linkages between industry and R&D performing institutions’ (cf. 4.6.1).

While it is acknowledged that in India there are success stories in the area of ICT development and policies, it is also still argued that “India’s innovation performance is still very modest” (Stahlecker, Wogart and Mangelsdorf, 2008; see also Baskaran and Muchie, 2006). As was discussed with regard to NIS, it is noted that India’s ICT innovation practice has had a gradual progression from being a closed state-controlled industry towards being a more liberal and outward-looking practice, thereby promoting competition.

Both German and Indian ICT innovation policies do not seem to have paid attention to language and cultural factors, except for what has been mentioned with regard to their respective NIS policies. The focus of this comparative study is not on ICT per se, but rather on how ICT policies impact on language and cultural factors.
Consequently, the author does not wish to elaborate further on the ICT sectors for Germany and India.

Due to the observed trend among South African companies, whose staff members were interviewed by the author, and whose technological innovations are mainly in ICT (68%), the South African ICT innovation policy has been included in this chapter and is dealt with next.

### 4.4.3 The Case of South Africa

![ICT Innovation System in South Africa](image)

Adapted from: Baskaran and Muchie (2006)

**Figure 4.3, ICT Innovation System in South Africa**
Figure 4.3, shows the ICT innovation system in South Africa. This figure indicates that the South African Government and its agencies have identified policies, goals, objectives and institutions for ICT innovation. From this figure, it is clear that work is being done to promote, support and develop ICT innovation in South Africa. This vigorous attempt to promote ICT innovation in South Africa, may have contributed to the significant number of interviewed technological innovators who operate in this sector. The National ICT Policy Framework in South Africa caters for both private and public sector innovation as can be seen from figure 4.3.

As already mentioned in the introduction and background (cf. 4.1), the author observed that most of the participants in this research operate in the ICT sector. In South Africa, Telecommunication and Information Technology rank highly economically according to the Department of Trade and Industry (2004). This high ranking may partly be due to the fact that the “Department of Trade and Industry has been actively promoting the ICT and electronics sectors” Baskaran & Muchie (2006), as well as due to the comprehensiveness and appropriateness of the ICT innovation policy as shown in figure 4.3.

South Africa is a country with two different economies known as the first economy - which is similar to an economy of a developed country and the second economy – which is less developed (see figure 4.4 on the next page). For this reason, according to researchers and policy makers, South Africa needs an innovation system that reduces the disparities in economy and also bridge the digital divide (see Baskaran and Muchie, 2006). It would seem that in South Africa there is more potential for technological innovation in ICT than what is currently being realized, and that dealing with the disparities that exist would unleash it. The level of education, business
language skills, business and technological innovation culture are elements of innovation that are also unevenly distributed due to these disparities. Most of what happens with regard to technological innovation in South Africa is driven by members of the first economy and the second economy participants are merely recipients.

Figure 4.4, Potential Role of ICT in Lopsided or Uneven National Innovation System in South Africa

The purpose of this research, however, is not to provide an in-depth discussion on the developments in this sector, but to highlight what has been done in order to contribute
towards the creation of an enabling environment for innovators, as well examine whether language and cultural factors have played any role. According to the South African Department of Education (2003), the policy-makers have identified critical elements necessary for determining the impact of ICT on socio-economic development in South Africa. These are:

(i) “cost effectiveness of technology and solutions in order to benefit rural areas;

(ii) sustainability of the technology and,

(iii) capacity building & support mechanisms for efficient utilization of ICT.”

The following sub-section (4.5) briefly discusses salient features present in Germany and India with respect to language and cultural in relation to technological innovation.

4.5 SOME LANGUAGE AND CULTURAL ASPECTS IN RELATION TO TECHNOLOGICAL INNOVATION

According to Dwivedi (2002) and DeNisi & Griffin (2006), although there are more than fifteen official languages in India with different scripts and sounds, Indians do not find it hard to communicate with others at the workplace. On the other hand, in Germany the situation is different, in that “instructions are misconstrued and dissemination of job related information poses problems for supervisors and managers”, Paelmke and Erwee (2007). Furthermore, on the question of culture, Paelmke and Erwee (2007), with reference to the research by Hofstede (1991) and Trompenaars & Hampden-Turner (1993) state, “Indian culture seems to be more traditional than the German culture”. From this discussion it would seem that Indians experience fewer language barriers within India and with English speaking countries.
outside of India, despite having more official languages, compared to Germany. On the other hand Germans do not seem to have such language flexibility.

Studied literature indicates that although Germans are confident and proud to use their own language in technological innovations, when they do business and research with other countries, English is predominantly their language of choice (Paelmke and Erwee, 2007). Although Germany has different language dialects, the German society uses one common language (see Paelmke and Erwee, 2007).

Similarly, Indian participants and phase one participants in this study stated that in India, the Indians may speak indigenous languages such as Hindi among themselves, but they ensure that they can communicate effectively in English for business dealings with foreigners. Referring to India, Paelmke & Erwee (2007) state, “Although two languages, Hindi and English, are used for official communication, about 2150 newspapers in 92 languages (Gopinath, 1998) illustrate the complexity of the Indian linguistic landscape”. South Africa, is not different from India and Germany in terms of language use with regard to business language. According to South Africa Year Book (2008-2009), although in South Africa, the “Constitution recognises 11 official languages” and “English is the mother tongue of only 8.2 % of the population, it (English) is the language most widely understood, and the second language of the majority of South Africans”. Clarification in brackets is by the author.

With regard to culture, Germans seem to have a less traditional and open culture, which is something regarded as important and advantageous for continued technological development. In addition the Indian culture, compared to the German
culture, is more traditional (see Hofstede, 1991; and Trompenaars & Hampden-Turner, 1993).

4.6 SUMMARY OF NIS LITERATURE AND METHODOLOGY BASED ON GERMANY AND INDIA CASE STUDIES

Literature on NIS policies and methodological processes applied in the process of improving technological development elucidated what the author has summarized with the depiction in figure 4.5. In figure 4.5 it is shown that both Germany and India view the importance of supporting and ensuring that there is collaboration among the critical stakeholders as imperative for success in technological innovation and development processes.

Figure 4.5, A Pictorial Summary of NIS in Germany and India

The Role of Language and Culture in Technological Innovation
These stakeholders have been identified to be; big industries and small firms, public and private research institutions, as well as government and private institutions. In the process of collaboration, government funding and private funding become paramount. The subsequent sub-sections highlight some of what the literature elucidates as well as discussion supporting the articulation and arguments advanced in the current subsection (4.6).

4.6.1 Technology Transfer Culture of Collaboration between Industry and Public Research Institutions

The German and Indian studies indicate that it is important for collaboration to exist between public research institutions and industry. This model has had positive contributions towards technological development in Germany. In India, in the recent years, there seems to be a growing awareness of the potential benefits that exist in this kind of collaboration, but in terms of the implementation of this model, India lags behind Germany. According to ITU (2006) the Federal Government in Germany “wants to continue developing the new research program IT 2010, together with the science and business sectors”. In the same research article by ITU (2006) on Germany, it is stated, “The Federal Government will continue its positive partnership with companies, associations and other social groups to pursue and intensify the implementation of these political goals”. From this report it is clearly stated that the research results from the research tasks will be implemented “in products and services” and that there will be public funding of R&D.

In the research by Herstatt et al. (2008), it is stated, “Good links between industry and academia support innovation. In [the] case of India the situation is not optimal”. 

The Role of Language and Culture in Technological Innovation
Herstatt et al. (2008), further state, “...lack of innovation or hubs, linking the industry, services, researchers and academics is a major constraint in India”. This limited interaction in India between research organizations and industry is also highlighted by Bhattacharya and Arora (2007). Among the beliefs held about this feeble research and industry link is the argument that in India, “Government funded educational and research institutions are ‘focused on publications’” Herstatt, et al., (2008). The result of this is a more academic orientation than cooperation with industry. Elsewhere, Baskaran and Muchie (2006) state, “Although such arguments may sound too negative, Indian ICT industry certainly suffers from a number of weaknesses such as uneven growth, imbalances between different sectors, weak linkages between the industry and R&D performing institutions such as universities...”.

In conclusion, Karnik (2005) states, “One of the failings of the Indian knowledge ecosystem has been the lack of industry-academia collaboration”. Furthermore, Stahlecker, Wogart and Mangelsdorf (2008) remark that, the curricula of many institutions in India, “…are too rigid and theoretical, reflecting the lack of interaction between the majority of educational institutions and industry”. Germany on the other hand seems to be doing better than India in the area ‘industry-academia’ collaboration through a group of institutes called the An-institutes (Frietsch and Kroll, 2008).

4.6.2 Importance of Funding for the Promotion of Technological Innovation Culture

Both in Germany and India efforts are being made to promote and support technological innovation by allocating funds for technological development. Major scientific agencies in both countries allocate funds for R&D activities, but the share,
funding application processes, and registration process for new companies still need improvement. According to Stahlecker et al. (2008) in India, “research in Science and Technology has been government-led. Two thirds of the gross domestic expenditure on R&D (GERD) are directly funded by central government, with an additional 9% coming from the state governments and 5% being funded by higher education sector. Only 20% are financed by private sector”.

In Germany, according to Frietsch and Kroll (2008), “…after the contact has been made, the company is frequently still confronted with a single-stage application process, that requires a comparatively high input of resources, before the application has even been preliminary assessed”. Furthermore, it is argued that SMEs “often do not have a chance in the research and development field compared with large companies and concerns, as they generally cannot be sure that their investments costs will be covered and at the same time that other parties can be successfully prevented from utilizing the research results” (Frietsch and Kroll, 2008).

As has already been mentioned at the beginning of this discussion on funding, efforts with regard to supporting and promoting funding are being made and need continuous improvement. However, as has also been discussed (cf.4.6.1), the involvement of government agencies in promoting innovation, and with support in terms of funding being in place, there is still the need to translate research findings into tangible outputs. The outputs need not only be in terms of publications, but also in terms of developing new products, processes and technologies in general.
From the discussion in 4.6.1 it would seem that the industry-academia linkages need to be promoted in order to achieve these technological innovation and development outputs. Finally, a summary of these pillars for success in technological development, according to the findings of this comparative study, is provided and illustrated by the author in figure 4.5.

4.7 CHAPTER CONCLUSION

The author’s conclusion is that in India and in Germany, the subject of culture and language on technological innovation is discussed briefly without seeking coherent empirical data to either dismiss it as a major factor, or determine how it influences the process of technological innovation (cf. 4.3.1 and 4.3.2). Language and culture issues are simply regarded as soft factors. While this is the case, when discussing radical innovation (cf. 2.2.3 and also see Rogers, 1995; for more information on radical innovation) across nations, Tellis, Prabhu, and Chandy (2008) state, “As with labor and capital, culture can operate at both the national and firm level”. A country’s religion and the values of its citizens, according to the longitudinal research by Hofstede (2003) on national culture, may drive innovation. According to the discussion in this chapter it can also be concluded that a culture of openness (outward-looking) rather than a closed one (inward-looking) does not only foster FDI inflows and outflows, but also drives innovation and technological development. Flexible or universally applicable language skills have also been highlighted as the essential constituent for interactions and common understanding during the innovation process.

The author also concludes that presently in India and in Germany, there seems to be considerable focus on ICT, and thereby relatively sufficient data in this area, as well
as in general technological innovation. This is more so, than on technological innovation with emphasis on language, and cultural, - as well as cross-cultural, factors. This view is supported by Paelmke and Erwee (2007), in their research on diversity management in German and Indian manufacturing companies where it is stated, “…cross-cultural research studies involving German and Indian organisations are rare …”. The author has however discussed pertinent data on ICT innovation and NIS in general. This data will be compared with the findings, and in its light, this study’s conclusion will be examined and compared. The author concludes that this comparative study provides some insight into a technologically-active, developing economy and technologically-active, developed economy, both of which have had, and continue to have, lessons to learn in the process of technological development.

Government policies in South Africa are also gradually improving and favouring the participants in this field as can be seen in the National ICT Framework in South Africa. However, the author did not come across any specific efforts made or attention given, with regard to the language and cultural factors on technological innovation in South Africa.

As South Africa has good trade relations with both India and Germany, there is an opportunity for these countries to share learning in the processes of technological innovation and development. According to South Africa Year Book (2008-2009), “Germany has been South Africa’s largest source of imports, showing annual growth of 18.5% between 2007 and 2008. Similarly it is reported that, “India is a key partner for South Africa in South Asia, and total trade has been increasing rapidly since 1994” (South Africa Year Book ,2008-2009). The next chapter (Chapter 5) deals with
the analysis and presentation of first hand data that was collected by the author during the interviews. This data presents information that serves as the basis for the ultimate conclusion drawn at the end of this thesis. What emerges in the next chapter is viewed in the context of what has been discussed in the previous chapters. The aim is to reach carefully considered conclusions without losing sight of the relevant findings by other researchers.
CHAPTER 5

PRESENTATION AND ANALYSIS OF PRIMARY DATA

5.1 INTRODUCTION AND BACKGROUND

This chapter focuses on the presentation and analysis of collected interview data. This is done by ensuring that data presented here is comprehensible, purposeful and well supported by carefully illustrated charts and tables. The analysis process is linked to the objectives of this study. For this reason, the format of presentation follows that which was used in the questions for the interview guide.

- Firstly, the profile of the participants (technological innovators) is presented analyzed, and justified.
- Secondly, the opinions and experiences of the participants are presented and analyzed. This section is large compared to other sections as it deals with most of what will greatly contribute to the findings of this study.
- Finally, an assessment done by the participants on themselves and their companies, regarding the role of language and culture in technological innovation, is presented and analyzed (see also 3.14.2).

The author provides interpretation and discussion in Chapter 6, so as to be able to offer a complete interpretation of data, which fully addresses the objectives of this study.
5.2 PROFILE OF PARTICIPANTS

5.2.1 THE RANGE OF HOME LANGUAGES OF PARTICIPANTS

Figure 5.1 illustrates that among the interviewed participants, eight (32%) speak English as their mother tongue. The three (12%) participants classified as ‘Other’ in figure 5.1, stated that their respective mother tongues are German, Farsi, and Hindi. However, they immediately stated that they now use the English language for communication, and that they conduct and execute their innovations in English. They individually stated that, had the question been what language do you speak and use in technological innovation?, they would have stated that it is English. Instead, the question was; ‘what is your mother tongue or home language?’. Taking this discussion into consideration, the author therefore concludes that these participants are part of the English language group. This would therefore mean that 44 percent (32% and 12%) is the actual percentage of participants whose language for communication is English.
Afrikaans (24%), IsiZulu (20%) and IsiXhosa (12%) home languages respectively follow after the English home language in terms of the participants who were identified, as shown in figure 5.1.

5.2.2 RACE GROUPS OF PARTICIPANTS

![Figure 5.2, Race Groups of Participants]

Participants were grouped as shown in figure 5.2. The African group comprised Zulus and Xhosas. From the list of technological innovators who were identified, 13 (52%) were White, followed by eight (32%) Africans, three (12%) Indians and one (4%) Coloured (term for a mixed race group in South Africa) participant. The White group comprised participants of English, German, Polish, and Afrikaans-speaking backgrounds and descents. One participant who wished to be classified as Indian was of Belgian (mother’s side) and Iranian (father’s side) descent. For the purpose of this study, his preference did not matter, as he specifically mentioned that he had adopted an English culture and also spoke English both at home and at work. He also indicated
that his adopted language and culture were in any case, well suited for his Information Technology (IT) discipline.

