How transformational leadership and advanced technologies foster radical innovation: The role of advanced training, organisational learning, innovative climate and capabilities in large firms

By

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Wafa Ashoor declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Management/ UTS Business School at the University of Technology Sydney. This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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In the loving memory of my dad, Abdullah Ashoor.

~ I miss you and I wish you were with me to feel proud of my achievement ~

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ABSTRACT

Radical innovation is a key enabler to sustained competitive advantage and long-term success of firms. Despite its importance, there is lack of understanding of what components of a firm are able to best promote this type of innovation in dynamic market environments. Drawing on the dynamic capability theory, this study investigates how transformational leadership as a 'human factor' and advanced technology as a 'machinery factor' can 'in parallel' encourage radical innovation. This study proposes a conceptual framework and empirically tests path-dependent influences of: transformational leadership, advanced technology, advanced training, organisational learning, innovative climate and innovation capability on radical innovation within the specific sphere of large Saudi firms.

To fulfil the purpose of this study, a deductive approach was used, and the unit of analysis was at the individual level to examine the hypothesised relationships between factors. Focus group discussions and a pilot-test are applied to ensure content appropriateness and validity of the measurement items in the tested model. The sample for this study consists of seven large firms in four different sectors. The target population includes only employees working in innovative activities in large firms who have first-hand knowledge of organisational features that contribute to the innovation processes. Data were collected via an online survey from seven large Saudi firms in four different sectors, resulting in 237 usable responses for analysis. The hypotheses were examined by employing Structural Equation Modelling (SEM) with the statistical software program AMOS version 24.

The conceptual framework of the study was affirmed and supported by empirical results. The results indicate that both transformational leadership and advanced technology are two significant determiners for successful radical innovation in large firms. The findings reveal that both transformational leadership and advanced technology enhance the positive effects of organisational learning and advanced training on innovative climate. An improved innovative climate then has a direct positive influence on innovation capability, which promotes radical innovation.

This study contributes to the existing body of the innovation literature by explicating the parallel effect of transformational leadership and advanced technology on cultivation of the innovation capabilities necessary for radical innovation. It enriches the existing literature by explaining how transformational leadership and advanced technology influence organisational learning, advanced training, and innovative climate to create innovation capabilities respectively. Moreover, it contributes to the innovation literature by identifying and addressing that innovative climate is a significant mediating factor on the relationship between both of advanced training and organisational learning on innovation capability. The findings of this study offer a set of implications for practitioners and executives to assist them to support radical innovation outcomes through, for instance, recruiting for and/or developing a preferred leadership style, how technology might be deployed, and ways to configure these in order to produce a more innovative climate in the organisation.

Finally, the current study provides a number of avenues for future research on similar topics, including the suggestion to replicate this study within different settings, including other Arabian Gulf and Middle Eastern countries.

Keywords: Radical innovation, transformational leadership, advanced technology, innovative climate, innovation capability, organisational learning, advanced training

CHAPTER ONE: INTRODUCTION AND OVERVIEW OF STUDY

1.1 Introduction

In highly competitive and dynamic environments, radical innovation has become the lifeblood of firms wanting to achieve a competitive advantage (Slater, Mohr & Sengupta 2014). Shorter product life cycles and growing demand for new products with novel superior technology increase the pressure on firms to maintain their capabilities to innovate in order to cater to rapidly evolving customer requirements in the dynamic marketplace (Tidd, Bessant & Pavitt 2001; Rubera & Kirca 2012). In this environment, long-term success requires that firms emphasise the consolidation of a set of internal human, technological and structural capabilities that enable them to sustain a steady flow of radical innovations (Slater, Mohr & Sengupta 2014).

This thesis reports a study examining the intersection of three prominent areas of research — leadership, advanced technology and radical innovation. It investigates *how* leadership as a 'human factor' and advanced technology adoption as a 'machinery factor' are related to radical innovation. In doing this, the study aims to identify the organisational practices and activities that enhance radical innovation for global competitiveness. This is done by investigating the perception of individuals (e.g., managers, supervisors, scientists etc.) and their practices in seven large firms from Saudi Arabia at a time when innovation is both a competitive necessity and national strategy for Saudi Arabian firms.

This chapter introduces and summarises the research project reported in this thesis. In doing so, it distils important features of the research background, design, approach, and outcomes. It considers the implications of the study and outlines the structure of the full thesis. It thus provides a road-map for the remainder of the thesis.

The chapter continues in section 1.2 by outlining the research background and research problems that served as the basis for the study. Following this, section 1.3 presents the research questions. The research methodology of the current study is then outlined (section 1.4). Next, section 1.5 discusses the significance of the study, including the theoretical and managerial contributions, followed by the structure of the study as a whole (section 1.6). Concluding the chapter, section 1.7 provides a chapter summary.

1.2 Research Background and Research Problems

It has been argued that radical innovation is a significant source of sustainable competitive advantage that can make a marked contribution to a firm's growth and profitability in an era of intense global competition (Hoonsopon & Ruenrom 2012; Christensen 1997; De Jong & Vermeulen 2006; O'Connor & DeMartino 2006). *Radical innovation* (the study's dependent variable) is defined in this thesis as innovation that involves the development of novel products that are achieved on the basis of significant leaps in technological development compared with their competitors; it concerns new materials and features, novelty in the market-place and the potential of a considerable cost reduction. These offer a significant increase in customer benefit (Chandy & Tellis 1998; Majchrzak et al. 2004; Leifer et al. 2001). This study, therefore, focuses on 'tangible' radical new products rather than 'intangible' processes or services innovations.

Despite the importance of radical innovation for firms, its drivers are not well documented in the innovation literature (Flor et al. 2017). Authors have called for further investigations to recognise which organisational components can promote this type of innovation in dynamic environments (Perra et al. 2017; Sadovnikova et al. 2016; Aagaard 2017). To contribute to this literature, the current study suggests and examines a conceptual model that incorporates organisational capabilities and resources like transformational leadership, advanced technology, organisational learning, advanced training, innovative climate and innovation capability. This approach permits the study to consider various academic discussions from different perspectives and to provide a clear understanding of the way in which large firms can produce radical innovation in dynamic environments.

The term *dynamic environments* refers to the rate of variance in market and industry changes (Kellermanns et al. 2005). These environments are characterised by volatile customer preferences (demand) and uncertainty of products (Miller et al. 2012). In such environments, firms must consider how to configure their internal capabilities in order to achieve the most efficient ways to sustain competitiveness (Sadovnikova et al. 2016; Herrmann et al. 2007). Producing radical innovation has become necessary as it enables large firms to differentiate themselves from the competition by providing exclusive benefits to their clients (Zhou et al. 2005). It provides major opportunities for large firms to explore new markets (locally and globally), generate first-mover advantages, obtain positive cash flows (De Jong & Vermeulen 2006; Tellis, Prabhu & Chandy 2009) and ensure their long-term success (Subramaniam & Youndt 2005). These benefits may be especially pertinent for large firms (those with 200 or more employees, Swanepoel & Harrison 2015), which are increasingly susceptible to competition whether from large firms in the same industry or from small and medium firms, which benefit from greater flexibility in terms of routines, structures and processes (Tripathi 2013; Chang et al. 2012).

Despite the importance of radical innovations for firms' competitiveness, large firms are bound to face some challenges in developing suitable conditions and capabilities required for this type of innovation. As stated by Wind and Mahajan (1997, p. 3), '*the challenge is how to increase an organization's ability to develop breakthrough products*'. Firms that wish to produce radical innovation must recognise the configuration of components that, collectively, compose the capabilities of radical product innovation (Slater, Mohr & Sengupta 2014).

Through a deep review of the related literature, two subjects of research were found to be repeatedly associated with and central to increasing radical innovation: (1) transformational leadership (human factor), and (2) advanced technology (machinery factor). Firstly, on the evidence of the literature review, transformational leadership has been consistently identified as one of the most significant individual factors in supporting radical innovation capabilities (Jung, Chow & Wu 2003; Jung 2001; Aragón-Correa et al. 2007; Engelen et al. 2014). Leaders exhibiting this style have the ability to inspire followers to change expectations, perceptions, and motivations and thereby work towards common goals. Transformational leadership style draws much attention in organisations because of its contribution to firm innovation, organisational learning, and employees' creativity skills (De

Jong and Den Hartog, 2007; Aragon-Correa et al., 2007). In this study, transformational leadership is defined as a type of leadership that, through the transformation of followers' values, behaviours, attitudes and beliefs, is intended to encourage followers to achieve higher-order goals and to exert extraordinary effort in pursuit of an organisation's innovative ambitions (Bass 1985). The literature review highlights that producing radical innovation necessitates continuous change to a firm's operations, practices, processes or structures (Leifer et al. 2000) and so is contingent upon how leaders set directions, make decisions, coordinate activities, and motivate individuals (Hamel 2006).

In today's complex and dynamic business environment, transformational leaders are be seen as ideal agents of change. They influence their followers by a variety of means to rise above their self-interest by altering their morale, ideals, interests, and values, in the process motivating them to perform better than initially expected (e.g., Rowold 2011; Jung et al. 2008). Therefore, transformational leadership has advantages over other leadership styles (i.e. transactional or laissez-faire) through its ability to identify organisational characteristics (i.e. capabilities, skills and knowledge) that promote radical innovation (Bass and Avolio 2000; Tellis et al. 2009; Engelen et al. 2014; Gumusluoglu and Ilsev 2009; Jung et al. 2003). The present study, consequently, builds on transformational leadership style since it targets change and innovation (Chen et al. 2102), the key themes of this study.

Although previous studies have demonstrated the positive impact of transformational leadership on radical innovation (e.g., Eisenbeiss et al. 2008), there is a need for further studies to identify the components and mechanisms through which transformational leadership can practically influence radical innovation in large firms (Cortes & Herrmann 2017; Chang 2016; Tahir et al. 2014; Li, Mitchell & Boyle 2016). To contribute to this literature, the present study investigates the effect of transformational leadership behaviours through four distinctive mediating components (organisational learning, advanced training, innovative climate and innovation capability) to build a framework that successfully generates radical innovation. This investigation could partially fill the void in the innovation literature and advance understanding of the mechanisms for the success of radical innovation in a firm.

A second internal feature that has been regularly associated with radical innovation is the adoption of advanced technology (e.g., Kleis, Chwelos & Ramirez 2012; Jobar et al. 2010). The changes in the current market (e.g., customer needs) and the actions of competitors have pushed firms, particularly large firms, to seriously consider the deployment and adoption of cutting-edge technology as important to grasping and exploiting opportunities (Sharma et al. 2014; Teece 2010). In this regard, Jobar et al. (2010) suggest that adopting new advanced technology has not only become a key driver for competitive success, but also acts as the main driver for the sustainability of a firm in the long-term by its contribution to the suite of innovation capabilities necessary to produce radical innovation. For the purposes of this study, *advanced technology* can be defined as the extent of a firm's tendency to continuously and rapidly integrate all types of sophisticated technologies to enhance its capability to find a technical solution and satisfy its customers changing requirements with novel superior technology (Gatignon & Xuereb 1997; Hurley & Hult 1998).

Although prior studies have provided empirical evidence regarding the positive effect of advanced technology adoption on innovation performance (e.g., Ali et al. 2016), most of these studies emphasise advanced technology as a moderator or a mediator in supporting other variables to enhance radical innovation (Batra et al. 2015; Hsu et al. 2014; Chen et al. 2014). There are, however, few studies that investigate its role as a key driver in facilitating radical innovation. This dearth of studies is surprising, given that advanced technology adoption is considered an essential ingredient to successful radical innovation. Thus, it is the intention of the present study to develop richer insights into the link between advanced technology adoption and its impact on the radical innovation of a firm via the mediating effects of organisational learning, advanced training, innovative climate and innovation capability. Through this examination, the current study gives more credence to the growing importance of the role of advanced technology adoption in supporting a firm's internal and external capabilities to successfully achieve radical innovation.

Prior theoretical studies have emphasised the role of innovation capabilities as a significant facilitator of radical innovation (Troilo et al. 2014; Chang et al. 2012). Thus, firms that wish to produce radical innovation must recognise the configuration of components that contribute to it (Slater, Mohr & Sengupta 2014). In this study, *innovation capability* is defined as a firm's capability to recognise, search for, integrate, experiment with, and commercialise novel innovative products (Kim et al. 2012; O'Connor & McDermott 2004). This study concentrates on three main organisational capabilities for improving radical innovation in large firms: openness (the ability of a firm to search for sources through external, distant and wider directions), integration (a firm's ability to integrate and align its organisational connectedness) and experimentation (a subset of a firm's ability to learn, probe and experiment with new ideas). Although earlier research has acknowledged that innovation capability plays a significant mediating role for the improvement of radical innovation, there was little empirical examination of the interrelationship between these two areas (Chang et al. 2012; Jiménez & Valle 2011). There is a need for further research that includes an in-depth examination of the mediating role of innovation capability on radical innovation performance, especially in large firms (e.g., Chang et al. 2012; Forés & Camisón 2016). Therefore, this study will empirically examine this relationship, including openness, integration and experimentation for radical innovation performance. In doing so, the study could offer a more nuanced understanding of the proposed causal relationship.

Prior studies have documented the positive effects of *transformational leadership* on innovation capabilities (e.g., Noruzy et al. 2013; Haakonsson et al. 2008; Jung et al. 2008; Wang et al. 2011; Gumusluoglu and Ilsev 2009) and argue that transformational leaders tend to increase the consciousness of collective interest among members of a firm and support them in accomplishing their goals (Bass & Avolio 2000; García et al. 2008). Several studies have analysed this relationship through different intermediate constructs such as culture (e.g., Ogbonna and Harris 2000), competitive strategies (e.g., Menguc et al. 2007), flexibility (e.g., Rodriguez Ponce 2007), absorptive capacity (e.g., García Morales et al. 2008) and entrepreneurship (e.g., García Morales et al. 2006). However, this positive relationship requires a wider analysis of the intermediate steps between transformational leadership and innovation capabilities performance (Crossan and Apaydin 2010; Jaiswal and Dhar 2015; Jung et al. 2008). Thus, the underlying mechanisms behind how transformational leadership may contribute to a firm's innovation capability development is still not fully explained

(Malek Al-edenat 2018). Therefore, the current study addresses this gap by identifying the mediating role of learning activities (organisational learning and advanced training) and innovative climate in the relationship between transformational leadership and innovation capability in increasing radical innovation.

In addition, *advanced technology* adoption has been argued as a strategic orientation for organisations to achieve competitive advantage (Mutlu & Sürer 2016). It plays a significant role in creating and maintaining a firm's resources (internally and externally) and capabilities to enhance innovation capabilities performance (Yang et al. 2014; Akgün, Keskin & Byrne 2012; Noble et al. 2002). Nevertheless, prior studies have mostly investigated its effects at a macro-level (e.g., Batra et al. 2015) such as on economic growth (e.g., Antonietti 2005), organisational performance (e.g., Liaoning et al. 2016) and product performance (e.g., Zhou et al. 2005). However, studies that investigate the effect of advanced technology adoption on micro-level processes such as employee learning activities and work atmosphere within an organisation are rare (e.g., Straub 2009; Siadaty, Gasevic & Hatala 2016). Therefore, there seems to be a definite need to establish an empirical link between advanced technology adoption and innovation capabilities performance at the level of micro-level processes. Thus, this study will investigate the way advanced technology adoption can shape both the learning activities (organisational learning and advanced training) and innovative climate that reinforce innovation capabilities to enhance the radical innovation performance of a firm.

To this end, this study attempts to focus on the various mechanisms and developmental procedures to enhance radical innovation in the context of large firms. Within the proposed model, this study will empirically examine the role of both transformational leadership and advanced technology as two key drivers for radical innovation success in large firms. At the individual level, the study tests a proposed conceptual model in which advanced training, organisational learning, innovative climate and innovation capability have path-dependent influences on increasing radical innovation performance.

Finally, the strategy literature indicates that in today's business environment, large firms are facing strong competition (Tripathi 2013). Some large firms have achieved sub-optimal results in the production of radical innovation due to inadequacies in their capabilities (e.g., openness, integration and experimentation) (Börjesson et al. 2012; Martini et al. 2012). These capability defects make them unable to generate radical innovation (Junarsin 2009). The question in relation to large firms' innovation is how to address these issues and help large firms identify key drivers and develop capabilities that will enable them to produce radical innovation for global competitiveness. Hence, this context is assumed to be appropriate for empirically testing the conceptual model. The proposed model of the current study, developed from the review of the existing literature, is illustrated in Figure 1.1. The tested model showed the expected relationships that shape the basis of the hypotheses of this study. Table 1.1 summarises definitions of key constructs of the current study. In the next section, the research questions will be proposed.

Figure 1.1: The Proposed Model of the Development of Radical Innovation in Large Firms.

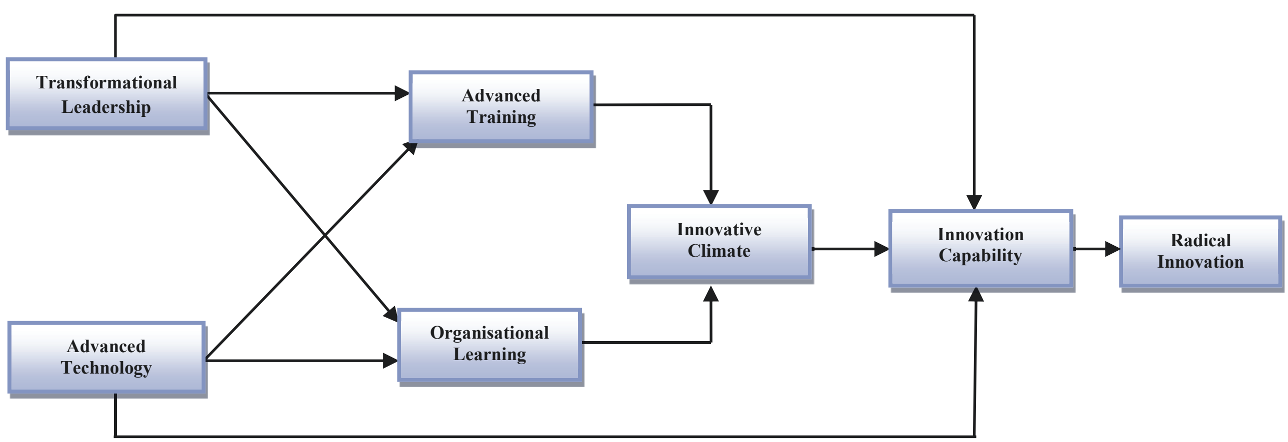


Table 1.1: Definition of the Study Constructs

Construct	Definition	Source
Radical Innovation	Innovation that involves the development of novel products or performance advantages that are achieved on the basis of significant leaps in technological development compared with that of competitors; it concerns materials and new features, newness to the market-place and a considerable reduction in terms of time and cost in order to offer a significant increase in customer benefit.	(Chandy & Tellis 1998; Majchrzak et al. 2004; Leifer et al. 2001)
Transformational Leadership	A type of leadership that, through the transformation of followers' values, behaviours, attitudes and beliefs, is intended to encourage followers to achieve higher-order goals and to exert extraordinary effort in pursuit of an organisation's innovative ambitions.	(Bass 1985)
Advanced Technology	The extent of a firm's tendency to continuously and rapidly integrate all types of sophisticated technologies to enhance its capability to find a technical solution and to satisfy its customer's new requirements with novel superior technology.	(Gatignon and Xuereb 1997; Hurley and Hult 1998)
Advanced Training	A planned process designed to support individuals through effective training methods for a specific period to obtain a high level of knowledge and skills in a certain speciality so that they are then able to generate innovative ideas as well as to support the firm more generally in the production of innovation.	(Schuler & MacMillan 1984; Chiaburu & Tekleab 2005)
Organisational Learning	'A dynamic process of creation, acquisition and integration of knowledge aimed at developing the resources and capabilities that allow the organization to achieve a better performance'.	(Lopez et al. 2006, p. 217)
Innovative Climate	The cognitive representations of individuals within a firm regarding its policies, practices and procedures (in all their aspects) as encouraged by the leaders' direction, including the provision of the necessary resources, rewards, autonomy and motivation to encourage employees' innovative initiatives.	(Scott & Bruce 1994; Ekvall 1991)
Innovation Capability	A firm's capability to recognise, search for, integrate, experiment with and commercialise novel innovative products.	(Kim et al. 2012; O'Connor & McDermott 2004)

1.3 Research Questions

Based on the above conceptualisation and research gaps in the existing literature, this study aims to answer the following research questions:

RQ1: How does transformational leadership affect radical innovation performance through the mediating effects of advanced training, organisational learning, innovative climate and innovation capability?

The sub- research questions for RQ1 ask:

1. To what extent do practices executed by transformational leadership affect the degree of innovation capability in large firms?

2. To what extent does organisational learning mediate the effect of transformational leadership on innovative climate?

3. To what extent does advanced training mediate the effect of transformational leadership on innovative climate?

RQ2: How does advanced technology adoption influence radical innovation performance through the mediating effects of advanced training, organisational learning, innovative climate and innovation capability?

The sub- research questions for RQ2 ask:

1. To what extent does advanced technology adoption impact the degree of innovation capability in large firms?

2. To what extent does advanced training mediate the effect of advanced technology on innovative climate?

3. To what extent does organisational learning mediate the impact of advanced technology on innovative climate?

By answering these questions, the study will examine the roles of both transformational leadership and advanced technology in producing radical innovation in large firms, where the constructs (namely, advanced training, organisational learning, innovative climate and innovation capability) are mediating factors in its production.

1.4 Research Methodology

This study employed a deductive research approach, and the unit of analysis was at the individual level to examine hypothesised relationships between theoretically-derived variables using an online survey to collect quantitative data. Responses were analysed using statistical analysis techniques. Data collection was preceded by a series of focus group discussions to realise opinions and judgements with regard to the relevance and validity of the measurement items in the tested model (Choe et al. 2006). The sample for this study consisted of seven large Saudi firms; two in the oil and gas sector, one in the petrochemical sector, three firms in the pharmaceuticals and medical sector, and one firm within the food production sector. As the current study focuses on generating radical innovation, participants included only employees (e.g., managers, supervisors, scientists etc.) who were working in innovative activities in their firms and who had first-hand knowledge regarding innovation processes. The participants, therefore, were qualified and in a position to effectively evaluate the behaviour of their firm (or their strategic business unit) in relation to radical innovation and the relevant variables.

Data were collected via a large-scale online questionnaire managed via ‘Survey-Monkey’, one of the most common platforms used for online surveys (Wright 2005). From the seven sample firms, 250 responses were received and of these, 237 responses were complete and useable for analysis to generate meaningful results (Kline 2005), an overall response rate of 46%. Exploratory Factor Analysis (EFA) using the data analysis software SPSS version 24, Confirmatory Factor Analysis (CFA) and Structural Equation Modelling (SEM) with the software AMOS version 24 were used to record the participants’ responses and to conduct data analysis.

1.5 Significance of the Study

The significance of this study can be discussed through its main contributions to several related bodies of knowledge, as well as its relevance to practitioners. Both these are discussed here.

1.5.1 Theoretical Contributions

Although radical innovation studies have been the subject of ongoing research, further studies are needed to understand which organisational components can produce this type of innovation (Sadovnikova et al. 2016; Aagaard 2017; Flor et al. 2017). The present study responds to calls for more research and contributes to radical innovation literature by examining the effect of both transformational leadership and advanced technology on radical innovation in the context of large firms. To contribute to the innovation literature, this study:

1) examines and tests *how* transformational leadership and advanced technology interact simultaneously with the internal organisational building blocks to produce radical innovation.
2) provides insight into the mechanism between transformational leadership and innovative climate for increasing innovation capability.
3) generates new insights into the role of advanced technology adoption on innovation capabilities for radical innovation performance.
4) expands the scope of previous studies by investigating the impact of advanced technology adoption on innovative climate (micro-level) through the mediating effects of learning factors (organisational learning and advanced training) to improve innovation capability.
5) tests the mediating effect of innovative climate on the relationship between learning activities (organisational learning and advanced training) and innovation capability to increase radical innovation in the context of large firms.

Specifically, from the dynamic capability view, this study empirically examines the roles of both transformational leadership and advanced technology 'in parallel' for generating radical innovation through a specific number of organisational factors, namely advanced training, organisational learning, innovative climate and the presence of an innovation capability. This study is unique in substantiating the genesis of radical innovation described in existing literature by studying the combined impacts of transformational leadership and advanced technology on radical innovation in large firms. This is the first study to test a framework on how these two factors interact with important organisational building blocks (organisational learning, advanced training, innovative climate, and innovation capability) in producing radical innovation. In doing so, it provides new insights into causal mechanisms that can drive radical innovation.

This study is unique in proposing and examining four distinctive mediating components (organisational learning, advanced training, innovative climate and innovation capability) to build a framework that explicates how radical innovation is generated. In the existing literature, several different pathways have been proposed regarding the effect of transformational leadership on radical innovation, although this has been identified as inadequate (Eisenbeiss et al. 2008; Makri & Scandura 2010). This study goes beyond these by proposing and testing a new combination of components through which transformational leadership can influence radical innovation in the context of large firms. It thus provides new insights into causal mechanisms that drive radical innovation.

This study also enriches the *innovation* literature by revealing that advanced technology, in combination with appropriate leadership style, is a key driver of the organisational capabilities and conditions that enable radical innovation. That is, advanced technology is neither as a mediator nor a moderator of radical innovation (as in some previous studies) but can be a key driver of conditions enabling radical innovation in its own right. This finding sits in contrast to prior studies, which provide mixed results regarding the effect of advanced technology adoption on innovation performance (Lee, Dedahanov & Rhee 2015), reporting an insignificant relationship between the advanced technology and radical innovation (e.g., Gao et al. 2007; Hakala 2011), or focus on advanced technology as a moderator or mediator in supporting variables to enhance innovation performance (e.g., Batra et al. 2015; Hsu et al. 2014).

This study also extends our understanding of the role of organisational learning in creating innovation performance. Despite the broad consensus that a positive connection exists between organisational learning and innovation performance, this relationship is yet to be supported empirically (Montes, Moreno & Morales 2005). Instead, studies have essentially focused on analysing the direct impacts of organisational learning on different kinds of innovation (e.g., Jyoti, Chahal & Rani 2017; Liao, Fei & Liu 2008), without explaining how organisational learning activities can influence organisations' capability to change their climate for innovation performance. This study addresses this gap by identifying the mediating role of innovative climate on the relationship between organisational learning and innovation capability in the context of large firms.

The results presented in the thesis address calls to articulate mediating mechanisms through which advanced training creates value for organisations (e.g., Glaveli & Karassavidou 2011). Specifically, it provides insights into the mediating role of innovative climate in the link between advanced training and innovation capability in the context of large firms. Prior research has revealed mixed findings about the relationship between advanced training and innovation performance (e.g., Chen & Huang 2009; Sung & Choi 2014). Further, the vast majority of studies have failed to examine the direct effect of advanced training activities on the work atmosphere within an organisation (either at an individual or micro-level) that could affect innovation capability performance (Glaveli & Karassavidou 2011), with just a few studies empirically examining whether the relationship between advanced training and innovation capability performance is mediated or moderated by other variables (e.g., Tharenou et al. 2007; Makkonen & Lin 2012; Jørgensen, Becker & Hyland 2014).

This study advances the existing body of knowledge by providing new insights into the mediating roles of learning factors (advanced training and organisational learning) for the causal path of the influences of transformational leadership on innovative climate to increase innovation capability. Although the existing literature provides sufficient empirical evidence of the positive influence of transformational leadership on innovative climate performance (e.g., Haakonsson et al. 2008; Wang et al. 2011), the extant studies examining this relationship through the mediating effects of different strategic variables are rare (e.g., Jaiswal & Dhar 2015; Brimhall et al. 2016). The present study empirically tests the mediating effect of organisational learning and advanced training on the relationship between transformational leadership and innovative climate.

Finally, despite the growing interest in the dynamic capability view, its conceptualisation remains ambivalent (Zhou & Li 2010; Wang & Ahmed 2007), an ambiguity that is reflected in the considerable differences between various proposed perspectives on how dynamic capability can be understood, how it can be applied, and how it impacts the improvement of strategic management (Dangelico 2016; Lin & Wu 2014; Wu 2010). The current study contributes to this field by providing some clarity about (some of the) primary mechanisms in which a firm's dynamic capabilities can be established and retained. Notably, the study maps the relationship between a suite of 'innovation' conditions that contribute to a firm's innovative outcomes. In doing so, it enriches the innovation literature by defining the antecedents of radical innovation in the context of large firms. Although earlier research has acknowledged that innovation capability plays a significant mediating role for the improvement of radical innovation, there was little empirical examination of the interrelationship between these two areas (Chang et al. 2012; Jiménez & Valle 2011). There is a need for further research that includes an in-depth examination of the mediating role of innovation capability on radical innovation performance (e.g., Forés & Camisón 2016).

1.5.2 Managerial Contributions

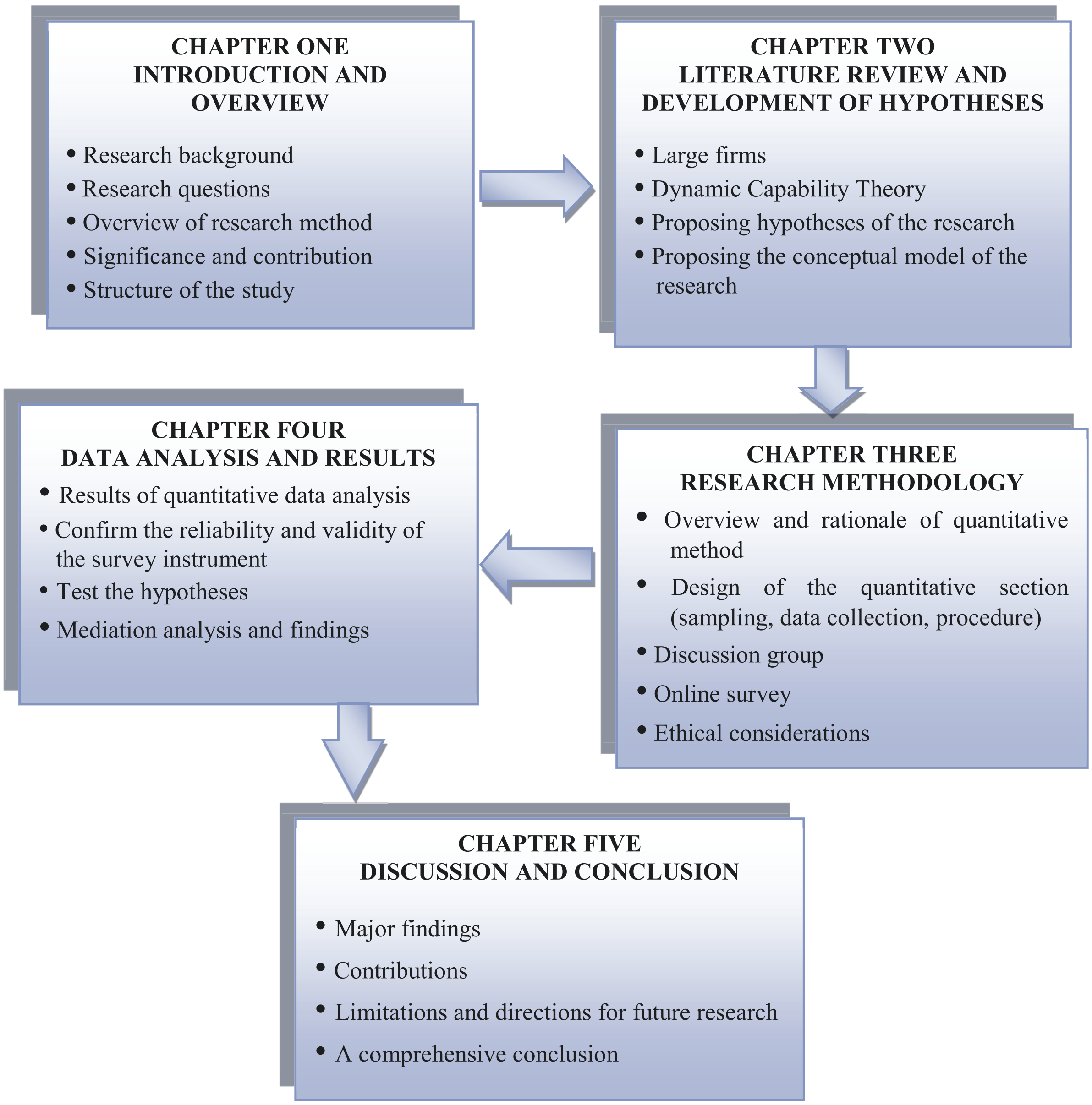
In an era of intense global competition and dynamic market environments, large firms have become susceptible to their competitors, particularly small and medium firms (Tripathi 2013). Hence, identifying the organisational conditions and capabilities that will enable them to understand and support the key drivers to produce radical innovation are increasingly important for global competitiveness (Sainio et al. 2012; Gómez & Alcamí 2015).

In this light, the findings of this study can be used in at least three ways by managers and practitioners tasked with supporting radical innovation in their firms. First, the results show how the style of leadership used by managers can activate the organisational conditions and capabilities that enhance radical innovation. In doing so, it provides empirical validation of the potential benefit of managers in large Saudi firms using a transformational style of leadership. Secondly, this study will help managers and decision makers to gain new insights into the importance of advanced technology adoption as a complementary tool to be used in unison with transformational leadership to facilitate radical innovation in large firms. Managers in large firms will increasingly be equipped (through this and subsequent research) with the knowledge and information that will enhance their understanding of the significance of advanced technology adoption as a functional dynamic capability that supports their firms in the continuous development of their resources, capabilities and processes to produce radical innovation. Finally, it is anticipated that this study will be able to provide a practical tool in terms of recommendations for managers who seek to enhance the health of their innovative climate practices. The findings of this can be expected to equip large firms with new knowledge regarding the strategic importance of the learning activities (advanced training and organisational learning) for supporting innovative climate.

1.6 The Structure of the Thesis

This thesis is organised into five chapters, the structure of which is outlined in Figure 1.2. The contents of the remaining four chapters are summarised below this.

Figure 1.2: Structure of the Study



CHAPTER TWO: LITERATURE REVIEW AND DEVELOPMENT OF HYPOTHESES

This chapter provides details on the literature regarding all seven constructs included in the tested model. It starts with an introduction to the literature review and then offers useful discussion that relates to the research model. The large firm perspective is explained, followed by a discussion on a foundational theory applied in the study. From this literature a series of hypotheses on the relationships between the constructs are then developed and the study's theoretical underpinnings presented. At the end of this chapter, a summary of the contents is provided.

CHAPTER THREE: RESEARCH METHODOLOGY

This chapter focuses on the study's research design and the methods used to answer the research questions posited in the opening pages. It summarises a variety of research methods, including explanation of differences in quantitative and qualitative methods, and offers justifications for the research methods selected. An explanation of the various elements of the research design and data collection is followed by a discussion of sampling methods and details of the procedures used to conduct the study. Clarification of the study's ethical considerations leads to the end of the chapter which offers conclusions relating to the methodology in terms of both selection and implementation.

CHAPTER FOUR: DATA ANALYSIS AND RESULTS

This chapter describes the data analysis and the results of this for the sake of testing hypotheses for this study. It commences by outlining the procedures used to ensure the study's validity and reliability using data analysis techniques including Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). It the reports the results of the Structural Equation Modelling (SEM) that was used to test the study's hypotheses and concludes with an overview of the study's key results.