5.2.3 AGE GROUPS OF PARTICIPANTS

Figure 5.3, Age Groups of Participants

Note: *x-axis = Group numbers (0-6); y-axis = Frequency (0-12)*

Figure 5.3 shows four age groups (*indicated on the horizontal (x) axis*) that the participants were grouped in. Above each group is data that pertains to it. Group 1 would have been ‘below 20’, but none of the participants belonged to this group and that is why figure 5.3 does not show anything above Group 1. Twelve percent of the participants belonged to Age Group 2 (20-30) and this group had the smallest number of participants. The group that had the largest number of participants was Group 3 (31-40) with 40 percent of participants. Group 3 was followed by Group 5 (over 50) with 28 percent of participants. Group 4(41-50) had 20 percent of participants. All
African participants were in Groups 2 and 3. Six of the African participants were in Group 3 and two of them were in Group 2. Other than the African participants, the only other participant in Group 2 was an Indian participant, and this was the same participant who wished to be classified as Indian (cf.5.2.2) under race groups, though he is born of a Belgian mother and an Iranian father. Another observation that the author made is that, except for one Indian participant, all the other participants who were in Group 5 (over 50 years of age) were from the White race. The author merely makes observations at this stage and does not wish to make any conclusions, as the reasons were not thoroughly investigated. Also, of note, was the observation that, except for the one who was over 50 years of age, the identified female participants were in Group 3 (31-40). The author then proceeded to examine both the gender groups (cf.5.2.4) of participants and their level of education (cf.5.2.5).

5.2.4 GENDER GROUPS OF PARTICIPANTS

Despite ensuring that all the female technology innovators from the TT100 (Top Technology 100) innovators’ list were part of this study, the author still ended up with
16 percent (4 females) females compared to 84 percent (21 males) male participants, as illustrated in figure 5.4. There may be historical and cultural reasons responsible for this disproportion. One female participant stated that her culture did not encourage women to be technology innovators. All female participants stated that they were now more involved in the marketing departments of their respective businesses and less in the technical aspects.

5.2.5 LEVELS OF EDUCATION AMONG PARTICIPANTS

Figure 5.5, illustrates that 92 percent (23 participants) among the technological innovators who were identified and interviewed had a tertiary qualification. The two (eight percent) participants who had high school education, had both matriculated. One of them was busy studying towards a technology management qualification at a university. Except for the one who was not studying and had only a high school qualification, all the other participants stated education had, and was continuing to-,
play a major role in their technological innovations. More than 50 percent of them mentioned that, even a non technical tertiary qualification was beneficial for marketing, networking and communication purposes. The participant with only a high school qualification stated that, there are many people with technical tertiary qualifications but they are not involved in technological innovations. According to him, “innovation is an inherent ability”.

5.3 OPINIONS AND EXPERIENCES OF PARTICIPANTS

In this section the author presents and analyses responses to the open-ended and general questions on innovation (see sub-headings 5.3.1, 5.3.2 and 5.3.3). The purpose was to discover factors that participants think influence their innovation capabilities and how these factors influence innovation generally. The author asked these questions so that it would be possible to compare the initial opinions and experiences of participants before questions were asked specifically about culture and language.

5.3.1 SITUATIONS THAT LEAD TO INNOVATION

*(Opinion Questions [1,4]*)

*This refers to the numbering in the questionnaire in appendix C.*

In response to questions; “1. please tell me about the times and places when you are most innovative”; and “4. what do you believe stimulates innovation?”, most of the participants signified the “need” to be the main factor. 9 participants used the word “need”, and 7 of them used related words such as “problem” (4 participants) and
“lack of resources” (3 participants). The combined total was 16 participants. The rest of the participants used the words captured below:

**Responses to: [1]**

**Common key words that emerged:** *Obtained from the interview transcripts.*

More frequent:  Need(x9); Under-pressure(x5); Problem(x4); Challenge(x4); Lack of resources(x3); Sleeping(x3); Morning(x3); Brainstorming(x3); Frustration(x2); Solution seeking(x2); Quiet times(x2)

![Figure 5.6 (a), Situations that Lead to Innovation [Q.1]](image)

Less frequent (x1):

*No comfort; Being busy; Relaxing; Migration/change; Praying; Conviction; Stress; Trust and Care; Workplace; Curiosity; Questioning; Opportunity; Strange Ideas; Exposure; Networking; Night; Anytime; Inspiration.*
The author tried to find a relationship between the words used by the participants in relation to culture. The following words from the provided list, according to definitions from the literature review conducted in chapter 2 (cf. 2.2.6 and 2.3.1), suggest a link between technological innovation and culture:

Migration and change, exposure, inspiration, relaxing, being busy, trust and care, brainstorming, praying, curiosity, and questioning.

The other words or responses appeared to refer to both environmental factors, for example, the place, problems and challenges on one hand, and the time of the day or night when it is quiet on the other. The author then decided to interact with the responses to a related question (question 4) to this one.

The question was; “what do you believe stimulates innovation?”. The purpose of this question was to compare responses to it with those from question 1. Again the “need” was accentuated as the most responsible circumstance for stimulating innovation. Six participants (24%) used it in their responses. But this time, besides the word “problems”, new words emerged from the conversation, and these were:

Responses to: [4]

More frequent: Need (x6); Reward/Incentive (x3); Belief (x3); Competition (x2);

See figure 5.6(b) on the next page.
Less frequent (x1):

Problems, Information and Awareness, Hard-work, Belief, Sharing Ideas, Improvement, Research, Learning

Reward, belief and competition were mentioned as important factors and conditions responsible for stimulating technological innovation.

5.3.2 TECHNOLOGICAL INNOVATION TRIGGERS
(Opinion Questions [2,3])

When asked, “Q.2. What do you believe triggers innovation in a person?”; “Q.3. What factors or situations do you believe contribute(ed) to your innovation(s)?”, most of the participants highlighted the “need” to: improve, achieve, survive, make a difference, solve a problem; as major triggers. Apart from this the participants also indicated that; financial support, reward, knowledge and entrepreneurial skills, encouraging environment, challenges and problems, opportunities, confidence, innate ability, creativity, curiosity, and competition were some of the essential elements in triggering technological innovation.
Subsequent to analyzing all the responses to this question, the author realized that they all in various ways had to do with an individual’s culture and environment (see 2.3.1 and 2.4 in Chapter 2).

5.3.3 BARRIERS TO TECHNOLOGICAL INNOVATION

(Opinion Question [7])

When asked, “what do you believe can be a barrier to innovation?”, answers included the following responses:

Copyrights and patents; culture (organizational and home culture); language; lack of education and information; lack of exposure; lack of clarity of vision; negative attitudes; environment; lack of financial support; little salary; lack of confidence; technical barriers; politics and competition; gender issues and lack of support at home, from friends and colleagues; and fear of failure.

Responses to this question, according to the author, indicate that both culture and language can serve as barriers to technological innovation. For example, the participants indicated that poor or lack of language skills could lead to the following: lack of exposure, lack of education and information, lack of clarity of vision, technical barriers, and lack of confidence. While, on the other hand, all the responses given by participants also relate to both cultural and environmental issues.

The questions asked and discussed thus far, are open-ended questions. The author used them specifically to determine what would emerge from responses without asking direct questions which are related to language and culture. As discussed, the author concluded that most of what emerged has a link to culture and to a lesser extent
to language as well. The question that follows now (question 5.4.4) asks specifically about language and culture influences on technological innovation. Due to the fact that this was an interview, the participants did not really know what was going to be asked next as they were not given the list of questions in advance. The author did this purposely so as to be able to contrast responses from open-ended non-leading questions and the subsequent direct questions in order to observe whether or not language and cultural issues would emerge from both types of questions.

5.3.4 LANGUAGE DATA PRESENTATION AND ANALYSIS

In Chapter 2, which focuses on the review of literature, the author discussed that some researchers view language as an integral part of culture (cf. 2.3.2). Again, in Chapter 2, the author stated that for the purpose of this study language will, on the one hand, be treated as part of culture and on the other singled out for the purpose of in-depth examination on its role in technological innovation (cf. 2.3.1). Furthermore, language is viewed as a tool that is necessary both for the discourse on innovation as well as for triggering innovation (Grant, D., Keenoy, T. and Oswick, C., 2001; Rigg, 2005; Checkland, 2000; Watson, 2000; Czarniaskwa, 1998; Woodilla, 1998). This literature review guided the process of choosing relevant questions to use during the interviews. What is presented and analysed next are the author’s own findings on the subject of language influence in technological innovation. The constant play between talk, meaning and action (Rigg, 2005; Grant et al., 2001) is what the author seeks to analyze in the following presentation.
5.3.4 (i) DOES LANGUAGE STIMULATE INNOVATION?.................[Q.9]

16 of the 25 participants (i.e. 64%) answered yes to this question. The author subsequently examined their reasons for the yes answer. What emerged from the reasons given by these participants is that any language can stimulate invention or an innovative idea. Furthermore, participants indicated that knowledge of a business language is important for the process of innovation. By ‘process’ it is meant, that after thinking of an innovative idea or inventing something, it has to be developed further and marketed using a business language. All the participants stated that English was the business language to which they were referring. One participant stated that this business language “provides you with access to information. It allows you to do better research. It makes you understand things. You use it to negotiate. You use it to share knowledge”. “Lack of English skills can be an impediment and frustration due to miscommunication”, is what another participant stated. With regard to mother tongue (including English and other languages), it emerged from the responses that “it helps with spontaneity” and “a sense of pride” and it also “assists in acquiring values”.

Figure 5.7, Does Language Stimulate Innovation?
Six of the 25 participants (i.e. 24%) who, however, gave “no” as the answer supported their opinion with reasons that indicated that their mother tongues, which were not English, did not help with innovation.

Three of the 25 participants (i.e. 12%) who gave “yes” and “no” answers stated, that “it depends what language it is”, and that some languages have limitations when one innovates, and also that, “language is not for idea generation, but it is important when it comes to commercialization and the execution of the idea”. The author concluded that they also believed that languages other than English have limitations when an innovator is developing and marketing an innovation.

5.3.4 (ii) LANGUAGE ROLE IN TECHNOLOGICAL INNOVATION………………………………………..[Q.11D]

Participants were then asked whether language plays a major role, neutral role or an insignificant one in technological innovation. In this section the author presents the responses by some participants. Other participants indicated that they had already given their views in other related questions, and yet others had more views to express. The author has grouped the verbatim quotations on these views under sub-headings, major role and insignificant role as follows:

**Major Role:-**

- “Yes it provides advantage”.
- “Major role”
- “Yes language plays a major role. It helps with mental pictures. Spoken language, however, limits the way we think”.

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*The Role of Language and Culture in Technological Innovation*
• “Yes”
• Major role, but not for thinking or generating (new) ideas, but more for marketing and commercializing them”. “Anybody, regardless of the language they speak can think new ideas, but for implementing them you would still need to use an international or global language which in our case is English”.

This participant was an Afrikaans-speaking woman.

• “In communicating ideas to others, but not in thinking about them. A chimpanzee, for example may think of something, but not be able to communicate and express abstract ideas to another one, due to language limitations”.
• “Significant role, communication is important. I can communicate in Tswana, English and (Isi)Zulu and this helps to innovate”.

Insignificant Role:
• “Not major, unless you are referring to English then I would say major”.
• “Little, just in communicating with beneficiaries”.
• “My mother tongue does not play a major role, except when I am discussing something with a (Isi) Xhosa speaker”.
• “English due to the fact that it is geared for the industry”.
• “My mother tongue (Afrikaans) plays no role, because at the office we speak more English which is a better language in my technical field”.
• “Certainly English, but not mother tongue (IsiZulu)”.

These responses indicate that language plays a significant role in the commercialization of technological innovations. What is also clear from these responses is that both non-English and English-speaking participants consider the
English language to be notably necessary for innovation due to both being “…geared for the industry” as well as being “…the global language”. These responses concur with the ones given in sub-section 5.3.4. Both the participants who view language as an important factor in technological innovation and those who state that it plays an insignificant role, base their opinions on the fact that mother tongues other than English play a lesser role compared to the English language, which they affirm is the business language.

5.3.4 (iii) LANGUAGE OF THOUGHT IN TECHNOLOGICAL INNOVATION………………………………………..[Q.11H]

Figure 5.8, Language of Thought in Technological Innovation

Figure 5.8 illustrates that 72 percent of the participants stated that they think in English when they innovate. The author observed that less than half (32%) as shown in figure 5.1) of this percentage of participants stated that English was their mother tongue. 72 percent is notably also more than the 44 percent (32 percent English and 12 percent Other) stated in figure 5.1. The author considered and examined the reasons the participants gave as an explanation for what is illustrated in figure 5.8.
The author concluded from the responses and comments made by participants in other questions that the main reason is that they believe English is both a universal and business language. It is for this reason they use it so much, to the extent that it has taken over as a language of thought in their technological innovations. Another observation from figure 5.8 is that eight percent of the participants believe that “thinking has no language”, and another one stated, “I think in pictures or models”. The next two paragraphs illustrate some of these findings.

One Afrikaans-speaking male participant stated, “I believe that a universal language is important”. He further stated, “…mother tongue may (perhaps) be good for things like literature”. The emphasizing word in italics has been added by the author based on the context of discussion with the participant. “The reason I use English more, is to avoid limitations (even though) I am a third generation French speaker” one participant stated, “My wife is from Czechoslovakia. I try to speak Czech, but I know I don’t have to and I’d still be fine in my innovations, because everything is in English,- so from that perspective, I would say the English language is important, though it is not the only language I speak. But for someone who speaks a different language, (about one second pause)…they might need to learn English seriously”.

Another participant stated, “language, for example English, plays a huge role when it comes to sharing ideas or communicating, but not for thinking of ideas”. This participant does not believe that language is a tool for thought. This is supported by the research done by; Chomsky (1959), Weiskrantz (1988), Vernon and Koh (1971), and Stuckless and Birch (1966), in Chapter 2 under the section on language issues (cf.2.3.2).
5.3.4 (iv) LANGUAGE OF IDEA SHARING AND COMMUNICATION........................................[Q.11I]

It can be seen from figure 5.9 that the majority (72 percent) of participants stated that English is the language they use in technological innovation. The responses to the question about the language of sharing are similar, to some extent, to those illustrated by figure 5.8 about the language of thought. The author was then more interested in the reasons given by participants. Following is a list of these reasons:

- I share ideas or communicate “more in English than in Hindi”.
- I use English because it is “geared for industry”.
- Though “…my mother tongue is Afrikaans I have adopted English, -my wife’s tongue, as a home language”.

*Figure 5.9, Language of Sharing and Communication in Technological Innovation*
• I speak “Afrikaans mixed with English”.
• “I use my mother tongue with family and English with the world”.
• “I use 80 percent Afrikaans and 20 percent English”.

The author was able to glean valuable information from the above quotations with regard to the language of idea sharing and communication.