CHAPTER FIVE: DISCUSSION AND CONCLUSION

This chapter focuses on the implications of the study in terms of its theoretical and practical contributions. It starts by summarising the major findings of the study. It then describes the theoretical and practical contributions. The limitations of the current study, future research directions and a comprehensive conclusion are outlined.

1.7 Summary of the Chapter

This chapter has introduced the study and has presented a road-map for this thesis. It briefly introduced the research background and research problems. From this, the research questions were posed and the significance of the study, including its theoretical and managerial contributions, was briefly presented. Finally, the structure of the study was illustrated. The next chapter will provide a detailed review of the existing literature from which the model that forms the centrepiece of this thesis is developed.

CHAPTER TWO: LITERATURE REVIEW AND DEVELOPMENT OF HYPOTHESES

Chapter One summarised the key features of the research reported in this study. This chapter presents a detailed analysis of the literature available on the constructs related to the tested model and outlines the theoretical case for the research reported in this study. Based upon the research gaps and objectives discussed in Chapter One, the related literature will be reviewed.

The chapter is structured as follows. It commences by presenting an introduction to the chapter (section 2.1). Next, section 2.2 provides an overview of large firms, including their roles regarding innovation. As part of this review, innovation in the context of Saudi Arabia is discussed, with a particular focus on the role of, and implications for, large Saudi firms, the setting for the research reported in this study (section 2.3). Following this, section 2.4 provides the main theoretical perspectives that underpin this study and identifies some of the central organisational variables and outputs that form the basis of this study's theoretical framework. Then, section 2.5 presents an overview of radical innovation, including its relationship with transformational leadership and advanced technology. Section 2.6 presents the case for a series of fourteen hypotheses relating to the variables investigated in this study. This section introduces and explains the case for relationships among each of these variables and is followed by the presentation of the theoretical model to be tested in this study (section 2.7). The chapter concludes in section 2.8 by summarising the study's model and hypotheses, and articulates the study's research purpose and questions, setting the scene for study's empirical component in the following chapters.

2.1 Introduction

In an era of intense global competition and dynamic market environments, radical innovation is considered a key enabler for a nation's economic growth, better firm performance and sustainable competitive advantage (Hoonsopon & Ruenrom 2012; De Jong & Vermeulen 2006; Sood & Tellis 2005; Sorescu, Chandy & Prabhu 2003). Given that the achievement of this kind of innovation needs a wide range of facilitators, both internally and externally, including the acquisition and use of additional capacity or knowledge (Chen et al. 2014), several researchers across different disciplines have proposed a number of theories about the drivers of radical innovation in firms (Tellis, Prabhu & Chandy 2009), particularly large firms (Birkinshaw et al. 2007). Despite the importance of producing radical innovation for firms' survival and competitive advantage, the drivers of radical innovation are not well documented in the literature (Flor et al. 2017). Further investigations are warranted to know which components can promote this type of innovation in dynamic environments (Perra, Sidhu & Volberda 2017; Sadovnikova et al. 2016; Aagaard 2017).

Drawing on the radical innovation literature, two central bodies of literature have contributed in increasing understanding of radical innovation: (1) leadership style (human factor), (2) advanced technology (machinery factor). Despite the abundance of studies that have demonstrated the positive effects of transformational leadership (e.g., Engelen et al. 2015) and advanced technology (e.g., Jobar et al. 2010) on radical innovation performance, there is a lack of studies to articulate mediating factors through which transformational leadership and advanced technology generate radical innovation (e.g. Cortes & Herrmann 2017; Mahathi, Pal and Ramani 2016). In other words, the mechanisms through which these levers influence a firm's production of radical innovations is yet to be examined and explained.

To address this, the study reported in this thesis focuses on mechanisms and developmental procedures theorised to enhance radical innovation in large firms. Within the proposed model, the study will examine the roles of both transformational leadership and advanced technology in producing radical innovation in large firms, where the constructs (advanced training, organisational learning, innovative climate and innovation capability) are mediating factors in radical innovation production.

Over the years, numerous research results have pointed out the positive relationship between leadership and producing radical innovation in organisations (Birasnav et al. 2013; Aragón-Correa et al. 2007). Thus, understanding how firms can encourage the role of leadership in facilitating radical innovation is crucial for survival in a competitive environment (Yukl 2008). With the increased use of leadership model concepts (guides that propose certain leadership behaviours to utilise in a particular environment or situation in firms) (Prasad & Junni 2016), the question naturally arises as to what style of leadership is most suitable to achieve the desired outcome; in this case what style is appropriate for promoting radical innovation. On the evidence of the literature review, transformational leadership has been identified as being one of the most important human-related factors supporting radical innovation capabilities (Jung, Chow & Wu 2003; Jung 2001; Aragón-Correa et al. 2007). Without effective leadership, it is often thought that innovation in a firm would not increase because of the important role effective leadership plays in bringing together and supporting attributes and activities (both internally and externally) that enhance innovation (Augier & Teece 2009).

In this study, transformational leadership was defined as a type of leadership that, through the transformation of followers' values, behaviours, attitudes and beliefs, is intended to encourage followers to achieve higher-order goals and to exert extraordinary effort in pursuit of an organisation's innovative ambitions (Bass 1985). Transformational leadership is characterised by numerous patterns of behaviours that can develop and shape the capabilities of a firm through intellectual stimulation, inspiration and commitment where individuals can be more creative and innovative in seeking different ways to collect knowledge and solve problems (Gumusluoğlu & Ilsev 2009; Wang & Howell 2010) as well as by supporting intra-organisational integration and putting energy into overcoming difficulties (Voet 2014). Although previous studies have demonstrated the positive impact of transformational leadership on radical innovation (e.g., Eisenbeiss et al. 2008), there is a need for further studies to enable large firms to recognise which components and mechanisms are those through which transformational leadership can practically influence radical innovation (Cortes & Herrmann 2017; Chang 2016; Tahir et al. 2014; Mitchell & Boyle 2016).

In addition, several studies have emphasised the importance of adopting advanced technology within a firm as a non-human (machine) factor to enhance radical innovation (Kleis et al. 2012). In the current market where things change quickly and advanced technologies rapidly supplant each other, firms need to take greater responsibility for increasing radical innovation so as to be able to fulfil their customers' emerging needs and those of the broader market. These changes in the current market have pushed firms, particularly large firms, to rethink their strategies in terms of the deployment and adoption of new advanced technology as the key to grasping and exploiting the opportunities that are offered by a dynamic business climate (Sharma et al. 2014). In this study, advanced technology was defined as the extent of a firm's tendency to continuously and rapidly integrate all types of sophisticated technologies to enhance its capability to find a technical solution and to satisfy its customer's new requirements with novel superior technology (Gatignon & Xuereb 1997; Hurley & Hult 1998). On this front, Jobar et al. (2010) suggest that adopting new advanced technology has not only become a key driver for competitive success, but also acts as the main driver for the sustainability of a firm in the long-term. This has made the adoption of new advanced technology unavoidable and a significant strategic consideration for a firm wanting to produce radical innovation (Gaimon 2008). Though prior studies have provided empirical evidence regarding the positive effect of advanced technology adoption on innovation performance (e.g., Mahathi, Pal and Ramani 2016), most of these studies emphasise advanced technology as a moderator or a mediator in supporting other variables to enhance radical innovation (Batra et al. 2015; Hsu et al. 2014; Chen et al. 2014). There are, however, few studies that investigate its role as a key driver in facilitating radical innovation. This dearth of studies is surprising, given that advanced technology adoption is considered an essential ingredient to successful radical innovation.

Based on the brief conceptualisation outlined above, this study aims to answer the following research questions:

RQ1: How does transformational leadership affect radical innovation performance through the mediating effects of advanced training, organisational learning, innovative climate and innovation capability?

The sub- research questions of RQ1 ask:

1. To what extent do practices executed by transformational leadership affect the degree of innovation capability in large firms?

2. To what extent does organisational learning mediate the effect of transformational leadership on innovative climate?

3. To what extent does advanced training mediate the effect of transformational leadership on innovative climate?

RQ2: How does advanced technology adoption influence radical innovation performance through the mediating effects of advanced training, organisational learning, innovative climate and innovation capability?

The sub- research questions of RQ2 ask:

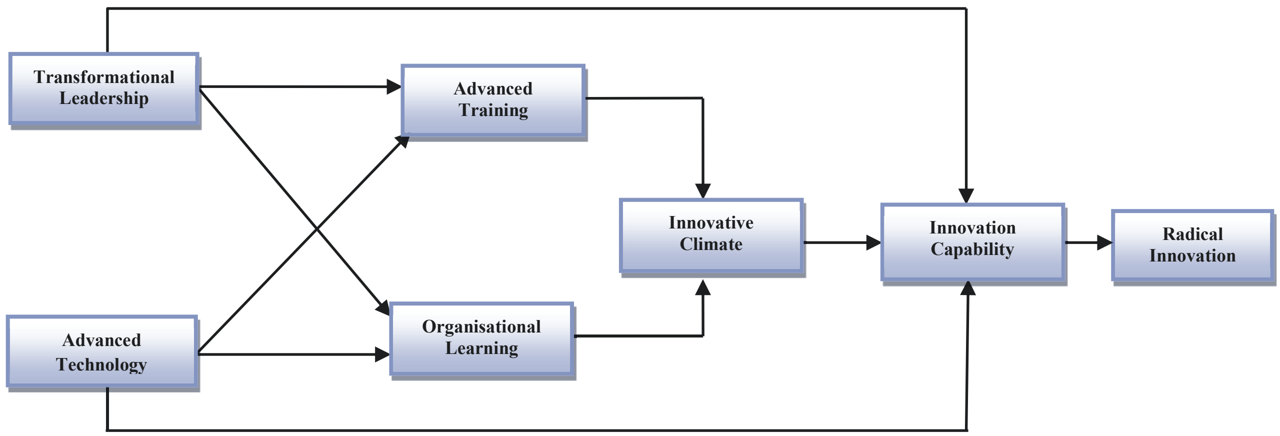
1. To what extent does advanced technology adoption impact the degree of innovation capability in large firms?

2. To what extent does advanced training mediate the effect of advanced technology on innovative climate?

3. To what extent does organisational learning mediate the impact of advanced technology on innovative climate?

To answer these questions, this study proposes a conceptual model that can be empirically tested to unearth the roles of transformational leadership and advanced technology 'in parallel' as the main two contributors in generating radical innovation through a number of mediating factors, including advanced training, organisational learning, innovative climate and the presence of an innovation capability. The model of the current study is illustrated in Figure 2.1. The model is developed from the review of the existing literature on the constructs related to the tested model and shows the expected relationships that shape the basis of the hypotheses of this study.

Figure 2.1: The Proposed Model of the Development of Radical Innovation in Large Firms.



Subsequent sections of the literature review explain the above framework in greater detail and articulate clear hypotheses based on the correlation of the constructs outlined above. Before that, two contextual features of this study are addressed; first, the distinctive characteristics of large firms (including their roles regarding innovation) will be discussed in more detail, and then, an overview of the national context for the study (Saudi Arabia) is provided.

2.2 Overview of Large Firms

Organisation size has long been argued in the literature to be one of the most important contingency variables in macro-organisational studies (Kimberly 1976). Several authors (e.g., Hoffer 1975; Rogers 2002), have considered a firm's size as a significant contingency variable moderating the correlation between strategy and performance. Smith, Cuthrie and Chen (1989) supported this notion empirically in their study. Moreover, organisation size has been argued to impact such variables as the probability of change in core features (Kelly & Amburgey 1991), research and development expenditures (Cohen & Klepper 1996) and innovation production (Hitt, Hoskisson & Ireland 1990). There is a well-established body of literature highlighting the inherent advantages of large firm size over small and medium firm size. These advantages, summarised in Table 2.1, can assist firms in their goal of creating radical innovation. The following section will detail the related benefits and challenges presented by large firms specifically in relation to the production of radical innovation.

Table 2.1: The Main Advantages of Large Firms

No	Advantages	Sources
1	Economies of scale	Symeonidis 1996; Tether 1998
2	Strong cash flow	Kamien & Schwartz 1982; Rogers 2002
3	Large sales volume	Cohen & Klepper 1996; Symeonidis 1996
4	Ability to perform several projects simultaneously	Chandler 1990
5	Strong capability to obtain sufficient resources	Granstrand & Sjölander 1990; Hymer 1976
6	Greater experience and strong brand name recognition	Hambrick et al. 1982; Woo & Cooper 1981

2.2.1 Role and Issues for Large Firms Regarding Innovation

The relationship between a firm's size and its capability to innovate has been thoroughly investigated by many scholars and a well-founded body of literature exists (Audretsch & Acs 1991; Cohen 1995). The outcomes of these investigations have been decidedly various. On one hand, some researchers argue that large firms are at a disadvantage in producing radical innovation (Chesbrough & Brunswicker 2014). Such researchers attribute this disadvantage to the complexity of large firms which slows responses in terms of implementing needed changes (Ettlie, Bridges & O'Keefe 1984). Similarly, Shane (1995) indicates that large firms display a tendency to resist the necessary changes due to organisational inertia. According to Cyert and March (1963), rapid changes in innovation requests lead to demands for greater flexibility in firms' routines and processes which are harder to achieve in larger firms than in small and medium firms. Moreover, other researchers have cited bureaucratic structures within large firms as impeding innovation capacity as the bureaucracy in larger firms is not conducive to dealing with any improvements involving a degree of risk-taking, as any step forward in terms of radical innovation must progress through several organisational layers (Scherer 1992).

On the other hand, several authors have affirmed that large organisations have more advantages with regards to producing innovation, particularly radical innovation, than medium and small firms (e.g., Chang et al. 2012). Their arguments advancing the advantages of large firms vary and are based on various reasons. For example, authors such as Nelson and Winter (1982) cited as advantages the ability of large firms to fund the cost of investment in research and development activities (R&D) and the ability to disseminate innovation risk over different projects and exploit their monopoly market positions (Teece 1986; Cohen & Klepper 1996). Cohen (1995) and Scherer (1992) supported this notion in their research and reported that large firms have the advantage of economies of scale that enhance their ability to research and develop radical innovation. By utilising economies of scale, the possible risks related to developing radical innovations can be spread broadly, while sufficient financial support for innovation is often more easily obtained.

Consistent with these viewpoints, Treacy (2004) states that radical innovation is a complex, high-cost and high-risk business strategy. This kind of innovation needs an exploration capability (a firm's ability to explore new resources and capabilities that are unique from those used in the past) in adopting new technologies, a willingness to enter new markets and a huge investment in integrating processes such as implementation, production and R&D (Freeman 1994). In responding to all these requirements, the costs are extremely high, and a strong cash flow is required to support these activities (Lynn et al. 1996). Thus, it is hard for small and medium firms to develop radical innovations (Hill & Rothaermel 2003). Furthermore, authors such as Green, Gavin and Aiman-Smith (1995) point out that because large firms have more functional areas and various workers are involved in an innovative project, this could be advantageous in reviewing, observing and evaluating the progress of developing radical innovation given its high level of uncertainties and ambiguities in terms of design, implementation, production and marketing approaches. Based on the literature review, one of the most obvious advantages of large firms is their ability to obtain a wide range of sufficient resources (Granstrand & Sjölander 1990). Where there are rapid and frequent changes in radical innovation requirements, large firms are also able mobilise sufficient resources to incorporate new advanced technologies, create new markets and develop novel ideas (Story, Hart & O'Malley 2009). In the same vein, Bower (1970) argues that large firms' 'slack resources' (or spare capacity) such as people, finance and accumulated knowledge can positively impact the process of radical innovation through maintaining the integrity of processes, creating strong relationships with external parties, and accelerating the improvement process which, in turn, facilitates the opening up of new markets or new product arenas. From these viewpoints, large firms are more likely to generate radical innovation due to their great capabilities.

As the present study is undertaken in the context of Saudi Arabia, the next section will discuss innovation in Saudi Arabia, with a particular focus on the role of, and implications for, large Saudi firms.

2.3 Innovation in Saudi Arabia

A member of the Group of Twenty nations (G-20), Saudi Arabia is currently one of the richest countries in the world and a major economic and political influence (Baki 2004). Much of this wealth has come from Saudi Arabia's vast oil reserves and its entry (in December 2005) into the World Trade Organization (WTO), which gave Saudi products greater access to global markets, created jobs and encouraged foreign investment (Jurgenson, Bayyari & Parker 2016). Saudi Arabia has become one of the best performing countries in the G-20 and is considered one of the fastest developing countries in the world despite global financial market volatility and stagnation in equity prices (International Monetary Fund 2016).

At the same time, the Saudi government has recognised that the country's economy was too reliant on its oil resources and has taken steps to diversify. This came to a head in 2005 following a period of depressed oil prices (when oil revenues returned to their 1982 level), at which time the Saudi government determined it would reduce its dependence on oil income by diversifying the national economy through designing and implementing plans to become a knowledge-driven economy (International Monetary Fund 2016). This has been manifested in three broad stages, represented in Figure 2.2, designed to transition the economy from a 'factor-based economy' dependent on central planning and oil revenues (Mehta et al. 2014) to one that will be innovation and knowledge driven, with higher levels of entrepreneurship and innovation.

Figure 2.2: Economic Phases of Saudi Arabia

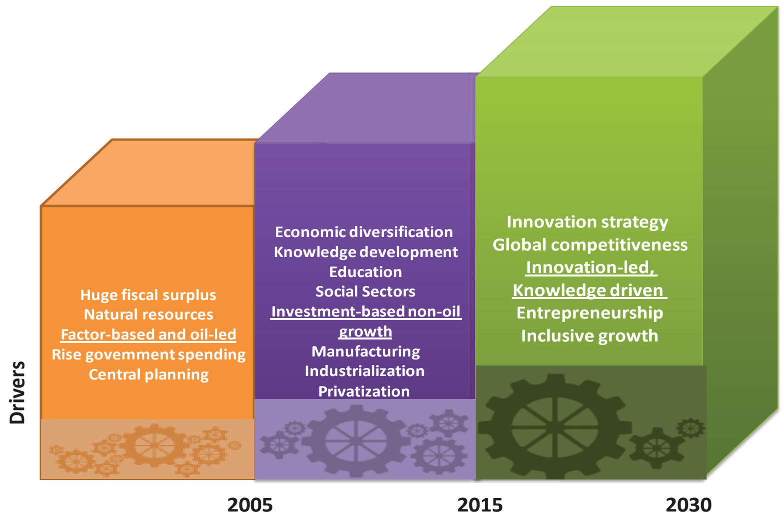


Figure 2.2: Economic Phases of KSA.
Source: ARANCA Analysis

According to Mehta et al. (2014) from ARANCA (a global research, analytics and advisory company), Saudi Arabia has progressed to the third phase of its economic development plan, represented in the column on the right of Figure 2.2, which focuses on economic expansion and transformation via firms (particularly large domestic ones) building effective strategies with innovation at their core.

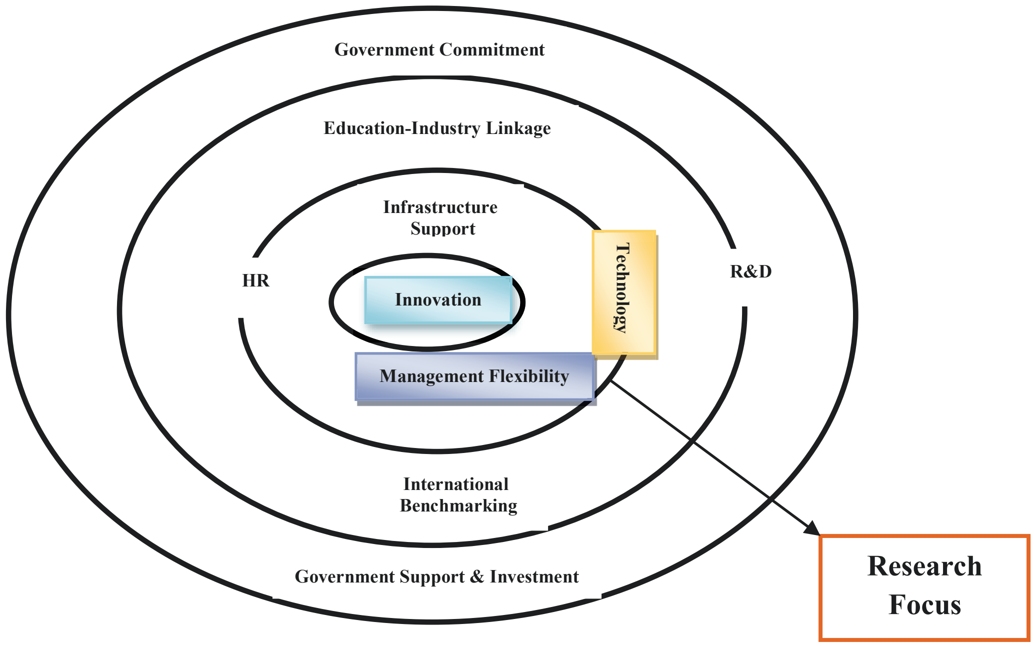
The Saudi government remains deeply involved in this transformation. In 2016, it launched 'Vision 2030' and the National Transformation Program (NTP) designed to transform the economy over the next 15 years by diversifying growth and increasing the role of private firms, especially large firms, for global competitiveness. One of the main objectives of 'Vision 2030' is to support innovation as a key driver for economic growth. Motivated, in part, by the Global Innovation Index Report (2017), which indicated that 'innovation' can be considered a significant determinant of the metrics of economic growth and social well-being, the government has committed USD2 trillion over the next 15 years to reduce its dependence on oil income (Germeraad, Khan & Ravindranath 2017), including, for instance, creating the USD 100 billion logistics hub at King Abdullah Economic City

(KAEC) in Rabigh that aims: '*to be a global logistics and manufacturing hub that will feature an education zone, "industrial valley", business district, resort area, sea port, and residential areas for various income brackets*' (Moser, Swain & Alkhabbaz 2015, p. 71).

As a result of this transformation, and consistent with the national policy, many firms (particularly large firms) have begun to implement strategies to shift into a knowledge-driven economy and to pay more attention to adopting innovation as a cornerstone of economic development. To this end, the Saudi government also has supported large firms with incentives, such as direct share investment and subsidies, designed to boost their global competitiveness (Alshuwaikhat & Mohammed 2017). These include supporting large-scale projects in non-oil sectors (such as steel) or the manufacture of value-added oil related products such as petrochemicals (in contrast to the export of crude oil). For instance, the fast-growing petrochemical and steel producer, Saudi Basic Industries Corporation (SABIC), has the ambition to become the world leader in chemicals (MEED 2014). One of its petrochemical projects is anticipated to account for approximately one-fourth of the global polyolefin market by 2020. Similarly, steps have been taken to increase the efficiency of large firms through opening state-owned or controlled enterprises to private investment. These private firms now play an increasingly significant role in the Saudi economy, accounting for around 48 per cent of gross domestic product (GDP) (MEED 2014).

With knowledge- and innovation-based sectors still in the minority in Saudi Arabia, one way to understand the country's innovation landscape is Iqbal's (2011) model of innovation for Saudi Arabia. Based on previous studies of innovation and on the experiences of top innovation-oriented countries that have already demonstrated successful integration of innovation mechanisms, this model is represented graphically in Figure 2.3 and explained below.

Figure 2.3: The Model for Innovation in Saudi Arabia



Source: Adnan Iqbal (2011)

The model shows that successful innovation practices do not comprise a linear process; instead, they involve several cyclic interactions among various stakeholders from different disciplines. According to Iqbal (2011), the model consists of three layers:

Layer 1 (outer circle): Government commitment, support and investment — This layer includes the prominent role that the Saudi government can play in supporting firms, particularly large firms, for generating innovation that relies on government commitment, support and investment; *Layer 2 (middle circle): Education–industry linkage, HRD, R&D and international benchmarking* — This layer identifies support provided by education-industry linkages (universities) in developing human capital, encouraging R&D and disseminating international benchmarking. The educational apparatus absorbs scientific knowledge and imparts it to students and potential (and current) employees, enabling them and their firms to keep abreast of global trends. Importantly, educational institutions enable timely and appropriate knowledge transfer to industry. According to Iqbal (2011), the Saudi government should enhance these elements and develop effective mechanisms for creating a skilled and educated workforce for building indigenous innovation capabilities; and *Layer 3 (inner circle): Infrastructure support, technology adoption and management flexibility* — In order to transform the current economy into an innovation-based economy, Iqbal argues that Saudi policies and plans should be consistent with the underlying structural shifts in resources and the new national vision of human capital that is enhanced by the adoption of cutting-edge technology and managerial capabilities.

Of particular note to the inner circle are two features that, according to Iqbal (2011), are especially important requirements for facilitating innovation in Saudi firms. The first is the importance of technology adoption on innovation outcomes. The second is the role that advanced leadership skills and associated practices can play in facilitating innovation, especially in light of the constraining impacts of bureaucracy in Saudi firms on the adoption of innovation (Iqbal 2011). In this regard, Jabbar and Dwaivedi (2004) point out that most organisations in the Middle East are characterised by a highly stratified and powerful bureaucracy and stagnation in relation to change, which are considered major obstacles to innovation in Arab organisations. Studies of large Arab firms have indicated the importance of flexible organisational structure and the real need for leadership that can inspire and empower innovative actions among staff to overcome this bureaucracy and support the changes required to generate innovation (Al-Shoaib et al. 2009). While the government can support these features through, for instance, removing unnecessary restrictions, encouraging initiative, providing funding, and improving IT sector infrastructure (Fuller & Hohman 2010), the onus rests with firms to configure their human and non-human resources to enable these innovation capabilities to flourish.

These two drivers of innovation — management flexibility (exhibited in the style of leadership that is displayed in the organisation) supported by the adoption of advanced technology — are highlighted in Figure 2.3 and represent the starting point for the following literature review. Interest in these variables has a theoretical basis in dynamic capabilities theory (Teece et al. 1997), and related theoretical perspectives, reviewed in the following section, which provide the theoretical backdrop for the research reported in this study.

2.4 Foundational Theory Applied in the Thesis

This study has its theoretical roots in Dynamic Capabilities Theory (DCT). An expansion of the resource-based view of the firm (Amit & Schoemaker 1993; Barney 1991; Peteraf 1993) and one of the most commonly used hypothetical structures within the management literature, DCT is a theoretical perspective used to understand how firms maintain competitive advantage in a changing business environment by adopting non-traditional management mechanisms and techniques (Lin & Wu 2014). Originating in the strategic management field and encapsulated by Teece, Pisano and Schuen's work (1997, p. 517), the concept of 'dynamic capabilities' refers to '*the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments*'. It encompasses the organisational processes (and strategies) utilised to leverage organisational knowledge into value for an organisation (Eisenhardt & Martin 2000). Dynamic capabilities, more specifically, help organisations to discover valuable new ideas and convert their thoughts to action in order to influence change (Zollo & Winter 2002). Dynamic capabilities that are intended to prepare firms for exploration into the unknown are therefore different from recurring practices or routines (Schreyögg & Kliesch-Eberl 2007).

In this sense, the term 'dynamic' refers to the capacity of firms to respond to a changing business environment by renewing their effective competencies via certain innovations (Teece et al. 1997). In this context, 'capabilities' focuses primarily on the role of managers, leaders and decision-makers to efficiently adapt, integrate and reconfigure (both internally and externally) the organisation's skills, resources and functional competencies in order to meet the requirements of business competition in a changing environment. In combination, these capabilities are now recognised as transforming agents that permit the development of firms and the renewal of their capabilities, empowering them to react to significant internal and external changes in environments (Teece et al. 1997), to renew resources (Zahra et al. 2006), and to recognise new production opportunities (Easterby-Smith & Prieto 2008). In other words, in unstable and changing business environments, a dynamic capability view of the firm draws attention to both the resources and capabilities of the firm to innovate their products and services (i.e. innovative capabilities), and the ways in which leaders of the firm (re)configure these resources and capabilities to renew and redeploy them to enhance the capture and exploitation of changing opportunities (Teece, Pisano & Shuen 1997).

Since being introduced in the 1990s as a potential basis for achieving competitive advantage in firms, dynamic capability theory has been subject to rapid appraisal (Rindova & Kotha 2001; Zollo & Winter 2002; Keil 2004; Zahra et al. 2006). This theory has spawned numerous papers and has been viewed and adapted for a range of disciplines, including human resource management and information technology (Easterby-Smith & Prieto 2008). Many previous studies have demonstrated the relationship between dynamic capabilities and innovation. For example, Danneels's study (2002) of five high-tech firms shows that dynamic capabilities play a major role in producing innovation and competencies. Equally, Zott's study (2003) examined the positive impact of the dynamic capabilities approach on radical innovation and how the dynamic capabilities of firms can influence their performance within the same industry. His study highlights the observation that any small initial difference among the dynamic capabilities of firms can produce a major disparity in the competencies and performance of said firms over time. Several authors (e.g., Eisenhardt & Martin 2000; Teece et al. 1997) attribute this positive relationship to the advantages that effective dynamic capabilities can offer in terms of intangible resources, especially the creation of new knowledge for specific situations (tacit knowledge rather than explicit knowledge) as well as 'learning before doing' (Pisano 1994), where these resource bases are adjusted over the course of their changing environment.

Teece et al.'s (1997) definition of dynamic capabilities draws attention to the firm's 'managerial processes or routines', including its decision-making approaches and learning (Easterby-Smith & Prieto 2008) as well as the current assets or 'market position'; for example, the status of a firm in terms of technology and intellectual property (such as patents and copyright), and its history (path dependence) which influences the strategic alternatives available to a firm (Teece, Pisano & Shuen, 1997). Thus, capabilities should operate in a reliable manner to be effective (Helfat & Peteraf 2003) and involve sets of '*business processes strategically understood*' (Stalk et al. 1992, p. 62).

Teece et al. (1997) point out that the term 'capabilities' focuses on the main role of strategic management in a firm in efficiently adapting, integrating and reconfiguring (internally and externally) its organisational skills, resources and functional competencies to meet the requirements of business competition in a changing environment. Therefore, they suggest that a firm should depend on its ability to reconfigure, renew, and redeploy its resources and capabilities to enhance the capture and exploitation of changing opportunities. In the same vein, Amit and Schoemaker (1993) consider capabilities as bundles of correlated routines and processes. These capabilities are firm-specific and more difficult to transfer than resources, and hence have a larger capacity to generate superior performance levels for the firm (Prahalad & Hamel 1990). Similarly, Ngo and O'Cass (2012) observe that capabilities (as the interrelated routines and behaviours used in achieving certain functional missions) do not reside in employee routines but instead emerge throughout the integration of several correlated routines and processes. They can then be built through managerial selection that identifies, develops and integrates a firm's routines and processes. The research also affirms that building capabilities in this way has significant implications for firms in terms of inimitability and value.

The dynamic capabilities literature has become one of the predominant and most powerful contemporary influences in the analysis of the sustainability of competitiveness in recent research, especially for radical innovation (O'Connor et al. 2008; Reid & de Brentani 2010). This study, therefore, builds on the foundations set by the dynamic capability approach. This is because radical innovation requires firms to mould and integrate various capabilities simultaneously, as well as superior quality resources in regard to value, rarity and the inimitability of embedded competencies, skills and tacit knowledge (Barney 1991). This can be obtained through the ability of the firm to exploit its existing resources and explore new, not yet existing or at least not fully realised (i.e. dynamic) capabilities (Kylaheiko et al. 2002).

In applying this theoretical lens to the current study, dynamic capabilities theory draws attention to the prominent role of leadership, particularly transformational leadership, in organising resources and in producing an environment capable of changing the organisation's existing mental models and paradigms in order to better seize opportunities for exploitation due to the firm's enhanced competitiveness. Dynamic capabilities theory also places emphasis on how strategic assets (such as advanced technology) can be integrated within a firm to support the capability to achieve the innovation capacities that provide this competitive advantage. These features take on amplified importance when applied to ground-breaking or radical innovation. In the next section, an overview of radical innovation and its significance will be discussed.

2.5 Radical Innovation Overview

Radical innovations have been viewed differently in the literature depending on the perspective of innovations being considered (Chang et al. 2012). Central to these, however, are two defining characteristics: extreme novelty, and value/benefit. For instance, Chandy & Tellis (1998) describe radical innovation as involving the adoption of significantly higher technology and offering a great increase in customer benefit at the same time. Similarly, Majchrzak et al. (2004) and Leifer et al. (2001) clarify that radical innovation should offer unprecedented development or performance advantage that is accomplished in significant leaps in technology concerning materials and functions, newness to the marketplace and dramatic decreases in time and cost. Linton (2009) distinguishes two main dimensions of novelty: a major change in technological improvement (technical dimension) and new characteristic features or their development (for example, social innovation).

More comprehensive models have delineated four features of firms that deploy radical innovation (Chandy & Tellis 1998), including the introduction of completely new products, and redesigned processes when launching new products. Building on these conceptions, for the purposes of this study, *radical innovation* was defined as innovation that involves the development of novel products that are achieved on the basis of significant leaps in technological development compared with their competitors; it concerns new materials and features, newness to the market-place and a considerable reduction in terms of time and cost in order to offer a significant increase in customer benefit (Chandy & Tellis 1998; Majchrzak et al. 2004; Leifer et al. 2001).

Given that the achievement of this kind of innovation needs a wide range of facilitators, both internally and externally, including perhaps the acquisition of additional capacity or knowledge (Chen et al. 2014), researchers across different disciplines have proposed a number of theories about the drivers of radical innovation in firms (Tellis, Prabhu & Chandy 2009), particularly large firms (Birkinshaw et al. 2007). Radical innovation enables firms to differentiate themselves from the competition by providing exclusive benefits to their clients (Zhou et al. 2005). It provides major opportunities for firms to open up new markets (locally and globally), generate first-mover advantages and obtain positive cash flows (Mosey, Clare & Woodcock 2002; De Jong & Vermeulen 2006; Tellis, Prabhu & Chandy, 2009). It includes exploring and exploiting opportunities and utilising them for the significant development of new products or services (Van de Ven 1986). It can therefore be seen as a key driver for ensuring long-term solvency in a rapidly changing commercial environment (Subramaniam & Youndt 2005). Firms demonstrating radical innovation tend to dominate global markets and encourage the worldwide competitiveness of their home economies (Atuahene-Gima 2005; Tellis & Golder 2001).

At the same time, previous studies have indicated that radical innovations are highly dependent on inventive approaches that need to be considered throughout the prototype, experiment and exploration phases (Li et al. 2008). This means that in order to produce radical innovation, a firm needs to continuously change the methods of its business operations, whether by entering new marketplaces or introducing new products or services through the use of advanced technologies that are critical to their industry. This type of innovation is, therefore, a high-risk strategy (Nieto et al. 2015). Thus, authors such as Leifer et al. (2000) have stated that radical innovation can be described as an uncertain and high-risk process because it depends upon undeveloped knowledge, unfamiliar technology, an unknown marketplace and the capability of individuals. In connection with this, authors such as Rice et al. (2002) and Kunz and Warren (2011) mention that the high level of uncertainty involved in the execution of radical innovation can be a major obstacle to achieving radical innovation. Several empirical studies have confirmed that managing radical innovation is more difficult than managing incremental innovation (Junarsin 2009; Koen et al. 2010). This is because radical innovation needs different strategies, practices, capabilities and methods of measuring performance (Leifer et al. 2000).

Despite the importance of radical innovation for firms, its drivers are not well documented in the innovation literature (Flor et al. 2017). Further investigations are warranted to recognise which organisational components can promote this type of innovation in dynamic environments (Perra et al. 2017; Sadovnikova et al. 2016; Aagaard 2017). To contribute toward this understanding, the current study concentrates on the main roles of both transformational leadership (as a human factor) and advanced technology (as a machinery factor) for introducing radical innovation for global competitiveness within the specific sphere of large firms. In the next two sections, the relationship of the two factors with regard to radical innovation will be explored.

2.5.1 Transformational Leadership and Radical Innovation

Leadership, one of the most widely investigated areas in business literature (Bolden et al. 2003), is a process whereby one individual influences a group of individuals to achieve a common goal (Northouse 2010; Tannenbaum et al. 1961; Yukl 2008). Several theories of leadership have been generated in an attempt to understand the concept and its operation (Hemsworth, Muterera & Baregheh 2013) and various schools have emerged (Turner & Müller 2005). This is attributed to the importance of effective leadership within organisations of all sizes to the maintenance of profitability, efficiency and innovation processes (Kirkbride 2006). Leaders emphasise motivation, influencing and inspiring followers to attain the desired goals (Nahavandi 2006). Effective leadership also concerns the development of followers and dealing with them respectfully (Keskes 2013).

One style of leadership that has gained prominence in recent years is transformational leadership, a style of leadership that allows followers to rise above their self-interest by altering their morale, ideals, interests, and values and motivating them to perform better than initially expected (Bass 1985). It has emerged as a preferred leadership style in response to the challenges of leadership in an era of intense global competition and dynamic market environments (Dvir et al. 2002; Van Seters & Field 1990).

Burns was responsible for the first development in the transformational leadership concept in 1978. He conceptualised two main types of leadership: transactional or transformational. In leadership terms, transactional leaders establish their legitimacy and later maintain power through the use of rewards, praise and promises that satisfy the immediate needs of their followers (Northouse 2010). The leaders attract and engage their followers by offering rewards in exchange for the achievement of required goals (Burns 1978). Such an analysis is based on behavioural theory. On the other hand, transformational leadership can be recognised through its impacts on followers (Felfe, Tartler & Liepmann 2004). As Burns (1978, p. 4) states:

> *The transformational leader recognizes and exploits an existing need or demand of a potential follower. But, beyond that, the transforming leader looks for potential motives in the followers, seeks to satisfy higher needs, and engages the full person of the follower*.

Transformational leadership theory became well-accepted in the late 1990s, when several firms from various industries were subject to strong initiatives of change. The style of leadership associated with transformational leadership theory is regarded as one that has the ability to transform and change followers' behaviours and also that of the overall firm (Kao et al 2015). Contrary to previous theories (where traditional leadership was seen as reliant upon trait theory), transformational leadership has offered significant developments in the field of leadership (Hunt 1999). One of the most important features of this style of leadership is its visionary aspect (To, Tse & Ashkanasy 2015). Leaders not only inspire their subordinates, they engage their subordinates and make them believe that the vision set out by the leader can be achieved by them collectively (Bass & Avolio 1994). This significant characteristic of transformational leadership has extended the traditional leader's role into the role of a 'manager of meaning' (Bryman 1996). It has also served as a strong connection with organisational culture literature and symbolic aspects of organisations (Hunt 1991). For the purposes of this study, *transformational leadership* was defined as a type of leadership that, through the transformation of followers' values, behaviours, attitudes and beliefs, is intended to encourage followers to achieve higher-order goals and to exert extraordinary effort in pursuit of an organisation's innovative ambitions (Bass 1985).

Based on Burns' (1978) theory of transformational leadership, Bass (1985, 1990) and his colleagues' Avolio, Waldman and Yammarino (1991) identified four main components of transformational leadership:

(1) Idealised Influence: under this component, leaders act as role models for their subordinates. The leaders display exceptional abilities and intentions that inspire followers and make them emulate the leaders. Followers attempt to be like leaders who are well trusted, appreciated and recognised as having an attainable mission, values and vision (Bass & Riggio 2006); *(2) Inspiration Motivation:* transformational leaders act in a way that motivates and inspires their followers. They also provide meaning for and challenges in regard to the work of their followers. Leaders encourage their followers to participate in the process of envisioning desirable future states (Bass & Riggio 2006). Moreover, transformational leaders supply symbols and provide simplified emotional appeals in order to enhance follower consciousness and perception of mutually required goals. They also display a commitment to the desired objectives and the shared vision of a firm (Bass 1990). They have the ability to instil enthusiasm and optimism in an individual and team (Bass & Riggio 2005); *(3) Intellectual Stimulation:* transformational leaders encourage their followers to question their own assumptions, beliefs, expectations and values. Moreover, they stimulate their followers' innovative attempts by simplifying problems through looking at them from varying angles and supporting new ideas in different ways. Leaders support creative thinking by giving sufficient time for brainstorming and by training followers in innovation techniques (Bass & Avolio 1994) and promoting critical thinking necessary for maximising successful innovation; and *(4) Individualised Consideration:* leaders pay close attention to each individual by attempting to understand them and their particular needs, concerns and desires. This means that leaders treat followers uniquely, respectfully and equitably, according to their followers' requirements and potentials. In addition, transformational leaders pay more attention to individuals' opinions and feedback, thereby encouraging two-way communication (Bass & Riggio 2006). Leaders are able to determine whether followers require additional support or learning opportunities and are thus able to provide appropriately tailored training in a timely manner, further enhancing workplace efficiency and innovation. Moreover, leaders delegate workplace assignments as a means of improving a follower's skills and competencies (Bass & Avolio 1994).

The results of several studies have provided a substantial body of evidence to support the positive effects of transformational leadership on radical innovation performance (Aragón-Correa et al. 2007; Mumford et al. 2002; Birasnav et al. 2013). Engelen et al. (2014) point out that transformational leadership has been viewed as a key facilitator of radical innovation due to its capability to articulate a vision, provide intellectual stimulation and individualised support, and generate expectations of high performance. Thus, this style of leadership appeals to their employees' intrinsic motivations (Avolio et al. 1995) and can '*transform or change the basic values, beliefs, and attitudes of followers so that they are willing to perform beyond the minimum levels specified by the organisation'* (Podsakoff et al. 1990, p. 108). Moreover, Marvel and Lumpkin (2007) point out that this style of leadership affects radical innovation factors such as employees' learning, support for experimentation (O'Connor et al., 2008), building of informal networks (O'Connor & McDermott 2004) and encouragement of risk taking (Cabrales et al. 2008). Based on the above, it is apparent that transformational leadership is an essential determinant in identifying the internal and external organisational characteristics that promote radical innovation (Tellis et al. 2009).

Schuh et al. (2013) and Shih and Orochena (2016) point out that in the field of leadership theory, there now is a plethora of research into the mechanisms of transformational leadership. There is, however, a need for further studies to enable large firms to recognise which components and mechanisms are those through which transformational leadership can practically influence radical innovation (Cortes & Herrmann 2017; Chang 2016; Tahir et al. 2014; Mitchell & Boyle 2016). A variety of mechanisms appear to be important in effecting this (Eisenbeiss et al. 2008), as has been reflected in research into processes that illustrate the role of a leader's influence in creating and maintaining radical innovation (Li, Mitchell & Boyle 2016; Avolio & Yammarino 2002). This study takes research a step closer to understanding this relationship by investigating how transformational leadership can, in practice, encourage radical innovation towards global competitiveness within the specific sphere of large firms.

The following section moves on to talk about the second major predictor of radical innovation investigated in this thesis; the 'non-human' variable advanced technology, and its relationship to radical innovation.

2.5.2 Advanced Technology and Radical Innovation

Despite the importance of leadership in influencing the development of radical innovation in a firm, many authors argue that this kind of innovation cannot be achieved without considering other factors that support leadership in fostering radical innovation (Rosing et al. 2011). In this regard, many researchers have confirmed the significant role of advanced technology adoption within a firm for generating radical innovation (Gatignon & Xuereb 1997).

In recent years, an increasingly dynamic business climate characterised by rapid technological change and globalisation (Jung et al. 2003) has attracted interest among researchers as to how firms can adapt their capabilities and create superior business performance by producing innovation (Tuominena et al. 2004). This rapid development and change in the modern business world have put pressure on firms to search for new ideas, products and services (Gumusluoğlu & Ilsev 2009). The changes have pushed firms (particularly large firms) to rethink the deployment and adoption of advanced technologies as the key to grasping and exploiting opportunities that are offered by a dynamic business climate (Sharma et al. 2014). In this regard, Jobar et al. (2010) note that adopting new advanced technology has not only become a key driver for competition, but it also acts as the main driver for firm sustainability in the long term. This relationship with sustainability has made the adoption of such technology unavoidable and an important strategic consideration for firms (Gaimon 2008). Therefore, strategic focuses on the development and adoption of advanced technologies have become significant determinants for improving competitive position, regardless of industry (Harrison & Samson 2001).

Due to the benefits of adopting advanced technologies for many business operations, scholars take a broader view and consider advanced technology as a complicated activity that leadership should integrate into the strategic planning process (Wilbon 2015). With regard to this, Wheelwright and Clark (1992, p. 36) point out that the main objective of an advanced technology strategy is to guide the firm in acquiring, developing, and applying technology for introducing radical innovation to achieve competitive advantage. In the same vein, Zahra (1996) states that a strategy of adopting advanced technology articulates a firm's plans to successfully improve, obtain, and deploy technological resources that support the firm's competitiveness and performance. In connection with this, Gatignon and Xuereb (1997) note that a firm with advanced technology adoption has the capability to accumulate a substantial technological background and utilise it in producing radical innovation. In addition, more recent studies have shown the positive impacts of the possession of advanced technology on R&D activities (Anzoategui et al. 2017; Zhou et al. 2005; Slater et al. 2007). These activities will provide a dynamic environment which, in turn, may support firms to build new technical solutions and offer new advanced products to meet customer needs (Ali, Leifu & Rehman 2016) or successfully anticipate those needs, which offers a distinct competitive advantage.

Overall, therefore, firms with advanced technologies are expected to have a competitive advantage. This is so in terms of innovation (Frambach et al. 2003), first mover advantages (Milesi et al. 2013; Veer & Jell 2012), cost advantages (Grinstein 2008), market share (Baldwin & Sabourin 2004), acquisition of new technological skills, and support for risk taking, knowledge sharing and better decision making, as well as the creation of new ideas both within the firm and absorbing them from outside (Slater et al. 2007). Such firms are able to exploit new opportunities (Farrell 2000) and provide advanced products to customers. These all serve to increase a firm's radical innovation performance (Prahalad & Hamel 1994; Voss & Voss 2000). As documented in recent empirical studies for ten OECD countries, advanced technology adoption has significantly contributed to Total Factor Productivity (TFP) growth. The studies also indicated that adopting new advanced technologies has typically more influence on TFP growth than spending on R&D activities (OECD 1998). This appears to indicate that the adoption of the proven results of others' research into advanced technology is generally more cost-effective than in-house activities and may have more immediate effect than duplicating or pursuing costly research efforts.

Hurley and Hult (1998) consider the presence of advanced technology as an indication of a firm's openness to new ideas and its propensity to adopt technologies continually in its desire to achieve radical innovation. Similarly, Dvir et al. (1993) define 'advanced technology orientation' as a firm's propensity to invest in observing (and actively investigating) and adopting technological innovations. It refers to the tendency of a firm to regularly employ new advanced technologies (Sainio et al. 2012). In contrast, Gatignon and Xuereb (1997) define advanced technology orientation as the capability of a firm to create a technical solution for the new requirements of its customers, whether in-house or through the adoption of externally generated technological advances. Gatignon and Xuereb (1997) measured advanced technology by practical items such as the level to which the firm utilises advanced technologies in improving new products, the firm's proactivity in developing new advanced technologies, the degree of acceptance of the development of new product based on research results and the rapidity of integration of new advanced technologies. The authors believe that more radical innovations should result in the adoption of new advanced technologies to achieve a competitive advantage. Building on these conceptions, for the purposes of this study, *advanced technology* was defined as the extent of a firm's tendency to continuously and rapidly integrate all types of sophisticated technologies to enhance its capability to find a technical solution and to satisfy its customer's new requirements with novel superior technology (Gatignon & Xuereb 1997; Hurley & Hult 1998).

From a strategic management perspective, that it is important for decision-makers (leaders) to accelerate the adoption of advanced technologies to achieve a competitive advantage (Mahathi, Pal and Ramani 2016). They argue that if the firms adopt the new advanced technologies sooner than their competitors, they will attain a competitive advantage as long as their competitors do not adopt similar or even more advanced technologies. However, if firms adopt similarly advanced technologies after their competitors, this may lead to negative impacts on their long-run productivity and sustainable development as their existing market share may already be eroded and potential sales and potential for market share expansion lost. Therefore, it appears essential to understand the impacts of delayed and sequential adoption of new advanced technologies by large firms in terms of the continuity of competition (Bosma et al. 2007). It has also been suggested in the strategic management literature that decision-makers within firms have a great responsibility in predicting anticipated future market demands (nature and volume) in relation to a firm's real need for new advanced technologies. To this end, decision-makers should gather valuable information about the future, assuming different future scenarios and evaluating the trend of the market and technologies at various phases (Milliou & Petrakis 2011) and across the globe, not just locally.

Several researchers point out the importance of advanced technology adoption for encouraging radical innovation. For example, Hambrick et al. (1995) argue that firms that have adopted more recent technology put more resources towards the generation of new ideas and new methods of processes and operations to support innovative activities. Furthermore, Chen et al. (2014) note that from a resource-based view, advanced technology adoption is a key factor in facilitating decision-making and organising processes within a firm and this is a valuable resource for enhancing entrepreneurial performance in organisations. Consequently, advanced technology adoption causes the renewal of processes and reorganising operations, units and divisions, ultimately resulting in improved coordination and communication between business units (Jung et al. 2003; Moriano et al. 2011). In the same vein, Noble et al. (2002) state that based on the strategic orientation of the firm, its technology adoption reflects its values and beliefs with regard to its strategic management and resource allocation. Furthermore, a positive attitude to advanced technology adoption can assist firms to place emphasis on the expansion and development of product design and quality and on the need to avoid potential risks (Akgün, Keskin & Byrne 2012). In regard to advanced technology adoption, Jobar et al. (2010) relate some success stories of large firms in generating radical innovation in Asia, particularly in Korea and Taiwan. The authors refer to their successful engagement in advanced technology adoption strategies in a modern competitive world.

Although prior studies have provided empirical evidence regarding the positive effect of advanced technology adoption on innovation performance (e.g., Ju et al. 2013), most of these studies emphasise advanced technology as a moderator or a mediator in supporting other variables to enhance radical innovation (Batra et al. 2015; Hsu et al. 2014; Chen et al.

2014). There are, however, few studies that investigate its role as a key driver in facilitating radical innovation. This dearth of studies is surprising, given that advanced technology adoption is considered an essential ingredient to successful radical innovation.

Based on the above, it is apparent that transformational leadership and advanced technology are two significant drivers for successful radical innovation. From dynamic capability theory, it has been suggested that transformational leadership as an individual human (non-machine) factor that contributes to innovation is an essential factor in recognising, expanding and maintaining a firm's resources and competencies (externally and internally) to enhance the capture and exploitation of opportunities to produce radical innovation. On the other hand, machine (non-human) advanced technology adoption appears to be able to work in unison to support transformational leaders to implement strategies, practices and processes to achieve competitive advantages through radical innovation. This study considers the two components (transformational leadership and advanced technology) 'in parallel' as the main two drivers in generating radical innovation through a number of mediating factors, namely, advanced training, organisational learning, innovative climate and the presence of an innovation capability.

In the next section, the research hypotheses based on the proposed conceptual framework will be presented and illustrated.

2.6 Development of Hypotheses

Based on the preceding discussion and suggested research questions, the following thirteen subsections present the case for a series of fourteen hypotheses relating to the variables investigated in this study and linked to the proposed conceptual framework. These thirteen subsections introduce and explain the case for relationships among each of these variables.

2.6.1 Transformational Leadership and Innovation Capability

While much research in the field of management focuses on innovation as a process or outcome (Crossan & Apaydin 2010), it is increasingly acknowledged that a focus on ‘innovation capability’ of an organisation is more helpful. That is, instead of a narrow focus on innovation activities or processes only, a systematic understanding of innovation is adopted that involves working through all aspects that enhance the firm’s capability to innovate or encourage it to flex its ‘muscles for innovation’ (Börjesson & Elmquist 2012; also see Assink 2006; Bessant et al. 2005; O’Connor et al. 2008). Such a view, consistent with a dynamic capabilities perspective, acknowledges that to keep abreast with ever changing scientific knowledge, firms must exploit new ideas by integrating research findings into their products or processes (Kafouros et al. 2008).

DeSarbo et al. (2007) and Prange and Verdier (2011) point out that, in order to achieve success, the ability to gain resources through a distinctive innovative capability might be more significant than the resources themselves. This is because innovation capability supports a firm in the continuous improvement of its resources and processes as well as enhances exploration and exploitation of opportunities in terms of developing new products that are needed by a market (Szeto 2000). In addition, the development of innovation capability can help firms to generate radical innovation outcomes, understand the market environment and improve performance (Neely et al. 2001). Similarly, Canals (2001) points out that the innovation capability of a firm helps that firm to gain the required flexibility to respond to rapidly changing markets and client expectations and thus contribute to innovation-driven prosperity.

Various definitions of innovation capability have been proposed in the literature, depending on the perspective of innovation being considered (Börjesson & Elmquist 2012; Lawson & Samson 2001). For example, Adler et al. (1990) define innovation capability as the ability of a firm to develop, respond to and identify new processes, products and services, whereas Burgelman et al. (2004) define innovative capability as a comprehensive set of characteristics within a firm that can facilitate and encourage innovation.

Relying on these definitions and based on the purpose of this study, *innovation capability* was defined in this study as a firm’s capability to recognise, search for, integrate, experiment with and commercialise novel innovative products (Kim et al. 2012; Yam et al.

2004; Tasi & Tasi, 2010; O'Connor & McDermott 2004). These capabilities are the basis of generating and exploring new ideas and concepts and assist firms to develop these ideas and concepts into marketable and effective radical innovation products.

It has been argued in the literature that a firm's innovation capability varies depending on the type of innovation outcomes (radical or incremental). March (1991) and Roussel et al. (1991) indicate that a firm engaged in incremental innovation tends to concentrate on exploitation, proficiency-increasing and aligning activities. In contrast, a firm engaged in radical innovation tends to concentrate on exploration, and flexibility-encouraging and adaptative activities. Hence, it is suggested that firms engaged in radical innovation should have a variety of mechanisms, efficient strategic management and distinctive capabilities. Despite the growing interest in innovation capability of an organisation across the literature review, most studies focus on innovation outcomes, or on one or two indicators to investigate the natural innovation capability in a firm (e.g., Chang et al. 2012). However, innovation capabilities studies of firms indicate that to be successful in producing radical innovation, firms require a set of combinations of these indicators (Löfsten 2017; Mousavi & Bossink 2017; Vicente, Abrantes & Teixeira 2014).

Based on the Chang's et al. (2012) study on organisational capabilities, this study focuses on three main capabilities for *radical* innovation performance:

(1) Openness capability: this capability refers to the ability of a firm to search for sources of radical innovation through external, distant and wider directions instead of internal, local and limited sources. Firms with greater openness capability tend to gain more useful information and knowledge from external or international sources (Srivastava et al. 2011). Thus, a strategy of openness is necessary in the search for external knowledge on a global scale to enhance innovation capability (Martini et al. 2012; Kovács et al. 2015).

(2) Integration capability: strategic integration capability can be recognised as a subset of a firm's abilities to integrate and align its organisational connectedness to support the capability to innovate (O'Reilly 1996). Successful integration and alignment within a firm play a key role in strengthening the interconnection between all phases that are required in innovation processes and ensure the flexibility for successful innovation (Kelley 2009).

(3) Experimentation capability: this capability refers to a subset of a firm's ability to learn (Philips et al. 2006; Kelly 2009), to probe (Philips et al. 2006), to experiment with new ideas (Junarsin 2009) and commercialise these new ideas through research and development units, manufacturing processes and marketing disciplines. Probing can be recognised as the ability of a firm to experiment with an early version of radically innovative outcomes to a rational initial market. Learning, in this context, can be viewed as a firm's ability to recognise the potential of technological developments and how these technological developments can be refined to maximise market benefits, any potential applications, whether in their entirety or as segments of the whole, or whether external factors can influence their development or marketability (Chang et al. 2012).

While the literature points to several antecedents that are correlated with these characteristics (Ukko et al. 2016; Calik, Calisir & Cetinguc 2017), strong theoretical reasons exist to believe that the attitudes and behaviours exhibited by transformational leaders in both their interpersonal interactions and their strategic decisions within an organisation can have a direct influence on a firm's openness (e.g., Lin 2006), integration (e.g., Voet 2014), and experimentation (e.g., Jung, Chow & Wu 2003) capabilities. The relationship of each is explained briefly below.

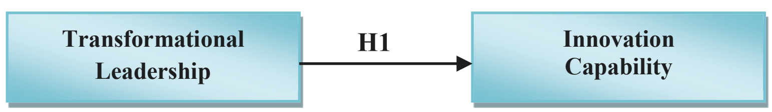
The main role of transformational leaders in encouraging followers to acquire external information and knowledge for the production of novel and valuable ideas has attracted attention in recent years (Anderson, Potočnik & Zhou 2014). Theoretically, the patterns of behaviours exhibited by transformational leaders are believed to encourage a firm's openness by supporting the knowledge and skills needed for creativity (Coad & Berry 1998; Avolio et al. 2004). This occurs through the leader's ability to motivate and intellectually stimulate followers to perform beyond their own and others' expectations (Northouse 2010). This intellectual stimulation, it is posited, can encourage followers to challenge traditions and to think about problems from different perspectives. Doing so requires followers to gain new internal and external knowledge (Shin & Zhou 2003). In a similar vein, Bass (1985) and Lin (2006) have affirmed that the inspiration and commitment demonstrated through transformational leadership is a key driver in enhancing followers' ability to gain knowledge from external sources in order to perform tasks more efficiently. Furthermore, this style of leadership can to inspire followers to be creative and innovative in seeking different ways to collect external knowledge and solve problems in novel ways (Gumusluoğlu & Ilsev 2009; Wang & Howell 2010).

Next, strategic integration across units can be achieved through coordination at the management level (leadership) and a strong, broadly shared corporate culture (Birkinshaw 2008). There is a consensus in the literature that transformational leadership plays a significant role in inspiring and enthusing followers which, in turn, increases their motivation, commitment and efforts on behalf of a firm (Shamir et al. 1993). Through inspirational motivation, a leader empowers followers and enhances their sense of collective efficacy, which encourages followers' persistence in task performance (whether physical or intellectual) and enhances their capability to increase intra-organisational integration and overcome difficulties (Voet 2014; Agle 1993). In addition, through their vision and by symbolic means as a leader (for example, by their personal charisma), leaders can provide a focal point that enhances the cohesion between followers in organisational units, as well as effect improvement in an organisational structure, where all units can be more closely integrated and aligned (Bass 1991). The emphasis is on cooperation rather than competition. Furthermore, shared values and goals can be adopted and cooperation between the followers in the organisation achieved through overall improved internal processes (Waldman & Yammarino 1999) facilitated by transformational leadership. Moreover, these behaviours of leaders increase the salience of the collective identity which, in turn, enhances the organisational employees' identification with the organisation and their willingness to make the required changes in organisational structure that may be required for better performance (Shamir et al. 1993).

Finally, recent studies have confirmed that transformational leaders play a key role in supporting learning and experimentation with novel ideas within an organisation by encouraging intellectual stimulation and providing inspirational motivation and self-confidence among employees (Dong et al. 2016; Chang 2016). Many authors (e.g., Bass & Riggio 2006; Dvir et al. 2002) point out that this style of leadership has been identified as a key factor in developing followers in the direction of autonomy and empowerment and away from automatic ‘followership’ by using a ‘critical-independent approach’. This approach is an important empowerment-related process among followers where it helps followers to think on their own and create and contribute new ideas (Bass 1990; Gumusluoğlu & Ilsev 2009). It also transforms followers so that they are able to rise above their own self-interest (Bass 1990; Gumusluoğlu & Ilsev 2009). In addition, this approach supports an employee’s willingness to learn through experimentation, exploration, communication and discussion (Menguc et al. 2007).

Taken collectively, the literature suggests that organisations with leaders who enact a transformational style are more likely to develop the openness, integration and experimentation capabilities within the organisation or business unit that will contribute to its innovation capability. Therefore, in relation to transformational leadership and innovation capability, it is hypothesised:

Hypothesis 1: *Transformational leadership is positively associated with innovation capability.*



2.6.2 Transformational Leadership and Advanced Training

Based on the purpose of this study, *advanced training* is defined as a planned process designed to support individuals through effective methods for a specific period to obtain a high level of knowledge and skills in a certain speciality so that they are then able to generate innovative ideas as well as to support the firm more generally in the production of innovation (Choi et al. 2011). Advanced training may take various forms such as conferences, workshops and/or seminars (Stahl et al. 2011; Shipton et al. 2006; Chen & Huang 2009) and can be conducted in developed countries such as the UK, Germany, Japan, Australia etc. (where practicable) so firms can gain full advantage of advanced knowledge and thus secure the best outcomes from expenditure on advanced training and from the training itself. In order to maximise effectiveness, the country (and training selected) should offer firms the greatest potential to meet trainee and industry needs. Advanced training can also be delivered through other methods in-house, whether on-the-job or off-the-job (by importing experts, professionals, scientists etc.) or through industry or sector networks (Chinomona 2013). Looking beyond one's sector or industry can also result in obtaining intellectual stimulation for innovation within one's own firm by enabling one to 'think outside the box' of routine practices and experiences.

Developing human capital competencies is recognised as one of the most primary activities for any firm to achieve innovation and also sustain competitive advantage (Birasnav et al. 2009; McGregor et al. 2004). Human capital can be defined as *'the combined knowledge, skill, innovativeness and ability of the company's individual employees to meet the task at hand'* (Bontis 2001, p. 5). Many scholars consider people as a firm's most significant resource. Employees are regarded as a knowledge warehouse for firms and are expected to deal with the emerging challenges in the era of globalisation (Cheng & Hampson 2008). In the same vein, Teemu (2012) argues that investment in human capital has gained attention in recent studies due to the large positive impact this has had on performance, productivity and innovation within firms. Indeed, investment in human capital is considered one of the cornerstones upon which innovation can be built (Leiponen 2005; Schneider et al. (2010) because of the importance of intangible characteristics such as industry- or sector-specific (Sánchez et al. 2003) and organisational (Bollinger & Smith 2001) knowledge, skills and attributes.

Perhaps the most commonly used tool to develop the human capital within organisations is via formal and structured training programs (Leiponen 2005; Schneider et al. 2010), introduced by leaders with the aim of improving the collective knowledge and skills of employees in order to achieve a specific purpose. Beach (1965) defines training as an organisational program by which employees learn knowledge and skills for a specific purpose. Schuler and MacMillan (1984) define training as activities that provide a significant role in regard to organisational effectiveness. Chiaburu & Tekleab (2005, p. 29) on the other hand describe training as '*planned intervention that is designed to enhance the determinants of individual job satisfaction*'.

The innovation capability of a firm mainly relies on its capacity to acquire and develop new knowledge and skills (Ciras-Cali et al. 2015) and so ongoing advanced training is particularly important since it permits employees to constantly attain new competences (Vasilaki 2011). Based on the related literature, organisations' investment in and support for staff advanced training has been shown to be positively related to business growth and success (Ibrahim & Ellis 2003; Reid & Harris 2002). Adequate funding and support may be especially important for innovation because the advanced training and environment generated can provide staff with the knowledge and skills to create new routines, methods, or systems (Stahl et al. 2011; Weber & Tarba 2010) to apply to their work. It also strengthens a psychologically positive attitude toward innovation as well as creating within staff a sense of efficacy in utilising the material to support their firm's innovative performance (Venkatesh et al. 2003). This is an internal reward system that sustains further effort. Furthermore, staff advanced training aims to provide great opportunities for employees to learn new knowledge and skills for a specific purpose (Beach 1965) and to share the knowledge, behaviours, skills and attitudes required for the future rather than take action after a problem emerges (Glaveli et al. 2011).

Advanced training can be viewed as having both qualitative and quantitative features, including the accessibility, frequency and quality of training programs (Jin Nam Chol et al. 2011; Patterson et al. 2005). In considering what aspects might contribute to the extent and efficacy of advanced training, several authors (e.g., Colquitt et al. 2000; Barrick and Mount 1991) have identified the major role that can be played by leadership qualities.

Drawing on transformational leadership theory, it is proposed that a transformational style of leadership can influence the extent and efficacy of advanced training in an organisation in several ways:

- recognising that advanced training is important, and so making greater investment in advanced training initiatives for staff;
- better understanding of the followers' (and organisations) advanced training needs;

- manifesting attitudes and behaviours that encourage and motivate followers to learn and participate in advanced training, and to give them the confidence and opportunity to apply this newly acquired knowledge and skills to the workplace; and
- taking the greater share of decision-making regarding strategies, resources, budget etc. for developing their employees and through encouraging the psychological aspects of trainees such as motivation, perceptions or confidence.

Avolio and Gibbons (1988) argue that one of the main goals of transformational leadership is to expand follower self-management and self-development. Prior research has demonstrated that this style of leadership has the ability to define and employ human resource policies, practices and expectations that can shape employee participation in advanced training activities (Kuvaas & Dysvik 2010; Towler et al. 2014). Through individualised consideration, transformational leaders realise the individual abilities, skills, talents and needs of their employees and support their strengths (Walumbwa et al. 2008; Zhu et al. 2009). Thus, several authors affirm that a leader embodying transformational behaviours exerts influence and has the capability to justify advanced training programs, attract budget support, recognise and utilise the most efficient training for innovation strategies, manage expectations, analyse satisfaction feedback, and identify professional development needs (Dvir et al. 2002).

As outlined by Klink, Gielen and Nauta (2001), supervisory support is a significant element for advanced training effectiveness and success. Some researchers (e.g., Woggnum & Veldkamp 2006; Michel, Lyons and Kavanagh 2007) describe supervisory support as the extent to which leaders behave in a way that encourages trainees to gain learning via advanced training activities and support their subsequent employment of the skills and knowledge acquired in that advanced training outcome. Leader support may take different forms, including enhancing trainee confidence, explaining the objectives of the advanced training, or providing guidance (Clarke 2002; Nijman et al. 2006). Well-supported trainee employees move over time from compliance to self-efficacy and from not merely a belief that they can achieve a desired goal or task (Bandura 1982) but through relevant individualised advanced training they are equipped to do so (Bass 1985, 1996; Yukl 2008).

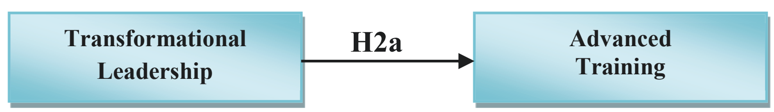
As discussed in section 2.5.1, transformational leadership has a direct impact on psychological empowerment, organisational commitment and higher-level self-actualisation needs of employees. This, in turn, encourages employees to share and apply the newly acquired competences in their jobs (Nemanich & Keller 2007; Avolio & Bass 2004).

Through inspirational motivation, transformational leaders also can influence the efficacy of advanced training by convincing followers of the importance of learning. A meta-analysis of advanced training programs indicates that one of the most relevant measures of advanced training success is trainee motivation (Arthur et al. 2003; also see Towler & Dipboye 2001), defined as the desire of trainees to learn the required contents of training programs (Noe & Schmitt 1986). Noe (1986) indicates that trainees will be more motivated if they perceive that: (1) a high-level of effort will lead to high level of performance in training, (2) a high-level performance in the training leads to high level in the job performance; and (3) a high level in the job performance will gain the desired outcomes (innovation). Thus, previous research suggests that the transformational leader plays a central role in influencing the impact of advanced training programs. Specifically, subordinates have a stronger will and confidence in the program's benefits and so possess stronger advanced training motivation when their leaders support their participation and application of advanced training content before, during and after advanced training program (Chiaburu & Tekleab 2005).

In particular, transformational leadership can motivate and intellectually stimulate followers to achieve beyond the expectations of their firms' needs (Burns 1978). Such leaders normally inspire subordinates to be motivated; they talk optimistically regarding the future and build the subordinates' confidence levels (Eisenbeiss et al. 2008). This transformational leader contribution to a supportive environment for employee/follower development has positive impacts on individual employees and on the collective cultural environment of the workplace or business, supporting radical innovation. On a similar note, consider a study conducted by Tharenou (2001). The author conducted research with 1705 Australian trainees, investigating the role that can be played by leadership for advanced training success. She found that support offered by transformational leadership behaviours have a direct positive impact on trainees with regard to their participation in employee advanced training and development initiatives and motivation to acquire new skills, experience and knowledge for innovation activities. In addition, Baldwin and Magjuka (1991) conducted a study on 193 engineers to investigate whether leadership actions affect trainee intention to transfer their knowledge, skills and experiences to their jobs for innovation prosperity within their firms. The authors conclude that transformational leadership actions have a significant influence on the transfer of advanced training behaviours for innovation production.

Based on the above, it is argued that transformational leadership is an important determinant in the success of advanced training through the advanced training choices made by these types of leaders (such as in relation to type and quantity of training) and through the efficacy of these advanced training programs (further motivating trainees' attendance of training and application of content). Thus, it is hypothesised:

Hypothesis 2a: *Transformational leadership is positively associated with advanced training.*



2.6.3 Advanced Training and Innovative Climate

Due to the significant impact of the cooperative environment of an organisation on the level of innovation capability and organisational growth (Koene, Vogelaar & Soeters 2002; Schneider et al. 1996), the concept of innovative 'climate' (or environment) has been investigated in different disciplines such as psychology and organisational sociology (Isaksen & Akkermans 2011). The investigations are done through understanding that people's behaviours as individuals and collectively create an environment or climate that either supports or discourages innovation. Mumford et al. (1988) mention that individuals who wish to launch creative initiatives are unwilling to do so if the climate is not ideal for innovation. They argue that within a firm an ideal climate to facilitate innovation capability is one that can create a positive cognitive (psychological) basis for innovation. This works in terms of supporting the generation of novel ideas and motivating the actions required to implement these ideas. Such a climate also displays acceptance and appreciation for the work of individuals by leadership (Scott & Bruce 1994).

Schneider et al. (1983) argue that the climate within a firm has a direct impact on individual behaviour since it reflects individual perceptions of 'relatively enduring features' of the firm that can set parameters for how they work within it. Some scholars conceptualise climate as the individuals' constructive representations or cognitive schema of their work environments, which have been processed through individuals' sense-making of their work environment (Ashforth 1985; James & Jones 1974).

Several definitions have been provided in the literature that attempt to describe climate. For instance, James and Sells (1981, p. 276), define climate as *'individuals' cognitive representations of proximal environments . . . expressed in terms of psychological meaning and significance to the individual'*. Contrary to this, Ekvall (1991) describes climate as an observed pattern of behaviours, attitudes, contingencies, requirements, interactions in the work environment and feelings which describe working life in a firm. However, Denison (1996) considers climate a changeable aspect, able to be controlled by leaders and managers while involving social and environmental aspects which are realised by the firm's individual employees. Thus, climate is described in different ways by different researchers (Rousseau 1988).