5.3.4 (v) WORDS, PHRASES, AND DEFINITIONS ASSOCIATED WITH INNOVATION

The question about words, phrases, definitions associated with innovation was aimed at finding out;

(1) what the participants understood innovation to be (2) whether in their home languages they could explain it, (3) whether in their home or national cultures they have some inspiring phrases, words or definitions or stories, or not, (4) whether they could think of innovation in their mother tongues or not.

The author encouraged the participants to, as far as possible, think of; words, phrases and definitions in their own mother tongues. Participants, except for one, were quite slow in terms of responding to this question. They mentioned that it is an exercise they have never done before. Others even promised to come back to the question if they thought of something else, and this never happened despite the fact that the author reminded them about their promises. They simply said they could not really think of any more words. The one participant who responded instantly to this question, said in Afrikaans, “uitdagings”, which means challenges. The rest of the participants used words such as; creativity or kreatief, invention, ukuqamba kabusha (to compose anew), umsunguli (initiator), ukuthuthuka (development), competition
versus collaboration, ‘n boer maak ‘n plan, (literally, a farmer makes a plan), oorspronklik (originality), marketing, process, system, experiment, simplification, curiosity, creative design, ubugcisa (skills), nuwe idea (new idea), changing, improving, adding value, trial and error, endurance, stamina, civilization, iNyathi ibuzwa kwabaphambili (learning from the experienced or wise). The author observed that those whose mother tongue was an African language (IsiXhosa and IsiZulu) struggled more, followed by Afrikaans speakers who mostly remembered the phrase “‘n boer maak ‘n plan” (a farmer makes a plan), and English speakers did better in this question with creativity being the word they all used amongst other words.

5.3.5 CULTURE DATA PRESENTATION AND ANALYSIS

Literature reviewed in Chapter 2 of this thesis indicated that; environment, experience and exposure, attitudes, decision-making (career choices, for example) values and beliefs, are all part of culture (cf.2.1 and 2.3.1). In formulating the questions for the interviews, all these issues and suggestions were taken into consideration. The author also incorporated suggestions made by phase 1 participants. These propositions furthermore aided the author during the process of deciding on the profile of participants. Moreover, all these issues and suggestions were considered during the categorization process of culture and language variables.

This section examines Question 8 of the interview that investigates whether or not culture stimulates innovation. Culture categories are examined using Question 11 [A,B,C, E-1,2,3,4 F-1,2,3,4 G-1,2,3,4].
5.3.5 (i) DOES CULTURE STIMULATE INNOVATION? .......[Q.8]

In this question, the author asked whether or not culture stimulates innovation. This question was followed by a question that sought to determine the rationale behind the given responses. The reason for a follow up question was to allow the author to gain insight into the reason for the given answer. This was also particularly important for the author to know, because in this study emphasis is more on analyzing the content (qualitatively) rather than the numbers (quantitative). Both the numbers and reasons (triangulation) were however taken into consideration in order to have a rich analysis.

Figure 5.10, Does Culture Stimulate Innovation?

Figure 5.10 shows that 15 participants out of 25 participants (i.e. 60%) said “yes” when asked whether or not culture stimulates innovation. The author subsequently examined the reasons given by participants, both male and female participants, across racial groups, educational background and ages, and observed the following: All fifteen of them talked about home culture. For example, about the positive and inspiring role played by; religion and other beliefs, history and war stories, exposure, gender, family, and pioneers from similar backgrounds.
8 out of 25 (i.e. 32%) said “no”. Those who gave “no” as the answer supported their views with statements such as; “home culture tends to confine a person to his or her environment”, also that “only a culture of science can stimulate innovation”, and by further stating, “people are born with certain types interests which the environment can develop and nurture”. Moreover they stated, “we have inherent and innate abilities which have nothing to do with culture”, and some even blamed systems such as the communist system that provides job security- something which, according to them, is not good for innovation.

1 out of 25 said “yes” and “no”. This participant argued that “…it depends on the type of culture it is”. He further argued, “…that some cultures may promote innovation, whereas, other cultures may stifle it”. In fact, on exactly this point, the author had also observed that even the participants who had answered “yes” to this question clearly stated that they were talking about their own cultures and not about all cultures. The author further examined whether there was consistency in the answers given by English-, or Afrikaans-, or IsiXhosa-, or IsiZulu-speaking participants, and realized that there was not. Also both female and male participants did not give similar answers.

However, the one participant who said she “was not sure” (coded as X) was a white Afrikaans-speaking female. Her reason was that “girls are not expected to be innovative in the Afrikaans community”. The author could not establish whether this was indeed the case among all Afrikaans communities. One of the participants who said “yes” was a Zulu female and her reason for answering “yes” was that, “…being a woman the culture of multi-tasking helps a lot”. She also stated, “…the culture of
sharing” as a woman, stimulates innovation. Next is a presentation on the role of education in technological innovation.

5.3.5 (ii) **ROLE OF EDUCATION**

When asked to choose between major role, neutral role, and insignificant role 96 percent (24 out of 25) of the participants stated that education plays a major and positive role in technological innovation. The one participant who chose neutral gave the reason that, education plays a role “only to a certain extent”. He further stated, “some people are educated but they are not innovative”. Due to the reason given by this participant, it seems that he agrees that education plays some role but his argument is that something else may still need to happen for the person to be innovative. The author then began to examine the reasons why the other participants gave an unequivocal “yes” response. The responses given by participants are follows:
• “It is a business recipe that helps in doing research and enhances innovation”.

• “It broadens horizons. Gives you the ability to make new linkages”.

• “It helps in organizing and executing ideas”.

• “Especially up to high school which is even more important than tertiary education”.

• “Gives framework to innovate”.

• “Especially skills education”.

• “Both home education and school education”.

• “It helps with exposure”.

• “It helps in overcoming barriers”.

• “It plays a major role, but not in the desire to be innovative - culture is what motivates the desire-. But it enables one to be innovative”.

The above responses suggest that education plays a significant role in technological innovation. Figure 5.11 further elucidates the degree of influence education has in technological innovation. At this point the author did not see the necessity for further examination on the influence of education on technological innovation as this was explicity evidenced by the quoted statements. The next sub-section (cf. 5.3.5(iii)) explores the influence of experience and exposure on technological innovation.
5.3.5 (iii) EXPERIENCE AND EXPOSURE .......................... [Q.11B]

Figure 5.12 illustrates that 23 participants (92%) viewed experience and exposure as major role players in technological innovation. 2 participants (8%) asserted it plays a neutral role. One of those who argued that experience plays a neutral role stated that it played a limited role because if he had not been funded, he would not have innovated. The other one who also affirmed it plays a neutral role argued that the role “can be positive or negative”. None (0 %) said experience and exposure play an insignificant role. One participant stated, “…experience and education are good for innovation. Development of language (foreign business language skills) takes time but it is necessary for us to innovate in other languages as well”.

Next, is a list of responses from the participants, as the author decided to use direct quotations, rather than a summary. The basis for this decision is that the quotations seem to adequately capture the arguments that were advanced.
• “Experience allows people to make mistakes and then figure out what works and what does not work”.

• It “gives the thought that there is a better way to do something”.

• It can play a major role in two ways:
  - “Negative role – It can be a barrier in the sense that you avoid certain ideas due to experience”.
  - “Positive role – It helps you in identifying your strengths and weaknesses”.

• “Migration and poverty play a major role”.

• “Especially hands-on experience”.

• “Definitely, but just in polishing the idea – motivation is still need”.

• “There is no question about it!”, one participant stated.

Once again the author believes that the above quotations provide an adequate and lucid discussion that requires no further elucidation. The following sub-section (cf. 5.3.5) on culture and environment is based on the responses to question 11C of the interview schedule. Moreover the discussion in the following sub-section is further augmented by figure 5.13, which must be viewed in the light of what will be discussed.
22 participants (88%) signified that culture plays a major role in technological innovation. The two participants (8%) who stated that culture plays a neutral role, both supported their statements by arguing that it can either promote or stifle innovation. The one participant (4%) who indicated that it plays an insignificant role cited that it plays an important role to some people, but not to him. He is originally from Poland, though he has now adopted the English language and culture, and he believes that his Polish culture plays an insignificant role in his innovations.

Following is an account on responses from the participants with regard to culture and environment:

- The participants stated that the following religions were influential; Christianity, Judaism, Islam, Bahá’í Faith. In Chapter 2 literature clarified that belief systems such as religion and others are part of what defines
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culture (cf.2.3.1). “Culture (the shared values, beliefs, and behavior patterns characterizing a group of people) is a powerful, yet amorphous concept” Singer et al. (2008), see also Samuel and Douglas (2006).

elucidate

• One participant stated, “…being a Christian played a negative role” in his innovation, because he was “encouraged to follow the leader”.

• “Self belief and good upbringing” were mentioned as positive things for innovation.

• “Culture of sharing makes a positive contribution in technological innovation”.

• With regard to environment it was indicated by participants that; “poverty”, “joblessness”, and “role models” are important contributors to innovation.

• Participants also stated that the environment “can either stifle or nurture innovation”.

• “Migration” was indicated as a positive role player.

• “Indians and Germans have the correct culture for innovation. Koreans, Taiwanese, Japanese and Chinese have the correct culture as well”. This participant did not, however support this statement.

However, the author observed that these responses did not seem to have anything to do with race, gender, and language group.

The next section (see 5.3.5) deals with the discussion on the reasons for career choice. The author sought to find out what informed the participants to choose the careers in which they practice their technological innovations.
5.3.5 (v) **REASONS FOR CAREER CHOICE** [Q.11E]

![Figure 5.14, Reasons for Career Choice](image)

Participants were requested to state the reason for their career choice. Participants had to choose from the following list as can be seen from the interview schedule (cf. Q.11E):

1. I was exposed to it at school.
2. My family/friends encouraged me to choose it.
3. I was exposed to it at university.
4. I learnt about it at my workplace.
5. It was my talent.
Other, please specify

28 percent of participants, as shown in figure 5.14, stated that all (1, 2, 3, 4, and 5) these options were applicable and had each played a role in determining what career to choose. 20 percent gave Other reasons instead. These reasons were the following; 1) “desire to help”, 2) “need for stimulation”, 3) “by accident”, 4) “out of interest”, 5) “it chose me due to retrenchment”, 6) “I stumbled on it”. Eight percent of participants stated that it was their talent. The rest of the participants, as illustrated in figure 5.14, stated that they were either influenced by the work environment, or education or
family or combinations of these factors. This shows that many factors contribute towards one’s innovation and/or career choice.

5.3.5 (vi) PRIOR KNOWLEDGE TO CAREER CHOICE............[Q.11F]

Figure 5.15, Knowledge before Career Choice

The following options were given to participants to choose from with regard to their knowledge before career choice:

1  New to me, I was only exposed to it at the workplace
2  Familiar to me due to school experience
3  Familiar to me due to exposure by family/friends
4  New to me, I was only exposed to it at university
5  Other: Please specify______________________________

The author observed that, according to what is illustrated by figure 5.15, the majority (68 percent) of the participants indicated that the careers in which they were innovating; were new to them and that either the workplace or university education or
both had introduced them to the career. It can also be seen from figure 5.15 that there is not much indication that family or friends and pre-university education had played a major role. Participants who either stated 1 only or 4 only, by making these choices not only did they indicate that the career was new to them, but that either workplace knowledge or university knowledge had introduced them to it. Therefore this clearly indicates that it is possible for one to innovate in a specific area or discipline, even though there may not be historical evidence of his or her exposure to it. If this is indeed the case, it therefore means that, relatively new influences on someone may also contribute to his or her career choice or innovation.

5.3.5 (vii) TYPE OF KNOWLEDGE APPLIED DURING INNOVATION………………………………………..[Q.11G]

Figure 5.16, Useful Knowledge for Technological Innovation
Participants were requested to choose from the following list, the type of knowledge they apply in technological innovation:

1. School knowledge to my innovations
2. Family/background knowledge to my innovations
3. My tertiary education knowledge to my innovations
4. My workplace learnt knowledge to my innovations
5. Other, Please specify__________________________

As can be seen from figure 5.16, the majority of participants (32 percent) stated that all the choice options from 1 to 5 were applicable. 20 percent of participants stated that they use their workplace-learnt knowledge (option 4) in technological innovation. 16 percent suggested that both tertiary education knowledge (option 3) and workplace-learnt knowledge (option 4) were useful in technological innovation. Eight percent indicated that only tertiary education knowledge (3 only) had helped them in their innovations, and another eight percent of participants gave other reasons (option Other). The only participant who chose option 1 was the one who did not have a tertiary qualification. He argued that he innovates and that high school education was sufficient in order for one to be innovative. The author observed that only one participant indicated that he applies family background knowledge (option 2). The participants who chose option Other gave the following reasons: “I apply my common knowledge and encouragement”; and the other stated, “streetwise knowledge and experience”.

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5.4 PARTICIPANTS’ OWN ASSESSMENT

At the end of each interview, the author requested each participant to perform his or her own assessment with regard to what they understood to be the impact of language and culture on technological innovation. The arbitrary scale that was chosen and used ranged from 0 to 10. The participants had to choose any appropriate number (score rating), and were made to understand that zero (0) was the lowest score, five (5) the average, and ten (10) the highest. This assessment by participants was deliberately reserved to be the last formal interview question and the participants did not know about it in advance.

The following presentation indicates what emerged from that exercise. In some instances the participants did not merely choose a number, but they also gave explanations to justify the choice. While some of the explanations had already been captured in the previous responses, others were new and have therefore been incorporated in the analysis provided after each figure.

The figures provide a graphical representation of the scores that the participants gave. The line graph indicates which score was the highest in terms of percentage. The table below each graph provides details for each given score rating. These details indicate the number of participants who gave each rating, and below that the percentage values illustrated by the line graph are provided.
According to figure 5.17, 40 percent of participants gave a score rating of eight for culture’s role in technological innovation. This score was followed by scores 10 and 9 with 20 percent and 12 percent of participants rating them as such, respectively. There was only one participant for each score from score rating 5 and below. This noticeably illustrates that the majority (88 percent) of the participants view culture as having a major influence in technological innovation.

Subsequent to this observation the author then proceeded to examine the score ratings for language as indicated in the next figure (figure 5.18). Figure 5.18 shows a somewhat similar graph to the one shown in figure 5.17 with between eight percent and 32 percent of participants giving score ratings from 5 and above. The same participant who gave a score rating of zero for culture again gave a score rating of zero for language. The reason he gave for this rating is that, “children are natural innovators, but they do not know much about culture and language”. According to the author this participant contradicted himself, because earlier he had stated that his Islamic beliefs play a major role when asked about the role played by culture.
An important observation from both figures 5.17 and 5.18 is that the majority of participants view both language and culture as factors that play a major role in technological innovation.

5.5 CHAPTER CONCLUSION

In this chapter, careful presentation of collected data and an analysis of the same data have been provided with brief explanations and discussions. Where it was possible to quote participants verbatim, without disturbing the flow and logic of presentations, such quotations were provided. In other cases the author provided a summary.