Relying on these definitions and based on the purpose of this study, *innovative climate* can be defined in this study as the cognitive representations of employees in innovative activities encouraged by the leaders' direction, the provision of the necessary resources, rewards, autonomy and motivation, associated to its policies, practices and procedures (in all their aspects) within a firm. This study draws on the social interactionist perspective and posits that leaders and work-group influence individual innovative behaviour directly and indirectly through perceptions of innovative climate (James et al. 1978; Scott & Bruce 1994; Ekvall 1991).

Few contextual theories of innovative climate have attempted to identify components or factors of work environments that are related to innovation. In this respect, Schneider (1990) suggests that components of the innovative climate would vary according to the purpose of the investigation and the criterion of interest. Empirical work by Scott and Bruce (1994) has identified four broad factors that are assumed to influence innovative climate: *(1) Nature of interpersonal relationships*: this component focuses on the relationship of individuals within a workplace and whether it is strong, deep and close. Trust, cooperation and respect by the leaders are considered the main factors that interpersonal relationships; *(2) Nature of hierarchy*: this component concentrates on decision making policy and includes factors like whether decisions are made centrally or through consensus and participation, whether a spirit of teamwork exists, and whether special concessions are provided to certain employees; *(3) Nature of work*: this aspect centres on workplace environment issues such as challenges, routines, the provision of adequate resources to undertake tasks efficiently, and whether work is able to be done flexibly; and *(4) Focus of support and rewards*: this parameter represents aspects of appreciation and rewards for employees.

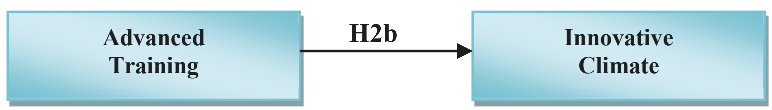
Although earlier research has demonstrated the positive effect of advanced training on innovation performance (e.g., Schneider et al. 2010), prior studies offer very little explanation about how the link of learning activities (i.e. advanced training) with the work atmosphere within an organisation influences innovation capability (Jyoti, Chahal & Rani 2017; Liao et al. 2009; Glaveli & Karassavidou 2011). With the increasing emphasis on innovative climate in practice, several studies have been conducted to examine factors influencing innovative climate (Lim & Morris 2006). Among these factors, providing advanced training to employees has been associated with innovative climate, since advanced training influences employees' knowledge, attitudes and behaviours (Tharenou et al. 2007; Golparvar, Barazandeh & Atashpour 2012). Through advanced training, employees can become adept at utilise and applying innovation to their work, strengthen their psychological readiness for innovation as well as the sense of efficacy in utilising it to support their firms' innovative performance (Venkatesh et al. 2003). Advanced training can, therefore, be viewed as a systematic acquisition and development of relevant skills, competencies, values and attitudes which, in turn, enable employees to adequately perform their tasks and increase their performance, and improve innovative climate (De Grip & Sauermann 2013). When employees are adequately rewarded in their roles and in their learning, they are more receptive to advanced training. Consequently, employees can feel strongly supported by a firm through the provision of the necessary resources and rewards, in addition to the motivation provided by leaders; these enhance innovative climate (Scott & Bruce 1994).

On the basis of a review of the innovative climate literature, creating, sharing and using knowledge are considered some of the most significant factors in encouraging an innovative climate (Xue, Bradley & Liang 2011). In this regard, Ipe (2003) points out that a firm should implement effective strategies to enhance individuals' participation in the exchange of knowledge, particularly tacit knowledge. It has been argued that effective interactions between team members are a significant factor for enhancing the innovative climate in which they operate (Anderson & West 1998). On this front, Noe (2002) points out that advanced training can be viewed as an intentional activity provided by firms to transfer job expertise and knowledge as well as modify attitudes and behaviours of individuals in a way which is aligned with a firm's goals for promoting innovation. In connection with this, Børing (2017) indicates that advanced training within a firm (e.g., utilising training on-the-job, in-house, classroom or internal networks) is considered a great opportunity for effective interactions between team members. Through the team member meetings, their relationships and communications are strengthened, and the development of a high level of trust, openness, commitment, participation and motivation is far more likely (Vera & Crossan 2004). In this environment, all team members can discuss matters with their colleagues and exchange their knowledge, ideas and opinions for generating innovation. This atmosphere also supports team members in decision-taking through consensus and participation (Golparvar, Barazandeh & Atashpour 2012). More importantly, team members will be more likely to be highly appreciated by their leaders. Such appreciation can include allowing adequate time for employees to pursue creative ideas, as well as the provision of adequate resources and reward for innovation-oriented activities which, in turn, improve innovative climate (Hulsheger et al. 2009).

Drawing on the training literature, international training opportunities such as seminars, conferences and workshops have a consistent positive correlation with innovative climate (Shipton et al. 2006). Authors such as Chen and Huang (2009) argue that overseas advanced training, particularly in developed countries, tends to generate higher training outcomes (in terms of knowledge and skills). Consequently, the trainees return to their firms equipped to achieve higher standards of innovation. The authors attribute this to the diverse and valuable new knowledge that employees can obtain to perform their tasks as well as to the ability of employees to become more experienced to troubleshoot work-related problems to generate innovation. Thus, through the acquisition of new (external) knowledge, employees can support other members within the firms by sharing this knowledge, and their experiences, skills and ideas. This action will lead the firms to highly appreciate their employees and therefore provide them with sufficient resources, motivation and rewards which, in turn, will significantly affect innovative climate (Schmidt 2010). This argument has been affirmed by a study conducted by Xiao et al. (2009) on China's overseas management training. The authors state that Chinese policy makers are aware that developing China's managers is crucial in creating competitive advantage in the post- World Trade Organisation (WTO) period. Consequently, large numbers of Chinese managers have been sent abroad, particularly to Western and developed countries, in order to bring new ideas, skills and competences to encourage innovation in China. When their training programs were completed, the Chinese trainees transferred the new knowledge and experiences to their firms to enhance innovation performance. As a result, many firms have achieved their objectives and sustained growth by the transfer of trainees' experiences, knowledge and ideas to their firms. This, as well as the provision of adequate motivation, appreciation and support for their employees, has enhanced innovative climate within the firms.

Consistent with these observations, a study conducted by Børing (2017) used a data set of 5204 Norwegian enterprises to examine the impacts of advanced training programs on the teamwork for innovative climate activities. The study found (on the basis of correlation coefficients) a positive relationship between advanced training activities and teamwork as such activities stimulated new ideas and creativity among individuals. The author attributed this result to the positive advantages that advanced training can offer individuals as well as to the support of leadership through the provision of sufficient resources (financial, time and information) to the team members. In connection with this, another study conducted by Tabassi et al. (2012) with some construction firms in Iran (sample population 107) investigated the effects of advanced training programs on teamwork and task efficiency. The investigation comprised a correlational study, while its analysis methodology was descriptive and regression-based. The findings affirmed that there is a strong correlation between advanced training programs and improvement in teamwork for innovative climate in construction projects. The authors indicate that through interaction and communication by individuals during training programs and through direct support by leadership (e.g., reward system, resources and the exchange of new ideas), team members could increase a spirit of teamwork that contributed to innovative climate. Based on the above, it is proposed that advanced training will have a positive tangible impact on innovative climate. Therefore, it is hypothesised:

Hypothesis 2b: *An advanced training is positively associated with innovative climate.*



2.6.4 The Mediating Effect of Advanced Training

Extending the above arguments into the second aspect of innovative climate, it would be reasonable to assume a direct impact of transformational leadership on a firm's innovative climate (e.g., Kao et al. 2015; Haakonsson et al. 2008; Jung et al. 2003; Wang et al. 2011). However, innovative climate attributes cannot be generated 'from scratch'; rather, they are dependent on what a firm is actually capable of or can generate through learning factors (i.e. advanced training) (Paavola et al. 2004; Moolenaar et al. 2010). This is supported empirically by studies that reveal the positive relationship between transformational leadership and learning activities (e.g., Towler et al. 2014; Zhu et al. 2009; Pirc 2001). Accordingly, it can be inferred that advanced training plays a mediating role in the relationship between transformational leadership and innovative climate.

Considerable research has indicated a relationship between transformational leadership and human resource policies, practices and expectations that can shape employee participation in advanced training activities (Kuvaas & Dysvik 2010; Towler et al. 2014). This is because transformational leaders tend to act as mentors to generate learning opportunities by providing their followers sufficient resources to enable learning, by offering adequate training programmes, and by instilling confidence in followers to apply this newly acquired knowledge and skills to the workplace and by providing opportunities to do so (Chiaburu et al. 2010; Schmitt et al. 2016). With the direct support of transformational leadership to advanced training programmes, individuals become more learning-oriented and are encouraged to actively pursue diverse information and knowledge needed to better perform their tasks (Chen & Huang 2009; Shipton et al. 2006). These leadership practices also promote the personal development and proactive involvement of employees at work, and have the potential to enhance their capacity to troubleshoot work-related problems, develop creative solutions, and apply these solutions in practical situations. Consequently, leaders will be more likely to appreciate employees and provide them with adequate time, resources and incentives to pursue creative ideas and innovation-oriented activities. This, in turn, influences innovative climate (Hulsheger et al. 2009). Predicated on the above, it is proposed that advanced training is positively related to innovative climate, and that this mediates the relationship between transformational leadership and innovative climate. Thus, it is hypothesised:

Hypothesis 2c: *Advanced training mediates the relationship between transformational leadership and innovative climate.*

2.6.5 Transformational Leadership and Organisational Learning

The concept of organisational learning was first discussed by March and Simon (1958) and, since that time has expanded to become recognised as essential in generating innovation and, consequently, competitive advantage as it involves positive cognitive and behavioural change (José, Pén & Ordás 2006). Most firms disappear, having failed to secure a competitive advantage due to their inability to enhance learning in their firms (Argyris & Schön 1996). Previous research indicates the great benefits of the concept of organisational learning to firms. For example, Kandemir and Hult (2005) mention that organisational learning is a significant factor in generating superior customer value in the long-term since learning can stimulate a firm to continuous adaptation in a rapidly changing global market and enhance dynamic capability. Azadegan and Dooley (2010) mention its importance in organisational performance, while Santos et al. (2010) highlight its role in marketing orientation and relationship, Hult et al. (2002) flag service and product quality, and Akgün et al. (2006) see its potential in producing innovation. The last is the specific focus of this study.

The term 'organisational learning' has in fact been applied by different researchers to different domains, making this term hard to define (Lopez et al. 2006). For instance, Huber (1991) explains the concept from an information-processing perspective, while (in the same vein) Klimencki and Lassleben (1998) consider organisational learning a result of changes in organisational knowledge. This new knowledge can be generated throughout information processing in a firm and leads to the discovery of new methods of sustaining and succeeding in new situations. Nonaka and Takeuchi (1995) apply the concept to product innovation and consider organisational learning as the capacity of an organisation to facilitate the creation and acquisition of knowledge and then to disseminate it around the organisation to improve its products, services and systems. Nevis et al. (1995) consider organisational learning as the capacity or processes that are produced within firms in order to sustain and improve performance, with the content of such learning depending on or responding to the firms' experiences.

Predicated on the above, organisational learning can, therefore, be considered as the process of how individuals within a firm can increase effective knowledge via an organised method and 'leech' this knowledge into the firm's knowledge systems (Lopez et al. 2006). This process may take place within a firm as social interaction (internal and external) or via individuals and their interactions with colleagues. The process is one whereby the firm creates knowledge, either tacit or explicit (Nonaka & Takeuchi 1995; Beeby & Booth 2000). In addition, Sadler-Smith (2001) understands organisational learning to be the improvement and acquisition of new effective knowledge or skills in reaction to internal and external stimuli which, in turn, leads to permanent changes in collective behaviour, encouraging organisational efficiency and performance. Indeed, there are efforts among these researchers to assemble some common threads. The domains are, however, significantly different. Although these definitions differ in describing the term 'organisational learning', all authors concur that the term can be treated as a process within a firm that is undertaken in order to create an efficient knowledge distribution process.

Based on the purpose of this study, organisational learning can be defined as:

> *A dynamic process of creation, acquisition and integration of knowledge aimed at developing the resources and capabilities that allow the organization to achieve a better performance* (Lopez et al. 2006, p. 217).

Tippins and Sohi (2003) divided the processes of organisational learning into four major dimensions: acquisition of information, dissemination of information, interpretation, and organisational memory development. Generally, knowledge acquisition can be described as the process of development or creation of skills, insights and relationships (Hoe and McShane 2010). Its description also includes how it is collected, that is, its extraction, structuring and/or organisation. It can be further subdivided into external and internal knowledge acquisition (Chiva et al. 2007). In contrast, knowledge dissemination can be defined as the process of managing the way knowledge is shared and diffused throughout the organisation (Yang et al. 2014). More precisely, knowledge must be transferred within and across settings for that knowledge to be utilised to meet future needs, that is, for it to be used efficaciously. Interpretation, on the other hand, occurs where individuals share and integrate aspects of their knowledge which are not familiar to all individuals. It is a juncture where knowledge can become distorted or misunderstood. The challenge is for those disseminating information and for those learning to attain a shared and accurate understanding of that information. The presence of 'feedback loops' and openness and trust (rather than fear) driven communication are integral to accurate information transfer as well as continued high motivation for its integration in workplace processes. The process also requires coordination in decision making (Hoe & McShane 2010). Organisational memory development is the process whereby knowledge is stored for future use, whether in organisational systems designed for this purpose or in the form of regulations, procedures and other systems (Hoe & McShane 2010). To summarise, the processes involved in learning in an organisation are very wide-ranging, including the gaining of knowledge, the collecting of knowledge (data or previous experiences) and its dissemination and storage, and the creation of new uses for the resources (a process of innovation) (Nonaka & Takeuchi 1995). Based on the related literature, the main responsibility for creating organisational learning in the firms lies with their leaders (Imran et al. 2016). The role of leadership, particularly transformational leadership in learning organisations, has been investigated (Kamoche & Mueller 1998).

In the current organisational context more generally, however, many scholars have confirmed that transformational leaders have the abilities to achieve the necessary level of organisational competence (Judge & Piccolo 2004). This is because transformational leaders inspire followers to be motivated and help followers build enthusiasm, and team *esprit de corps* as well as individual spirit or morale (Yukl 2008). As outlined by Bass and Avolio (2000) and García et al. (2008), transformational leadership has the capacity to increase the consciousness of collective interest among members of a firm and support them in accomplishing their goals. Furthermore, transformational leaders are visionary leaders (Bass 1985) and, therefore, they are able to enhance organisational learning through encouraging 'intellectual stimulation' and promoting 'inspirational motivation' and 'self-confidence' among employees (Coad & Berry 1998). This style of leadership is often seen as a significant factor in the level and quality of knowledge which is communicated and disseminated throughout a firm (Avolio et al. 2004).

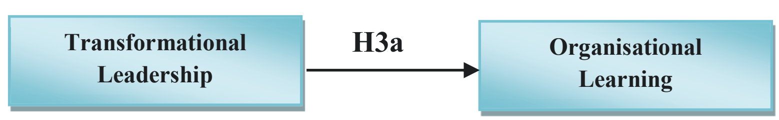
In addition, transformational leadership supports 'shared mental models' that favour continuous learning and assist technological learning (Senge et al. 1994). In connection with this, Lei et al. (1999) and Argyris and Schön (1996) point out that communication and dialogue within an organisation are strongly supported by transformational leaders, since they are the basis for knowledge acquisition, sharing and utilisation. This is because communication and dialogue assist the development of social relationships and permit leaders to commit openly to learning, and to become a force generator and key facilitator in overcoming internal and external difficulties to set up learning within an organisation (Wick & Leon 1995). On a similar note, consider a study by Amitay et al. (2009) of 44 community clinics run by a health-care organisation in Israel. It found that a transformational leadership style was significantly associated with organisational learning.

In contemporary knowledge based organisations, leaders are conscious that they are not the only ones who have knowledge (Bukowitz & Williams 1999). Knowledge also resides in their employees. Tapping into employees' existing knowledge and dealing with workers' competency needs requires skills and personal charisma to build confidence and engagement, and this can be done through 'intellectual power, conviction and interactive dialog' (Ribière & Sitar 2003, p. 39). In this sense, Bono and Judge (2004) state that transformational leadership is widely accepted not only due to its success in enhancing inspiration, commitment and intellectual stimulation that can support knowledge and learning activities, but also due to its associated behaviours, including offering rewards, letters of appreciation, allocation of resources, bonuses, etc. (Paul et al. 2002). Moreover, this style of leadership has the ability to evaluate employee activities and contributions to the creation and sharing of knowledge (Pedler et al. 1996). In the same vein, Pirc (2001) and Pfeffer and Sutton (1999) state that transformational leadership plays a major role in facilitating learning and knowledge sharing through reinforcing the message that employees are supported to experiment with new ways of working, new ideas and to keep learning from their experience.

More importantly, Bass (2000) indicates that transformational leaders are able to inspire trust, loyalty and admiration in employees. In this respect, a trusting environment plays a fundamental role in the development of organisational learning. This is because employees can obtain a significant level of power and authority to express their opinions and ideas freely without fear in an environment that supports them to fully share their knowledge (Vera & Crossan 2004). Shaw (1997) points out that building trust among employees can be done through demonstrating respect, keeping promises, being honest, being accessible and open, operating across a model of greater equality while maintaining leadership through example, recognising employees and their efforts and achievements, being credible, demonstrating integrity, etc. As a result of increased trust, the level of teamwork in the workplace environment and the interaction between employees will increase, and acquisition and sharing of knowledge (particularly tacit knowledge) will expand among employees (Pfeffer & Sutton 1999).

In view of the above, it is evident that transformational leaders play important roles in improving learning within organisations (Maani & Benton 1999). This style of leader can provide a safe environment rich with trust for knowledge sharing and supporting employees' ideas, opinions and experiences. Transformational leaders are able to encourage their employees to acquire the vision and goals of the organisation. They facilitate communication and dialogue between employees to support an environment of learning in which knowledge can be easily created and shared among employees and with management (DeLong 2004). Therefore, in relation to transformational leadership and organisational learning, it is hypothesised:

Hypothesis 3a: *Transformational leadership is positively associated with organisational learning.*



2.6.6 Organisational Learning and Innovative Climate

Due to the impact of innovative climate on innovation capability (Koene, Vogelaar & Soeters 2002), organisational growth (Koene, Vogelaar & Soeters 2002) and sustained competitiveness (Epstein et al. 2013; Caniëls et al. 2014), several researchers have investigated the drivers that affect innovative climate within organisations (Amabile et al. 1996; Ekvall 1996). Numerous studies have provided a strong basis for the direct positive impact of organisational learning on innovation performance (e.g., García-Morales et al. 2007). However, few studies have been found in the literature examined the innovative climate performance through the mediating effect of organisational learning.

As stated earlier, innovative climate creates a positive cognitive (psychological) basis for innovation. It supports the generation of novel ideas and motivating the actions required to implement novel ideas for innovation production. Such a climate also displays acceptance and appreciation for the work of employees (Mumford et al. 1988). Further, as long as perceptions of climate provide a reference point for the behaviour of employees within a given setting and make them believe that their work atmosphere encourages ideas, opinions, change and provides the necessary resources and rewards for innovative initiatives, employees can innovate freely and frequently (Scott & Bruce 1994).

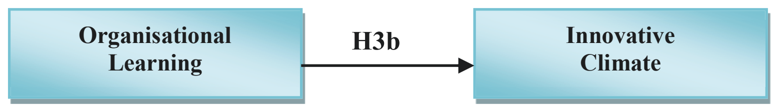
Building upon the innovative climate literature, Kanter (1983) and Paavola, Lipponen and Hakkarainen (2004) point out that innovative climate generally results from positive social interactions between individuals. These interactions facilitate knowledge sharing and the generation of new ideas which are critical factors in enhancing an innovative climate. In this respect, Lozano (2014) and Cirella and Shani (2012) emphasise the importance of establishing mechanisms within a firm to facilitate the creation and acquisition of knowledge for encouraging the cognitive representations among individuals. Authors such as Wang and Wang (2012) and Monica Hu et al. (2009) state that the adoption of organisational learning practices as a strategy has been acknowledged as a significant factor in strengthening the practices, procedures and behaviours of employees for an innovative climate.

In concert with this view, Catmull (2008) states that most creative ideas inside firms result from exchanges in a 'collective space', when communication triggers ideas through debate, dialogue and cooperative communication and activities. Clough and Ferguson (2010) and Beeby and Booth (2000) mention the importance of developing learning processes within a firm as an organised dynamic method to support employees in the creation and acquisition of new ideas. This process may take place within a firm as a community interaction (internal and external) or via employees and their interactions with colleagues or leadership whereby the firm creates knowledge, whether tacit or explicit (Nonaka & Takeuchi 1995; Beeby & Booth 2000). In this vein, Sonnenburg (2004) states that the structures and platforms of organisational learning within a firm, such as internal and external electronic communication network systems, blogs and social media tools, are some examples of what promotes collaboration, a social work environment and communication (whether between employees themselves or with leadership) (Epstein et al. 2013). In this regard, authors such as Gherardi and Nicolini (2002) and Swan et al. (2002) point out that leadership initiative must assist employees to learn more efficaciously as well as attend to the social processes that inform how valuable knowledge and creative ideas can be actionable in the organisation as cross-functional teams or communities of practice. Under the organisational learning perspective, (a high-level of innovative climate, including support by leadership, motivation, resources and rewards, can be argued to be an expansion of the success of learning process (Lopez et al. 2006).

The related literature indicates that informal social interaction mechanisms between employees throughout learning practices lead to permanent changes in collective behaviour and organisational routines and are able to respond to the changing environment (Sadler-Smith 2001; Zahra & George 2002). These changes help employees to share common values (Holmquist 2007), providing an obvious shared cognitive vision (Stetler & Magnusson 2015), encouraging dialogue (Lundgren et al. 2005), enhancing perception (Sadler-Smith 2001), increasing relationships (Santos et al. 2010) and supporting a common conceptual language (Antonacopoulou & Gabriel 2001). Indeed, these interactions between employees are significant for an open orientation towards innovation, even radical innovation (Keeney 1992; Frank, Zhao, & Borman 2004). As a result, organisational learning will lead to be high justification, appreciation and supports by leadership in innovation activities (Lundgren et al. 2005). Accordingly, innovative climate will be increased.

In addition, communication and interactive dialogue through learning practices adopted within a firm assist the development of social relationships of employees with leaders. This permits leaders to engage openly with employees to commit to learning, to become force generators and key facilitators in overcoming internal and external difficulties (Wick & Leon 1995). Once new ideas change initiatives and employees' creativity are respected and built through organisational learning within a firm (Lei et al. 1999), leaders are able to easily play a vital role in offering rewards and allocating resources for radical innovation which is risky for investment. Some are tokens or symbols of appreciation, others more substantial, some directed to individual employees or the team, while still others include alterations to workplace practices or processes (Moolenaar et al. 2010). These include letters of appreciation, allocation of resources such as time and budget, confidence, engagement and bonuses (Adler & Kwon 2002). Predicated on the above, it can be clearly seen that organisational learning practices within firms have positive effects on innovative climate. Thus, it is hypothesised:

Hypothesis 3b: *Organisational learning is positively associated with innovative climate.*



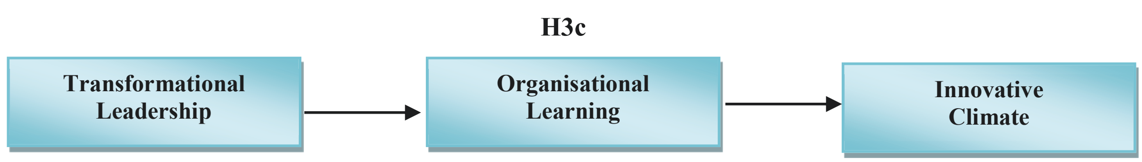
2.6.7 The Mediating Effect of Organisational Learning

In addition to advanced training, it is proposed that organisational learning mediates the relationship between transformational leadership and innovative climate. Central to this argument is the notion of relationships as a form of a firm's resources exchange (i.e. knowledge, skills, ideas and competencies) (Sundgren et al. 2005; Woodman et al. 1993; Sung & Choi 2014). Organisational learning is often viewed as a social or interpersonal activity (Yang et al. 2014; Paavola, Lipponen & Hakkarainen 2004). Therefore, it seems logical that firms should have the support mechanisms that allow learning to take place in order to increase the innovative climate. Without such support mechanisms, participation in organisational learning will be limited, if it exists at all (Tobin et al. 2006). Recent studies on transformational leadership have indicated that this style of leadership has the capability to build teams and provide them with direction and support for the processes of change and organisational learning (Schmitt et al. 2016; García-Morales et al. 2012). This style of leadership has the ability to analyse, modify and drive systems, designing them to share and transfer knowledge, particularly tacit knowledge through the process of organisational learning (Lei et al. 1999; García-Morales et al. 2012).

Furthermore, innovative climates are defined by their social nature, with interpersonal interactions providing multiple opportunities for input and refinement (Wang and Wang

2012). Communication, sharing knowledge and ideas, and opportunities to engage in discussion and decision making are critical for a climate orientation towards innovation (Frank et al. 2004; Monge et al. 1992). This suggests that the innovative climate of an organisation underlies the development of social learning processes in which the combination of different people, knowledge, and resources triggers the generation of new ideas and practices (Kogut & Zander 1992). Thus, to foster a firm's innovative climate, transformational leaders may direct their behaviour towards encouragement and support, as well as establishing and maintaining nurturing relationships (Shalley & Gilson 2004). Hence, it is proposed that by supporting organisational learning processes, transformational leaders are able to foster individuals to bring together the knowledge, expertise, novel ideas and skills of others in a climate that permits innovation to emerge (Jung 2001; Shalley 2003; Storey & Salaman 2005). By shaping an overarching environment that supports and promotes learning, individuals can increase their abilities to adequately perform their tasks and improve the firm's performance (Frank, Zhao and Borman 2004). In view of the above, it is proposed that organisational learning mediates the relationship between transformational leadership and innovative climate. Thus, it is hypothesised:

Hypothesis 3c: *Organisational learning mediates the relationship between transformational leadership and innovative climate.*



2.6.8 Advanced Technology and Innovation Capability

In the current unstable market where things change quickly, and advanced technologies rapidly supplant each other, firms need to take greater responsibility for increasing innovation capabilities so as to be able to fulfil customers' needs. As mentioned earlier, a firm's innovation capability for radical innovation outcomes can be increased through the possession of three main capabilities: openness, integration and experimentation capabilities (Chang et al. 2012). Despite the importance of these innovation capabilities for the improvement of radical innovation, no study in the extant literature appears to empirically examine the influence of advanced technology adoption on these capabilities for radical innovation performance. There is a need for further research that specifically examines the mediating role of innovation capability on radical innovation performance (e.g., Forés & Camisón 2016).

Successful radical innovation requires firms to be capable of generating as well as transferring effective knowledge and novel ideas from a wide range of sources, whether internal or external (Osborne et al. 2008). In this regard, Srivastava et al. (2011) indicate that the ability of firms to search and gain more effective information and useful knowledge from external or international sources is an important factor for supporting the organisation's 'openness' capability. Producing innovation through openness regarding a firm's existing knowledge and production boundaries can be a key to exploiting potential economic value in the firm's ideas and technologies (Chesbrough 2003) in the search for knowledge on a global scale (Martini et al. 2012; Kovács et al. 2015).

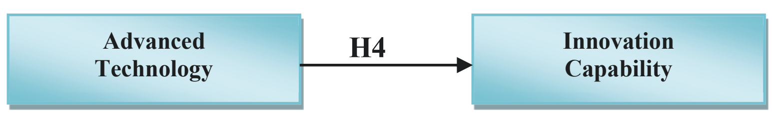
In this regard, Kleis et al. (2012) point out that adopting advanced technology within a firm has been acknowledged as a key factor in enhancing openness capability for innovation outcomes. This is because the adoption of new technology supports the firm's willingness to cross their existing boundaries and so be able to search and obtain useful knowledge and novel ideas (Savino et al. 2017; Chesbrough & Crowther 2006). As mentioned earlier, adopting new technology can lead to some changes in an organisational structure (Woodward 1965), procedures (Littlejohn et al. 2012) and routines (March & Levitt 1988) which, in turn, positively influence the social interactions between employees (Moreland 1999).

Through social interactions, employees may enhance their firms' openness capability by seeking and acquiring external knowledge and novel ideas by establishing relationships, developing communication and improving cooperation with external parties such as customers and suppliers. This, in turn, leads the firm to be able to bring valuable information about different technologies and evaluate these in relation to the firm's requirements and resources to achieve innovation (Rai et al. 2012; Dong 2016; Parasuraman et al. 2005). The adoption of new technology is associated with greater uncertainty about its optimal use, perfect product attributes and user preferences, which can instigate the firm to acquire valuable knowledge and novel ideas from external sources in order to recognise the most salient product characteristics, realise the nature of customers' needs, understand consumer preferences, and estimate market size (Dong 2016). The result of this is that the generation of radical innovation can be increased during the post-acquisition phase; it is the beginning of new development, not its conclusion.

Integration capability, on the other hand, can be defined as the firm's ability to integrate and align its organisational connectedness to ensure the flexibility required for successful innovation (Kelley 2009). On this front, Iansiti and Clark (1994) point out that adopting new advanced technology is positively associated with successful integration capability. This is because adopting advanced technology can positively influence different functions within a firm like operations, systems, and processes (Song et al. 1997). Through the adoption of new technology, cooperation and coordination between a firm's disparate units (disparate in the sense of function and location) and centres will be facilitated in managing these different functions. As a result, all operations of the units/centres in the same firm will be integrated, aligned and interdependent (Stringer 2000). As mentioned earlier, advanced technology plays a role in improving the infrastructure in terms of acquiring, integrating, reconfiguring and disseminating valuable resources that are embedded in the social, structural and cultural context (Barua et al. 2004). This, in turn, enhances the link between units and centres and increases the perception of them as co-productive and ultimately facilitates the realisation of such operational activities (Kanter et al. 1991) or assists construction of an integrated system between all units and centres (O'Connor & Ayers 2005; Kelly 2009).

From the organisational culture perspective, supporting experimentation capability is one of the key workplace culture elements that can boost radical innovation in large firms (Osborne et al. 2008). Experimentation capability is the ability of a firm to probe, experiment using test runs (in one or various markets) and so forth, and then commercialise radical ideas and concepts. Brown and Eisenhardt (1998) indicate that a firm that is willing and able to experiment is capable of proactively pursuing and identifying new opportunities early and thus is able at the same time to achieve competitiveness. Generally, in order to achieve experimentation capability, firms need to collect valuable information to envision the future and at the same time maintain their ability to identify unexpected opportunities in the present and react quickly and change strategies in response to an unstable market or to unanticipated responses or contingencies affecting product acceptance (Koberg, Detienne & Heppard 2003). The extant literature suggests that adopting advanced technologies within a firm has become increasingly important for promoting improvisation and experimentation capability (Koberg, Detienne & Heppard 2003). These advanced technologies can support the firm's ability to draw insights from diverse knowledge pools as well as increase knowledge sharing, encourage employees to work in open systems, facilitate social relationships with other parties within industry, which in turn provide various opportunities for probing the future (Raghuram, Tuertscher & Garud 2010; Santoro & Gopalakrishnan 2000, 2014; Zhang et al. 2015). Moreover, through the adoption of advanced technologies, firms can improve their understanding of customer needs from an early stage (as well as the acquisition and retention of such information) which, in turn, facilitates the acceptability and acceptance of a new radical innovation (that is, during the commercialisation phase). This process enables integration of customers' considerations at earlier stages of the innovation cycle (Trainor et al. 2011; Coviello & Johnston 2007). Collectively, these studies point to a relationship between adopting advanced technology and innovation capability, particularly openness, integration and experimentation capabilities. Thus, it is hypothesised:

Hypothesis 4: *Advanced technology is positively associated with innovation capability.*



2.6.9 Advanced Technology and Advanced Training

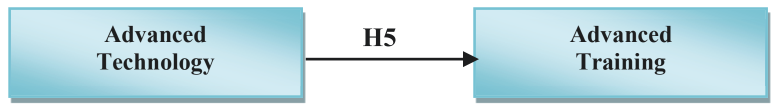
Recognising the influence of the adoption of new advanced technologies on employee skills within firms has increasingly become essential in recent decades (Bartel et al. 2003). Previous studies have affirmed that advanced technology adoption has led to major changes in the need for the development of employee skills, competencies and knowledge (Autor et al. 1998; Arnal et al. 2001; Bresnahan et al. 2002; Bartel et al. 2003). This is because the adoption of new advanced technology increases the relative demand for skilled workers to effectively adopt these technologies and integrate them within their firms (Bartel & Lichtenberg 1987). In the same vein, Black and Lynch (2004) point out that when firms adopt new advanced technologies, employees should obtain new skills and upgrade their skills level. This is due to the fact that the characteristics of the new advanced technology might be completely different from the old technology. Therefore, several empirical studies have demonstrated that advanced technology adoption can determine the direction of and foundation for the firm-specific training for innovation (Bresnahan et al. 2002).

In addition, Antonietti (2005) mentions the growing importance of organisations and managers understanding how new advanced technologies adoption influences employees' skills through associated formal training, especially after the recognition of the skill-based nature of rapid technological change. He attributes this importance to the abilities, knowledge and skills (particularly technical skills) that employees can obtain in order to efficiently strengthen the production processes, resolve technical dilemmas and physically perform innovations within the production processes. Moreover, providing formal training for innovation when new technology is adopted enhances the capability of employees to maximise their awareness of new advantages, provides them with the necessary skills to operate this technology more efficiently, and increases theit opportunities to produce innovation (Helpman & Rangel 1999). Helpman and Rangel (1999) support this position, arguing that historical evidence indicates that adopting new advanced technology in a firm generally produces an initial slowdown, a dilemma for firms acquiring new technology. This produces an urgent need for technology-specific experience, knowledge and skills that employees should acquire through a formal learning (training) to utilise the new technology and to increase the productivity related to the technology adopted. Thus, a perspective held within advanced training literature suggests that the availability of appropriate training for employees within a firm is a significant determinant of whether innovation is successful when new technologies are adopted (Northcott & Walling 1988; Northcott & Vickrey 1993). This is because it is only through the acquired skills and knowledge that employees can generate value and maximise the profits from the new technology. As mentioned by Hashimoto (1991), the efficient adoption of new advanced technologies by Japanese firms is frequently attributed to the adequate provision of appropriate training within the firms, the use of effective training strategies, and the provision of sufficient overseas training.

The most direct evidence is provided by Boothby, Dufour and Tang's (2010) study on 4200 Canadian manufacturing firms in different industries. This examined the effect on firms' economic performance of the employee training associated with the adoption of new technology. The authors conclude that firms who have a high tendency to employ new advanced technologies are more likely to provide all kinds of training to their workers than firms with low technologies within the same industries. The authors also indicate that the type of training is correlated with the adoption of a certain advanced technology, as different advanced technologies might have different skills requirements. This suggests that adopting new advanced technology determines the specific content of training that employees should receive for enhancing innovation capability. For example, adopting new technology in computer-aided design and control, employees should be trained at the same time in computer literacy and technical skills (Boothby, Dufour and Tang 2010). In support of this view, Baldwin et al.'s (1996) study affirmed this argument by mentioning that to maximise the benefits of training for innovation, employees should be provided with specific advanced training to match the specific advanced technology adopted, instead of general training that does not match the specific technology.

In addition, consider a study conducted by Bartel et al. (2007) on a valve manufacturer to investigate the effects of adopting new information technology on the human resource practices in terms of productivity growth. The authors conclude that the adoption of new information technology increased the demand for specific skills (particularly technical and problem-solving skills) in machine operators. Formal training was required to enhance these skills, and advanced training was an integral process of the overall strategy for productivity growth. Therefore, mainstream theoretical models that are based on the concept of advanced technology adoption should note the need for such technology to be accompanied by specific training. The study confirmed the positive impacts of advanced training on employees' productivity (Antonietti 2005). As a number of studies provide considerable evidence to support the positive impacts of the adoption of advanced technology on the advanced training, it is hypothesised:

Hypothesis 5: *Advanced technology is positively associated with advanced training.*



2.6.10 Advanced Technology and Organisational Learning

In the persistent tempo of technological growth, adopting advanced technology within a firm has not only been acknowledged as involving a modification and mastery of the technology, viewed in a narrow sense, but also considered as a catalyst for changing workplace routines, procedures and attitudes (Littlejohn et al. 2012; Bartel et al. 2007; Johnson & Rice 1987). New advanced technology adoption triggers many responses within a firm (Helpman 1999). When new technologies are adopted within a firm, they can serve as a powerful addition to the firm's infrastructure (Huber 1990) and, consequently, the learning activities and practices of the firm can be radically changed (McGahan 2004). Further, Dewett and Jones (2001) point out that in a knowledge-intensive environment, adopting new advanced technology plays a major role in supporting (formal and informal) learning by providing organisational employees with new skills, capabilities and knowledge for generating innovation. In this view, Edmondson et al. (2003) point out that adopting new advanced technology within a firm can affect organisational learning in two ways. First, decision makers (leadership) recognise the significant advantages of the new technology and its absolute benefits for innovation processes and spread awareness to his/her employees to enhance their adoption with regard of new systems, practices, structures and procedures that the new technology can require (Easterby-Smith et al. 2000). Secondly, employees appreciate and understand the absolute benefits of the new technology through discussion, interaction, and communication with each other, whether via networks or face to face. This will, in turn, allow employees to acquire new relevant knowledge, skills and capabilities to strengthen the innovation production of the firm (Bell et al. 2014).

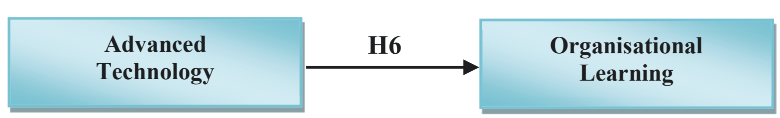
Related literature has also revealed that adopting radical new technology may be disruptive for a firm. This is because new technology adoption generally involves an initial reduction in production while the technology's advantages are recognised (Helpman & Rangel 1999) and relevant advanced training provided to help employees develop the knowledge and skills to operate it. Once this barrier is overcome, production not only generally matches previous levels but exceeds them. Recognising employees' learning needs is an integral part to overcoming this dilemma as is realising the correct advanced training required to meet those needs, whether through means that are formal (e.g. training) or informal (i.e. organisational learning). Leaders therefore have a great responsibility to take effective actions within a firm in facilitating and improving the dissemination of knowledge and skills needed among employees to achieve the desired level of proficiency (Mukherhee & Wassenhove 2000; Bohmer & Edmondson 2001). Thus, new knowledge and skills must be disseminated among employees through social interactions (Moreland 1999). Accordingly, employees become aware of the strengths of the new technology and have absorptive capacity and development capability to then respond to market demand with high quality products in the correct quantity in a timely manner (Tidd & Trewhella 1997).

In a similar vein, Woodward (1965) points out that adopting a certain type of technology (e.g., unit or process production) can lead to some changes in an organisational structure (e.g., functional vs line-staff structure). On this view, Miller (1996) indicates that changes in an organisational structure affect the employees' cognition and their actions regarding the conscious acquisition of knowledge. It has been suggested in the literature that organisational learning connects cognition and action (Crossan et al. 1999), meaning that adopting new technology can positively affect the process of organisational learning.

Regardless of the importance of the need for stability in routines of a firm, relevant literature declares that routines can be changed (March & Levitt 1988). Organisational routines can be explained as the repeated patterns of employees' behaviour bound by the regulations and customs that describe much of the firm's ongoing activities (Nelson & Winter 1982). On this front, March and Levitt (1988) point out that an existing technology (and its processes) can be viewed as a routine. Thus, it is proposed that adopting new advanced technology is a factor in changing organisational routines due to its impacts on cognitive and interpersonal changes (e.g., Tyre & Oriikowski 1994; Szulanski 2000) in adapting to the new technology. In regard to cognitive changes in technological frames, these can be described as how employees think about a new technology and how the suitable use of this technology is facilitated (Oriikowski 1993). Barley's study (1986) on two hospitals that implemented new advanced CT scanners found that interpersonal relationships and interactions between physicians and technicians changed as a result of the hospitals' adopting new CT scanners which had, in turn, led to some changes in established routines in the two hospitals. In connection with change in routine, Nelson and Winter (1982) mention that organisational learning can be understood as a change in a routine (or routines) of a firm. It seems reasonable to suggest that adopting new technology generates organisational learning as it changes the firms' routines. For this reason, Levine and Moreland (1999) affirm that adopting new technology may create new routines within a firm where communication, coordination and interaction among employees will be affected which, in turn, has the potential to increase the collective learning process.

Consistent with these observations, consider a case study conducted by Woiceshyn (2000) on two large Canadian oil firms. The author examined the consequences of the adoption of horizontal drilling technology on the organisational learning processes within the two firms. The findings indicated that the process of organisational learning in both firms was positively affected. However, one firm was more successful than the other. The author attributes this success not only to changes in employee cognition but to the actions that were undertaken by the firm to enhance the process of learning where the shared understandings, information processing and perspectives of both individuals and group members were developed which were necessary for coherent collective action. Taking these studies holistically, it is hypothesised:

Hypothesis 6: *Advanced technology is positively associated with organisational learning.*



2.6.11 Innovative Climate and Innovation Capability

Several empirical studies have affirmed that innovative climate has a direct positive impact on a firm's innovation capability (e.g., Koene, Vogelaar & Soeters 2002; Schneider, Brief, & Guzzo 1996). These studies have been undertaken as a means of understanding individual behaviour because individuals are the key driver to deploying innovation capabilities (Popa, Acosta & Conesa 2017). As outlined by Mumford et al. (1988), an ideal climate for increasing innovation capability is one that can create a positive cognitive (psychological) basis for innovation where individual innovative behaviour is affected directly and indirectly through perceptions of innovative climate (the social interaction approach). This works in terms of supporting the generation of novel ideas, motivating the actions required to implement these ideas, and encouraging creativity and innovative initiatives (Kanter 1983). Through the support by leadership and allocating adequate resources, employees can obtain a significant level of power and authority to experiment with new way of working, and create, develop and express their opinions and ideas freely without fear in an environment that assists employees (Vera & Crossan 2004). In addition, employees can feel free to take the initiative, and participate in decision making without getting permission first (Cirella, Radaelli & Shani 2014).

In addition to supplying valuable resources, an innovative climate also displays (as a manifestation of the firm's support for enhancing innovation capability) acceptance, respect, and appreciation by the firm's leaders for the work of individuals (Scott & Bruce 1994). Thus, it has been suggested in the literature that when a climate supports individuals in ways that permit innovation to emerge, offering, for example, motivation, resources and rewards, the individuals are more likely to consider the firm as a whole as being supportive of innovation (Scott & Bruce 1994). Based on this, it is proposed that within an innovative environment, there is a high degree of trust and openness among all individuals and mutual obligation, cooperation, communication and motivation are also present (Siegel & Kaemmerer 1978).

Based on an extensive literature review, it is found whenever individuals within a firm feel a deeper sense of respect and engagement and experience a climate conducive to innovation, employees within a workplace conform to the firm's norms and values and comply with socially desired attitudes (Bharadwaj et al. 2004). This suggests that when the process of knowledge sharing and collaboration across a firm's functional areas are increased, individuals can easily explore externally available strategic knowledge instead of just internal, local and limited sources (Srivastava et al. 2011). In this sense, Chesbrough (2006) states that individuals within such a climate can actively seek appropriate external knowledge to fill knowledge gaps and such knowledge is required by the firms to increase their innovation capability. In addition, cooperation among individuals enhances opportunities for informal social relationships which, in turn, increase knowledge accessibility and the acquisition of deep understanding. Such relationships also promote the adoption of improved searching strategies for external knowledge (Adler & Kwon 2002; Jansen et al. 2006). All these, in turn, encourage increased openness capability of the firm.

The literature reveals that related innovative climate is characterised by an orientation toward creativity, support for individuals in performing independently in the pursuit of novel ideas, and the provision of adequate supplies of valuable resources such as equipment, facilities and time which are critical to strengthen innovation capability (Amabile 1988; Angle 1989). Innovative climate explains the individual's desire to meet or exceed a firm's expectations for behaviour. Employees also need to be aware of the potential consequences of adopting desired behaviours to further motivate them (James & Sells 1981). Accordingly, individuals react to these expectations by adjusting their own behaviour to the new set of norms and values (Chang 2016). Hence, individuals within a highly innovative climate can act in ways that are needed to integrate all the necessary mechanisms to achieve organisational outcomes at both the firm and unit levels (Wright et al. 1994). In situations of this sort, individuals in such units experience greater feelings of self-confidence, self-satisfaction and self-pride (Bandura 1988). Furthermore, shared values and goals can be positively adapted (James et al. 1977). Moreover, the collective identity of individuals and their willingness to make the required organisational structural changes for better performance will be enhanced. Consequently, overall internal processes in the organisation will be better integrated and aligned (Waldman & Yammarino 1999). These, in turn, enhance the level of a firm's strategic integration across its units.

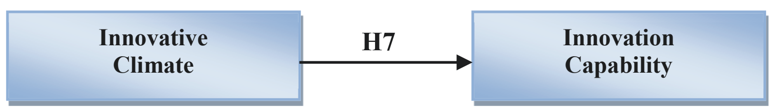
A review of the literature shows that processes of building innovation capability for radical outcomes can be reflected in the extent to which there is practical support for a policy that fosters learning and experimentation with novel ideas (Kelly 2009). Being aware of this, many theorists have emphasised cognitive sense-making to explain the formation of psychological climate. The social processes and personal interrelationships influence the sense-making process (Ashforth 1985; Glick 1988). In this regard, it is worth noting here that leadership support has a significant influence on individuals' innovative behaviour through the formation of climate perceptions (Andersoni & West 1998). These perceptions can be built through motivation, rewards and sufficient resources being given in recognition of excellent performance and encourage an individual's willingness to experiment with innovative ideas (Abbey & Dickson 1983).

In connection with this view, the extant research on innovative climate affirms that a leader's support of individuals can successfully build high quality relationships between them and provides individuals with a high level of autonomy and a degree of decentralisation within a larger structure (Kang & Snell 2009). As a result, individuals are able to share their ideas and suggestions (including listening and sharing multiple perspectives), experiment with new methods, articulate dissimilar ideas without fear of being blamed, and accept the risky ideas of others (West & Richter 2008). These, in turn, enhance individuals' abilities to participate in the process of enhancing the firm innovation capability (Popa, Soto-Acosta & Conesa, 2017).

Consistent with these observations, Çakar and Ertürk (2010) support this relationship in their study and provide empirical evidence for the significant impact of leadership's support for individuals in regard to increasing innovation capability in SMEs. They observe that a lack of support for individuals and a lack of openness lead to the centralisation of decision-making which, in turn, potentially diminishes individuals' capacity and willingness to learn and experiment with innovative ideas and leads to a firm's inability to sustain innovation capability processes. Moreover, Hunter et al. (2007) examined 42 studies using a meta-analysis related to workplace atmosphere with regard to innovation capability performance. They argue that an innovative climate is a key driver for innovation capability in a firm and its consequent successful and sustainable radical innovations. The authors attribute their findings to the work climate for individuals within the firms that support feelings of a deeper sense of respect, and greater engagement and broader experience.

In addition, it is important to consider a study by Hsu and Fan (2010) of 1830 national research centre employees in Taiwan which measures the degree of creative and innovation capability. They found that the innovative climate at the research centre was a significant factor in terms of overall creative and innovation productivity. This is related to a positive outcome in terms of the availability of adequate resources, autonomy and trust, and the absence of obstacles such as organisational impediments. In addition, the authors indicate that creative and innovation capabilities would increase when employees perceived they had sufficient resources, adequate time and rewards from their leadership. The above analysis indicates that the innovative climate is likely to influence innovation capability positively. Therefore, it is hypothesised:

Hypothesis 7: *Innovative climate is positively associated with innovation capability.*



2.6.12 The Mediating Effect of Innovative Climate

Previous studies acknowledge the role of innovative climate as a mechanism linking learning practices and innovation capability performance (e.g., Makkonen & Lin 2012; Jørgensen, Becker & Hyland 2014). For instance, Sung and Choi (2014) state that despite the existing literature providing empirical evidence of the positive relationship between various learning practices and organisational innovation capability, this relationship would be more pronounced in organisations with a robust climate for innovation. Therefore, it is reasonable to propose that innovative climate plays a mediating role in the relationship between both advanced training and innovation capability performance, and organisational learning and innovation capability.

Earlier studies have demonstrated the direct positive impact of learning practices (i.e. advanced training and organisational learning) on innovation capabilities of firms (e.g., Hussain et al. 2018; Liao et al. 2009; Benoit 2014; Jørgensen 2014). Central to this association is the main role of individuals in applying the newly acquired knowledge, skills, ideas etc. through learning activities from a variety of contexts (Michel, Lyons and Kavanagh 2007; Nemanich & Keller 2007). Nevertheless, some authors (e.g., Jyoti, Chahal & Rani 2017; Liao, Fei & Liu 2008; Glaveli & Karassavidou 2011) argue that learning practices are not just about generating new ideas and knowledge creation, but they are also about how these new ideas and knowledge can be transferred and shared by individuals through building a work climate that can affect innovation capabilities performance. The authors stress the importance of understanding the mechanisms through which learning practices have impacts on innovation capabilities performance by creating a work environment that enables individuals to feel committed to their firm and drives the readiness for further collaborative behaviours between them. In this regard, Isaksen and Ekvall (2010) supported this position arguing that learning is one where novel ideas, knowledge, creativity and change are encouraged. They asserted that a key aspect of improving the capability of a firm for innovation is creating the appropriate climate so that individuals can share and build upon each other's ideas and suggestions.

Because effective sharing, integration, and utilisation of knowledge, skills and ideas are core processes required for innovation capability (Chen & Huang, 2009; Gómez et al. 2004), advanced training programs may be seen as meaningful predictors of innovation capability performance. However, advanced training itself may not guarantee such performance (Tharanganie 2013). More specifically, advanced training can result in increased innovation capability, but only when it actually instigates greater sharing and utilisation of knowledge among individuals (Bontis et al., 2002; Kang et al., 2007). Therefore, some scholars (e.g., Sung and Choi 2014; Hatch & Dyer 2004) recognise innovative climate (on the basis of an observed pattern of behaviours, attitudes and interactions) as an integral process for the impact of advanced training on innovation capability performance.

As stated earlier, advanced training programs that offer opportunities for communication among individuals from different departments and from the same department stimulate individuals to share ideas, skills and experiences (López et al. 2006). Likewise, participation in external advanced training programs should encourage participants to introduce new trends and perspectives to other individuals to troubleshoot work-related problems, develop creative solutions and apply these solutions in practical situations (Rhoades & Eisenberger 2002). Under such situations, individuals are likely to engage in collaborative interactions, which in turn promote interpersonal learning in the form of active involvement in mutual learning, coaching, and cross-training of each other's task element (Noe et al. 2010). These practices thereby promote the personal development and proactive involvement of individuals at work, which enhance individuals' sense-making of their work environment (Ashforth 1985). By working together in a highly interactive work climate, individuals can gain an understanding of each other's tasks and responsibilities, and clearly recognise the interrelationships among jobs and consequently influences innovation capability performance. Therefore, advanced training programs offer the potential to continuously promote strong collaborative relationships and interactions between individuals and increase sensitivity to innovative climate which, in turn, contributes to innovation capability of a firm.

Predicated on the above, it is proposed that innovative climate is positively related to innovation capability, and that this mediates the relationship between advanced training and innovation capability. Thus, it is hypothesised:

Hypothesis 8a: *Innovative climate mediates the relationship between advanced training and innovation capability.*

In addition, the mediating effect of innovative climate on the relationship between organisational learning and innovation capability performance has been demonstrated in several studies. For example, Ismail (2005) found that the relationship between organisational learning practices and innovative climate seems relevant to innovation capability, considering that both organisational learning practices and innovative climate in organisations contributed to 58.5 per cent of the explanation of the observed variances in the innovation capability construct. In the same vein, Lozano (2014) and Cirella and Shani (2012) argue that organisational learning establishes a system and culture that provides a fertile climate with regard to cognitive representations of individuals within a firm. This, then, increases the innovation capability performance of the firm. The authors suggest that the relationship between organisational learning and innovation capability can be explained by incorporating the mediating role of innovative climate.

Furthermore, organisational learning practices provide a foundation for connecting organisational members in a climate that promotes a common language, shared knowledge, joint action and perceptions and beliefs (Holmquist 2007; Stetler & Magnusson 2015; Santos et al. 2010). This results in the realisation of an increased effort in achieving organisational objectives to improve innovation capabilities (Arago´n Correa et al. 2007; Real et al. 2006). In sum, organisational learning processes underlie the development of innovation capability through the formation of an innovative climate (Paavola, Lipponen & Hakkarainen 2004) in which the combination of different members, knowledge and resources triggers the generation of new ideas, skills, experience and practices (Kogut & Zander 1992).

Taking all these arguments into account, it is proposed that innovative climate is positively related to innovation capability, and that this mediates the relationship between organisational learning and innovation capability. Thus, it is hypothesised:

Hypothesis 8b: *Innovative climate mediates the relationship between organisational learning and innovation capability.*

2.6.13 Innovation Capability and Radical Innovation

Previous studies argue that firms engaged in radical innovation should have a variety of mechanisms, efficient strategic management and distinctive capabilities (Flor et al. 2017; Chang et al. 2012). The capabilities associated with *radical innovation* are delineated at three levels in this study, namely openness, integration and experimentation capabilities. Although earlier research has acknowledged that innovation capability plays a significant role for the improvement of radical innovation, there was little empirical examination of the interrelationship between these two areas (Chang et al. 2012; Jiménez & Valle 2011).

Strong theoretical reasons exist to believe that these capabilities have a direct influence on a firm's radical innovation performance (e.g., Martini et al. 2012; Philips et al. 2006). The relationship of each capability regarding radical innovation is explained briefly below. It has been suggested in the innovation literature that obtaining novel ideas and competencies from a wide array of sources are significant factors for radical innovation success (Lichtenthaler et al. 2009). Numerous scholars emphasise the role of openness capability in overcoming the limits of firms' internal knowledge (Savino et al. 2017; Chesbrough & Crowther, 2006). Such diversified knowledge sources (internal and external) play a key role in supporting radical innovation (Osborne et al. 2008). The openness capability strategy thus is a necessity in the search for external knowledge on a global scale (Martini et al. 2012; Kovács et al. 2015). In this sense, Srivastava and Gnyawali (2011) explain openness capability as a firm's ability to search for and gain relevant information and knowledge from external or international sources more efficiently. The higher the degree of openness capability, the more frequently firms tend to seek more valuable information and knowledge (Stuer, Husig & Biala 2010). In this respect, Iansiti (1998) points out that due to rapid technological developments and technologies' shorter life cycles, firms through searching from external sources can rapidly integrate the relevant information and knowledge into their internal technologies in order to launch a highly improved product or service onto the market at a time that should generate the best response.

On this view, Rai et al. (2012) and Dong (2016) point out that a firm's openness capability can be strengthened by establishing strong external relationships, participating in industrial networks and improving cooperation with external parties such as customers and suppliers. Through these relationships, the firm will be able to obtain precious information, develop brand new ideas and recognise up-to-date technologies available in the market. These, in turn, support the firm to recognise the most salient product characteristics, to realise the nature of customer need and to understand consumer preferences (Dong 2016). Moreover, firms can commercialise both external and internal ideas by deploying outside (and in-house) pathways to estimate the market size and to get to the market first (Chesbrough 2003). All these, in turn, enhance radical innovation performance.

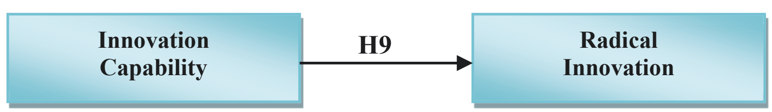
Likewise, Sakkab (2003), senior vice president, Research and Development, Global Fabric and Home Care, at Procter & Gamble, supported this notion in his research and reported that P&G has achieved remarkable successes in terms of producing radical innovations. He attributes this success to the implementation of the strategy of ‘connect and develop’. The author indicates that due to the company’s openness strategy and building strong relationship with various external parties such as researchers, universities, institutions and suppliers, the company obtained unprecedented opportunities with regards to novel ideas as well as valuable information. These openness capabilities, together with the company’s willingness to allocate sufficient resources, enabled P&G to develop what had been ideas into actual new products in order to provide high customer value. In addition, the company could open a new window to the outside world by being involved in ‘Joint Technology Developments’, which includes developments with other organisations and institutions whose expertise is in strikingly different technical fields. These opportunities provided the company with the ability to upgrade its products and produce new benefits in existing product categories; the company was able to connect advanced technologies with latent consumer needs. Therefore, the adoption of the ‘openness’ strategy is a significant factor in promoting radical innovation (Martini et al. 2012; Kovács et al. 2015).

Strategic integration capability can be recognised as a subset of a firm’s abilities to integrate and align its organisational connectedness of radical innovation with its core business (O’Reilly 1996). Much of the innovation literature affirms that radical innovation activities should be tightly connected and viewed as co-produced (Kanter et al. 1991) or as an integrated system (Kelly 2009) between corporate R&D centres and lines of business, otherwise producing radical innovation will be suboptimal (O'Reilly 1996). Hence, to generate radical innovation, it is important to transmit radical innovation products from the R&D phase to the manufacturing phase and then to the marketing phase in current and new businesses without facing obstacles or restrictions (Chang et al. 2012). Thus, successful integration and alignment within a firm play a key role in strengthening the interconnection between all phases that are required in innovation processes and ensure the flexibility for successful innovation (Kelley 2009). This perspective also suggests that innovative ideas can arise from anywhere (from multiple units) in the firm (Knight, 1987). Individuals can simply draw on their own initiative and resourcefulness, be supported and thus strongly motivated (including being provided with incentives to be creative) and persistent in their efforts (Brazeal 1993). Individuals may, consequently, gain specialised knowledge (Grant 1996b) and exhibit greater commitment to participate in radical innovation activities (Russell 1999).

Different integration mechanisms have been discussed in the organisational capabilities literature. For example, Tushman and O'Reilly (1996) emphasise the importance of creating 'ambidextrous organizations' and of including an integration mechanism to support the firm in its management of both incremental and radical innovation as they coexist in the same firm. This mechanism helps the firm to manage two different innovation strands to work interdependently (Birkinshaw & Gupta 2013). According to Park and Gil's (2006) study on Samsung's strategies to transform its corporate R&D units from development-based to research-based units, an emphasis on integration and strong alignment between R&D centres and business units at the strategic planning phase played a key role in producing radical innovation.

Probing is recognised as the ability of a firm to experiment with an early version of radically innovative product to a rational, easily anticipated initial market. The extant literature shows the importance of a firm's ability to learn (Kelly 2009), to probe (Philips et al. 2006), and to experiment with novel ideas and new disciplines in generating radical innovation, particularly in large firms. However, learning was viewed as a firm's ability to recognise technological developments and how they can be incorporated and expanded for the firm's market benefit. It is important for firms to recognise any potential applications of the whole or of segments of that whole and anticipate external factors that may enhance its acceptance (Chang et al. 2012). In this sense, Heiskanen et al. (2007) indicate that firms should consider the degree of acceptability of a new radical innovative product from their clients' perspective, seek their input and integrate their suggestions into manufacture. Firms introducing radical product innovations might need to take consumers' resistance more seriously. They might need to reconsider the acceptability of new product innovations and integrate consumer opinions in the initial phases of the radical innovation cycle. This can be done through an experimental approach (Junarsin 2009). Thus, experimentation capability can be viewed as a firm's capability to probe, experiment with, and have their R&D units test successive potential products until a market-acceptable product is formulated. Therefore, the ability to commercialise radical ideas and concepts, involves various stages and marketing strategies (Chang et al. 2012). The above analysis indicates that innovation capabilities, specifically openness, integration and experimentation capabilities within a firm are likely to have a positive impact on radical innovation performance. Thus, it is hypothesised:

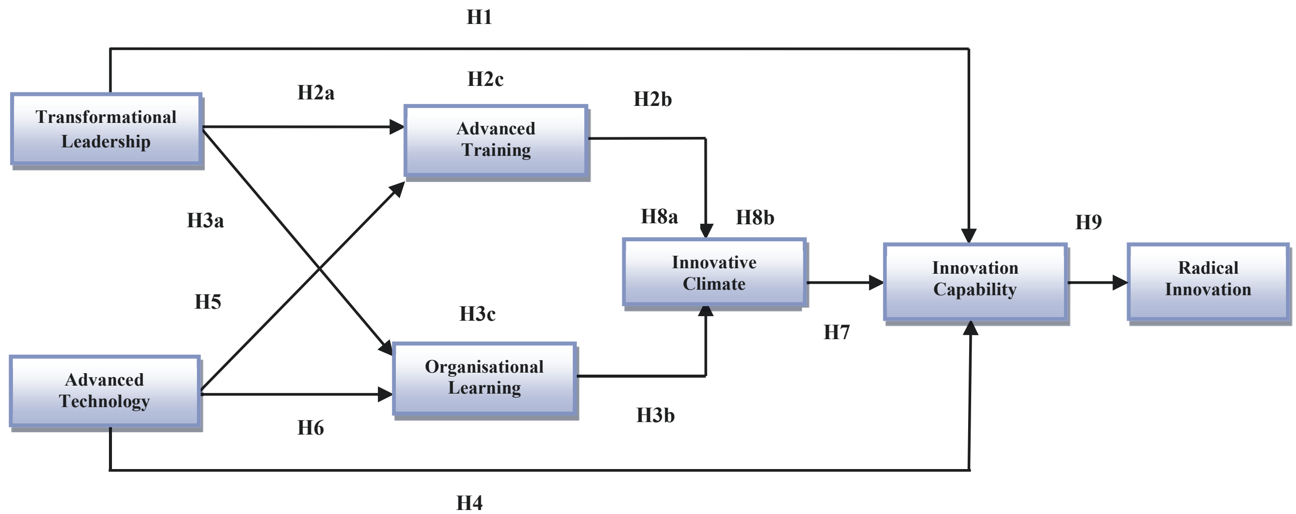
Hypothesis 9: *Innovation capability is positively associated with radical innovation.*



2.7 Overall Theoretical Model

Figure 2.4 illustrates all the expected correlations that form the basis of the hypotheses and reviews the related literature on the constructs in relation to the tested research model.

Figure 2.4: The Proposed Model of the Development of Radical Innovation in Large Firms.



2.8 Chapter Summary

Following the study objectives and questions discussed in Chapter One and based on the findings of the relevant literature review available on various constructs, this chapter has developed a theoretical framework for understanding the way that transformational leadership and advanced technology adoption impact radical innovation in large firms. This chapter first summarised research gaps existing in large firms' radical innovation research which were identified in Chapter One. Then, the definition of large firms and their importance to Saudi Arabia were explored. A dominant theory, that of dynamic capability theory, was reviewed. Based on findings from this literature review, fourteen hypotheses on the relationship between constructs related to the tested research model were presented. The following is a summary of the hypotheses:

H1: *Transformational leadership is positively associated with innovation capability.*

H2a: *Transformational leadership is positively associated with advanced training.*

H2b: *Advanced training is positively associated with innovative climate.*

H2c: *Advanced training mediates the relationship between transformational leadership and innovative climate.*

H3a: *Transformational leadership is positively associated with organisational learning.*

H3b: *Organisational learning is positively associated with innovative climate.*

H3c: *Organisational learning mediates the relationship between transformational leadership and innovative climate.*

H4: *Advanced technology is positively associated with innovation capability.*

H5: *Advanced technology is positively associated with advanced training.*

H6: *Advanced technology is positively associated with organisational learning.*

H7: *Innovative climate is positively associated with innovation capability.*

H8a: *Innovative climate mediates the relationship between advanced training and innovation capability.*

H8b: *Innovative climate mediates the relationship between organisational learning and innovation capability.*

H9: *Innovation capability is positively associated with radical innovation.*

These hypotheses clarify the causal correlations amongst these variables. The hypotheses will be empirically tested through a large-scale survey. The results of the empirical findings and verification of these hypotheses will be reported in detail in Chapter Four and discussed in Chapter Five. The next chapter will explain the steps undertaken to empirically investigate the model developed from a review of the relevant literature.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

Chapter Two reviews the relevant literature and develops a theoretical model for understanding the way that transformational leadership and advanced technology are two key drivers impacting radical innovation in large firms. Based on the literature review, fourteen hypotheses on the relationship between constructs related to the tested research model are presented.

This chapter clarifies the research methodology to be used in employing the study's model to investigate these interactions, the results of which are described in Chapter Four. The methodology adopted in the current study is quantitative research based on the theoretical paradigm of positivism. A cross-sectional study with a deductive strategy was selected for the research design since as the most appropriate approach to answer the study's research questions.

The chapter is structured as follows. Following the introduction (3.1), the research paradigm is outlined (section 3.2). Next, section 3.3 discusses research methods, including differences in quantitative and qualitative methods, closing with justifications for the use of the quantitative research method. The research design, including the level of analysis, is then explained (section 3.4). Section 3.5 discusses the sample design, including the sample of firms and respondents, sample size, closing with demographic characteristics of respondents. Section 3.6, meanwhile, illustrates the data collection method. Following this, section 3.7 provides a measure of the scope of this study. Then, section 3.8 displays the procedures of data collection used in this study, including questionnaire development, focus group discussions, survey instructions, the survey structure and choice of questionnaire language. It closes with creation and testing of the online instrument. Section 3.9 clarifies the ethical considerations, while section 3.10 outlines the process of ethical approval. The chapter concludes in section 3.11 by offering a chapter summary.

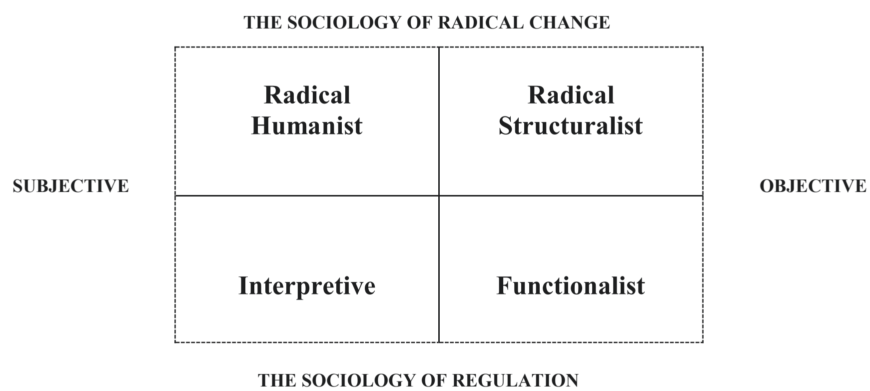
3.2 Research Paradigm

The research paradigm provides a framework for academic research (Proctor 2005). A paradigm can be defined as '*the basic belief system or world view that guides the investigator, not only in choices of method but in an ontologically and epistemologically fundamental way*' (Guba & Lincoln 1994, p. 105). There has been much debate around research paradigms and each opinion has struggled to make a case for the primacy of one paradigm over any other (Guba 1990). As a result, several schools with regard to paradigms have been created, leading to the later so-called 'paradigm wars' (Creswell 1994). Cameron (2009) mentions a school known as the 'purists' who emphasise that paradigms and methods should be qualitative or quantitative and should not be mixed. Another school, the 'situationalists', believe that certain methods and paradigms can be used in particular situations. In contrast to the 'purists' can be found the 'pragmatists', they advocate the efficient use of both qualitative and quantitative methods.

Kuhn (1970, p. 175) describes a paradigm as '*a set of values and techniques which is shared by members of a scientific community, which acts as a guide or map, dictating the kinds of problems scientists should address and the types of explanations that are acceptable to them*'. More specifically, Ikart (2005) explains a paradigm as being a set of propositions that clarify how the world is experienced. This concept contains a world view and a method for simplifying the complexities of the world. It also permits researchers to concentrate on what is sensible, crucial and valid. To this end, Guba and Lincoln (1994) state that paradigms allow researchers to find relationships between variables in order to identify appropriate methodologies and perform certain research tasks. In addition, Kuhn (1970) points out that a paradigm can be seen as an accepted set of theoretical constructs and research methods that are included within a certain area of science. Furthermore, Lewis and Grimes (1999) clarify that a paradigm can empower the grasp and hypotheses of organisational phenomena such as intricacy, ambiguity and paradox.

Having studied previous debates and discussions on paradigms for the analysis of social theory, Burrell and Morgan (1979) developed a typology of paradigms to facilitate the understanding of the existing sociology of science theories. This typology has been formalised as a matrix and consists of the four structured paradigms shown in Figure 3.1. The four paradigms describe basic perspectives for the analysis of social phenomena and society. All social theorists can be located in these four paradigms based on their meta-theoretical assumptions (Lewis & Grimes 1999). In addition, the four paradigms together provide a map for discussing the field which, in turn, gives appropriate means for recognising the similarities and differences of diverse theorists. Each paradigm is located in terms of the dimensions of objective–subjective and regulation–radical change. On the horizontal axis of Figure 3.1, 'objectivity' includes the external realism of deterministic and expected relationships, whereas 'subjectivity' includes contextually-bound and fluid social constructions. Moving to the vertical axis, 'regulation' includes harmonious and orderly social relations, while 'radical change' includes conflict and power asymmetries (Lewis & Grimes 1999, pp. 673–4).

Figure 3.1: Four Paradigms for the Analysis of Social Theory



Source: Burrell and Morgan (1979, p. 22)

The 'radical humanist' paradigm (top left, Figure 3.1) is defined by its concern to develop radical changes in social and organisational arrangements from a subjectivist standpoint. It emphasises the role that different social and organisational forces play in understanding radical change, modes of domination, emancipation, deprivation and potentiality (Zyl 2015). With regard to the 'radical structuralist' paradigm (top right), theorists placed within this paradigm advocate radical change from an objectivist standpoint. The radical structuralist focuses upon the need to overthrow the restrictions located in existing social and organisational arrangements. It has tended to be realist, deterministic and nomothetic (Burrell & Morgan 1979). The 'interpretive' paradigm (bottom right) is, however, informed by a concern to understand the world as it is and the primary nature of the social world at the level of subjective experience. It seeks explanation within the realm of individual consciousness and subjectivity and within the socially constructed ambit of human relations (Burrell & Morgan 1979).

In contrast, the 'functionalist' paradigm or *positivism* upon which this study is based (bottom right), provides the dominant framework for the conduct of academic sociology and the study of organisations. This paradigm represents a viewpoint for the sociology of regulation and approaches its subject matter from an objectivist point of view. It is characterised by a concern for providing explanations of the status quo, social order, social integration, consensus, need satisfaction and rational choice (Kidder & Judd 1991). In other words, this approach provides essentially rational explanations of social affairs and seeks to understand society in a way that can generate valuable knowledge for utilisation and provides practical solutions to practical problems.