Chapter 6 aims to provide a synthesis and interpretation of this data in preparation for thesis conclusion. Synthesis and interpretation in the next chapter is done by relating discussions with the objectives delineated in Chapter 1 of this thesis. Throughout this chapter (Chapter 5), the author ensured that illustrations are meaningful, readable,
useful and well explained as mentioned in the introduction of this chapter. Few necessary comments were made without going into exhaustive discussions due to the fact that the next chapter is devoted to an in-depth interpretation and synthesis. The author noticed that some points concur with the reviewed literature in Chapter 2, and that several new points have also emerged.

Therefore, in the subsequent chapter, both the findings which corroborate the ones from the reviewed literature and those that are either new or refute other researchers’ findings are discussed. For more information on some of the illustrations provided in this chapter, reference can be made to appendices.
CHAPTER 6

INTERPRETATION AND DISCUSSION OF RESEARCH FINDINGS

6.1 INTRODUCTION

Synthesis is accomplished by relating data that emerged from chapter 5 with the objectives of this study. Consequently, the sub-sections used in this chapter are derived from the objectives of the study in order to ensure that all the objectives are addressed. This chapter aspires to ensure that all the sub-problems that were indicated as guiding statements for this thesis in chapter 1 have been dealt with. As stated in the conclusion for chapter 5, these sub-problems have all been used as sub-headings for the sub-sections discussed in this chapter and they are listed below:

- Relationship between language and technological innovation (see 6.2).
- Relationship between culture and technological innovation (see 6.3).
- Role of language in the cognitive process in technological innovation (see 6.4).
- Role of culture in the cognitive process in technological innovation (see 6.5).
- Roles of language and culture in the creative process in general (see 6.6).
- Relationship between language and culture in technological innovation (see 6.7).
- Language and culture barriers in technological innovation (see 6.8).
- Language and culture opinions in technological innovation (see 6.9).
• Language hybridity versus purity in technological innovation (see 6.10)
• Culture hybridity versus purity in technological innovation (see 6.11).

With regard to interpretation, the author also uses the three phases of a simplified innovation process by Herstatt et al. (2008) with the aim of showing where in the process, language and culture influence technological innovation. An attempt is made to focus on all phases of innovation development. In other words, from the; cognitive process - which is the ‘conception’ phase, to the creative process - which is the ‘development’ and/or ‘implementation’ phase, and finally to the end of the process or the actual technological innovation result - which refers to using and/or ‘marketing’ the innovation. These phases have been incorporated into the wording of the sub-sections, as well as into the discussions, rather than being discussed in isolation. Herstatt et al. (2008) provide the following three phases:

- **Conception;** which refers to idea generation,

- **Implementation;** which refers to the ‘development’ of an innovation product or idea and,

- **Marketing;** which refers to, “production or market launch and penetration (National and International)”.

The aim is to analyze and discuss both, the nature of impact and the stages where such impact is made, by language and cultural aspects in the technological innovation process.
Technological innovation is therefore discussed from the perspective of a broader value chain, namely; idea generation, development, and utilization/commercialization - as illustrated in Figure 6.1. Following an exploration concerning the innovation process, the author concluded that researchers agree with the process highlighted in Figure 6.1. For example in systems engineering, Sage and Rouse (2004) state,

“A simple functional definition of systems engineering is that systems engineering is the art and science of producing a product or a service, or a process- based on \textbf{phased} efforts that involve \textit{definition} or the desired end result of the effort followed by \textit{development} of the product or service or process, and culminating with \textit{deployment} of this in an operational setting – that satisfies user needs” (\textit{emphasis in bold is by the author}).
Furthermore, von Stamm (2009) states, “the three phases of the innovation process are; search, selection and implementation” (emphasis in bold is by the author).

“Technology managers who understand the phases of innovation, the critical role of standards and the various and sometimes conflicting capabilities needed to manage both new and mature product development, can better compete in today’s rapidly changing environment” (Martinich, 2002 – emphasis in bold is by the author). Gibbons et al. (1994) state, “…knowledge production becomes part of a larger process in which discovery, application, and use are closely integrated” (emphasis in italics is by the author). Gibbons et al. (1994) refer to knowledge production as it is currently understood that knowledge and technology, at some level, refer to the same phenomenon.

In Chapter 2 (c.f. 2.2.6), the author stated, “in this thesis the term technology refers to both knowledge (Indigenous knowledge or foreign knowledge) and hardware” (see also, Autio & Hameri, (1995)). Eveland (1986) concluded that, “…technology is not simply hardware or physical objects; rather, it is knowledge about the physical world and how to manipulate it for human purposes”. Similarly, Pérez-Bustamante (1999) concluded that, a combination of technical expertise (technos) and knowledge bases (logos), is a matter that refers to technology. In this thesis, the integrated nature of these three stages has been taken into account, in constructing the conclusion presented in Chapter 7.

All of these authors believe that any invention that does not reach the end of the process – which is either commercial success or value addition, remains simply an invention and cannot be regarded as an innovation. For innovation to happen, they
accentuated the importance of good marketing skills within the organization. Some even went as far as stating that most inventions that had a commercialization potential realized their potential simply because good marketing methods were non-existent. Furthermore, von Stamm (2009) stresses the importance of good leadership with preconditions such as sincerity and consistency.

6.2 RELATIONSHIP BETWEEN LANGUAGE AND TECHNOLOGICAL INNOVATION

This study has indicated that there is a significant relationship between language and technological innovation. In chapter 5 it was established that 64 percent of the interviewed participants said yes when asked (see Q.9) whether language does stimulate innovation (cf. 5.3.4).

According to reviewed literature, language influence is more at the level of meaning making in the thought and definition process. With regard to meaning making and developing new practices, Rigg (2005) states, “Doing things differently can require new ways of framing, new perspectives, new language, new ways of thinking about work”. New language in this context does not refer to learning a new language per se, instead to using the language differently. For example, Rigg (2005) continues to clarify this point by stating that new language refers to the understanding that there is a need to “encourage, persuade, cajole or coerce other members to adopt new practices”. This is however meant in the context of managing an innovation process with a group. Jacobs and Heracleous (2005) state, “In the context of viewing management as an essential verbal, communicative process, it becomes important to further understand how the use of language can foster critical processes such as
strategy innovation”. The researcher understands from these arguments that other researchers view language as an important factor in managing meaning-making among innovating groups. Further, Jacobs and Heracleous (2005) state, “The role of communication in general and of conversations in particular for processes of change has been widely acknowledged in the literature” see also (Heracleaous and Barrett, 2001; Deetz, 2003; Barrett et al., 1995; Weick and Quinn, 1999).

The author could not, however, find literature that directly explains the relationship between the language of an innovator and technological innovation. This study has indicated that language of communication does not play a significant role at the origin of the innovation process. Research participants indicated that thinking has no language. Statements such as, “language, for example English, plays a huge role when it comes to sharing ideas or communicating, but not for thinking of ideas” suggest that it is debatable whether language is indeed a tool for thought. These participants do not believe that language is a tool for thought. This is corroborated by the research conducted by; Chomsky (1959), Weiskrantz (1988), Vernon and Koh (1971), and Stuckless and Birch (1966), in Chapter 2 under the section that discusses language issues (cf.2.3.2). However, researchers appear to concur that language plays a significant role in communicating thoughts.

Kottak (1991) states “According to the principle of linguistic relativity, all dialects are equally effective as systems of communication, which is language’s main job. Our tendency to think of particular dialects as, better or worse than others is a social rather than a linguistic judgement”. This conclusion by Kottak (1991), an anthropologist, is supported by the author’s own findings. As illustrated in figure 7.2, the language
influence at the origin of an innovation is negligible and at best, as discussed here, it seems more useful when there is a team working on innovation for meaning-making.

It must be reiterated that this study is predominantly using a qualitative approach due to nature of the used sample. However, it was noted that participants’ own assessment indicated that the role of language in technological innovation is significant with an average of 7.68 in the 0 to 10 scale (see Table D in appendix D). In this scale, 40% of participants gave a score rating of 8.

This average (7.68) and highest (40%) score rating (8) were subsequently verified with the statements and arguments made by participants when answering other questions in order to confirm consistency of their views. Except for one case, the author found that there was consistency between the views expressed by participants on other questions and the participants’ own assessment of the relationship between language and technological innovation.

The one case where there was inconsistency was when the participant indicated the important positive role played by his religion (which may influence culture) in his innovation. Yet this same participant indicated that both language and culture have nothing to do with technological innovation by arguing that even children innovate though they do not have adequate language skills and do not yet have cultural influences.
In summary, the author concludes that there is agreement between both the participants’ own assessment on themselves and that which was deduced from other sources that informed this study (literature and interview data).

6.3 RELATIONSHIP BETWEEN CULTURE AND TECHNOLOGICAL INNOVATION

Throughout this study, both literature (cf.2.3.1) and data from participants (cf.5.3.5 and appendix D) indicate a strong relationship between culture and technological innovation. Participants’ own self-assessment using the 0 to 10 scale illustrated a noteworthy relationship between culture and technological innovation, in that 40% of participants gave 8 as the score rating from the scale and an average which is 7.56.

Participants indicated that a culture of innovation is necessary. It was also mentioned that culture can either be stifling or conducive for innovation. It can therefore be concluded that culture plays a considerable role in technological innovation. Further it must be appreciated that this role can be positive or negative. A positive culture is one that allows a person to explore without restraint. A negative culture on the other hand is one that emphasizes uniformity, conformity and excessive control over the people.

The authors’ own assessment from both secondary (literature review) and first hand (interview data) data corroborates the participants’ own assessment. In other words there does not seem to be any incongruity between the participants’ own assessment and the assessment the author conducted based on both literature data and interview data.
6.4 ROLE OF LANGUAGE IN THE COGNITIVE PROCESS IN TECHNOLOGICAL INNOVATION

Gross (2001) states, “…It’s now widely accepted that Whorf (see Chapter 2 of this thesis) overestimated the importance of language differences”. Berry et al. (1992) state, “Language as an instrument for thinking has many cross-cultural variant properties. As humans, we may not all be sharing the same thoughts, but our respective languages do not seem to predestine us to different kinds of thinking”. According to Morgan et al. (1986), the linguist Whorf (1956), “argued that the higher levels of thinking require language and that the characteristics of a particular language actually shape the ways that users think about things”. Whorf’s controversial linguist relativity hypothesis (see Chapter 2 of this thesis), has come under attack over the recent years as can also be seen in the statement by Gross (2001). It is also stated that, “Whorf based his hypothesis on studies of North American Indian languages, but his hypothesis is said to hold for all languages” Morgan et al. (1986).

Recent research has, however, “shifted away from relativity to universal thinking… perhaps the basic thought processes are similar even though languages differ” Morgan et al. (1986). This study, as discussed in Chapter 5 (5.3.2), explained the need, to be both the trigger and situation that leads to innovation. While the importance and influence of language has been acknowledged by participants, it has been indicated and argued to be playing a significant role more on commercialization and marketing of an innovation, rather than in “determining how we see the world” Morgan et al. (1986). It seems to the author that rather extreme experiments have been conducted in an attempt to ascertain the relationship between thinking and cognition (the process of knowing –see Capra, 2002). Morgan et al. (1986) quoting Smith et al. (1947) indicate
that, “A number of experiments have indicated that movements of the vocal apparatus may indeed accompany thought, but other experiments have made it clear that such movements are not necessarily for thinking”. Morgan et al. (1986) further state,

“In this rather heroic experiment, the subject, a physician, was completely paralyzed by means of a drug. He literally could not move a muscle, and his breathing was done for him by an iron lung. The paralyzing drug, however, did not affect the way his brain worked; it merely acted on the excitation of muscles by the nerves. While under the influence of the drug, the subject was given certain verbal problems to solve; he could not answer, of course, because the muscles necessary for speaking were paralyzed. There is no way to be certain that he was thinking while under the influence of the drug, but all indications are that he was because after the paralysis was removed by a counteracting drug, he clearly remembered what had taken place while he was drugged and promptly gave the answers to the problems”.

Experiments such as the one stated above indicate the level of interest researchers have had on the subject of language, thinking, and cognition, but they do not seem to have yielded sufficient insights into the subject, no wonder some researchers decided to retire from the subject. The author, however, believes that this study has explained something that may be of benefit in terms of understanding the relationship between language and innovation or technological innovation in particular.
Following a systematic examination of interview data and reviewed literature, the author concluded that cognition seems to be a “process of knowing” rather than an event (see also Capra, 2002). Capra (2002) also states, “During the past twenty–five years, the study of the mind from this systemic perspective has blossomed into a rich interdisciplinary field, known as cognitive science, which transcends the traditional frameworks of biology, psychology and epistemology”.

In conclusion, without disregard to the extensive debate on the exact relationship between language and thought in which views such as; “thought is dependent on/or caused by language”, “language is dependent on, and reflects, thought”, “thought and language are initially quite separate activities”, and that “language and thought are one and the same”, have been articulated, the author however, concludes from this study that language becomes more important towards the end of the innovation process rather than at the beginning. It has been stated clearly by the participants that any language (mental pictures or spoken) or no language is adequate for thinking (cognitive process and consciousness). Further this study indicates that a business language becomes more important towards the last phase or phases of technological innovation. Specifically, the English language was highlighted as an important business language in technological innovation.

6.5 ROLE OF CULTURE IN THE COGNITIVE PROCESS IN TECHNOLOGICAL INNOVATION

Correspondingly, the role and influence of culture in the cognitive process varies in importance in accordance with the phase of technological innovation along the technological innovation continuum. This technological innovation continuum is the
phrase that the author has coined after concluding that, technological innovation is a process rather than an event, and also that the direction it takes and where it starts and ends, cannot always be predicted. This phrase is discussed in chapter 7 wherein conclusion of this thesis is provided.

This study shows that culture and environment may contribute more in the innovation process at the initial stages, herein referred to, as phases. About half-way through the technological innovation process, both language and culture may still be contributing, but other factors such as; education, politics, economic situation, and skills, become progressively more important. Culture in the form of; values, beliefs and convictions on one hand, and environment in the form of; need, challenges, competition, conduciveness, role modeling, and exposure on the other, have been highlighted as major influences in the preliminary stages of the cognitive process or conception.

6.6 LANGUAGE AND CULTURE ROLES IN THE CREATIVE PROCESS IN GENERAL

In chapter 5 (cf.5.3.4), as observed by the author, ‘Language is viewed as a tool that is necessary both for the discourse on innovation as well as for triggering innovation (Grant, D., Keenoy, T. and Oswick, C. (2001); Rigg, 2005; Checkland, 2000; Watson, 2000; Czarniaskwa, 1998; Woodilla, 1998)’. In chapter 5 (cf.5.3.4), it has been illustrated that language stimulates innovation. Sixty-four (64%) percent of participants affirmed that language stimulates innovation. It was argued that language provides access to information for an inventor or innovator. The author also noted that the participants indicated that language “helps with spontaneity” and that, lack of language skills, English in particular, could be an obstacle. Of note is also the
understanding that, in the creative process, language assists in; negotiations, research and knowledge sharing.

Apart from cultural factors, which are similar to the ones discussed in the context of language, in addition the author observed that there are two types of culture, namely those that promote innovation and those that stifle innovation. A culture, in which there is excessive control, has been indicated to be a counter-productive factor in the creative process.