Evered and Louis (1991) state that investigations in the positivism paradigm use a quantitative method like, for instance, survey questionnaires and statistical analysis, used in the current study. Buttery and Buttery (1991) point out that those who prefer to use this type of method classify themselves as being non-biased and autonomous. The process of this approach typically begins with the development of hypotheses that undergo empirical examination through the use of quantitative methods. Similarly, Wynn & Williams (2012) indicate that social science research can be viewed as a positivist approach if there are identified propositions, variables, testing of hypotheses and a statement of conclusions about an event from a sample group. The research questions for this study, shaped throughout by the literature and based on the development and testing of clearly defined hypotheses, can be classified as falling within a positivism paradigm.

This theorising suggests that a functionalist paradigm (positivism) is most appropriate for the subject of this research and is the one most commonly adopted in innovation and organisational research. As outlined by Burrell and Morgan (1979, p. 28) '*most organisation theorists, industrial sociologists, psychologists and industrial relations theorists approach* *their subject from within the bounds of the functionalist paradigm*'. It was therefore the paradigm that was chosen to inform the study reported in this thesis, primarily because of its fit with the study's research questions and being best suited to provide the evidence needed to test the hypothesised relationships in the model reported in the previous chapter. A second, albeit subordinate, consideration informing the choice of a positivist (functionalist) paradigm was its consistency with the researcher's own epistemological views, that research should be undertaken in a value-free or unbiased manner (Saunders, Lewis & Thornhill 2012), and not based on '*personal, political or religious values*' (Newman 2003, p. 74).

Because positivism seeks objectivity by proposing that an observer be independent from what is observed (Easterby-Smith et al. 2015). Consistent with this school of thought, the researcher took all necessary steps to ensure the objectivity of the research by maintaining a distance from research participants and taking efforts to remove subjectivity in the design of data collection methods and analytical process. The scientific approach of positivism (e.g. sampling approach and data analysis techniques) are designed to allow the researchers' results to be generalisable with regard to the population from which the samples were drawn (Wilson 2014). Such an outcome was an important consideration for the firms participating in this study, and so adopting the functionalist paradigm was one way to support the generalisability of the study's results. Finally, positivism is broadly accepted in the literature and applied in different fields such as management, social science and business studies (Neuman 2014; O'Gorman & MacIntosh 2015), particularly in the innovation research (e.g., Chang et al. 2012; Suk Bong et al. 2016). Therefore, the dominance and significance of the positivism paradigm in innovation studies has encouraged the researcher to select it for the current study.

3.3 Research Methods

Selecting a research method is a significant part of any research project as it contributes to the reliability of the study's results (Creswell 2003; Sekaran 2003). Generally, research methods can be classified into two main categories 'quantitative' or 'qualitative' methods (Venkatesh et al. 2013). Burns (1997) tells us that the two methods are recognised as part of the scientific empirical tradition and the naturalistic phenomenological approach.

Choosing an appropriate research method, whether quantitative or qualitative, depends upon the research paradigm or assumptions (Sale et al. 2002). In the next section, both methods will be discussed in more detail.

3.3.1 The Differences in Quantitative and Qualitative Research Methods

Qualitative research methods focus on the importance of evaluating variables and concentrate on the depiction and evaluation of social phenomena. This method assists scholars to comprehend the nature of events by understanding why people behave as they do and how people are affected by these events. Through the description of the way a social phenomenon occurs naturally, a more holistic understanding of that event can be obtained. In this regard, qualitative methodology can be described as '*a nonmathematical process of interpretation, carried out for the purpose of discovering concepts and relationships in raw data and then organising these into a theoretical explanatory scheme*' (Strauss & Corbin 1990, p. 11). Since the 1960s, qualitative research has grown considerably in terms of its applications and has been much improved (Vidich & Lyman 1994). Bryman (2007) indicates that qualitative research is an ideal approach for the understanding of social phenomena, using natural instead of simulated settings for data collection and producing (rather than simply testing) theories. Qualitative researchers tend to place emphasis on contextual understanding rather than generalisable outcomes like those sought by quantitative researchers.

On the other hand, the quantitative method focuses on a numerical form of analysis and is based on a positivist or objectivist perspective (Leedy & Ormrod 2001). Quantitative research is focused on the quantification of relationships between variables, with researchers normally detached from the research itself and with the final output context free. Pinsonneault and Kraemer (1993) note that this type of approach is used typically to find out; 'what', 'how much' and 'how many', as well as the frequency and percentage or proportion of responses. More specifically, the quantitative method involves the collection of objective statistics that can be converted into graphs, tables and charts which can be examined using statistical methods. In that vein, Black (1999) mentions that samples taken for the quantitative approach should be sufficient to be representative of an entire population in order that the outcomes can be generalised and replicated elsewhere. In general, quantitative research methods are used to evaluate a theory which necessarily exists prior to data collection in quantitative research using the hypothetical-deduction method (Hammersley 1996). Such studies seek to test and, where appropriate, alter the existing theory. This can be contrasted with qualitative research methods, which seek to expand a phenomenon's theoretical base by establishing theories that evolve or 'emerge' from that research by utilising the analytical-induction method.

The quantitative approach is generally centred on a quantity of entities. This type of approach is efficient when researchers attempt to quantify relationships between variables of interest in order to formulate and test proposed hypotheses that have been obtained from theories to be either accepted or rejected depending on comparative and statistical analyses (Strauss & Corbin 1990). The quantitative approach is predisposed to being deductive and begins from a general theory with specific observations; this is referred to as a 'top down' approach (Abedin et al. 2016). The deductive approach depends upon existing theories and attempts to test them to strengthen, invalidate, adapt or improve them (Artsberg 2003). To that end, Myers (1997) states that conventional quantitative methods include a questionnaire delivered by mail, face-to-face or online to a stratified sample of the population. Other popular methods include mathematical modelling, laboratory tests, and econometrics.

Sieber (1973) mentions that the quantitative approach gives researchers a starting point to improve the design of fieldwork by identifying appropriate organisations or individuals for subsequent qualitative case study analysis. Further to this view, Jick (1979) argues that the quantitative approach permits researchers to draw inferences regarding a number of attributes for the whole population from a sample. To this end, researchers use tools drawn from both descriptive and inferential statistics. *Descriptive statistics* provide a summary and interpretation of outcomes and enable researchers to present data in a more meaningful way by using '*simple statistics*' or '*graphic displays*' (Liu, Parelius & Kesar 1999). It is a convention that in order to describe data properly through statistics and graphs, there are two main forms of descriptive statistics: 'central tendency' and 'dispersion' measurements. Central tendency measurements are used to describe the central position with regard to frequency distribution in a set of data. Measures of central tendency are seen as averages and can include the mode, mean and median. In contrast, dispersion measurement is also referred to as 'variability' and involves variance, standard deviation, absolute deviation, quartiles and range of distribution. These measurements will, therefore, explain how dispersed a data set is, or how that data varies from distribution mean and median. A second area of difference is related to outcomes.

Turning to inferential statistical methods, these are techniques that permit researchers to make generalisations with regard to the population from which the samples were drawn. Even more precisely, inferential statistics are employed to decide whether results based on samples are representative of the whole population and also to calculate the statistical significance of variations between two or more sets of data (Cormack 1991). This method helps researchers to make decisions regarding a null hypothesis or when an alternative hypothesis seems likely to be accepted. Generally speaking, there are two main types of inferential statistics, 'parametric' and 'nonparametric'. Nonparametric tests are differentiated from parametric tests essentially by the way that the data distribution is formed. For example, one parametric method used is the 't-test' which assumes that the data comes from a normal distribution. In this case, nonparametric tests will make no assumptions about the underlying population. In addition, nonparametric tests are suitable to deal with both ordinal and nominal variables.

3.3.2 Justification for the Quantitative Research Method

Patton (1999) points out that the choice of research methodology depends upon the research question(s) or goal(s). Quantitative research methods, consistent with a functionalist or positivist paradigm (e.g., Neuman 2014; Creswell 2014), are considered appropriate if the research objective is to identify particular variables that can impact an output (Creswell 2014), and when tools are available to systematically measure these variables with the purpose of explaining and predicting the phenomena. These features fit well with the conception of the current study. Specifically, the purpose is to examine the relationship between particular pre-defined variables and so tests a hypothesised 'model', consistent with a positivist paradigm (e.g., Wilson 2014; Abedin et al. 2016).

For the variables of interest to the current study, a range of recent studies have developed and utilised valid quantitative measures that allow these variables to measured objectively. Indeed, according to the literature review in Chapter 2, the majority of studies that focus on the effect of constructs such as transformational leadership, advanced technology, innovation capability on radical innovation are still dominated by employing the quantitative methodology. Table 3.1 provides some examples of previous studies in the literature that utilised non-experimental and quantitative research design, including survey instruments. These studies enabled the researcher to obtain valuable knowledge in terms of the questionnaire items or measurement tools that have been used and that are related to the current study. The material included in the table below demonstrates that the variables listed have been well-established and used regularly in quantitative studies. The researcher's theorising, however, has led to a model that shows the relationship between these variables in a way that has not been tested previously.

Table 3.1: Measures Used in Recent Studies Relating to Transformational Leadership, Advanced Technology and Radical innovation

Author(s)	Main Constructs / Variables	Research Approach	Survey Instruments
Transformational Leadership			
Jung et al. (2003)	*Independent Variable:* Transformational Leadership *Dependent Variable:* Innovation Performance	Quantitative	Bass & Avolio (1995) Three factors of innovation: R&D Expenditure, a percentage of gross revenue and patents number.
Politis (2004)	*Independent Variable:* Transformational Leadership *Dependent Variable:* Work Climate Creativity	Quantitative	Bass & Avolio (1995) Amabile et al. (1996)
Eisenbeiss et al. (2008)	*Independent Variable:* Transformational Leadership *Dependent Variable:* Innovative Climate	Quantitative	Bass & Avolio (1995) Anderson & West (1998)
Suk Bong et al. (2016)	*Independent Variable:* Transformational Leadership *Dependent Variable:* Innovative Behaviour	Quantitative	Bass et al. (2003) Janssen (2001), Kanter (1988) and Scott & Bruce (1994)

Advanced Technology			
Jaferian & Rezvani (2014)	*Independent Variable:* Technology Orientation *Dependent Variable:* New Product Success	Quantitative	Gatignon & Xuereb (1997) Atuahene-Gima et al. (2005) and Boso et al. (2012b)
Lee, Dedahanov & Rhee (2015)	*Independent Variable:* Technology Orientation *Dependent Variable:* Financial Performance	Quantitative	Gatignon & Xuereb (1997) Rhee, Park & Lee (2010)
Batra et al. (2015)	*Independent Variable:* Technology Orientation *Dependent Variable:* Innovation Performance	Quantitative	Gatignon & Xuereb (1997) Hurley & Hult (1998)
Hsu, Tsai, Hsieh & Wang (2014)	*Independent Variable:* Technology Orientation *Dependent Variable:* New Product Performance	Quantitative	Gatignon & Xuereb (1997) Griffin & Page (1993, 1996), Hultink & Robben (1999) and Langerak et al. (2004)
Radical Innovation			
Herrmann, Gassmann & Eisert (2007)	*Independent Variable:* Organisational Characteristics *Dependent Variable:* Radical Product Innovation	Quantitative	Chandy & Tellis (1998)
Chang et al. (2012)	*Independent Variable:* Organisational Capabilities *Dependent Variable:* Radical Innovation	Quantitative	Ernst & Kim (2002) Chandy & Tellis (1998)
Černe, Jaklič & Škerlavaj (2012)	*Independent Variable:* Individualism–Collectivism *Dependent Variable:* Radical Innovation	Quantitative	Hofstede (1980, 2001) Chandy & Tellis (1998)

Finally, the use of a positivist, quantitative research approach typically requires the use of a large sample sizes where results can be generalised to a large population (Myers 2002). Thus, an important consideration in the research design, discussed in the following section, was recruiting a sufficiently large sample in order to produce results that could be statistically generalised to the study's population, and with relative efficiency.

3.4 Research Design

Creating an efficient research design is a significant part of any research project since it lays out the framework that defines the methodology, methods and actions needed to investigate the research problem (Sekaran 2003). This design includes a range of options in relation to the type of sample, sampling frame and data collection methods to be used and in regards to measuring the variables of the questionnaire, the scaling procedures and data analysis techniques to be used. To this end, Kerlinger (1986, p. 280) defines research design as '*a plan and structure of investigation so conceived as to obtain answers to research questions*'. In addition, it is argued that the research design does not simply empower the researcher to investigate a phenomenon logically, reasonably, specifically and efficiently, it also aims to provide empirical evidence for a particular research problem. On a similar note, Churchill (1992) states that the research design lays out a blueprint for completing the study, and so helps researchers to recognise a strategy that permits the accomplishment of objectives (Churchill & Iacobucci 2005; Malhotra et al. 2006).

Neuman (2000) indicates that the choice of research design reflects the type of research questions and the scientific philosophy behind the study. A research design for this study was, therefore, developed based on the research questions and model proposed, and consistent with the functionalist/positivist paradigm that informed the research methods (Weston 1992). In connection with this, Babbie (2004) indicates the importance of sufficient time when creating a plan to carry out a research study. He also indicated the importance of being able to generalise research results. With regard to this 'generalisability', the work shows that the main point at issue here is the capacity of results obtained from the project to be generalised, as well as whether they can be differentiated for future study, or are only of use in the present situation.

Two major research methods can be adopted: cross-sectional and longitudinal studies. A cross-sectional study involves '*observations of a sample or cross section of a population or phenomenon that are made at one point in time*' and is normally linked to exploratory and descriptive studies (Babbie 2004, p. 101). A longitudinal study, however, is designed to permit observations of the same phenomenon over a long period, as in studies that need to monitor changes over time (Babbie 2004). Indeed, the main advantage of longitudinal studies is the ability to identify and/or measure changes that may occur across time. In the current study, time effects were not salient to the model being tested. Rather, this study attempts to empirically investigate the parallel path-dependent influences of transformational leadership and advanced technology in generating radical innovation through a number of mediating factors. The study's focus was on whether and how these variables interacted at the time the data was collected. Predicated on the above, cross-sectional analysis would appear to be the most appropriate and applicable method for a successful study in this instance.

Previous studies have indicated that an accurate evaluation approach can be implemented through either causal (explanatory) research or through correlational research. Whereas correlational research focuses solely on identifying meaningful relationships between particular variables, a causal study is an investigation method executed to identify and illustrate a specific cause-and-effect connection between variables (Hair et al. 2010; Sekaran & Bougie 2010). In order to determine causality, it is necessary to observe variation in the variable that is proposed to generate change in the other variable(s) which is reflected in a change in the latter (i.e. dependent) variable/s. The research model must facilitate the detection of the main reasons – that is, the causal or independent variables - for a particular occurrence. In light of the proposed relationships between the variables in the current study, the design is a causal investigation which examines cause-and-effect relationships in the proposed model and includes mediating variables.

Finally, the unit of analysis clarifies the level of the aggregation that the research emphasises, especially who or what is to be examined. Hair et al. (2012a) point out that the unit of analysis could be any element such as organisations (e.g., business units) or individuals (employees, teams or owners) in the target population being investigated. It is suggested that the unit of analysis be determined during the problem-identification phase of the study since it impacts the conceptual model, including the sampling frame and research constructs as well as the method of data collection (Zikmund & Babin 2007).

3.4.1 Level of Analysis

Firms, particularly large firms, mainly consist of a multilevel entity including individuals, teams, and divisions (Mathieu and Chen 2011; Molloy, Ployhart, and Wright 2010). Therefore, research in business and management should identify its level of analysis to avoid confusing issues could be displayed by multilevel complexities (Van de Ven 2007). Based upon the purposes and objectives of this study, it can be argued that the individual level can be identified as the level of analysis in this study. This is because the focus of this study is placed on the individuals who were working in innovative activities in large firms and with first-hand knowledge regarding innovation processes. Thus, as earlier discussed in Chapter One, this study is not a multilevel or macro-level research but is indeed a single-level study emphasising the micro-level factors (e.g., behaviour of leadership and processes of acquiring knowledge, skills, capabilities, etc.). Table 3.2 presents a summary of the research design dimensions of the current study. Therefore, all measurement constructs and measurement items were formulated and tested at the individual level.

Table 3.2: Overview of Research Design

Dimension	Details
Study purpose	Quantitative research: path-dependent hypothesis testing
Types of investigation	Causal relationship
Study setting	Non-contrived; field study
Unit of analysis	Individual level
Sampling design	Large Saudi Arabian firms
Time horizon	Cross-sectional study
Data-collection method	Quantitative method
Measurement of variables	Interval scale (seven-point Likert scale) and nominal

3.5 Sample Design

Sampling can be described as '*a physical representation of all the elements in the population from which the sample is drawn*' (Sekaran et al. 2010, p. 267). An appropriate sample design is crucial in obtaining necessary data that is the basis of any study. In the current study, this applied to both the choice of firms within which the phenomenon of interest (radical innovation) would be examined, and the choice of individual respondents from those firms who would provide their insights into the phenomenon. Details of both are described below.

3.5.1 Sample of Firms

The sample encompassed seven large firms in Saudi Arabia, a nation which typify an environment where effective change, new directions, regular and dramatic technological change and innovation-based strategies are believed to be the key to future business success and global economic competitiveness (Chapter 2). In order to maximise the generalisability of the study's results, the researcher sought to identify firms with these capabilities and to obtain an appropriate sample size and suitable return rate that would render the study's results valid. To achieve this, significant time was spent with contacts who work in large Saudi Arabian firms. After investigation, it was found that the most powerful industries in terms of their ability to produce radical innovation in Saudi Arabia were the oil and gas, petrochemical and pharmaceuticals and medical industries. The firms chosen within these sectors are also pioneers and leaders in Saudi Arabia and the wider Middle Eastern region. In addition, a company within the food production sector was chosen that is considered one of the most successful and fastest-growing multinational food groups across the Middle East, North Africa and Turkey.

The final sample for this study consists of seven large firms: two in the oil and gas sector, two in the petrochemical sector, two firms in the pharmaceuticals and medical sector, and one firm within the food production sector.

Table 3.3 provides descriptive characteristics for the seven sample firms. The sampling strategy required the firms to be large (i.e. more than 200 employees) Saudi-based multinationals renowned for their innovation-based strategies and global competitiveness. By way of example, all seven firms used the global language of business, English, as their primary corporate language. The two companies identified within the petrochemical sector (PE1, PE2) are among the largest companies in Saudi Arabia and one of them is ranked seventh worldwide in terms of innovation and number of patents applied for. With regard to the oil and gas firms (OG1, OG2), one of them is the largest oil company in the world in terms of proven oil reserves and production (US Energy Information Administration 2013). It has a fully integrated system with more than 12 R&D centres within the company locally and internationally, working with creativity and innovation at the core (Hertog 2013).

In sum, these firms were chosen to test the proposed model due to their importance in the market locally and globally, and because of the innovation-focused nature of their strategies. It can be assumed that the sample identified for this study includes firms that have capabilities in generating radical innovation.

Table 3.3: Descriptive Characteristics of the Seven Large Saudi Arabian Firms

	Company Name	Industry Type	Company Age (years)	Number of Employees	Net Income (2016) USD (billion)
1	PE1	Petrochemical	42	40,000	7.7
2	PE2	Petrochemical	19	5,000	2.3
3	OG1	Oil & Gas	84	65,282	250–400
4	OG2	Oil & Gas	35	1000	1.9
5	PH1	Pharmaceutical	32	545	0.12
6	PH2	Pharmaceutical	15	650	0.21
7	FP1	Food production	37	32,900	0.48

***Notes:** Information is based on 2016 annual reports with the exception of OG1, which at the time of compilation was yet to issue any financial annual report publicly. Reported net income is based on the website: money.cnn.com

3.5.2 Sample of Respondents (Target Population)

Selecting the correct participants was a significant step towards obtaining valid and reliable results for this study. As the current study focuses on generating radical innovation, the target population included only employees who were working in innovative activities in large firms and with first-hand knowledge regarding innovation processes. It was necessary, therefore, that participants were qualified and in a position to effectively evaluate the behaviour of their firms (or their strategic business unit) with regard to its attitude towards radical innovation and the relevant effective variables. In light of this, Gioia and Chittipeddi (1991) posit that mid- and high-level management positions such as senior managers and supervisors are responsible for setting and controlling proposed strategies for their firms. This is because they have a '*wide breadth of knowledge of all the organisation's functions, activities and operating environments*' (O'Regan et al. 2006, p. 35). To this end, a number of approaches were adopted to address these issues. These include: (i) interviews with managers during focus group discussions, which included discussing which organisational respondents would be suitably informed of the features of this study, and (ii) discussions with human resource managers at all seven participating firms (4 in person, 3 via telephone) about the most suitable respondents. It was these HR managers who assisted in facilitating contact with the study's final sample. Consequently, participation in the current study was sought from senior managers, managers, supervisors, scientists, engineers and employees from R&D departments of the seven sample firms. Within this category, representative diversity was sought in terms of participants' gender, age and occupational status.

3.5.3 Sample Size

The sample size should be large enough in order to provide statistically results for the hypothesised (direct and indirect) relationships (Vandenberg & Edwards 2009; Westland 2010), necessary since this study uses a multivariate model that includes causal relationships and covariance structures. As suggested by some researchers (e.g., Hair et al. 2014; Hair et al. 2012), this study uses the ten times "rule of thumb" proposed by Barclay, Higgins & Thompson (1995, p. 292). According to the rule, the minimum sample size should be ten times '*the largest number of antecedent constructs leading to an endogenous construct' or ten times 'the indicators on the most complex informative construct*'. Based on this rule, a sample size of at least 200 observations was sought to enable this to exceed the minimum requirement and to generate meaningful results (Kline 2005; Davey & Savla 2010).

Table 3.4 summarises the sample size from the questionnaire survey. As shown in the table, the total target population accessible from the seven sample firms for this study was 521 participants. From seven large Saudi firms, 250 responses were received (response rate of 48 percent). Of these, some 13 responses from three industries (4 from Petrochemical, 5 from Oil and Gas and 4 from Pharmaceutical) were incomplete or invalid and were removed accordingly. This resulted in a final sample of 237 responses that were complete and useable for analysis, representing an overall response rate of 45.5 percent. This number of responses was deemed suitable to provide satisfactory statistical power to test the proposed hypotheses data analysis (Davey & Savla 2010; Kline 2005). The response rate is considered satisfactory compared to other empirical studies in the innovation management literature such as the studies by Bartl et al. (2012) and Stanko et al. (2012), where the response rates were 12.7 percent and 14.10 percent respectively.

Table 3.4: Summary of Sample Size

	Company Name	Industry Type	Total Target Population	Number of Responses	Excluded	Final Responses	Percentage %*
1	PE1	Petrochemical	112	41	3	38	39%
2	PE2	Petrochemical	55	33	1	32	58%
3	OG1	Oil & Gas	132	52	3	49	37%
4	OG2	Oil & Gas	64	33	2	31	48%
5	PH1	Pharmaceutical	63	35	2	33	52%
6	PH2	Pharmaceutical	43	25	2	23	53%
7	FP1	Food production	52	31	0	31	60%
	Total		**521**	**250**	**13**	**237**	**45%**

***Note:** All percentages are rounded to the nearest whole number.

3.5.4 Demographic Characteristics of Respondents

Sample characteristics of the respondents are shown in Table 3.5. It can be seen that of the 237 respondents, the overwhelming majority were male (85%), middle-aged or older (103 or 44% aged 33−44 years; 78 or 33% aged 45–54 years); while 23% were aged 18−34 and just 1% were over the age of 55. Turning to their years of work, the largest proportion had more than 10 years experience with 41% of respondents having between 10 and 15 years experience and only 6 respondents had more than 20 years of experience (3%).

Table 3.5: Descriptive Statistics of Samples Surveyed

Sample Characteristics		
	Number of Respondents	**Percentage %***
Respondent Gender		
Male	202	85 %
Female	35	15%
Respondent Age		
18–24	6	3%
25–34	47	20%
35–44	103	44%
45–54	78	33%
55 or over	3	1%
Years working		
Fewer than 5 years	48	20%
5–10	41	17%
10–15	98	41%
15–20	44	19%
More than 20	6	3%

***Note:** All percentages are rounded to the nearest whole number.

Looking next at the employees' positions within their firms (Table 3.6), the collected data shows that the majority of respondents were in a high-level position in their company. The data shows that the majority of respondents were managers (51 or 22%), while 35 respondents were scientists or senior scientists (15%). With respect to education level, the highest number of respondents (118 or 49.80%) had bachelor degrees, while the lowest number of respondents had technical or vocational training and professional degrees (3 or 1.30% and 1 or 0.40% respectively). With regard to industry type, the largest portion of respondents (78 or 33%) was from the oil and gas industry, whilst the food production industry saw the lowest rate with just 31 respondents (13.08%).

Table 3.6: Descriptive Statistics of Sample Surveyed

Sample Characteristics		
	Number of Respondents	**Percentage %***
Respondent Position		
Senior manager (Director)	30	13%
Manager	51	22%
Supervisor	22	9%
Engineer	39	17%
Senior scientist	21	9%
Scientist	14	6%
R&D employee	40	17%
Other	20	9%
Total	**237**	**100%**
Education Level		
Doctorate degree	42	18%
Master Degree	73	31%
Bachelor Degree	118	50%
Professional Degree	1	<1%
Tech. / Voc. training	3	1%
Total	**237**	**100%**
Industry Type		
Petrochemical	70	30%
Oil & Gas	80	33%
Pharmaceutical	56	24%
Food production	31	13%
Total	**237**	**100%**

***Note:** All percentages are rounded to the nearest whole number. The total percentage (100%) for each characteristic does not therefore represent a simple addition of the nearest whole numbers.

3.6 Data Collection

Several empirical studies indicate that a questionnaire can be seen as an efficient investigation tool in such varied areas as business, politics and medicine (Belhadjali et al. 2012). Sekaran (1992, p. 200) describes a questionnaire as '*a prepared set of written questions for respondents to tally their response typically under similarly designed other options. A questionnaire survey is an effective information gathering tool when the research scientist understands specifically what is needed as well as the ideal approach for measuring the interest variables*'. Consistent with the positivist research paradigm and the deductive research method, a quantitative research method using a questionnaire survey for gathering evidence was considered suitable for the current study. The data collection approach was conducted through online surveys via the 'Survey-Monkey' website.

It is noted that as the Internet has become a major method of communication, as people are becoming progressively more computer literate. In that regard, Lefever et al. (2007) and Wright (2005) state that many researchers from different fields of study have become increasingly aware of the benefits of data collection via the Internet. Granello and Wheaton (2004, p. 388) point out that online surveys have several valuable advantages over other survey methods which make them preferable. As outlined in that work, the main advantages are '*reduced time, lowered cost, ease of data entry, flexibility in format, and ability to capture additional response-set information* [that] *are universal to Internet-based data collection in all fields*'.

Thus, utilising an online questionnaire survey in the quantitative methodology adopted can provide greater uniformity across study situations since participants respond to the same unified questions, and participants are able to respond to the questions provided in their own time (Lefever et al. 2007). In addition, there is also less interviewer bias that may otherwise be generated by the presence of someone who has an interest in changing the results or obtaining particular 'desired' results (Mertler 2002). Moreover, the confidentiality and anonymity that online completion allows enhances the likelihood of obtaining honest responses, particularly in this case when participants are asked to evaluate their leader's leadership style.

In addition to the benefits of using an online survey as mentioned in the literature, this method was also preferred in this instance for personal and cultural considerations. The unique culture of Saudi Arabia poses particular challenges to researchers, especially female researchers. For instance, men and women are segregated in some large firms and until recently (and when this research was being undertaken) driving was banned for women. These factors make interviewing respondents from the opposite gender problematic. In addition, when a woman simply wishes to enter some large firms, she has to be accompanied by a male. This situation makes it difficult for a female researcher to physically enter a firm easily. Moreover, political and security implications in Saudi Arabia make it difficult to make visits to large companies. Some firms and organisations have strict rules preventing entry to visitors or researchers without authorisation from HR managers or their Public Relation (PR) department. The use of online surveys provided the best solution to circumvent any obstacles and reduce the chance of ethical dilemmas.

The final survey contained 40 items to measure the seven variables in the model that was tested. An additional eight questions collected demographic information, including questions relating to two control variables. Details of the procedures for developing the survey, and the full survey questions, are outlined in Section 3.8 (Table 3.7), and a full copy of the survey is included in Attachment 1. The next section, however, outlines the details of the measures used in relation to the dependent, independent, and control variables.

3.7 Measures

Reliability can be described as the extent to which measures are free from errors (Peterson, Homer & Wonderlich 1982). Therefore, the more reliable an instrument, the less likely it is that measurement errors will occur. The items for the constructs in the model employed non-comparative (metric) scales. Ordinal (ranking) scales were utilised to identify the relative extent to which objects possessed the characteristics under attention. To this end, this study used an itemised, numeric balanced seven-point Likert scale with response categories ranging from 1 = ‘strongly disagree’ to 7 = ‘strongly agree’ or 1= ‘very low’ to 7 = ‘very high’.

The seven-point scale was adopted for this study since it is more suitable for data analysis including complicated statistical techniques (Diefenbach et al. 1993; Malhotra et al. 2009). More importantly, the seven-point scale is better at dealing with cognitive limitations and reliability concerns. In addition, it helps to avoid any ambiguity that a nine-point scale might cause (Hair et al. 2010). The use of the seven-point scale also means the choice of response options is on a non-forced scale, where neutral or middle ground is permitted to the participants. A non-forced scale gives participants the chance to express their true opinions and feelings and helps the study to get an accurate response from them. Parasuraman et al. (2005) and Malhotra et al. (2009) state that a non-forced scale makes respondents more relaxed with their answers than if they were forced to provide either a positive or negative opinion with regard to a given statement, as in a forced scale.

Dependent Variables

Radical Innovation

Radical innovation was operationalised as innovation that involves the development of novel products or performance advantages that are achieved on the basis of significant leaps in technological development compared with competitors; it concerns materials and new features, newness to the market-place and a considerable reduction in terms of time and cost in order to offer a significant increase in customer benefit (Chandy & Tellis 1998; Majchrzak et al. 2004; Leifer et al. 2001).

This study adopted four scale items to measure the level of radical innovation as provided by Chandy and Tellis (1998). We measured radical innovation in terms of (i) the extent to which the firm incorporates new knowledge and technology in their business, (ii) whether the firm had launched a completely new product in the market over the past three years, (iii) the level of technology used in comparison to their competitors, and (iv) the degree of redesign of processes when they launch new product (see Appendix B).

To obtain the overall construct of radical innovation product of a firm, the seven-point Likert scale was used with response categories ranging from 1 = 'strongly disagree' to 7 =

‘strongly agree’. The index of radical innovation production was constructed by collecting the scores, in line with recommendations provided by Churchill and Gilbert (1979) and DeVellis (1991).

Independent Variables

Transformational Leadership

Transformational leadership was operationalised as a type of leadership that, through the transformation of followers’ values, behaviors, attitudes and beliefs, is intended to encourage followers to achieve higher-order goals and to exert extraordinary effort in pursuit of an organisation’s innovative ambitions (Bass 1985). An eight-item scale was selected from the Manual for Multifactor Leadership Questionnaire (MLQ) provided by Jaiswal and Dhar (2015) based on Avolio, Bass and Jung (1999) in order to measure leadership behaviour in a firm (see Appendix B). This study has excluded the items of idealised influence (attributed) since prior studies have not considered it an aspect of leadership behaviour (Jaiswal & Dhar 2015; Kark et al. 2003; Wang & Rode 2010). In addition, despite the literature review (e.g., Bass & Riggio 2006) indicating that the construct of transformational leadership consists of four main components, recent studies of leadership have found a high inter-correlation between these components of transformational leadership where the average reliability is around ($\alpha = 0.72$) (Jaiswal & Dhar 2015; Gumusluoğlu et al. 2013; Wang et al. 2013). Thus, the items related to transformational leadership in the study consisted of three main constructs: (i) intellectual stimulation (three items), (ii) inspiration motivation (three items) and (iii) individualised consideration (two items). Participants were asked to evaluate their unit’s leadership behaviour with regard to all employees in their firms, particularly in departments that have innovation activities.

Advanced Technology

Advanced technology was operationalised to the extent of a firm’s ability to continuously and rapidly integrate all types of sophisticated technologies to enhance its capability to find a technical solution and to satisfy its customer’s new requirements with novel superior technology (Gatignon & Xuereb 1997; Hurley & Hult 1998). This study adopted four scale items to measure the level of advanced technology of a firm. These items were provided by Chen et al. (2014) based on the work of Gatignon & Xuereb (1997) (see Appendix B). The items measured four main dimensions: (i) the extent to which the firm uses sophisticated technologies in developing new products (one item); (ii) the extent to which the firm involves state-of-the-art technology in new products (one item); (iii) the degree to which the firm is proactive in developing new advanced technologies (one item); and (iv) the degree to which technical innovation based on research results is accepted in the firm (one item).

Mediating Variables

Advanced Training

Advanced training as a formal learning practice was operationalised in this study as a planned process designed to support individuals through effective methods for a specific period in order for them to obtain a high level of knowledge and skills in a certain speciality so that they are then able to generate innovative ideas as well as support the firm more generally in the production of innovation. Through advanced training, employees can find innovation easier to utilise and learn different methods to apply it to their work, strengthening the psychological readiness for the innovation as well as the sense of efficacy in utilising it to support their firms' innovative performance (Venkatesh et al. 2003). All items used in this study to measure advanced training for innovation were based on constructs developed and validated in earlier studies.

This study used a scale of five items developed by Choi et al. (2011) (see Appendix B) for this section. The items measured five dimensions: (i) the extent to which employees are given sufficient information during advanced training for innovation (one item); (ii) the extent to which the firm provides advanced training (internally) to employees for innovation (one item); (iii) the extent to which advanced training (generally) is available to employees who want to learn about innovation (one item); (iv) the degree to which advanced training is adequate for innovation (one item); and (v) the extent to which the firm provides sufficient overseas advanced training (one item).

Organisational Learning

Organisational learning as an informal learning practice was operationalised as '*[a] dynamic process of creation, acquisition and integration of knowledge aimed at developing the resources and capabilities that allow the organization to achieve a better performance*' Lopez et al. (2006, p. 217). This process may take place within a firm as social interaction (internal and external) or via individuals and their interactions with colleagues (Nonaka & Takeuchi 1995; Beeby & Booth 2000).

This study used a scale of four items developed by Morales et al. (2006) and Aragón et al. (2007) to measure organisational learning in a firm (see Appendix B). The items measured four main dimensions: (i) the extent to which the firm acquired and shared new and relevant knowledge (one item); (ii) the extent to which the firm's members have acquired critical capacities and skills (one item); (iii) the degree to which the firm is significantly improved by using the new knowledge (one item); and (iv) the degree to which the firm is a learning organisation (one item).

Innovative Climate

Innovative climate was operationalised in this study as the cognitive representations of individuals within a firm in relation to its policies, practices and procedures (in all their aspects) as encouraged by the leaders' direction, including the provision of the necessary resources, rewards, autonomy and motivation to encourage employees' innovative initiatives. Thus, whenever members within a firm feel a deeper sense of respect and engagement, and experience a climate conducive to innovation, they are more able to launch creative initiatives (Mumford & Gustafson 1988; Isaksen & Ekvall 2010; Bharadwaj & Menon 2000).

The present study selected a scale of six items provided by Scott and Bruce (1994) (see Appendix B). These measurement items have also used by Sarros, Cooper & Santora (2008) to investigate the effect of transformational leadership on innovative climate through the mediating role of organisational culture. The six items used to measure an innovative climate are as follows: (i) the extent to which employees are given confidence by their leadership with regard to taking work-related decisions; (ii) the degree of agreement with regard to the reward system in the firm; (iii) the degree to which creative ideas are respected by leadership; (iv) the degree of assistance in developing new ideas; (v) the degree to which the necessary resources are available; and (vi) the degree to which the time allowed is adequate to facilitate the pursuit of creative ideas.

Innovation Capability

Innovation capability was operationalised in this study as a firm's capability to recognise, search for, integrate, experiment with and commercialise novel innovative products (Kim et al. 2012; Yam et al. 2004; Tasi & Tasi 2010; O'Connor & McDermott 2004). This study focuses on three main capabilities for radical innovation products: (i) openness capability, (ii) integration capability and (iii) experimentation capability. These capabilities emphasise the main role of strategic management in a firm in its efficiently adapting, integrating and reconfiguring (internally and externally) organisational skills, resources and functional competencies in order to meet the requirements of producing radical innovation in a changing environment (Teece et al. 1997).

A scale of nine items provided by Chang et al. (2012) (see Appendix B) was used for the innovation capability scale. These items measured three dimensions: (i) openness capability (three items) which comprises the extent to which the firm participates in industrial networks, the extent to which the firm invites scientists to predict the future and the extent to which the firm cooperates with other institutions to create new ideas; (ii) integration capability (three items) which includes the degree to which the firm applies the previous knowledge to new projects, the degree to which the firm supports cross-functional learning and the degree to which the firm upgrades and integrates technology, new development and marketing; and (iii) experimentation capability (three items) which includes the extent to which the firm develops reliable products, the extent to which it commercialises proven concepts into the market, and the degree to which the firm develops new methods to enhance R&D.

Control Variables

Two control variables were incorporated into the study model to reduce the likelihood of confused results and spurious interpretations of findings, which might affect the validity of the results (Atinc et al. 2012). Prior research has emphasised the influence of firm size (Davis et al. 2009; Gulati & Higgins 2003; Rowley et al. 2000) and industry type (Lin et al. 2006; Hoffman et al. 1998) on a firm's innovation performance. Thus, the researcher employed *firm size* and *industry type* as control variables in this study.

The number of employees has been acknowledged as an appropriate measure of a firm size (Buyl et al. 2011). Extant research indicates that firms with a large number of employees are more likely to affect the firms' capabilities with regard to the improvement of their critical assets for innovation outcomes, such as obtaining critical resources (Parida et al. 2012), learning activities (Hulsheger et al. 2009; Holmquist 2007) and acquisition (external and internal) of strategic knowledge (Srivastava & Gnyawali 2011). Thus, participants were asked to identify the number of employees in their firms by placing their firm into one of the four categories suggested in the questionnaire (the number in brackets indicates the percentage of respondents whose firm falls within each size category): the number of respondents indicating a firm size of between 200 and 4,000 employees was 101 (42.61%), those indicating 4,001−8,000 numbered 23 (9.70%), and 118 (49.78%) indicated the number of employees as 24,001−200,000.

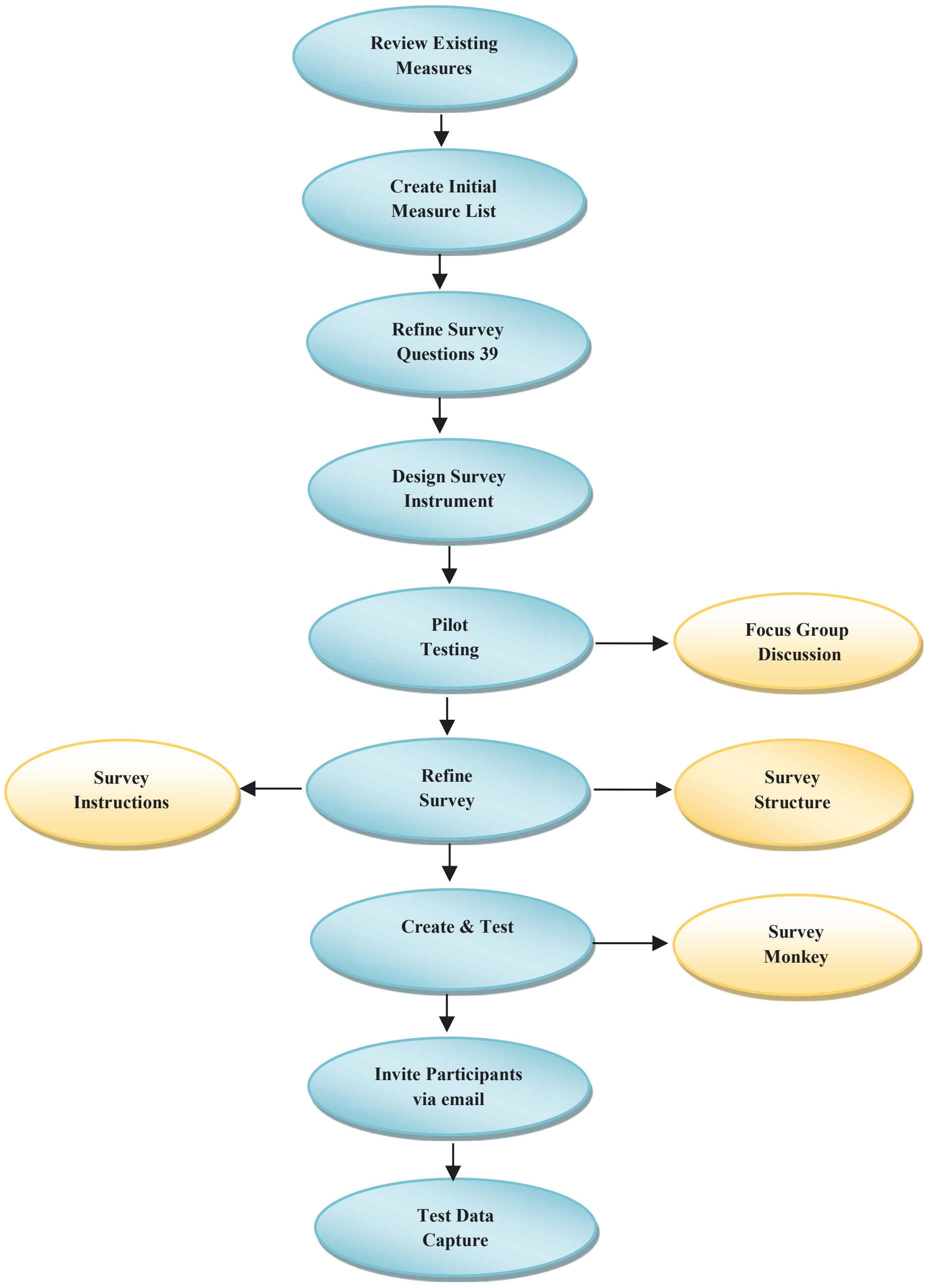
Four industry types were identified as a control variable in this study (the number in brackets indicates the percentage of respondents whose firm falls within each size category): Petrochemical 70 (29.53%), Oil & Gas 80 (33.75%), Pharmaceutical 56 (23.63%) and Food Production 31 (13.08%).

3.8 Procedure

Babbie (2004) classifies survey questions into two main types, open or closed-ended. With open-ended questions, participants have the option to respond to enquiries in any way that they like. It is suggested that respondents' answers must be evaluated and classified for further investigation of the data. To achieve their objectives, open-ended questions need to be coded and processed before computer analysis. In view of this situation, Babbie (2004) indicates that there is a probability of researcher bias. This is because the process of coding may lead to conclusions being made on the implications of participant responses. There is also a possibility of researcher bias as the coding process entails some deduction in terms of the implications in the feedback. Furthermore, the author points out that respondents' answers could be unrelated to the intentions of the study. Open ended questions are frequently utilised in qualitative research.

Conversely, closed-ended questions consist of a set of alternative options that are set by the researcher, allowing participants to select a specific answer. Closed-ended questions facilitate and guide participants, asking them to select answers from the choices provided. In addition, these types of questions assist with coding data simply and rapidly for further investigation (Sekaran & Bougie 2010) and can be uploaded in a computer-compatible format (Babbie 2004). For this reason, close-ended questions were utilised for this study, following Sekaran and Bougie's (2010) suggestions. Figure 3.2 displays the main steps undertaken for the data collection procedures, including measurement scales, survey instructions, the survey structure, focus group discussions, choice of questionnaire language and the creation and testing of the online instrument. The following sections will discuss these steps in further detail.

Figure 3.2: Summary of Data Collection Procedures



3.8.1 Questionnaire Development

The questionnaire for this study was designed to measure seven main variables: (1) transformational leadership, (2) advanced technology, (3) advanced training, (4) organisational learning, (5) innovation climate, (6) innovation capability, and (7) radical innovation.

Before starting to design the survey instrument for this study, the researcher followed the detailed guide provided by Hau and Evangelista (2007) and Edwards and Bagozzi (2000) with regard to the correlation between constructs, measurement and scale development. Based on the objectives, research questions and the theoretical model (i.e. hypotheses) of this study, the researcher first specified the study dimensions (i.e. constructs or components). Then, a deep review of relevant literature was conducted to explore which constructs had previously achieved validated measurement scales with high reliability (Podsakoff & Podsakoff 2011), particularly in the context of large firms, and whether their measurements included all the aspects that are linked to the current study (Edwards & Bagozzi 2000). The reliability is the degree to which the scale produces consistent results even when the same measure is repeated several times in several studies (Hair et al. 2014). In order to be deemed suitably reliable, the value of a scale's reliability, as measured by the statistical test Cronbach's α, should be greater than $\alpha = 0.70$ (Hair et al. 2006). The researcher was careful to adopt the measures, their items and scales from previous empirical studies to avoid measurement invalidities and attain reliability for this study (MacKenzie et al. 2011). As a result, a pool of questions was generated that was pertinent for each construct. From this pool, 39 scale items were selected that were flagged as relevant to the study. Table 3.7 provides the validated items which are used in this study based on previous empirical studies. In addition, these empirical studies have a high reliability, that is, one which is above the cut-off value of 0.7 (Hair et al. 2006).

Table 3.7: Questionnaire Items Adopted in the Study

Variable	Items	Reliability	Source
Transformational Leadership	***My unit leader:*** 1. Supports innovation by making sure that available resources flow smoothly to innovation projects 2. Makes long-term investments in technology and manufacturing, to support on-going innovation 3. Gives clear feedback on new innovative ideas 4. Articulates a compelling vision of the future 5. Has a clear sense of where he/she wants us to be in the future 6. Encourages new initiatives 7. Pays explicit attention to innovation and its role in future development 8.Supports innovation by ensuring that structure, processes and other organisational mechanisms support the innovation teams	**0.94**	Multifactor Leadership Questionnaire (MLQ) Jaiswal & Dhar (2015) based on Avolio, Bass & Jung (1999)
Advanced Technology	1.We use sophisticated technologies in our new product development 2. Our new products always involve state-of-the-art technology 3.We actively solicit and develop technologically advanced new products 4. Technical innovation, based on research results, readily accepted at this organisation	**0.91**	Chen et al. (2014) based on Gatignon & Xuereb (1997)

Organisation Learning	1.The organisation has acquired and shared much new and relevant knowledge that provided competitive advantage 2. The organisation's members have acquired some critical capacities and skills that provided competitive advantage 3. Organisational improvements have been influenced fundamentally by new knowledge entering the organisation (knowledge used) 4. The organisation is a learning organisation	**0.92**	Morales, Barrionuevo & Gutiérrez (2012) based on Aragón, Morales & Pozo (2007)
Advanced Training	1. Employees were given enough information during the training for the innovation 2. The training for the innovation was given to employees throughout the organisation 3. Training was readily available to employees who want to learn more about the innovation 4. The training employees received related to the innovation was adequate 5. Our company provides sufficient overseas training programmes for the innovation such as conferences or seminars.	**0.85**	Choi et al. (2011)
Innovative Climate	1. Employees are given confidence by their leadership with regard to taking work-related decisions 2. The reward system here encourages innovation 3. Our ability to function creatively is respected by the leadership 4. Assistance in developing new ideas is readily available 5.There are adequate resources devoted to innovation in this organisation 6. There is adequate time available to pursue creative ideas here	**0.75**	Scott and Bruce (1994)

Innovation Capability	***Openness capability*** 1. We participate in industrial networks such as industrial associations, standard organisations and industrial forums 2. We invite scientists and gurus to predict the future 3. We co-operate with universities / research institutes, to develop brand new ideas	**0.77**	Chang et al. (2012)
Innovation Capability	***Integration capability*** 4. We apply the knowledge gained in previous projects to new projects 5. We encourage cross-functional learning and fertilisation 6. We upgrade and integrate our technology capabilities, new product development and marketing	**0.83**	Chang et al. (2012)
Innovation Capability	***Experimentation capability*** 7. We usually adopt new ideas and develop them as reliable products 8. We commercialise proven concepts into market 9. We develop methods and tools, to improve R&D	**0.79**	Chang et al. (2012)
Radical Innovation	1. Introducing the products has meant significant changes in our production process 2. We are well known by our customers for radical product innovations 3. The number of radical product innovations introduced to the market by your company rose in the last three years 4. Compared with our competitors, our products are based on a significantly different technological solution	**0.90**	Herrmann, Gassmann & Eisert (2007) based on Chandy & Tellis (1998)

After identifying the desired measures as well as their items and scales from previous empirical studies, a number of steps were undertaken, including reviews by my supervisory panels, three academic staff members as well as six PhD students in the business school (Murphy 2009). Finally, the instrument was the subject of focus group discussion and pilot-tested through two focus groups with ten directors from two different large firms in Saudi Arabia. These details are explained next.

3.8.2 Focus Group: Pilot-Test

Several authors indicate that a focus group is crucial in providing accurate information to affirm the relevance and validity of variables to be used in quantitative studies (e.g., Choe et al. 2006). Kotler (1987, p. 226) defines the focus group as '*Groups of eight to twelve (people) ... usually (but not always) a relatively homogeneous group; brought together to discuss a specific set of issues under the guidance of a leader trained to stimulate and focus the discussion.*'

Prior to the formal study commencing (and before applying the quantitative method), two focus groups were conducted with ten directors at two different large firms in Saudi Arabia. The average length of each focus group session was thirty to sixty minutes. The first focus group was conducted on 15th and 16th January 2016 with five directors face-to-face and one director joining the discussion via Skype. The second focus group was conducted with five directors on 18th January 2016. Before focus groups were undertaken, based on the UTS Human Research Ethics Committee policies, all participants were asked to sign consent forms (see Appendix A).

The focus group discussions aimed to affirm the validity of the content and test the validity of the measurement items, as well as to identify participants' opinions and judgements on the clarity, relevance, and design of the format, layout and wording of questions in the survey (Choe et al. 2006). This action assisted the researcher to obtain sensitive information to confirm or improve the questionnaire before distribution among participants. It also assisted in enhancing the reliability of the results of the proposed model.

As part of the focus group discussions, directors were asked to complete the questionnaire in order to conduct a survey pilot-test. The main reason for doing a pilot-test was to gather their opinions and feedback with regard to the questionnaire in addition to the earlier discussions. It was also possible to validate the content of the questionnaire, affirm the structure and feasibility of the instrument and identify the time need to complete the survey before the actual formal launch of the questionnaire (Malhotra 2010; Zikmund 2000). After receiving their comments, improvements were made to the questionnaire in terms of their perceptions without undermining the integrity of the instrument. Following these improvements, a final version of the questionnaire was generated. It was then uploaded to 'Survey-Monkey' with seven different web-links labelled from (1) to (7) with each company receiving a different link. These links permitted the researcher to identify and separate responses from each of the seven companies easily and so assisted processes of the data analysis.

In addition to the structured focus groups, input and feedback was also sought from an independent British Professor (formerly employed by Harvard University) who had vast experience working with large Saudi firms as a consultant and a deep understanding of professional life in Saudi Arabian organisations. This resulted in improvements in the structure and phrasing of the questionnaire. For example, it was suggested that the survey should commence with main items instead of demographic questions in order to provide a sufficient time for participants to answer the survey. In addition, for items measuring leadership behaviour in a firm it was proposed that the term "our unit leadership" replace "our leadership" in order to prevent any ambiguity. These changes were incorporated in the final design of the questionnaire.

3.8.3 Survey Instructions

Providing clear instructions regarding responses is a crucial step towards getting valuable answers. When participants accessed the online survey – via a link provided in an email - the first page displayed the title of the study, its purpose, the estimated time required to complete the survey, and notes on ethics and the voluntary nature of participation. Importantly, the survey instructions advised respondents to think about how things actually are (rather than their opinion of how things ought to be) relative to their capability for sustaining radical innovation and regardless of whether they were successful or not. This instruction has been provided by the researcher so as to obtain realistic information from participants and to provide accurate results.

3.8.4 Survey Structure

To encourage accuracy in data collected for further statistical analysis, all items were carefully checked and slightly modified (i.e. language clarity, layout and design) to eliminate any ambiguity in the phrasing of the questions (Brace 2004) during the design phase. In addition, phrasing of the questions was further refined for logical coherence and visual appeal by a statistical specialist. Each section contained instructions and definitions for each group of items above each item group.

3.8.5 Questionnaire Language

The sample of this study encompassed seven large firms whose primary language of internal and external communication is English for their multicultural workforce at all levels. Managers from the human resource departments of all seven firms expressed preference for the questionnaire to be delivered in the English language. The main rationale provided was that, according to them, all members of the sample population were fluent readers of English as a first or second language. The language used in the survey, therefore, was English.

3.8.6 Creation and Testing of the Online Instrument

The questionnaire was uploaded to the site and a link obtained to distribute it among participants. Before distributing the final questionnaire to participants, the researcher requested six students (PhD students) who had academic experience in a business field to participate in this online survey which would record their opinions and observations with regard to their understanding and interpretation of the items used, for example, whether they detected any ambiguity or any other fault in the wording or formatting of the testing instrument. Having examined and undertaken the online survey, all confirmed that the questionnaire was clear to them and, in their opinion, ready to distribute. Then, their responses were deleted to prevent any contamination with the responses from the target participants of the present study. A sample copy of the full online survey used in this study, including instructions to respondents, can be found at (Appendix B).

The final questionnaires were uploaded on 26th January 2016 with seven different web-links labelled from (1) to (7) with each firm receiving a different web-link. Then, each web-link was sent to the human resource manager of each firm to distribute it to the target participants. The web-link allowed users to complete the form online and provided information in terms of the purpose of the study and ethical issues along with details of how to complete the survey. After completion of the survey (achieved by clicking on a 'submit' button), the raw data was deposited in a database on the website. The online survey was made available for completion for a four-week period between 26th January 2016 and 23rd February 2016.

3.9 Ethical Considerations

Ethical issues are key concerns in social research studies. Fontana and Frey (1998) point out that the subject of enquiries in social research is the human being and that great care should be taken to avoid causing harm to any person. For this reason, the researcher paid a great degree of attention to all participants in terms of ethics, principles, confidentiality and anonymity as well as the voluntary participation to protect their rights and safety. Information on the objectives and methodology of the study were provided to all participants in detail. All the digital data obtained from participants have been stored in the researcher's password protected laptop and in the university's computer. The data are accessible only to the researcher and the supervisors who are involved directly in the study. Participation remained anonymous and identifying details of participants were not obtained in conjunction with the survey results. The information that was provided to each respondent before completing the survey can be shown at (Appendix B).

Regarding the focus group discussions, informed consent was obtained from participants before their commencement of the survey and all participants were given the option to withdraw at any time. Authorisation was obtained by participants to record the discussion, and evidence of permission from all respondents (in terms of forms or voice record) was retained. All personal data was de-identified, and attention was paid to cultural sensitivities and to respecting the culture, religious beliefs, values and ethical principles of the respondents. All paperwork (written consents and written field notes) were scanned and digitalised for safe keeping, while the hard copies were safely stored in the researcher's personal filing cabinet at home. The names of the firms will not be published unless or until the researcher obtains permission from those firms. The researcher did not discuss any specific issues or answers that related to the participants with others except her supervisors. At the end of the focus group discussion, participants were given a symbolic gift (a bar of chocolate in the shape of one of the national iconic animals of Australia, a koala) as an expression of thanks and gratitude for their participation. Survey participants were offered no inducements or rewards for their participation.

3.10 Ethical approval

The researcher did not commence any data collection until ethical approval from the Human Research Ethics Committee (HREC) of the University of Technology, Sydney (UTS) was obtained. The UTS HREC approval number for this study is **2015000117**, confirmed on 16th November 2015.

3.11 Chapter Summary

This chapter has outlined the research methodology utilised in this study and offered commentary regarding that method. The chapter can be summarised as follows. The first section explained the research paradigm of the study. Secondly, the chosen research method was discussed, and justification given as to why it was selected as the best fit for this study. A deductive, cross-sectional approach with quantitative methods was adopted to examine the hypothesised relationships between the selected factors. Following that, the research design was detailed, and the level of analysis and unit of analysis clarified with reference to the research questions and the model proposed. The fifth section described the selected data collection method. An online survey (conducted through 'Survey-Monkey') was deemed the most appropriate method for data collection and one that would contribute to the success of this study, as it would (through good design and appropriate sampling) facilitate the collection and analysis of quantitative data. The sixth section included a discussion of sampling in this study. The target population comprised employees working in large firms who had first-hand knowledge of innovation activities in their firms such as senior managers, scientists and engineers. The sample consisted of employees from seven large firms in Saudi Arabia from four different industries. The seventh section discussed the scope of this study and detailed the dependent, independent, mediating, and control variables. The eighth section focused on the procedures used for data collection in this study. The major part of this section described steps undertaken in developing the survey questionnaire. These included the determination of a measurement scale; survey instructions; the survey structure; focus group discussions; questionnaire language and wording; and the creation and testing of the online instrument. At the end of the chapter, the ethical considerations and the ethical approval process were clarified.

CHAPTER FOUR: DATA ANALYSIS AND RESULTS

4.1 Introduction

Chapter Three outlined the research methodology utilised in this thesis for collecting the data for analysis. This chapter describes the data analysis and the results of this analysis for the sake of testing the study's hypotheses. To achieve this, SPSS version 24 and AMOS version 24 were used to record the participants' responses and to conduct data analysis. Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA) and reliability analysis were used to examine scale validity and reliability regarding the statistical properties of the various multi-item scales utilised in the survey. The hypotheses were examined by employing Structural Equation Modelling (SEM) analyses utilising AMOS to test the relations between the various scales. The statistical significance of the regression coefficients was utilised to determine whether the results supported each of the hypotheses (Hair et al. 2013).

In aggregate, data analysis on the sample size of 237 was carried out by using EFA, CFA and SEM, in three main steps. First, the EFA was conducted to examine the measuring items' underlying factors and to indicate the latent dimensions originating from the data found in the study. The measures' convergent and discriminant validity were determined initially through a series of EFAs, and the varimax rotation method employed to calculate and identify factors which had eigenvalues greater than 1 or factors of 0.4 or less loading value. An eigenvalue greater than 1 demonstrates a factor's convergent validity (Hair et al. 2013). Secondly, CFA was then employed for factor structure validation through the determination of the relationship between the factors, and which items are correlated, and which factors are represented. Thirdly, SEM was used to analyse the correlation between the factors and test the hypotheses.

This chapter has the following structure: section 4.1 presents the introduction to the chapter. Section 4.2 then displays the reliability analysis of each construct. This is followed by a discussion of the EFA of each factor separately (Section 4.3) and the EFA of the seven constructs overall (Section 4.4). Section 4.5 discusses the common-method variance (bias).

The CFA of the seven constructs are reported in Section 4.6, while Section 4.7 presents the Composite Reliability (CR) and explains the Average Variance Extracted (AVE) of each construct. Section 4.8 then provides the descriptive statistics and correlations for all constructs. This is followed in Section 4.9 by the hypotheses testing and model fit using SEM, before the results of the hypotheses testing and findings are discussed in Section 4.10. A chapter summary concludes the chapter.

4.2 Reliability Analysis

Reliability refers to the degree to which a scale produces consistent results even when the same measure is repeated several times in several studies. The analysis to determine the reliability of a specific construct is identified as reliability analysis. So, reliability basically measures the degree of association between different items of a construct (Hair et al. 2014; Field 2016). An indicator's reliability explains '*which part of an indicator's variance can be explained by the underlying latent variable*' (Götz et al. 2010, p. 694).

Cronbach's alpha is '*the most widely used objective measure of reliability*' (Tavakol & Dennick, p. 53). Cronbach's alpha can range from 0 to 1 with 1 being a measure which would be perfectly reliable and 0 being perfectly unreliable. There are no steadfast rules available for what constitutes a reliable measure. However, Nunnally (1978) suggests the following minimum standards for the coefficient alpha of reliability in the development of behavioural measures:

1) 0.5 to 0.6 for exploratory research;
2) 0.8 for basic research;
3) 0.9 or better in applied settings where important decisions will be made with respect to specific test scores. In strategic management research, reliabilities greater than 0.7 are often considered acceptable. See also Peter (1981) and Peterson (1994).

To this end, the Cronbach's alpha (α) coefficient for all variables used in this research was computed. The reliability results for each construct are summarised in Table 4.1. The table shows that the Cronbach's α for all constructs was greater than 0.70, an indication that all constructs achieved adequate levels of reliability. The reliability of the RADI construct, for instance, was α = 0.89. Thus, this construct demonstrates 89% of the true scores of its respective variables whereas 11% is the error term induced in this construct by its representative items. The ICAP construct (α = 0.96) showed the strongest result, and all constructs achieved results greater than the cut-off of 0.70 for acceptable reliability.

Table 4.1: Reliability Results of All Constructs

Construct	Cronbach's Alpha	No of Items
Transformational Leadership (TL)	0.95	8
Advanced Technology (TECH)	0.92	4
Organisational Learning (OL)	0.90	4
Advanced Training (TR)	0.95	5
Innovative Climate (IC)	0.94	6
Innovation Capability (ICAP)	0.96	9
Radical Innovation (RADI)	0.89	4

4.2.1 Reliability Analysis for Each Construct

Although Table 4.1 shows all the constructs possess adequate reliability, it is still worth looking into the contribution of individual items to each construct. For an individual item to make a useful contribution to the reliability of the overall measure, its corrected item-total correlation should be substantial. The usual cut-off point is 0.5. Alternatively, one can look at what happens to the Cronbach's Alpha if the item in question is deleted. For an item to be making a useful contribution, the Cronbach's Alpha should not decrease if the item of the construct is deleted. Table 4.2 illustrates the analysis for each construct.

Table 4.2: Reliability Analysis for Each Construct

Constructs	Items	Item-Total Correlation	Cronbach's Alpha if item deleted	Constructs	Items	Item-Total Correlation	Cronbach's Alpha if item deleted
Transformational	TL1	0.83	0.94	**Innovative**	IC1	0.76	0.94
Leadership	TL2	0.79	0.95	**Climate**	IC2	0.83	0.94
	TL3	0.81	0.94		IC3	0.86	0.93
	TL4	0.85	0.95		IC4	0.86	0.93
	TL5	0.86	0.93		IC5	0.85	0.93
	TL6	0.85	0.95		IC6	0.84	0.93
	TL7	0.85	0.94				
	TL8	0.83	0.95	**Innovation**	ICAP1	0.71	0.96
				Capability	ICAP2	0.87	0.95
Advanced	TECH1	0.79	0.89		ICAP3	0.81	0.95
Technology	TECH2	0.80	0.89		ICAP4	0.88	0.95
	TECH3	0.85	0.87		ICAP5	0.87	0.95
	TECH4	0.79	0.89		ICAP6	0.87	0.95
					ICAP7	0.82	0.95
Organisational	OL1	0.81	0.87		ICAP8	0.84	0.95
Learning	OL2	0.79	0.86		ICAP9	0.78	0.96
	OL3	0.74	0.88				
	OL4	0.75	0.87	**Radical**	RADI1	0.81	0.86
				Innovation	RADI2	0.79	0.86
Advanced	TR1	0.85	0.94		RADI3	0.74	0.88
Training	TR2	0.89	0.93		RADI4	0.75	0.87
	TR3	0.91	0.93				
	TR4	0.91	0.93				
	TR5	0.76	0.96				

4.2.1.1 Transformational Leadership (TL)

The overall scale reliability of the TL construct is α = 0.95. So, there is no need to delete any item for the sake of increasing reliability. Table 4.2 shows the reliability for the TL construct where the column 'Item-Total Correlation' shows that how much each item represents the true score of the construct and the degree to which the item influences the TL construct. The greater the total-item correlation, the less the error influence on the construct. The third column shows that the value of Cronbach's alpha (α) of the TL construct will increase if we delete the item which otherwise lowers the correlation. Hence, based on the reliability results, no item is a candidate for deletion for the sake of increasing internal consistency.

4.2.1.2 Advanced Technology (TECH)

For TECH construct, the overall reliability is α = 0.92. Table 4.2 shows the reliability for each item of the TECH construct. All the item correlations are greater than 0.70. If an item of the construct is deleted, the overall reliability would not exceed 0.92. Thus, no item is a candidate for deletion for the sake of increasing internal consistency.

4.2.1.3 Organisational Learning (OL)

For the OL construct, the overall reliability is α = 0.90. Table 4.2 shows the reliability for each item of the construct. All item correlations are greater than 0.70 which, as suggested by Tavakol & Dennick (2011), indicates a high standard of reliability. If an item of the construct is deleted, the overall reliability would not exceed 0.90. So, no item is a candidate for deletion for the sake of increasing internal consistency.

4.2.1.4 Advanced Training (TR)

For the TR construct, the overall reliability is α = 0.95. Table 4.2 shows that the overall reliability is in the range described by George and Mallery (2003) as indicative of acceptable reliability (regarding internal consistency). If we delete an item, the overall reliability of the construct slightly exceeds 0.95, rising to 0.96. Therefore, no item is a candidate for deletion for the sake of increasing construct reliability. It is also noted that all the item correlations are greater than 0.70.

4.2.1.5 Innovative Climate (IC)

For the IC construct, the overall reliability is α = 0.94. All the item correlations are greater than 0.70. Table 4.2 shows that if an item is deleted, the overall reliability of the construct would not exceed 0.94. Thus, no item is a candidate for deletion for the sake of increasing construct reliability.

4.2.1.6 Innovation Capability (ICAP)

For the ICAP construct, the overall reliability is α = 0.96. All the item correlations are greater than 0.70. Table 4.2 shows that if an item is deleted, the overall reliability of the construct would not exceed 0.96. So, no item is a candidate for deletion for the sake of increasing construct reliability.

4.2.1.7 Radical Innovation (RADI)

For the RADI construct, Cronbach's alpha is α = 0.89. All the items have correlations greater than 0.7. Table 4.2 shows that if an item is deleted, the overall reliability of the construct would not exceed 0.89. So, no item will be the candidate for deletion.

4.3 Exploratory Factor Analysis

Exploratory Factor Analysis (EFA) is the traditional way of testing construct validity. Construct validity can be broken down into two types: convergent and discriminant. Convergent and/or discriminant validity can threaten or bias the results of the study as *convergent validity* refers to the extent to which indicators of a specific construct converge or share a high proportion of variance in common. *Discriminant validity* refers to the extent to which a construct is truly distinct from other constructs (Hair et al. 2014). In order to establish dimensionality and convergent validity of the relationship between items and the structure of construct to be analysed (Costello & Osborne 2005), EFA was first applied for each construct separately on the original items scale. To demonstrate adequate convergent validity, a good rule of thumb is that the factor loading should be 0.5 or higher, and ideally 0.7 or higher (Hair et al. 2013).

The data collected was entered into SPSS version 24. EFA was applied through principal components with varimax rotation and an eigenvalue larger than 1 as the criterion for factor extraction. The following procedures were employed to carry out EFA. From the SPSS version 24 menu, the following instructions were followed: *Analyze > Data Reduction > Factor*. The criteria chosen in dialogue boxes under *Factor Analysis* are summarised in Table 4.3.

Table 4.3: EFA Criteria Selected in Dialogue Boxes under Factor Analysis

Dialogue Box	Selected Items
Descriptive	
Statistics	Initial solution
Correlation matrix	Coefficients
	Determinant
	Inverse
	KMO and Bartlett's test of sphericity
Extraction	
Method	Principal components
Display	Un-rotated factor solution
Extract	Based on eigenvalues greater than 1
Maximum iterations for convergence	25
Rotation	
Method	Varimax
Display	Rotated solution
Maximum iterations for convergence	25
Options	
Missing values	Exclude cases listwise
Coefficient display format	Sorted by size
	Suppress small coefficients
	Absolute value below 0.4

4.3.1 Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity

Prior to conducting of EFA for each construct, it was carried out the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity on all the constructs. The KMO Test measures sampling adequacy for each variable in a model and for a complete model. It measures the proportion of variance among variables that might be common variance, that is, caused by underlying factors (Hsiao 2006). KMO values between 0.80 and 1.0 indicate adequate sampling while a value of <6.0 or <5.00 indicates inadequate sampling. High values, that is, those close to 1.0, indicate that factor analysis may prove useful in assessing data (Grewal et al. 2004). Values of < 0.50 indicate that factor analysis may not prove useful. Values closer to 0.0 indicate difficulty will be encountered during analysis as there are many partial correlations. (Kaiser's own categorisation is as follows: 0.00-0.49 'unacceptable'; 0.50-0.59 'miserable'; 0.60-0.69 'mediocre'; 0.70-0.79 'middling'; 0.80-0.89 'meritorious'; 0.90-1.00 'marvellous' (Kaiser 1974)). By demonstrating that the data set is suitable for factor analysis, the results of such analysis are more able to be relied upon.

Calculations undertaken in Bartlett's Test of Sphericity inform researchers as to whether there is a relationship between variables. If the individual measurement items for each construct are making significant contributions, this Bartlett's test should be statistically significant (i.e., p-value < 0.05). If they fail to point to the existence of such a relationship, further analysis may prove fruitless. A *p* value of less than 0.05 indicates that factor analysis may be of benefit as a relationship exists between the variables (Hinton et al 2004, p. 349).

These two tests, therefore, form preconditions of more detailed analysis. The test results for each are summarised in Table 4.4.

Table 4.4: Kaiser- Meyer-Olkin and Bartlett's Test of Sphericity (SPSS Output)

Construct	Overall KMO*	Bartlett's test	df	p-value
Transformational Leadership (TL)	0.94	1889.89	28	0.00
Organisational Learning (OL)	0.85	599.71	6	0.00
Advanced Technology (TECH)	0.85	704.51	6	0.00
Advanced Training (TR)	0.90	1303.03	10	0.00
Innovative Climate (IC)	0.91	1377.02	15	0.00
Innovation Capability (ICAP)	0.94	2303.99	36	0.00
Radical Innovation (RADI)	0.84	572.21	6	0.00

Note: Factor Loadings principal components
* Kaiser-Meyer-Olkin measure of sampling adequacy.