An interpretation of the relationship between; language and culture, on technological innovation, is discussed in 6.7. Here the author examines the relationship between language and culture first and then their combined relationship in relation to technological innovation.

6.7 RELATIONSHIP BETWEEN LANGUAGE AND CULTURE IN TECHNOLOGICAL INNOVATION

It was found that both language and culture play complimentary roles in relation to each other. Language (L) shapes culture (C) and in turn culture shapes language and in the process, as has been discussed already in section 6.5, their impact varies along the technological innovation continuum.

The author decided to term it a technological innovation continuum because the stages overlap and the factors that influence the various stages of an innovation process also overlap. In other words the author argues, based on what has emerged from this study,
that the phases or stages and factors that influence technological innovation cannot easily be compartmentalized. This argument is further supported in chapter 7.

6.8 LANGUAGE AND CULTURE BARRIERS TO TECHNOLOGICAL INNOVATION

The following is a summary of responses to the question about language and cultural barriers in technological innovation:

- **Lack of Skills** (such as; educational, language, technical skills).
- **Lack of Support** (such as; lack of financial support, lack of support from home, lack of support from friends and colleagues).
- **Challenges** (such as; competition, politics, lack of clarity of vision, environmental challenges).
- **Over Regulation** (for example; copyrights and patents).
- **Other Cultural Factors** (such as; gender issues, lack of exposure, fear of failure, negative attitude, and lack of confidence).

The author observed that some of these responses confirm what was discussed in the literature review. Furthermore, the author observed that, except for the case where lack of language skills was highlighted, all the participants’ responses relate to cultural and environmental factors.

Some of the reviewed literature is supported by most of what emerged from this study. For example, Dunphy and Herbig (1994) state that an advisory committee
formed by the US (United States of America) Secretary of Commerce in 1966-1967 found that the sourcing of innovation and invention are mainly affected by taxation, finance and the degree of competition. This concurs with some of the external factors highlighted by participants in this study. In Chapter 7 (in subsection 7.2.2), these external or environmental factors are highlighted and discussed.

Dunphy and Herbig (1994) also refer to the work of Mokyr (1991) by stating that factors such as religion, a tolerant political structure, the type of education and general openness to new information and risks, have an influence in the process of idea generation. Furthermore, it is argued by Dunphy and Herbig (1994) that, the style of management in the United States of America allows relative freedom to the business innovators or technology entrepreneurs and that there are less obstructions resulting from language, tariffs, legal and currency challenges. This is viewed as feature that fosters innovation.

The preceding discussion, as well as the findings of this study, indicates that the summary of findings in this sub-section captures most of what is perceived to be barriers to technological innovation. However, it seems that the same factors that are aimed at fostering innovation could end up stifling it. This understanding is supported both by reviewed literature and in the findings of this study. For example, Martins and Terblanche (2003), after conducting research on building an organizational culture that is geared towards the stimulation of creativity and innovation, conclude that, cultural factors such as values, norms and beliefs that are involved during creativity and innovation in organizations can either promote or stifle creativity and innovation. This argument is based on how these factors might influence the behaviour of
individuals and that of the groups. Also, in this current research, participants indicated that culture can either stifle or promote innovation (see 5.3.5 (i) and (iv)). Miroshnik (2002), in her research on culture and international management makes conclusions that are supported by most of what emerged from this study.

In the context of this discussion, language is viewed as an integral part of culture and for this reason it is not discussed separately. This view is supported by Miroshnik (2002) when she concludes that a cultural environment includes, “customs, norms, values, beliefs, language, attitudes, motivations, social institutions, status symbols, religious beliefs…”. This view has also been articulated in Chapter 2 (cf.2.4 and 2.3.1) where it is argued that language and culture are intrinsically linked.

In Chapter 2 (c.f. 2.1), the author concluded that innovation literature has tended to focus on the negative impacts of language and cultural factors, and that this thesis would focus on the positive role played by these factors. Despite this statement, for the purpose of; a holistic, unbiased coverage, and an in-depth analysis and interpretation, the author decided to consider barriers as well.

6.9 LANGUAGE AND CULTURE OPINIONS ON TECHNOLOGICAL INNOVATION

The author is of the view that language and culture opinions have been presented and discussed sufficiently in the preceding chapters. Further discussion on this topic would therefore be a repetition and as such would not elucidate more valuable information than to just reiterate what has been covered. It is for this reason then, that the author has proceeded to discuss sub-sections 6.10 and 6.11. These next two sub-
sections have deliberately been discussed last, as they provide a possibly discordant angle, in the flow of what has thus far been discussed.

6.10 LANGUAGE HYBRIDITY VERSUS PURITY IN TECHNOLOGICAL INNOVATION

In this sub-section the author discusses what emerged from the interviews as well as what is stated in the literature about the question of hybridity and purity. Participants were never inquired specifically about the subject of hybridity and purity, but it came up from both the anthropology literature as well the participants themselves. Guidance from phase 1 participants (the experts who assisted in designing the questions), was that; it is usually a sensitive issue to ask participants whether they are of pure lineage or not, and in respect to that, it is a matter best left to emerge on its own from the study. Due to the fact that grounded theory (GT) is the main approach used in this inquiry, the author saw it proper to explore and discuss the topic of hybridity and purity, as and when it emerged. When some participants were asked about their nationalities, race groups and languages, they indicated that they were hybrids, though in the end they made a choice. For example, some Africans, Asians and people of European descent indicated that they did not necessary have a distinct culture due to intermarriages that their parents, grandparents and great grand parents had gone through. These intermarriages were between people of different African, Asian, and European languages and culture groups in South Africa. It seems to the author that, had the question been what do you identify yourself as?, the participants would have been more comfortable. Instead the author asked the participants about their race, mother tongue, and culture group. As a result of this, some participants stated that they speak more languages than one, and did not really have a mother tongue, and that
they were of mixed races and cultures. In relation to technological innovation, the question of language hybridity did not yield any more insights, other than what has already been discussed under language, as participants of diverse language backgrounds indicated that they were using the English language, as the language of communication.

6.11 CULTURE HYBRIDITY VERSUS PURITY IN TECHNOLOGICAL INNOVATION

Hutnyk (2005) states:

“For others, hybridity is the key organizing feature of the Cyborg, the woman/machine interface (Haraway 1997), and it invokes mixed technological innovations, multiple trackings of influence, and is acclaimed as the origin of creative expression in culture industry production…Kobena Mercer writes of ‘the hybridized terrain of diasporic culture’ (Mercer 1994, p. 254) and even the older terminologies of syncretism and mixture evoke the movement of ‘hybridization’ rather than a stress on fixed identity”.

As evidenced in the preceding quotation from Hutnyk (2005), emphasis on fixed cultural identity is discouraged, and instead hybridity asserts that there are “multiple trackings of influence” on technological innovations. Pieterse (2001) also states, “Creativity and innovation often turn on unlikely combinations, so in art and sciences hybridity is common and at times more readily acknowledged than in other domains”. See also Zuchermann (2009).
Although this study investigates the influence of some languages and cultures on technological innovation, the author does not pre-suppose that there is such a thing as language or culture purity (*uncontaminated*). While the author is cognizant of the hybridity concept, it does appear from the findings of this study that some languages, for example English, have advantage over others in marketing innovations (see discussion in the preceding chapters including this one).

### 6.12 CHAPTER CONCLUSION

This research has taken account of both culture and language in the context of; one being an integral part of the other, as well as separately, in relation to technological innovation.

The argument by Capra (2002) that, “*If language originated in gesture, and if gesture and tool making (the simplest form of technology) evolved together, this would imply that technology is an essential part of human nature, inseparable from the evolution of language and consciousness*”, advocates for inseparability.

The author here sought to conduct an in-depth analysis of these factors (language, culture and technological innovation), with the view to explain how they are related. In the process of doing this, the approach involved considering them both; in the same contexts, as well as outside the contexts of each other, as literature was also not consistent on inseparability or exclusivity.
This approach proved to be useful, as it provided the author with a more holistic rather than biased view for in-depth analysis. The next chapter reflects the results of analysis and interpretation based on a holistic and in-depth analysis.

This chapter provided a synthesis of the thesis by using the objectives of the study as the sub-headings of sub-sections 6.2 through 6.11. This has also provided a summary of the thesis in a way that ensured that all the objectives were addressed.

In wrapping up the thesis, chapter 7 will focus mainly on the summary of knowledge contribution made in this study. The author, however, wishes to indicate that this contribution can better be viewed in the light of all that has been presented and discussed thus far, rather than in isolation. The author ensured that each chapter in this thesis is in its own way a contribution in itself.
CHAPTER 7

THESIS CONCLUSION AND RECOMMENDATIONS

7.1 INTRODUCTION

Following is a summary, hereafter referred to as the ‘thesis contribution summary’, which summarizes and elucidates the major contributions made by this study. To strengthen this summary, the author has generated figures to illustrate its findings. This summary is organized in terms of the three main phases of the technological innovation process with respect to the role played by language and culture, namely:

(a) the origin or origination of an innovation or innovative idea,
(b) the execution of an innovation or innovative idea, and
(c) the promotion and application of an innovation or innovative idea.

A further illustration, referred to as the sun metaphor, is provided. The purpose of the sun metaphor is to better explain the influence of language and culture, and that of the other factors identified by this study, on technological innovation. These conditioning factors include; exposure, education, experience and environment. This research demonstrated that all these factors have an impact on language and culture, and for this reason the author decided to include them as causative agents.

Lastly, the implications of the ideas arrived at in this thesis are explored and recommendations are made about new directions for research to create a culture that
is more innovation friendly. These recommendations and forward looking research ideas are based on the author’s reflections on his own experience and discoveries while conducting the current study.

7.2 THESIS CONTRIBUTION SUMMARY

7.2.1 TECHNOLOGICAL INNOVATION CONTINUUM

The technological innovation continuum figure illustrates the following nine conclusions:

Figure 7.1, The Technological Innovation Continuum

The technological innovation continuum figure illustrates the following nine conclusions:
The three phases of the innovation process; the origin of innovation, the execution of an innovation, and the promotion of an innovative idea, overlap rather than being rigidly compartmentalized.

The innovation process could start or could be started anywhere along the continuum.

The culture of the innovator and the dominant business language are undeniably key factors that influence the process, progress and fate of an innovation.

The innovator’s personal culture and business language can play complementary roles or can help and/or hinder his or her efforts to advance an innovation in the larger world.

When the promotion phase is reached or as an innovation begins to enter the promotion phase, business language becomes increasingly important and the innovator’s cultural background becomes less important.

At the beginning of the idea formation stage of innovation process (the innovation generation phase), the innovator’s cultural background becomes more important, and it appears that any language is sufficient for innovative content.

Language and cultural factors are themselves integrated and therefore cannot always be treated as independent causative variables; it is during the execution phase of the innovation process that the interdependence of language and cultural factors most strongly conditions what happens to a potential innovation. In other words, they tend to converge and become more powerful determinants as the innovation process moves toward the execution phase.
It is useful to conceptualize the relationship between language and culture with respect to their impact on innovation as bi-directional, with culture decreasing (descending) in power as language is increasing (ascending) in power over time; culture is more determining at the beginning of the innovation process and language becomes progressively more determining as an innovation matures into a product or technology.

However, both language and culture remain active and play powerful roles during the execution phase.

The literature reviewed and the interview data indicate that, although language or cultural background positively contribute to the generation of innovative ideas, when it comes to promoting and marketing an innovative idea, the dominant business language plays a more significant role.

This study has also demonstrated that one’s national culture indeed plays a role in idea generation through the mediation of the many psycho-cultural factors such as needs, exposure, challenges, attitudes, beliefs, and values.
7.2.2 RECIPROCITY BETWEEN LANGUAGE FACTORS, CULTURAL FACTORS AND TECHNOLOGICAL INNOVATION

In Chapter 5 (cf. 5.3.1 through 5.3.5) it has been demonstrated that technological innovation is influenced by factors such as language, culture, exposure, education, experience and the environment. The author has attempted to capture the dynamic interplay between all these innovation shaping and retarding factors in the above figure that is depicted in 7.2.
In figure 7.2, it can be seen that metaphorically the sun (technological innovation or \( \text{TI} \)) sheds its rays (innovation spin-offs) in accordance to the gases (innovation factors) that influence its nature (technological innovation process). Likewise, \( \text{TI} \) is influenced by factors such as the ones shown in figure 7.2, and in turn it provides illumination necessary for more ideas (from the factors indicated) to come about, and this interactive reciprocity continues. Interactive reciprocity refers to the interplay between culture and language factors, as indicated by arrows pointing inward. The way the technological innovation process is influenced and affected, as indicated by the outward pointing triangles, generates certain insights, consequences and results.

In other words, technological innovation and/or its process, benefits from the influence of language and cultural factors. In turn, language (\( \text{L} \)) and culture (\( \text{C} \)) are influenced by the technological innovation (\( \text{TI} \)) and/or its process. The initial purpose of this study was to explain how technological innovation is influenced by language and cultural factors. This research, however, has led the author to the conclusion that \( \text{TI} \) also influences \( \text{L} \) and \( \text{C} \).

In Chapter 5, it was reported that participants whose mother tongues were not English, preferred to communicate in English because it was a common business language. As discussed in Chapter 5, the use of the English language when communicating about technology is preferred by the majority of the participants. “New vocabulary also develops as a result of new technology” is what one participant commented. This view is also shared by Capra (2002) who stated that, “Technology, however, is much older than science. It’s origins in tool making go back to the very
The Role of Language and Culture in Technological Innovation

dawn of the human species when language, reflective consciousness, and the ability to make tools evolved together”.

When referring to the “increasing tensions between cultural values and high technology” Capra (2002) states, “…defenders of technology do not realize that a specific technology will always shape human nature in specific ways, because the use of technology is such a fundamental aspect of being human”. This argument asserts that culture, like language, is deeply influenced by technology.

One participant stated, “…mother tongue may be good for things like literature, but not for my innovations”. Others stated, “The reason I use English more, is to avoid limitations (even though), I am a third generation French speaker”. Another participant (cf. 5.3.4 (iii)) stated “everything is in English, so from that perspective, I would say the English language is important, though it is not the only language I speak. But for someone who speaks a different language, (about one second pause)…they might need to learn English seriously”.

These recorded statements and arguments from credible sources indicate that the technical language or language of technology determines what language innovators will typically use. Participants whose mother tongues is not English, struggled to find words, phrases, definitions in their mother tongues compared to English-speaking participants (see 5.3.4 (i) - (v)). It can also be argued, that the struggle to use and master technology contributes to the improvement of vocabulary for engaging with the technology.
Rather than viewing the innovation processes from a specific perspective to the exclusion of other perspectives, this study has demonstrated that in most cases the technology, language, culture and human interactions resulted to complementary benefits. The following subsections (7.3 through 7.8) provide a discussion on lessons learned during this study. The purpose here is to contribute towards future improvement of research undertakings or commissions exploring the relationship between technology, language and culture in developing countries. The author believes this research indicates the inherent transdisciplinary reality of all processes of innovation. To this end, the author offers a few recommendations for consideration concerning the value of similar studies for unlocking the innovation potential in countries where it is lacking.

The following discussion is mainly based on the experiences gained by the author in the process of researching and writing this thesis. The lessons learned about research methodology are discussed below followed by a few comments on the importance of transdisciplinary research.

7.3 RESEARCH METHODOLOGY LESSONS LEARNED AND RECOMMENDATIONS

7.3.1 SAMPLE IDENTIFICATION PROCESS

It was challenging to identify the correct sample. The reason is that in some cases the inventor is either unknown or not the same person as the innovator. Quoting Evenson (1984), Shane (1992) states, “Three fundamental requirements must be met by an invention to qualify for the standard invention patent (1) the invention must be ‘novel’
(2) the invention must be ‘useful’ (3) the invention must exhibit an ‘inventive step’ (i.e. it must not be obvious to practitioners skilled in the technology field)”.

While this research was mainly conducted in South Africa and did not focus on international inventions, the researcher aimed at individuals and companies that met the criteria mentioned above for defining an inventor. An organization whose characteristics met enough of these criteria would be admitted into the sample. In South Africa a professional agency annually selects the 100 top technology innovators (TT100). The sample used in this research was sourced from the TT100 winners. The TT100 criteria for winners is based a number of relevant factors (see www.tt100.co.za):

*Alignment* which has to do with linking technology and people and meeting strategic objectives.

*Engagement* which has to do with linking innovation and people as well as ensuring that there is connectedness, contribution and credibility.

*Agility* which has to do with linking technology and innovation as well as “ensuring that the organization is able to meet the challenges of growing competition through the use of new tools. Here the concepts of First to Market, Productivity, and Rapid Prototyping are key attributes”.

As the research progressed, this approach to constructing the sample was found to be limiting the number of participants for the sample because the researcher was aiming to get a representative balance between South Africa’s major cultural groups. The
researcher speculates that there may be a limited number of innovators who either patent or enter innovation competitions, especially from certain language and culture groups. This speculation needs to be tested by future research.

It also appears that because of the accessibility of information in recent times there is more idea-stealing or reinvention than original invention. The rapid circulation of innovations is caused by intermarriage, cultural hybridity, migration, and several other reasons that create human beings who are profoundly multi-cultural. For the above reasons it is difficult to identify a balanced sample of genuine innovators who are culturally representative of South Africa. It is also generally difficult to precisely and conclusively determine the person who is the original inventor or innovator.

The author learned a major lesson from the experts who constituted phase 1 of participants and from the phase 2 innovators themselves. The lesson learned is that in South Africa, at the time of this research, there was still a need for more organizations that recognize and promote national innovations and gather useful statistics and information about innovators coming from all culture and language groups in the country. The author finally had to ultimately discontinue attempts to find innovation originators or inventors representative of the cultural diversity of South Africa. The researcher had to settle on interviewing innovators who were simply involved in innovation regardless of when they became involved. Upon finding these participants, the author had to try and find out as much as possible about where the original idea had come from (the past), its current status (the present), and what the present day carriers of a particular innovation aimed at achieving (the future). The process of sample identification was followed by the data collection process.
7.3.2 DATA COLLECTION PROCESS

The data collection process can challenge a researcher that lacks access to people with expertise needed to generate high quality data about his or her area of study. Attending many national and international conferences and networking as widely as possible helped the author to familiarize himself with the actors. While networking with innovators and students of innovation new ideas emerge about what questions to ask and how to investigate them and who to talk to. By surrounding oneself and interacting with experts more useful information emerges. The data collection process was followed by the data analysis process.

7.3.3 DATA ANALYSIS AND SYNTHESIS PROCESSES

The author recommends to future researchers in the field of innovation studies that they should expose themselves early on to a good sample of data gathering and analytical methodologies and software packages. The QSR Nudi*st software was useful for data searching, categorization and coding, sorting and pattern recognition. Nudi*st assisted by helping to manage the large number of documents with which the author was dealing in this research. Both the SPSS and Microsoft Excel software packages proved useful for analysis, meaning-making and presentation of data (see also subsection 1.4.2 in Chapter 1). These methodologies and software packages tended to complement each other, rather than confuse the author.

The author has found that it is generally good practice to consider recommendations by pioneers in any field. However, the author’s view is that researchers need to be
independent minded enough to discover what works for them. Dismissing certain techniques simply on the basis that they are not recommended by pioneers is a risky strategy; deciding to follow respected leaders in the field or to strike out in a new direction is a matter that requires careful judgement on the part of the researcher.

It may be necessary in some cases to rely on one’s own insights and creativity in order to arrive at an appropriate solution to a research challenge. When undertaking original research requiring high levels of data analysis, it is important for researchers to take certain risks to make new contributions to knowledge and to help those who will do research after them. As researchers experiment with various methodologies and software packages they must not forget to check why forerunners preferred or rejected particular methodologies and software packages. There is an opportunity to learn value lessons by understanding their choices. After analyzing everything, it helps to bring what one has learned back together, and evaluate where you are with respect to what set out to accomplish. This mental stock taking can be termed data synthesis.

A similar approach to the one about analysis is applicable to the data synthesis process. In this study, the author found that it works best to use the same sub-problems that informed the entire research project in the first place. Keeping the original purpose of your research project and its specific objectives clearly in mind is critically important. Another benefit of the data synthesis approach is that it ensures all the sub-problems get addressed before drawing a final conclusion.
7.4 GROUNDED THEORY AND TRANSDISCIPLINARITY:

A REFLECTION ON APPROPRIATENESS AND USEFULNESS FOR THIS STUDY

This study used a qualitative research framework. The main research methodology used within the qualitative research framework was grounded theory (GT). GT offered several appropriate methods and techniques of research such as open coding, axial coding and selective coding (cf. subsection 3.12.2 in Chapter 3) for data analysis. These analytical methods and techniques were carefully chosen in the light of the transdisciplinary nature of this study. Transdisciplinarity implies that knowledge generation is context dependent rather than confined within a particular paradigm. Language, culture and technological innovation need to be understood in their contexts because these domains span many disciplines (transdisciplinary). The knowledge that was generated from these different contexts was grounded in data and in accordance with the research principles of the grounded theory methodology. This study has therefore attempted to integrate the GT methodology of the qualitative research framework with the transdisciplinary mode of knowledge generation to guide the process of choosing appropriate methods and techniques for data gathering and analysis. The methods and techniques for accessing tacit knowledge, which is often beyond discipline specific boundaries, needed to be adapted to the dynamic contexts. For example, some participants could think of words and/or phrases relating to technology only in their home languages. The qualitative research framework used in this study made it possible for the researcher to allow the interview to change with the language or cultural context (mode 2) of the participants.
The methods and techniques available in a grounded theory methodology such as open coding, axial coding and selective coding proved useful. The *constant comparative method* of analysis available within grounded theory assisted when engaging in data analysis and looking for patterns. The power of inductive thinking within a qualitative research framework, supported by the GT methodology, has allowed the researcher to ask fundamental questions such as: why, how, and in what way? For example, ‘what is the relationship between language, culture and technological innovation?’

The understanding that this study is fundamentally transdisciplinary in nature – because the innovation process which it seeks to study is also a transdisciplinary process- allowed the researcher to follow emerging data (a feature of GT) in a non-discriminate manner. The researcher used the approach of having an open mind to that which lies beyond the individual disciplines (i.e. an attribute of mode 2 research or transdisciplinarity).

7.5 REPORTING AND PRESENTING ON NON-DISCIPLINE SPECIFIC TOPICS

A non discipline-specific topic, by its very nature implies that there is a possibility for an interdisciplinary specific audience and that interested readers will necessarily be from diverse educational backgrounds. Although it may be tempting to use discipline-specific jargon and terminology that is current in relevant disciplines, as far as possible the researchers should endeavour to use discipline neutral language when writing their reports and making presentations of their findings. The goal is to make
their insights and conclusions accessible to as wide range of professional and interested readers as possible. In researching and writing this thesis, the author has attempted to avoid using discipline specific jargon.

7.6 LIMITATIONS AND POSSIBLE FUTURE RESEARCH

Technological innovation is a complex multi-dimensional process that is not easy to observe in action. Technological innovation is often a product of a number of sub-processes, events, situations and people that come together in ways that result in an innovation. These combinations are not easy for the innovators themselves to anticipate, or predict. This limits the research process to what participants are able to recall and what they consider to have contributed towards a realized innovation.

Were the author to conduct this research again with the same participants under different circumstances it is likely that a comparison of the later findings with earlier findings would yield different—and possibly deeper insight into influence of language and culture influence on technological innovation. These circumstances could include different time periods, different data gathering methods, and resulting differences in data sets. Another limitation of this study is that apart from the Afrikaans and English language groups here in South Africa, the other participants identified from the sample were only from the Nguni language groups.

When reflecting on the research process, the author recommends that in the future, some kind of collaboration between different countries, developed and developing, be fostered. This collaboration could be focused on conducting a thorough comparative study between these countries based on exactly the same factors or variables (for
example language, culture and technological innovation). Such a longitudinal multi-
country comparative study is likely to discover more variation and more effects than
were demonstrated by this study.

7.7 CONCLUDING REMARKS

This thesis has affirmed that technological innovation breaks down into phases: (i)
innovation origin, (ii) innovation execution, and (iii) innovation promotion otherwise
known as marketing. Both literature and the empirical data from this thesis indicate
the importance of understanding that technological innovation is not an event. It is a
process marked by phases from inception to launching.

The original impulse of the process of innovation could be triggered anywhere along
the three phase continuum and proceed in one direction or another or both as
demonstrated in figure 7.1 The business language and the culture of an innovator
play complementary and integrated roles during technological innovation. In this
thesis the predominant business language referred to is English. The understanding of
the business language has been highlighted as an important factor that progressively
becomes more important as the innovation process moves along the continuum from
the origination phase towards the phase of marketing and technology utilization.

Both language and culture factors influence the rate of technological innovation in a
society and that at different stages of the technological innovation continuum one
factor increasingly plays a significant role compared to another (see also the
description below figure 7.1). For example, culture is shown to be playing a more
significant role during the innovation conception or idea generation stage compared to the role of business language whose role becomes more significant during marketing and utilization.

As demonstrated in figure 7.2, an innovator’s home or indigenous culture consisting of factors such as culturally shaped needs, exposure, challenges, attitudes, beliefs, and values plays an important role in the technological innovation process.

It is hoped that this study has demonstrated that different research methodologies can be used when investigating complex phenomena like innovation. The study also demonstrated that it is possible to use a transdisciplinary approach to study innovation without compromising the established rules for the use of the different methodologies.

As already mentioned before, this study is primarily based on the qualitative approach, however, as can be seen in appendix D, some quantitative methods were also used during data analysis and these methods yielded useful insights. These insights assisted in the formulation of the conclusion of this thesis.

The author learned a great deal about the research process and the complex field of innovation from this study. The hope is that this study will inspire other researchers to discover a new way of thinking about technological innovation. If this study had contribution to promoting this new way of thinking and researching innovation, then the effort to do this study will have been justified. Finally, the author has enjoyed the process of producing this work, as challenging as it proved to be in the end.
REFERENCES


The Role of Language and Culture in Technological Innovation


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*The Role of Language and Culture in Technological Innovation*


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*The Role of Language and Culture in Technological Innovation*


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The Role of Language and Culture in Technological Innovation


Table A1, **PHASE 1: RESEARCH PARTICIPANTS & EXPERTS**

<table>
<thead>
<tr>
<th>PARTICIPANT</th>
<th>POSITION</th>
<th>ORGANIZATION</th>
<th>COUNTRY</th>
</tr>
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<tbody>
<tr>
<td>1.</td>
<td>READER TECHNOLOGY SOCIOLOGY ENGINEER; HEAD OF DEPARTMENT, INNOVATION SYSTEMS POLICY</td>
<td>INSTITUTE SYSTEMS AND INNOVATION RESEARCH (ISI) FRAUNHOFER</td>
<td>KARLSRUHE, GERMANY</td>
</tr>
<tr>
<td>2.</td>
<td>DIRECTOR OF INNOVATION AND CREATIVITY</td>
<td>CENTRE FOR ENTREPRENEURSHIP (cfe), GREENWICH UNIVERSITY</td>
<td>UNITED KINGDOM, LONDON</td>
</tr>
<tr>
<td>3.</td>
<td>PROFESSOR OF CYBERNETICS: SCHOOL OF SYSTEMS ENGINEERING</td>
<td>THE UNIVERSITY OF READING</td>
<td>UNITED KINGDOM</td>
</tr>
<tr>
<td>4.</td>
<td>ADVISER (SCIENTIST-G), MINISTRY OF SCIENCE &amp; TECHNOLOGY/TECHNOLOGY/BHAVAN</td>
<td>GOVERNMENT OF INDIA: DEPARTMENT OF SCIENTIFIC &amp; INDUSTRIAL RESEARCH,</td>
<td>NEW DELHI, INDIA</td>
</tr>
<tr>
<td>5.</td>
<td>RESEARCH FELLOW: DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS CENTER OF INNOVATION FOR SUSTAINABLE DEVELOPMENT</td>
<td>CHALMERS UNIVERSITY OF TECHNOLOGY</td>
<td>GÖTEBORG, SWEDEN</td>
</tr>
<tr>
<td>6.</td>
<td>VICE DEAN, ASSOCIATE PROFESSOR: SCHOOL OF TECHNOLOGY MANAGEMENT AND ECONOMICS, DEPARTMENT OF INDUSTRIAL DYNAMICS</td>
<td>CHALMERS UNIVERSITY OF TECHNOLOGY</td>
<td>GÖTEBORG, SWEDEN</td>
</tr>
<tr>
<td>7.</td>
<td>PhD Researcher</td>
<td>UNIVERSITY OF TECHNOLOGY</td>
<td>HYDERABAD, INDIA</td>
</tr>
<tr>
<td>8.</td>
<td>CHIEF DIRECTOR: INSTITUTE FOR ECONOMIC RESEARCH ON INNOVATION (IERI), FACULTY OF ECONOMIC SCIENCES</td>
<td>TSHWANE UNIVERSITY OF TECHNOLOGY</td>
<td>PRETORIA, SOUTH AFRICA</td>
</tr>
<tr>
<td>9.</td>
<td>MANAGER: OPEN SOURCE CENTRE (OSC)</td>
<td>COUNCIL for SCIENTIFIC and INDUSTRIAL RESEARCH (CSIR)</td>
<td>PRETORIA, SOUTH AFRICA</td>
</tr>
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<td>10.</td>
<td>PRINCIPAL RESEARCH</td>
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<td>ILE-IFE, NIGERIA</td>
</tr>
<tr>
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<td>Position/Title</td>
<td>Institution/Department</td>
<td>Location</td>
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<td>12.</td>
<td>DEAN: LANGUAGES AND COMMUNICATION DEPARTMENT</td>
<td>WALTER SISULU UNIVERSITY</td>
<td>EAST LONDON, SOUTH AFRICA</td>
</tr>
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<td>13.</td>
<td>SENIOR LECTURER: LANGUAGES AND COMMUNICATION DEPARTMENT</td>
<td>WALTER SISULU UNIVERSITY</td>
<td>EAST LONDON, SOUTH AFRICA</td>
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<tr>
<td>14.</td>
<td>Professor of Technology Management, Innovation &amp; Psychology</td>
<td>DA VINCI INSTITUTE</td>
<td>JOHANNESBURG, SOUTH AFRICA</td>
</tr>
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<td>15.</td>
<td>EXECUTIVE DEAN: ENGINEERING AND BUILT ENVIRONMENT</td>
<td>UNIVERSITY OF JOHANNESBURG</td>
<td>JOHANNESBURG, SOUTH AFRICA</td>
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<td>16.</td>
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<td>17.</td>
<td>Head of Psychology Department</td>
<td>UNIVERSITY OF FORT HARE</td>
<td>EAST LONDON</td>
</tr>
<tr>
<td>18.</td>
<td>Senior Lecturer/Innovation Researcher</td>
<td>Gordon Institute of Business Science (GIBS)</td>
<td>JOHANNESBURG, SOUTH AFRICA</td>
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# Table B1, Phase 2: Top Technology Innovators & Interviewees

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<tr>
<th>Participant</th>
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<tr>
<td>1.</td>
<td>Computer Security at DST</td>
<td>BSc.(Electronics), MSc.(Computer Science)</td>
</tr>
<tr>
<td>2.</td>
<td>Information Technology(IT)</td>
<td>IT Degree, PhD (Strategic Management)</td>
</tr>
<tr>
<td>3.</td>
<td>IT Manager and Dentist</td>
<td>Degree in Dentistry</td>
</tr>
<tr>
<td>4.</td>
<td>Audiologist/Speech Therapist(prev.); Computer as an HR Tool (currently)</td>
<td>PhD (Educational Psychology), &amp; many diplomas</td>
</tr>
<tr>
<td>5.</td>
<td>Patents Consultant</td>
<td>MBChB</td>
</tr>
<tr>
<td>6.</td>
<td>Medical Education and Treatment</td>
<td>PhD (Medicine)</td>
</tr>
<tr>
<td>10.</td>
<td>Mechanical Engineering Design of Equipment</td>
<td>BSc. (Mech. Eng.)</td>
</tr>
<tr>
<td>11.</td>
<td>Chartered Marketer and Manager of Innovation Leadership at CSIR</td>
<td>MBA</td>
</tr>
<tr>
<td>12.</td>
<td>IT software designs, Mechatronics</td>
<td>BSc. (Mechatronics) and Business Dipl.</td>
</tr>
<tr>
<td>13.</td>
<td>Entrepreneur (Electronic Engineering Industry)</td>
<td>B Eng.(Electronics)</td>
</tr>
<tr>
<td>14.</td>
<td>Manager of Open Source Systems Centre at CSIR</td>
<td>BSc. (Comp. Science), MBA, and Certificates</td>
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<td>15.</td>
<td>IT, Client Relation Management</td>
<td>Matric</td>
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<td>19.</td>
<td>Teacher, Multilingual Education Material and Equipment Designer</td>
<td>Bachelor of Education, and Diplomas</td>
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<td>20.</td>
<td>Software Development</td>
<td>BSc.(Comp. Science), BSc. Eng.(Electrical and Electronics), MSc. (Elec.Eng.).</td>
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<td>Marketing</td>
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<td>23.</td>
<td>Social Entrepreneur and Artist</td>
<td>B.A fine Arts</td>
</tr>
<tr>
<td>24.</td>
<td>Frequency Identity Implants, Cybernetics</td>
<td>PhD</td>
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</table>

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The Role of Language and Culture in Technological Innovation
Dear Participant

I am currently doing field research toward my PhD studies by looking at the relationship between language, culture, technology and innovation. Kindly assist by answering the following questions which cover your brief profile, your opinions about innovation in general, and (if you can) specifically about technological innovation. This is not a judgment exercise and there are no wrong or correct answers as these are purely your opinions and experiences. Thanking you in advance for your valuable contribution to this research.

YOUR BRIEF PROFILE

(a) Mother/Father tongue(s)

(b) Preferred Language

(c) Gender  (0) Male  (1) Female

(d) Age  (1) under 20  (2) 20-30  (3) 31-40  (4) 41-50  (5) over 50

(e) Field of Specialization or Occupation (Current and Previous):

(f) Knowledge Acquisition

<table>
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<th>Education (i)</th>
<th>(1) Non –formal</th>
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<td>Level of education ( )</td>
<td>(1) High School</td>
<td>(2) College</td>
<td>(3) University / Technikon / Polytechnic</td>
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<table>
<thead>
<tr>
<th>Name(s) of Qualification(s) (ii)</th>
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</thead>
<tbody>
<tr>
<td>Name of Institution(s) (iii)</td>
</tr>
<tr>
<td>Language(s) of Study (iv)</td>
</tr>
</tbody>
</table>

(g) Societal background (i)  (1) Rural Village (2) Farm (3) Township (5) City/Suburb

(ii) Name of City/ Suburb/Township/Rural Village/Farm:

(iii) Region/Province/District:

(h) Ethnic Group:  (1) African (Black)  (2) Coloured  (3)Indian  (4)White  (5) Other (Specify)
YOUR OPINIONS AND EXPERIENCES

1. Please tell me about the times and places when you were most innovative:
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________

2. What do you believe triggers innovation in a person?
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________

3. What factors or situations do you believe contributed to one’s innovation(s)?
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
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   _________________________________________________________________

4. What do you believe stimulates innovation?
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________

5. Does this (answer in 4.) apply to all people? Yes  [ ] No  [ ]
6. Please provide the reason for the answer given in (5) __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

7. What do you believe can be a barrier to innovation? __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

8. Does your culture stimulate innovation?
   Please give reasons for your answer. __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

9. Does your language stimulate innovation?
   Please give reasons for your answer. __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

10. Please provide some words or phrases that are associated with innovation from your language and/or culture __________________________________________________________
    __________________________________________________________
    __________________________________________________________
    __________________________________________________________
    __________________________________________________________
    __________________________________________________________
    __________________________________________________________
11. What role did the following play in your innovations?:

<table>
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<th></th>
<th>Insignificant</th>
<th>Neutral</th>
<th>Major</th>
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<tr>
<td><strong>B. Exposure/experience</strong></td>
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<tr>
<td><strong>C. Culture and Environment (beliefs, values, up-bringing)</strong></td>
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<tr>
<td><strong>D. Language (Mother tongue or other, please specify)</strong></td>
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</tbody>
</table>

*The Role of Language and Culture in Technological Innovation*
E. I chose the career that I am following because:

1) I was exposed to it at school
2) My family/friends encouraged me to choose it
3) I was exposed to it at university
4) I learnt about it at my workplace
5) It was my talent
Other, please specify________________________________________

F. When I entered this career, it was:

1) New to me, I was only exposed to it at the workplace
2) Familiar to me due to school experience
3) Familiar to me due to exposure by family/friends
4) New to me, I was only exposed to it at university
5) Other: Please specify______________________

G. I apply my:

1) School knowledge to my innovations
2) Family/background knowledge to my innovations
3) My tertiary education knowledge to my innovations
4) My workplace learnt knowledge to my innovations
5) Other: Please specify________________

H. I think in:

1) My home language
2) My mother/father tongue
3) My workplace language
4) My language of learning
5) Other: Please specify________________________________

I. I am more comfortable in sharing my ideas in:

1) My home language
2) My mother/father tongue
3) My workplace language
4) My language of learning
5) Other: Please specify__________________________________
OWN ASSESSMENT

A. Does language play a role in innovation?

B. Does culture play a role in innovation?

Do you have any other comments on this study? If yes, please write them below:

Once again, thank you for your time and inputs

The Role of Language and Culture in Technological Innovation
The quantitative analysis has deliberately been made to form part of the appendix. The reason for this is that, it was found to be possible to report on results based on the used sample size, simply by using qualitative data and methods and then drawing from the quantitative analyses provided elsewhere in thesis.

The table below (i.e. Table D) shows that both \( L \) and \( C \) have individual averages and standard deviations (\( L\text{-AVE.}=7.68, \; L\text{-STDEV.}=2.212088 \) and \( C\text{-AVE.}=7.56, \; C\text{-STDEV.}=2.256103 \), respectively) that indicate a close relationship.

Further it was illustrated in the same table that in relation to technological innovation both \( L \) and \( C \) demonstrate a substantial degree of correlation (\( r=0.730359 \)).

Equations 1, 2 and 3 were used to calculate the mean, the standard deviation and the coefficient correlation, respectively. Table D illustrates the findings which are subsequently discussed briefly. The participant who gave zero (0) score ratings was also included (not treated as an outlier) during the calculations of the Means, Standard Deviations and the Correlation Coefficient. Therefore all 25 participants from the sample of technology innovators were included.
Table D, Mean, Standard Deviation and Correlation on Participants’ Own Assessment

Ratings on Role of Language and Culture in Technological Innovation

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<tr>
<th>LANGUAGE (L)</th>
<th>CULTURE (C)</th>
<th>STDEV</th>
<th>L</th>
<th>C</th>
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<th>C</th>
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</tbody>
</table>

L- AVERAGE 7.68  C- AVERAGE 7.56

Average for Language (L) and Culture (C) Score Ratings

L-STDEV 2.212088  C-STDEV 2.256103

Standard Deviations (STDEV) for Language (L) and Culture (C) Score Ratings

r (L and C) 0.730359

Correlation Coefficient for (L) and (C)

Table D provides a summary of the participant’s own assessments. The mean values for both language (L) and culture (C) are calculated using equation 1.
Equation. 1  \[ \text{Mean} = \overline{x} = \frac{\sum x}{n} \]

Where,
- \( \overline{x} \) = the Mean of L or C scores
- \( x \) = each score
- \( \sum x \) = summation of L or C scores
- \( n \) = number of scores

The mean values, as can be seen in Table D, indicate little variation of 0.12 in the scores for both language and culture in relation to technological innovation. The mean for language (7.68) scores is slightly higher than the one for culture (7.56). The author does not however, wish to read too much into this as it does not necessarily represent all technology innovators. What can be concluded from these mean values is that collectively the interviewed participants view both the language and culture factors as having a comparable degree of influence on technological innovation.

At this stage, the author sought to quantify the variability of values within the language data set and within the culture data set using a Standard Deviation (STDEV) equation. Following is the equation that was used and a brief discussion on what emerged as can also be seen from Table D.

Equation. 2  \[ \text{Standard Deviation (STDEV)} = s = \sqrt{\frac{\sum (x - \overline{x})^2}{n - 1}} \]

Where,
- \( s \) = the Standard Deviation
- \( \overline{x} \) = the Mean of L and C scores
- \( x \) = each score
- \( \sum \) = summation of scores
- \( n - 1 \) = number of sample scores
As can be seen from Table D, the standard deviations for both the language data set and the culture data set are not expansively dispersed. As was the case with the mean values, it can generally be concluded that there is a close relationship between language ($L$) and technological innovation (TI), and also between culture ($C$) and technological innovation. In other words, the values obtained indicate less variability among the $L$ scores within the $L$ data set in relation to TI, and also among $C$ scores within the $C$ data set in relation to TI (see Table D).

**Equation 3**

\[
\text{Coefficient of correlation } = r = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2 \sum (y - \bar{y})^2}}
\]

Where,

- $r$ = Correlation Coefficient
- $\bar{x}$ = the Mean of $L$ scores
- $\bar{y}$ = the Mean of $C$ scores
- $x$ = each $L$ score
- $y$ = each $C$ score
- $\sum$ = summation

Finally, the author wished to determine the degree of similarity between $L$ and $C$ by using a correlation coefficient equation (equation 3). The value obtained, which is (0.730359), indicates a moderate to significant correlation between $L$ and $C$ scores in relation to technological innovation as shown in Table D under $r (L \text{ and } C)$. 
COMPARISON OF LANGUAGE AND CULTURE DATA IN RELATION TO TECHNOLOGICAL INNOVATION USING CROSSCORRELATION AND COVARIANCE METHODS

CrossCorrelation & Co-Variance of L&C

Result

CROSSCORRELATION

COVARIANCE

((2xN)-1)

The Role of Language and Culture in Technological Innovation
Graph showing the result of cross-correlation between Language (L) and Culture (C) data using MATLAB for data analysis

L= Language;  C= Culture

L =

9  8  8  9  7  6  0  5  10  6  10  8  8  6  10  8  7  9
8  10  10  9  5

C =

8  6  10  8  3  8  0  10  10  7  10  9  8  8  7  6  8  8  9
8  8  9  10  5

CrossCorrelation Result of L&C

Results

0  500  1000  1500

2Xdata set for L&C

The Role of Language and Culture in Technological Innovation
The Role of Language and Culture in Technological Innovation

Result-for-L-C = 1.0e+003 *

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<thead>
<tr>
<th>Columns 1 through 15</th>
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<tbody>
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Standard Deviation Data and Graphs (A, B, C)

STDEV USING MS EXCEL (A)
The Role of Language and Culture in Technological Innovation

STDEV USING Matlab (B)

STDEV Residuals (C)

Residuals
### Table Showing Diversity and Profile of Participants

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<th>P #</th>
<th>A</th>
<th>E</th>
<th>L</th>
<th>C</th>
<th>G</th>
<th>T</th>
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**PARTICIPANT (P#)**

**AGE (A):** 1= UNDER 20; 2= 20-30; 3=31-40; 4= 41-50; 5= OVER 50

**EDUCATION (E):** 1= HIGH SCHOOL; 2 = TERTIARY EDUCATION

**SCALE:** 0 -10 (Where 0 = no, 5 = maybe, 10 = Definitely)

**ROLE OF LANGUAGE IN TECHNOLOGICAL INNOVATION (L)**

**ROLE OF CULTURE IN TECHNOLOGICAL INNOVATION (C)**

**GENDER (G):** 0= MALE; 1= FEMALE

**MOTHER TONGUE (T):** 1= ENGLISH; 2= AFRIKAANS; 3= ZULU; 4 = XHOSA; OTHER=5

**RACE (R):** 1= AFRICAN; 2= COLOURED; 3= INDIAN; 4= WHITE

**ROLE OF EDUCATION IN TECHNOLOGICAL INNOVATION (R/E):** 1= INSIGNIFICANT; 2 = MAJOR

---

The Role of Language and Culture in Technological Innovation
Figure Illustrating Comparison between Language and Culture Roles on Technological Innovation
Figure illustrating the Role of Language in Technological Innovation by showing the median and the standard deviation.
Figure illustrating the Role of Culture in Technological Innovation by showing the median and the standard deviation.
SUMMARY OF IDENTIFIED AND ASSESSED LANGUAGE AND CULTURE CATEGORIES IN TECHNOLOGICAL INNOVATION

(a) Culture

(i) Knowledge
(ii) Environment
(iii) Exposure & Experience
(iv) Career choice
(v) Attitude

(b) Language

(i) Sharing of Ideas
(ii) Thinking of Ideas
(iii) Words & Phrases
(iv) Education
(v) Access & research

(c) General, but significant points that have also emerged often and less often from data collection.
SITUATIONS THAT LEAD TO INNOVATION (cf. 5.4.1: Opinions [1,4])

(1) When smoking, when under pressure, necessity is mother of all inventions.
(2) When under pressure (x2), when frustrated, when there is no comfort, Innovation is a product of stress and frustration.
(3) Early in the morning, During praying times.
(4) When I cannot fall asleep, when having a problem (x1) at hand, when relaxing & during brainstorming (x1).
(5) When having problems (x2).
(6) By not accepting donations and no grants, circumstances, Lack of resources (e.g. funds).
(7) When needing a solution to a problem (x3).
(8) When there is a need.
(9) When there is a need.
(10) Migration, Change, new environment, challenge (x1).
(11) New ideas, Brainstorming (x2), Sleeping, Pressure (x3), busy, challenge (2), conviction, not relaxing.
(12) In the morning
(13) When there is trust and caring.
(14) Greatest Need, Lack of Resources; Curiosity; Fewness of numbers
(15) Need for a solution.
(16) When there is a need.
(17) Early in the morning, when sleeping, Under-pressure.
(18) When in the workplace (Studio).
(19) When questioning something.
(20) Anywhere where there is opportunity to innovate.
(21) When hearing about problems (e.g. crime).
(22) Need, pressure, brainstorming and obstacles (reint. as challenge).
(23) During quiet times, at events, when I get strange ideas.
(24) Need, Exposure, when Networking.
(25) Challenge, At night when it is quiet, Anywhere when there is Inspiration.
### DISCUSSION ON OPINIONS AND EXPERIENCES OF PARTICIPANTS (cf. 5.4)

## TECHNOLOGICAL INNOVATION TRIGGERS (cf. 5.4.1: Opinion [2, 3])

Responses to: [2]

1. Desire to standout from the crowd, desire to achieve in life, Desire to leave a legacy and something different.
2. Challenge to solve a problem, General Challenges, Opportunities to help others.
3. Gap/Need to improve systems or to simplify them.
4. The Need.
5. Curiosity, Not Accept NOs, Not accepting that things are impossible.
6. Four skills (Entrepreneurship, Marketing, Understanding the Market, and Creative Design).
7. Need.
8. The Need and when something cannot be overcome by old ways.
9. Challenging assumptions, Positive and Negative things that happen to me, Emotions such as Hatred, Speculation, New Ideas and belief in Convictions.
10. Need to see the tail end of the idea, believing that you are a problem solver.
11. Good knowledge and Background.
13. Needs, Training (lateral thinking training), Discipline.
15. Reward and Making a difference.
16. Self confidence and 80% innate ability.
17. Need to solve a Problem.
18. Questions.
21. Creativity.
22. Creativity, Invention and Competitive edge.
23. Desire to express oneself and make a difference.
24. 70% Need and desire to make a difference.
25. Inspiration for Pioneers and Risks.
DISCUSSION ON OPINIONS AND EXPERIENCES OF PARTICIPANTS (cf. 5.4)

BARRIERS TO TECHNOLOGICAL INNOVATION (cf.5.4.1: Opinion [7])

(1) Socially constructed barriers such as copyrights and Patents
(2) Politics block commercial ideas due to competition
(3) Organizational Culture, Police-like environment, Too much regulation and management
(4) Lack of means (e.g. Money), Lack of support (family and friends)
(5) Finance and access to finance and information
(6) Bad Influence, Lack of human support, Gender disadvantage, Lack of awareness.
(7) Lack of understanding of economy and development. Lack of understanding competition
(8) Jealousy among some cultures, conditions around us (Attitudes and behaviors)
(9) Lack of Confidence. Lack of Education
(10) Language, Lack of Exposure
(11) Focusing on obstacles, Lack of Clarity of Vision
(12) Lack of Technical Support, Lack of Funding, Lack of access to knowledge
(13) Lack of Money, (Unfavourable) Economic conditions
(14) Monopolystic and anti-competitive behaviour. Patents and monoculture.
(15) Bad influence from those around you.
(16) Legislation and other government policies, Lack of freedom, Lack of support from family and friends. Lack of innovation fostering
(17) Lack of Education
(18) Negative attitude, Time, One should have more plans than one.
(19) Environment (society where you were brought up)
(20) Lack of Motivations to be innovative (Bill Gibson’s talk), State of Mind
(21) Licensing organizations, Lack of Information (e.g. Patent treaty society, Cipro)
(22) Environment, Finance, Fear of Failure, Mindset
(23) Insecurity, Lack of Funding, Intellectual Property Rights (IPs), Policies and Regulation.
(24) Lack of Passion, Little Salary (little reward)
DISCUSSION ON OPINIONS AND EXPERIENCES OF PARTICIPANTS (cf. 5.4)

SITUATIONS THAT LEAD TO INNOVATION (cf. 5.4.1: Opinions [1,4])

(1) When smoking, when under pressure, necessity is mother of all inventions.
(2) When under pressure(x2), When frustrated, When there is no comfort, Innovation is a product of stress and frustration.
(3) Early in the morning, During praying times.
(4) When I cannot fall asleep, When having a problem(x1) at hand, when relaxing & during brainstorming(x1).
(5) When having problems(x2).
(6) By not accepting donations and no grants, circumstances, Lack of resources (e.g. funds).
(7) When needing a solution to a problem(x3).
(8) When there is a need.
(9) When there is a need.
(10) Migration, Change, new environment, challenge(x1).
(11) New ideas, Brainstorming(x2), Sleeping, Pressure(x3), busy, challenge(2), conviction, not relaxing.
(12) In the morning
(13) When there is trust and caring.
(14) Greatest Need, Lack of Resources; Curiosity; Fewness of numbers
(15) Need for a solution.
(16) When there is a need.
(17) Early in the morning, when sleeping, Under-pressure.
(18) When in the workplace (Studio).
(19) When questioning something.
(20) Anywhere where there is opportunity to innovate.
(21) When hearing about problems (e.g. crime).
(22) Need, pressure, brainstorming and obstacles (reint. as challenge).
(23) During quiet times, at events, when I get strange ideas.
(24) Need, Exposure, when Networking.
(25) Challenge, At night when it is quiet, Anywhere when there is Inspiration.
Responses to: [4]

**More frequent:** Need (x6); Reward/Incentive (x3); Belief (x3); Competition (x2);

**Less frequent:** Problems, Information and awareness, Hardwork, Belief, sharing ideas, improvement, research, learning

(1) Arrogance;
(2) Discipline, Proper planning, Organized, Sharing ideas.
(3) Research, learning, ongoing improvement.
(4) Perseverance, Belief, Hard-work.
(5) Problems, Need, information and awareness.
(6) Innovation Impact, Exploration.
(7) Competition.
(8) Environment.
(9) Need.
(10) Burning the Bridge.
(11) Mindset for a Solution, Focus on end result, Even little progress
(12) Research and re-evaluation, Improvement, Good feedback.
(13) Rewards.
(14) Need.
(15) Passion for completion (liking what you do)
(16) Rewards (e.g. financial)
(17) Adversity.
(18) Needs.
(19) Questioning.
(20) Incentive (Reward); Desire to be own boss.
(21) Exposure.
(22) Need and competition (something that stands out).
(23) Belief that you will succeed.
(24) Need.
(25) Challenge and Self-Belief.
Cf. 5.4.4

(A) DOES CULTURE STIMULATE INNOVATION?  [8]

1-Y  2-Y  3-N  4-Y  5-Y  6-N  7-N  8-N  9-N  10-Y/N
22-Y  23-X  24-Y  25-Y

(B) DOES LANGUAGE STIMULATE INNOVATION?  [9]

1-Y  2-Y  3-Y/N  4-Y  5-Y  6-N  7-N  8-N  9-N  10-Y/N
22-Y/N  23-Y  24-Y  25-Y
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<tr>
<th>Number</th>
<th>Phrase</th>
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<td>1</td>
<td>CIVILIZATION, INVENTIVENESS, CREATIVITY, CONTROVERSY</td>
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<td>2</td>
<td>MARKETING, PROCESS, SYSTEM, EXPERIMENT, HOW TO USE TECHNOLOGY IN A NEW WAY. DOING SOMETHING IN A</td>
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<td>NEW WAY THAT ADDS VALUE AND NOT DESTROY THINGS</td>
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<td>KRIATIVIET, ORIGINALITY/OORSPRONKLIK, USE YOUR HEAD AND NOT YOUR HANDS</td>
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<td>KREATIVE, ‘N BOERE MAAK ‘N PLAN. NUWE IDEA EN NUWE GOODES.</td>
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<td>UKUTHUTHUKA (DEVELOPMENT)</td>
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<td>CURiosity, STAMINA, ENDURANCE, TRIAL AND ERROR</td>
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<td>CREATIVE DESIGN, ‘N BOERE MAAK ‘N PLAN. SPIRIT HAS NOTHING TO DO WITH LANGUAGE, EDUCATION AND O</td>
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<td>NOTHING I CAN THINK OF IN ISIXHOSA</td>
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<td>CHALLENGE, RESOLVE, ANALYSIS AND DELIVER</td>
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<td>CURiosity, CHALLENGE ASSumPTIONS, BELIEVE IN YOUR CONVICTIONS, LIFE CIRCUMSTANCES SUCH AS PO</td>
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<td>12</td>
<td>INFORMATION TECHNOLOGY, CREATIVITY, RESEARCH</td>
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<td>INPUT MUST LEAD TO OUTPUT, DIVERSITY, ENVIRONMENT</td>
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<td>COOPERATION, COMPETITION VERSUS COLLABORATION</td>
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<td>PROGRESS, SIMPLIFY LIFE-STYLE.</td>
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<td>CREATIVITY, MOTIVATION, MARKETING, IMPROVING, CHANGING, ADDING VALUE</td>
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<td>‘N BOERE MAAK ‘N PLAN, KEEP GOING (WINSTON CHURCHILL)</td>
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<td>UKWENZA UMZAMO, UKUQAMBA KABUSHA, UMSUNGULI</td>
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<td>UKUPUHLISWA, UBUGCISA, UKUQAMBA NOKUSUNGULU</td>
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<td>UKWENZA INTO ENTSHA.</td>
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<td>CREATIVITY, INVENTION, COMPETITIVE EDGE</td>
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<td>CREATIVITY, NEW TECHNOLOGY, SOLUTIONS, SUSTAINABILITY</td>
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<td>INVENTION, CREATIVITY AND MANY MORE.</td>
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<td>Role Played by Experience and Exposure in Innovation</td>
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<td>(cf. 5.4.1) [cultura] [a,b,c, e-1,2,3,4] f-1,2,3,4 g-1,2,3,4</td>
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### Education [cf. 11(A)]

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1. Only to a certain extent 2. MAJOR ROLE 8 OUT 10.

### Exposure/Experience [cf. 11(B)]

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CULTURE & ENVIRONMENT(cf.11(C))

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1 BUT DIFFERENT ENVIRONMENTS CAN EITHER STIFLE OR NURTURE INNOVATION 2 CAN BE GOOD OR BAD 3 YES TO SOME PEOPLE BUT NOT IN MY CASE 4 MAJOR NEGATIVE ROLE (NO ROLE MODELS) - CONFORMITY DUE TO CHRISTIANITY - (FOLLOW THE LEADER) AND ACCEPT THE NORM 5 CAN STIFLE OR PROMOTE INNOVATION

5.4.1 REASONS FOR CAREER CHOICE (CULTURE) [E]

RESPONSES TO: 11[E]

| (1)[1,2,3,4,5] | (2)[X1] | (3)[X2] |
| (4)[1,2,3,4,5] | (5)[X3] | (6)[1,2,3,4,5] |
| (7)[5]        | (8)[3]  | (9)[1,2,3,4,5] |
| (10)[2,3]     | (11)[1,2,3,4,5] | (12)[3,4] |
| (13)[1]       | (14)[X6] | (15)[X7] |
| (16)[2,5]     | (17)[2]  | (18)[1,2,3,4,5] |
| (19)[1,2,3,4,5] | (20)[2,4] | (21)[3] |
| (22)[2]       | (23)[5]  | (24)[5] |
| (25)[1,2,3,4,5] |        |            |

1 DESIRE TO HELP 2 NEED FOR NEW STIMULATION 3 BY ACCIDENT 4 EXCEPT FAMILY 5 OUT OF INTEREST 6 IT CHOSE ME DUE TO RETRENCHMENT 7 I STUMBLED ON [OVER] IT
5.4.2 USEFUL KNOWLEDGE IN TECHNOLOGICAL INNOVATION (CULTURE) [F,G]

RESPONSES TO: 11[F]

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1 HAD COMPUTER EXPOSURE THROUGH FRIENDS

RESPONSES TO: 11[G]

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</table>

1 EXACTLY IN THAT ORDER  2 AND GENERAL LIFE EXPERIENCES  3 I APPLY MY COMMON KNOWLEDGE AND ENCOURAGEMENT  4 THESE HAVE HELPED WITH DISCIPLINE, SCHOOL
<table>
<thead>
<tr>
<th>KNOWLEDGE ADDS TO HOME VALUES AND EXPERIENCE</th>
<th>5 TO A LESSE EXTENT [4]</th>
<th>6 STREETWISE KNOWLEDGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**LANGUAGE OF THOUGHT IN TECHNOLOGICAL INNOVATION**

cf. 5.4.1 (LANGUAGE) [H]

RESPONSES TO: 11[H]

(1)[ALL]E  (2)[x¹]  (3)[3,4]MORE(E)


(7)[ALL]E  (8)[3,4]ENOTX  (9)[x²]

(10)[ALL]ELESSA  (11)[1,3,4]E  (12)[3,4]ENOTFARSI

(13)[1³]E  (14)[1]Z  (15)[ALL]E

(16)[ALL(1)]E  (17)[XX]  (18)[1,4⁴]

(19)[ALL]E  (20)[1,2]X  (21)[1,2,4]A

(22)[4]E  (23)[ALL(1)]E  (24)[ALL]E

(25)[ALL]E

---

1 THINKING HAS NO LANGUAGE  E-ENGLISH  A-AFIKAANS  Z-ZULU  G-GERMANY
X-XHOSA  2 I THINK IN PICTURES OR MODELS  3 MOTHER TONGUE IS AFRIKAANS BUT ADOPTED ENGLISH (WIFE'S TONGUE) AS HOME LANGUAGE  XX-DO NOT KNOW  4 COMPLEMENT EACH OTHER

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The Role of Language and Culture in Technological Innovation
LANGUAGE OF IDEA SHARING AND COMMUNICATION IN TECHNOLOGICAL INNOVATION (LANGUAGE) [J or I]

RESPONSES TO: 11[J]

(1) [ALL]E
(2) [ALL]E
(3) [ALL]E
(4) [1,2]AE
(5) [ALL]A
(7) [ALL]E
(8) [3,4]E
(9) [3,4]E
(10) [ALL]E
(11) [1,3,4]E
(12) [3,4]E
(13) [1]E
(14) [1]E
(15) [ALL]E
(16) [ALL (1)]E
(17) [a/e]E
(18) [1,3]E
(19) [ALL]E
(20) [ALL]E
(21) [ALL]E
(22) [3]E
(23) [ALL]E
(24) [ALL]E
(25) [ALL]E

1 MORE IN ENGLISH THAN IN HINDI
2 DUE TO BEING GEARED FOR INDUSTRY
3 MOTHER TONGUE IS AFRIKAANS BUT ADOPTED ENGLISH (WIFE’S MOTHER TONGUE) AS HOME LANGUAGE
4 AFRIKAANS MIXED WITH ENGLISH
5 80% AFRIKAANS AND 20% ENGLISH