The KMO value of each construct was calculated as follows: TL is 0.94, OL is 0.85, TECH is 0.85, TR is 0.90, IC is 0.91, ICAP is 0.94 and RADI is 0.84. Table 4.4 shows that the KMO of all constructs is greater than 0.80, reflecting a good sampling adequacy (Hsiao 2006). In addition, the results of Bartlett's Test of Sphericity indicate the degree of freedom where each factor is suitable for analysis. The corresponding p-values ($p = 0.00$) of all constructs are less than 0.05 which shows that the statistics are appropriate for the sake of conducting factor analysis, and that the results of such computations can be relied upon.

4.3.2 Exploratory Factor Analysis of Each Factor

This section reports the results of performing EFA to establish dimensionality and convergent validity of the relationship between items and the construct. EFA was performed on the original items of each construct scale. In order to determine the underlying dimensions, factors based on the latent root orientation (eigenvalue) and total variance were examined.

4.3.2.1 Transformational Leadership Factor (TL)

Table 4.5 displays the amount of variance in the total collection of items which is explained by the principal components. Only those amounts of variance are considered which have eigenvalues greater than 1. The findings show that only one item has an eigenvalue greater than 50% and is responsible for 76.18% of the variance while the remaining 23.82% of the variance is explained by the other seven items.

Table 4.5: Results for the Extraction of TL

Component's Items	Total	Eigenvalues % of Variance	Cumulative %
TL1	6.10	76.18	76.18
TL2	0.44	5.53	81.71
TL3	0.37	4.57	86.28
TL4	0.30	3.70	89.98
TL5	0.24	3.03	93.00
TL6	0.20	2.54	95.54
TL7	0.19	2.38	97.92
TL8	0.17	2.08	100

Extraction Method: Principal Component Analysis. See also Table 4.22 for details of each item.

Table 4.6 shows that eight items were extracted by EFA of the TL construct. All the items of the construct have a factor loading greater than 0.5 which clearly shows that no item is a candidate for deletion (Hair et al. 2006). Indeed, all factor loading values are greater than 0.80 and fall within a range of 0.84 to 0.89 which shows that all items are consistent in terms of their factor loading. This clearly shows the convergent validity of the items for the TL construct. There is no cross-loading and all items are consistent with the original dimension of the construct.

Table 4.6: Results of Exploratory Factor Analysis of TL

TL Construct	Individual KMO	Factor Loadings (PC)
(TL1)	0.94	0.87
(TL2)	0.94	0.84
(TL3)	0.94	0.86
(TL4)	0.95	0.88
(TL5)	0.95	0.89
(TL6)	0.95	0.89
(TL7)	0.94	0.89
(TL8)	0.94	0.87

(PC): Principal Component Analysis

4.3.2.2 Advanced Technology Factor (TECH)

Table 4.7 illustrates the amount of discrepancy determined by the EFA for the variable TECH. The results show that one item is responsible for the majority of the variance in the construct (79.99%) and the remaining variance is explained by the rest of the items (23.26%). So, there is no need to dimensionalise the construct of TECH into several other factors.

Table 4.7: Results for the Extraction of TECH

Component's Items	Total	Eigenvalues % of Variance	Cumulative %
TECH1	3.21	79.99	79.99
TECH2	0.33	8.27	88.27
TECH3	0.26	6.51	94.78
TECH4	0.21	5.22	100

Extraction Method: Principal Component Analysis. See also Table 4.22 for details of each item.

Table 4.8 shows that all items have a factor loading greater than 0.8 and all fall in the range from 0.88 to 0.92 which shows that all items are consistent in terms of their factor loading. This clearly shows the convergent validity of the items for the TECH construct. So, there is no cross-loading and all items are consistent with the original dimension of the construct.

Table 4.8: Results of Exploratory Factor Analysis of TECH

OL Construct	Individual KMO	Factor Loadings (PC)
(TECH1)	0.87	0.88
(TECH2)	0.86	0.89
(TECH3)	0.82	0.92
(TECH4)	0.86	0.88

(PC): Principal Component Analysis

4.3.2.3 Organisational Learning Factor (OL)

Table 4.9 shows the amount of variance revealed by the principle component analysis for the variable OL. The result displays that only one item is responsible for the majority of the variance in the construct (76.75%) and the remaining variance (23.25%) is explained by the rest of the items.

Table 4.9: Results for the Extraction of OL

Component's Items	Total	Eigenvalues % of Variance	Cumulative %
OL1	3.07	76.75	76.75
OL2	0.37	9.15	85.89
OL3	0.32	7.91	93.81
OL4	0.25	6.19	100

Extraction Method: Principal Component Analysis. See also Table 4.22 for details of each item.

Table 4.10 shows that all items have a factor loading greater than 0.8 and all fall in the range from 0.86 to 0.90 which shows that all items are consistent in terms of their factor loading. This clearly shows adequate convergent validity of the items for the OL construct.

There is no cross-loading and all items are consistent with the original dimension of the construct.

Table 4.10: Results of Exploratory Factor Analysis of OL

OL Construct	Individual KMO	Factor Loadings (PC)
(OL1)	0.82	0.90
(OL2)	0.83	0.89
(OL3)	0.87	0.86
(OL4)	0.87	0.86

(PC): Principal Component Analysis

4.3.2.4 Advanced Training Factor (TR)

Table 4.11 shows the degree of variance revealed by the EFA for the construct TR. One item is responsible for the majority of the variance (83.34%) in the construct. The other four items are responsible for the remaining variance of 16.66%.

Table 4.11: Results for the Extraction of TR Factor

Component's Items	Total	Eigenvalues % of Variance	Cumulative %
TR1	4.17	83.34	83.34
TR2	0.38	7.50	90.84
TR3	0.18	3.66	94.51
TR4	0.17	3.44	97.94
TR5	0.10	2.06	100

Extraction Method: Principal Component Analysis. See also Table 4.22 for details of each item.

Table 4.12 shows that the KMO value of each item of the construct TR is greater than 0.80 highlighting a very good sampling adequacy. The respective factor loadings are greater than 0.5 (indeed they range from 0.84 to 0.95) which shows that all items are consistent in terms of their factor loading so no item needs to be deleted from the construct as all falls well with each other to explain the construct. Hence, it shows the convergent validity of the construct.

Table 4.12: Results of Exploratory Factor Analysis of TR

TR Construct	Individual KMO	Factor Loadings (PC)
(TR1)	0.93	0.91
(TR2)	0.91	0.93
(TR3)	0.88	0.94
(TR4)	0.86	0.95
(TR5)	0.93	0.84

(PC): Principal Component Analysis

4.3.2.5 Innovative Climate Factor

Table 4.13 displays the degree of variance revealed by the EFA for the construct IC. Only that degree of variability is considered which has an eigenvalue greater than 1. One item explains the majority of the variance (78.69%) in the construct and the remaining variance is explained by the other four items. In other words, there is no need to divide the variable IC into several other factors.

Table 4.13: Results for the Extraction of IC Factor

Component's Items	Total	Eigenvalues % of Variance	Cumulative %
IC1	4.72	78.69	78.69
IC2	0.41	6.67	85.36
IC3	0.32	5.28	90.64
IC4	0.23	3.83	94.48
IC5	0.19	3.11	97.58
IC6	0.15	2.42	100

Extraction Method: Principal Component Analysis. See also Table 4.22 for details of each item.

Table 4.14 shows the items' KMO value and their corresponding factor loadings. The results indicate that the KMO of each item is greater than 0.80 which shows a very good sampling adequacy. Their respective factor loadings are greater than 0.5 (indeed they range from 0.83 to 0.91) which shows that all the items are consistent with the original dimension of the construct and that all items are consistent in terms of their factor loading. This clearly shows the convergent validity of the items for the IC construct. Hence, it proves the convergent validity of the construct.

Table 4.14: results of Exploratory Factor Analysis of IC

IC Construct	Individual KMO	Factor Loadings (PC)
(IC1)	0.93	0.83
(IC2)	0.94	0.88
(IC3)	0.90	0.90
(IC4)	0.91	0.91
(IC5)	0.88	0.90
(IC6)	0.90	0.89

(PC): Principal Component Analysis

4.3.2.6 Innovation Capability (ICAP) Factor

Table 4.15 displays the amount of variance determined by EFA for the ICAP construct. All items have eigenvalues greater than 1 and are therefore used as candidates for factor scrutiny. The analysis reveals that one item is responsible for the majority of variance (74.98%) in the ICAP factor while the other eight items are responsible for the remaining variance (25.02%).

Table 4.15: Results for the Extraction of ICAP

Component's Items	Total	Eigenvalues % of Variance	Cumulative %
ICAP1	6.75	74.98	74.98
ICAP2	0.68	7.59	82.57
ICAP3	0.35	3.88	86.45
ICAP4	0.31	3.41	89.86
ICAP5	0.25	2.78	92.65
ICAP6	0.21	2.34	94.98
ICAP7	0.18	1.97	96.94
ICAP8	0.17	1.86	98.80
ICAP9	0.11	1.19	100

Extraction Method: Principal Component Analysis. See also Table 4.22 for details of each item.

Table 4.16 displays the KMO value and respective factor loadings of ICAP items. The KMO value of each item is higher than the satisfactory limit of 0.8 highlighting a very good sampling adequacy. The factor loadings of the 9 items are also greater than 0.5 (ranging from 0.75 to 0.91) and show that all items are consistent in terms of their factor loading. The results demonstrate that all items are consistent with the original dimension of the construct and establish the convergent validity of the ICAP construct.

Table 4.16: Results of Exploratory Factor Analysis of ICAP

ICAP Construct	Individual KMO	Factor Loadings (PC)
(ICAP1)	0.93	0.75
(ICAP2)	0.95	0.89
(ICAP3)	0.92	0.85
(ICAP4)	0.92	0.91
(ICAP5)	0.93	0.90
(ICAP6)	0.94	0.90
(ICAP7)	0.95	0.87
(ICAP8)	0.94	0.88
(ICAP9)	0.96	0.83

(PC): Principal Component Analysis

4.3.2.7 Radical Innovation Factor (RADI)

Table 4.17 shows the amount of variance determined by EFA for the RADI construct. All items have an eigenvalue greater than 1. The analysis indicates that one item is responsible for a large percentage of the variance (75.64%) while the other three items are responsible for the remaining variance (24.36%).

Table 4.17: Results for the Extraction of RADI

Component's Items	Total	Eigenvalues % of Variance	Cumulative %
RADI1	3.03	75.64	75.64
RADI2	0.39	9.77	85.42
RADI3	0.34	8.37	93.79
RADI4	0.25	6.21	100

Extraction Method: Principal Component Analysis. See also Table 4.22 for details of each item.

Finally, Table 4.18 displays the KMO value of each item of the construct which is greater than 0.8 and the factor loadings are greater than 0.5 (ranging from 0.84 to 0.90). All items are consistent in terms of their factor loading. The results show that all items are highly correlated and demonstrate the convergent validity of the construct.

Table 4.18: Results of Exploratory Factor Analysis of RADI

Radical Innovation (RADI) Construct	Individual KMO	Factor Loadings (PC)
(RADI1)	0.87	0.84
(RADI2)	0.86	0.87
(RADI3)	0.80	0.90
(RADI4)	0.84	0.87

(PC): Principal Component Analysis

In summary, this section has examined the convergent validity of each construct used in this study. The analysis revealed that for all seven constructs, all items explained a given amount of variance greater than 0.5. Thus, the items that make up the measures of all seven constructs meet acceptable standards of construct validity for inclusion in the study. In the next section, we move on to report tests of the measures' discriminant validity.

4.3.3 Exploratory Factor Analysis: Seven-Factor Solution

To determine the discriminant validity of the constructs, that is, whether the items of a given construct are unique from each other, we need to perform EFA with a seven-factor solution. To assess the discriminant validity of the seven constructs with an all items scale (40 items), we loaded all the items into the software program SPSS version 24. Table 4.19 shows that the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy value is 0.97 which shows that the sample is highly suitable for seven factors EFA to be conducted. Bartlett's Test of Sphericity was also applied, and it has a p-value = 0.00 with a given chi-square value of 12359.667 and a degree of freedom of 946. As the p-value of Bartlett's test is significant, showing that there is some correlation among items of the different constructs. This draws attention to the discriminant validity of the constructs. To assess it further, a principle component analysis was conducted by undertaking a varimax rotation with Kaiser Normalisation.

Table 4.19: KMO Measure of Sampling Accuracy and Bartlett's Test of Sphericity

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.97
	Approx. Chi-Square	12359.667
Bartlett's Test of Sphericity	df	946
	Sig.	0.00

The output of EFA analysis of the seven factors is presented in Table 4.20. The results show that only five factors had eigenvalues of greater than 1.0, while two factors had eigenvalues of less than 1.0. Further, it can be noted that the first factor TL was responsible for the greatest proportion of variance, accounting for 59.24%, while factors 2, 3, 4 and 5 (TECH, OL, TR, IC respectively) were responsible for a total of 15.81% of the variance.

The EFA results for the remaining two factors (namely ICAP and RADI) — eigenvalues of less than 1 — indicate problems in relation to those constructs' discriminant validity. Such a result suggests that items of a given construct are not unique from each other; instead they are highly correlated with each other which threaten their unique ability to measure a specific construct. Researchers (Child 1990; Yong 2013) suggest that EFA can only be used when one aims to determine the dimensions within a given construct, whereas here in the Seven Factor Solution, all items utilised within the seven constructs rather than items within an individual construct are being measured.

The basic limitation of Principle Component Analysis (PCA) in EFA is that it may not work well with a large number of items. For the EFA analysis for the Seven Factor Solution there were 44 items. While EFA can sometimes be appropriate for models having constructs with an overall 30 items, for models having items totalling over 30, EFA may lack an ability to provide the correct information about item uniqueness (Snook & Gorsuch 1989). It neither suggests the true structure behind the observable items nor is it good for theory driven research (Overall 1964). Instead, it starts to give misleading results as may have occurred here (for example, 59.24% variance explained by TL: Table 4.20 below).

Some argue that EFA's inadequacy stems from it being a data driven method whereas CFA is a theory driven method (Hurley et al. 1997). CFA's focus in testing is whether the given dataset is suitable for testing the hypothesis of a given model. It also reveals whether the items converge in regard to their respective construct as well as being unique from the items of the other constructs by maintaining their discriminant validity.

The sources of total variance are presented in Table 4.20. As can be clearly seen, the variance for the first factor exceeded the recommended 50% level. This showed the presence of bias and our need to undertake CFA (see further below) as had been earlier anticipated.

Table 4.20: Total Variance Explained - All Items

Factor	Eigenvalue	% of Variance Explained	Cumulative %
TL	26.06	59.24	59.24
OL	2.3	5.24	64.49
TECH	2	4.56	69.04
TR	1.4	3.18	72.22
IC	1.25	2.83	75.05
ICAP	0.85	1.91	76.96
RADI	0.71	1.69	78.58

Extraction Method: Principal Component Analysis

4.4 Common Method Variance (Bias)

Common Method Variance (CMV) mostly occurs as a false correlation between the independent and dependent variables of a model. The major source of CMV is a researcher using a common data collection method (whether survey or interview) to gather material (Buckley, Cote & Comstock 1990; Lindell & Whitney 2001; Podsakoff et al. 2003). Using the same approach to collect a research study's entire data contributes to systematic error and a high proportion of variance (Podsakoff et al. 2003), generates misleading results by 'inflating or deflating findings' (Craighead et al. 2011) and provides misleading information to the researcher. Once there is an indication of CMV in the collected data, this can lead to a fear that the research findings are biased (Pace 2010). Researchers believe that CMV can reduce the reliability and validity of the results to a greater or lesser extent and thus pose a major threat to the research findings (Chang et al. 2010; MacKenzie & Podsakoff 2012).

Because this study involved data collection from a single source and method for all variables (online questionnaire), CMV was considered a potential concern in this study (Avolio et al. 1991) so several actions were undertaken to prevent the risk of CMV and to detect evidence of CMV in the data. Most notably, instruments from past research were obtained and the items modified to fit the current study (e.g., Choi et al. 2011; Scott and Bruce 1994; Chang et al. 2012). Further, these modifications were reviewed by several participants as well as refined through a pilot study to remove any possibility of ambiguity or confusing questions. Nevertheless, the results of EFA indicated the existence of CMV in the data. As shown in Table 4.20, the variance explained by the first factor is 59.24%, above the maximum limit of the first fixed factor of less than 50% that is generally indicative of a lower probability of CMV (Podsakoff et al. 2003; MacKenzie & Podsakoff 2012). Craighead et al (2011) suggest that it is better to address common method bias in the research for the sake of protecting the findings from contaminated data. It has been proposed that there are two main ways to control CMV, namely procedural remedies and statistical remedies (Podsakoff et al. 2003; Podsakoff, MacKenzie & Podsakoff 2012). This study embraces a statistical remedy: Confirmatory Factor Analysis (CFA). This was selected because CFA can control the severity of CMV in this study. The statistical method utilised to control common method bias in this study is presented in the sections below.

4.5 Confirmatory Factor Analysis (CFA)

Confirmatory Factor Analysis (CFA) is a statistical method used to observe the relationship between observed variables and their latent constructs. CFA encourages researchers to test the hypothesis and find whether there is a relationship between the observed variables and their latent variables in a given model. CFA is a theory driven approach and is useful when a researcher has crafted a clear hypothesis related to the measuring scale, such as its number of dimensions, the link between items and the kind of association between the various factors (Maul 2013). CFA is used to assess the 'measurement hypothesis' related to the internal consistency of the scale items. In short, CFA allows the researcher to determine the consistency between actual data generated from respondents and its respective measurement hypothesis. CFA allows researchers to have an insight into parameter estimates, modification indices and fit indices so that the researchers are able to discover how well the measurement hypothesis suits the actual structure of the participants' responses on the given scale. Apart from that, CFA also supports researchers in their consideration of several measurement hypotheses to determine which measurement hypothesis will be more stable in terms of the collected data. In other words, CFA is used for theory testing, theory development and theory comparison purposes (Hair et al. 2010).

Researchers need to conduct validity and reliability tests of the data for the sake of conducting research across various populations. Unlike other statistical techniques which require many steps to determine the validity and reliability of the data, CFA permits researchers to calculate the validity and reliability of the data more simply as well as test the measurement hypothesis (Maul 2013).

Most scholars consider CFA as a method superior to EFA but in reality, both methods have their own advantages and disadvantages. Whereas all the factor loadings and item loadings on various factors are ascertained after performing EFA, in prototypical CFA applications the factor structure is already hypothesised before conducting the analysis. In CFA, the items are already selected to indicate which factor they supposed to load (in diagrammatical representations this is often illustrated using arrows) (Hoyle 2000). Having explored the fundamental foundation of the study, and the dynamics within the data, the researcher proceeded to perform CFA to control the CMV.

As identified in the EFA, the first factor alone explains 59.24% of the variance while four other factors (each with an eigenvalue greater than 1) together explain 15.80 % of the total variation. Therefore, it was decided to introduce a common latent factor (CLF) to the CFA model to minimise the impact of common method bias and to assess its potential influence on the findings of this study.

To eliminate the bias, the researcher performed the most current and best approach for this procedure, namely the zero-constraint test which includes the CLF, and a Marker if available, and then conducting a chi-square difference test between the two models (1) unconstrained model and (2) a constrained model where all paths from the CLF are constrained to zero (Gaskin 2016). Comparing the change in fit of the first model where the marker construct-substantive item loadings are freely estimated to one in which they are constrained to zero is posited as a statistical test for detecting CMV (Richardson et al. 2009, p. 768). This approach tests whether the amount of shared variance across all variables is significantly different from zero. If it is, then we conclude that method bias does exist in our measures (Gaskin 2016).

Table 4.21 provides the Chi square difference test for the two models. As it shows, the unconstrained model reported an approximate Chi-square value of 1012.725 with 441 degrees of freedom (p=0.000). The Zero-constrained model reported an approximate Chi-square value of 1210.093 with 474 degrees of freedom (p=0.000). So, based on the χ^2 difference test between the models where was 197.368 with 33 degrees of freedom (p= 0.000). Although the chi-square statistics were statistically significant, this is not unusual with large sample sizes (Bagozzi, Yi & Phillips 1991). The CFI exceeded the recommended cut-off value of 0.90 (Bentler 1990). The values of the Root Mean Square Error of Approximation (RMSEA) were either close to or below the value of 0.08 recommended by Browne and Cudeck (1993). And the normed chi-square values (χ^2/df) were all less than 3. According to Chi square difference test, the common method bias has been controlled through the unconstrained model.

Table 4.21: The Results of Unconstrained and Zero- Constrained Model

Model ID	Description	Chi-square value	df	p-value	Sample size
1	Unconstrained model	1012.725	441	0.00	237
2	Zero-constrained model	1210.093	474	0.00	237
	Chi-square difference	197.368	33	0.00	

In the unconstrained model, the researcher removed eight items that did not appreciably load on any factor or loaded highly (above 0.70) on more than one factor. The removed items are: one item from OL, one item from TECH, one item from IC, two items from ICAP and one item from RADI. Thus, a seven-factor solution was derived from a total of 37 items loading which was considerably beyond the conservative cut-off level of 0.7. The preceding analysis shows all the 7 dimensions and their respective factor variables. According to Ghadi (2012), Hair et al. (2010), Jayasinghe-Mudalige (2012), Harun (2016) and Malik (2016), convergent validity is met when the factor loadings between the constructs and the items is greater than or equal to 0.5. In the preceding illustration, all the linkages were significantly greater than 0.5. This finding attests to the presence of significant convergent validity within each and every construct. This finding has been augmented earlier, with the presence of high reliability scores within each of the 7 constructs. The statistical fit of the overall model shows adequate model fit across all measures (i.e. χ^2/df= 2.29, goodness-of-fit index (GFI) = 0.907; adjusted goodness-of-fit index (AGFI) = 0.755, Normalised Fit Index (NFI) = 0.979, Non-Normalised Fit Index (NNFI) = 0.986, Comparative Fit Index [CFI] = 0.988, Root Mean Square Error of Approximation (RMSEA) = 0.0702). Therefore, the CFA results show that indicators loaded significantly on their respective constructs provided sufficient evidence of good model fit and did not need more improvement. Figure 4.1 illustrates the path diagram with estimated path coefficients (maximum likelihood estimates) of the tested model by using AMOS version 24.

Table 4.22 Results of Confirmatory Factor Analysis that follows Figure 4.1 provides the details of items for each construct, such items being referred to in Tables 4.5, 4.7, 4.9, 4.11, 4.13, 4.15 and 4.17 above).

Figure 4.1: Path Diagram with Estimated Path Coefficients (Maximum Likelihood Estimates)

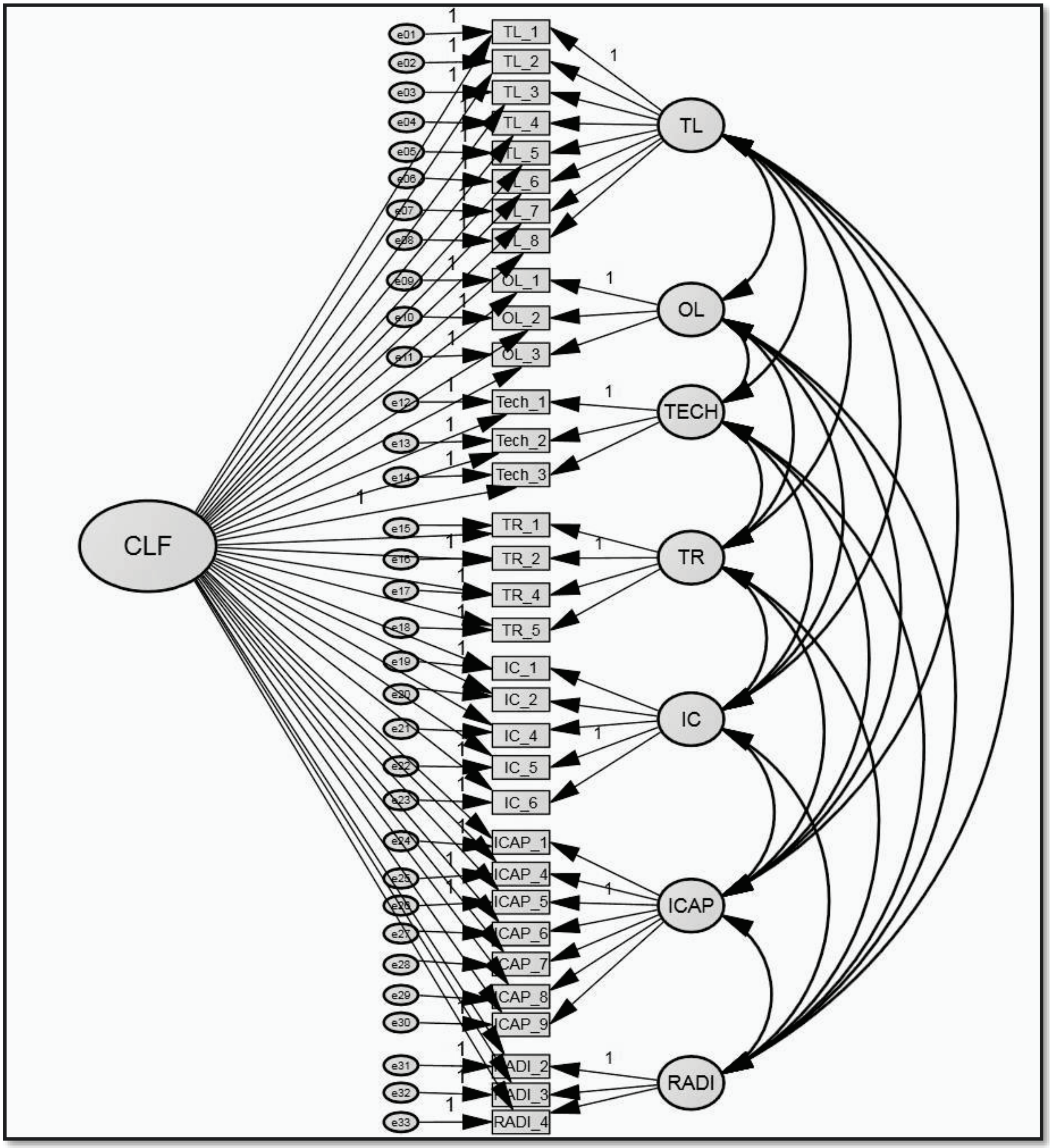


Table 4.22: Results of Confirmatory Factor Analysis

Factor Constructs	Item Scales	Factor Loadings (ML)*
Factor 1 Transformational Leadership (TL)	**TL1**. My leader articulates a vision of innovation for our firm.	**0.836**
	TL2. My leader has a clear sense of where he wants us to be in the future.	**0.801**
	TL3. My leader encourages new initiatives.	**0.820**
	TL4. My leader gives clear feedback on new innovative ideas.	**0.867**
	TL5. My leader pays explicit attention to innovation and its role in future development.	**0.875**
	TL6. My leader supports innovation by ensuring that structure, processes and other organisational mechanisms support the innovation teams.	**0.873**
	TL7. My leader supports innovation by making sure that available resources flow smoothly to innovation projects.	**0.879**
	TL8. My leader makes long-term investments in technology, manufacturing, etc., to support ongoing innovation.	**0.866**
Factor 2 Advanced Technology (TECH)	**TECH1**. We use sophisticated technologies in our new product development.	**0.832**
	TECH2. Our new products always involve state-of-the-art technology.	**0.856**
	TECH3. We actively solicit and develop technologically advanced new products.	**0.900**
Factor 3 Organisational Learning (OL)	**OL1**. Our organisation has acquired and shared much new and relevant knowledge that provided competitive advantage.	**0.840**
	OL2. Our organisation's members have acquired some critical capacities and skills that provided competitive advantage.	**0.871**
	OL3. Organisational improvements have been influenced fundamentally by new knowledge entering the organisation (knowledge used).	**0.815**
Factor 4 Advanced Training (TR)	**TR1**. Employees were given enough information during the training for the innovation.	**0.893**
	TR2. The training for the innovation was given to employees throughout the organisation.	**0.914**
	TR4. The training employees received related to the innovation was adequate.	**0.937**
	TR5. Our company provides sufficient overseas training programmes for the innovation such as conferences or seminars.	**0.778**

Factor 5 Innovative Climate (IC)	**IC1**. Leadership trusts people to take work-related decisions without getting permission first.	**0.777**
	IC2. The reward system in our organisation encourages innovation.	**0.856**
	IC4. Assistance in developing new ideas is readily available.	**0.892**
	IC5. There are adequate resources devoted to innovation in our organisation.	**0.902**
	IC6. There is adequate time available to pursue creative ideas.	**0.869**
Factor 6 Innovation Capability (ICAP)	**ICAP1**. We participate in industrial networks such as industrial associations, standard organisations and industrial forums.	**0.661**
	ICAP4. We apply the knowledge gained in previous projects to new projects.	**0.911**
	ICAP5. We encourage cross-functional learning and fertilisation.	**0.879**
	ICAP6. We upgrade and integrate our technology capabilities, new product development and marketing.	**0.907**
	ICAP7. We usually adopt new ideas and develop them as reliable products.	**0.885**
	ICAP8. We develop methods and tools, to improve R&D.	**0.860**
	ICAP9. We commercialise proven concepts into market.	**0.810**
Factor 7 Radical Innovation (RADI)	**RADI 2**. We are well known by our customers for radical product innovations.	**0.789**
	RADI 3. The number of radical product innovations introduced to the market by your company rose in the last three years.	**0.887**
	RADI 4. Compared with our competitors, our products are based on a significantly different technological solution.	**0.836**

* Maximum Likelihood Estimates (ML)

4.6 Composite Reliability and Average Variance Extracted

Composite Reliability (CR) measures the overall reliability of the collection of items in each factor whereas Average Variance Extracted (AVE) measures the amount of variance captured by the model in relation to the amount of variance due to measurement error and tests the convergent validity of the model. The discriminant validity of the model is assessed by comparing the AVE with the highest shared variance. However, highest shared variances are obtained by squaring the highest correlation.

CR can be described as the total amount of true score variance related to the total scale score variance. CR can be obtained through combining all of the true score variances and covariances in the composite of indicator variables linked to the constructs, and by dividing the sum by the total variance in the composite (Larker 1981). CR can be viewed as a preferable option because of its ability to draw on the standardised regression weights and measurement relationship errors for each item. Cronbach's alpha is used to assess the internal consistency of the items whereas CR can be computed by using CFA. According to Fornell and Larker (1981), the value of CR should be greater than 0.7 for signifying the internal consistency of the items.

Average Variance Extracted (AVE) is used to assess convergent validity. Fornell and Larker (1981) define AVE as a way to assess shared variance in latent variable. It is the degree of variance that is assessed by the latent variable in relation to the degree of variance due to its measurement error (Dillon and Goldstein 1984). In short, AVE is the amount of variance which shows how different items converge in a particular construct. AVE assesses the average amount of variance that a latent construct is able to explain in its respective observed variables which are theoretically tied to that particular construct. The latent construct correlates with these related observed variables and this correlation is known as the 'factor loading'. After taking the square of each factor loading, the figures produced are used to provide the shared variance. The AVE can be computed when this shared variance is averaged across all the observed variables which are theoretically linked to that latent variable (Farrell & Rudd 2009). Fornell and Larker (1981) suggested that to assure adequate convergent validity presence, the value of AVE should not be less than 0.5.

The following three tables provide CR and AVE measures for each of the seven factors used in the data analysis, the correlation matrix of factors, and highest shared variances respectively. According to the construct reliability measures, since they all are greater than 0.7, it can be concluded that there is acceptable reliability in all factors. Further, the AVE of each factor exceeds 0.5, providing evidence for good convergent validity (see Table 4.23). With regard to the aspect of discriminant validity, Harun (2016) and Hair et al (2010) suggest that the covariances between each of the constructs should never be greater than 0.8. In the preceding analysis, the finding attests to the presence of significant discriminant validity within each and every construct for all factors.

Table 4.23: The Results of the Discriminant Validity Test between the Constructs

Construct	CR	AVE
TL	0.96	0.73
TECH	0.89	0.75
OL	0.88	0.71
TR	0.93	0.78
IC	0.93	0.74
ICAP	0.95	0.72
RADI	0.88	0.70

VALIDITY CONCERNS
Discriminant Validity: the square root of the AVE for a construct is less than the absolute value of the correlations with another construct.

According to the correlations matrix outputs as shown in Table 4.24, all the correlations were very significant, at p=0.000 < 0.05. A shown in Table 4.24, the correlation between TL and TR is 0.529, OL with ICAP is 0.619, TECH with TR is 0.583, TR with IC is 0.807, IC with TR is 0.807, ICAP with TR is 0.707 and RADI with ICAP is 0.620. It is evident from the table of correlation matrix (Table 4.24) that the correlation between TR and IC and between TR and ICAP is 0.707 and 0.807 respectively.

According to the research of Fidell et al. (1996), if the correlations between the independent variables are equal to or greater than 0.7, then this is a sign of multicollinearity in the data which may contaminate the research findings. Multicollinearity is the presence of a high correlation between exogenous variables that no longer behave as an independent variable in the model. Multicollinearity also depends on the size of the sample. The smaller the size of the sample, the lower will be the cut-off value of correlation as an indication for multicollinearity.

On the other hand, Brown (2006) suggested a correlation value of 0.85 or greater may pose a threat to the construct discriminant validity. According to Hair et al. (2013), if there is an increase in correlation to 0.9 or higher, there is a need to be concerned about the possible presence of multicollinearity in the data. It is suggested that the respective variable be deleted for the sake of avoiding multicollinearity but in CFA where all variables fit well on the measurement model and the values of correlation also are within the prescribed range (Hair et al. 2013), there is no need to delete any variable or there is no sign of multicollinearity in the research model. Table 4.25 displays the highest shared variance of each construct.

Table 4.24: The Correlation between the Factors

	TL	OL	TECH	TR	IC	ICAP	RADI
TL	1						
OL	0.44**	1					
TECH	0.08	0.47	1				
TR	0.52**	0.59	0.58	1			
IC	0.50**	0.61	0.51	0.80	1		
ICAP	0.44**	0.61	0.58	0.70	0.69	1	
RADI	0.28**	0.27	0.24	0.48	0.38	0.62	1

*if r > 0.12 & **if r > 0.16

Table 4.25: Highest Shared Variance of the constructs

Factor	Highest shared variance
TL	0.27
TECH	0.34
OL	0.38
TR	0.65
IC	0.65
ICAP	0.50
RADI	0.38

Table 4.26 summarises the results of factor analysis of all constructs. The results indicate that all minimum requirements were met, therefore confirming the quality of our measurement.

Table 4.26: The Summary results of Factor Analysis

Constructs	Items	Factors Loading	ITC	Constructs	Items	Factors Loading	ITC
Transformational Leadership	TL1	0.836	0.825	**Innovative Climate**	IC1	0.777	0.740
CR=0.955	TL2	0.801	0.790	CR=0.934	IC2	0.856	0.816
Alpha=0.955	TL3	0.820	0.810	Alpha=0.931	IC4	0.892	0.848
AVE=0.727	TL4	0.867	0.845	AVE=0.740	IC5	0.902	0.861
	TL5	0.875	0.856		IC6	0.869	0.841
	TL6	0.873	0.847				
	TL7	0.879	0.848				
	TL8	0.866	0.828	**Innovation Capability**	ICAP1	0.661	0.649
				CR=0.947	ICAP4	0.911	0.890
Advanced Technology	TECH1	0.832	0.768	Alpha=0.946	ICAP5	0.879	0.855
CR=0.897	TECH2	0.856	0.785	AVE=0.720	ICAP6	0.907	0.876
Alpha=0.878	TECH4	0.900	0.743		ICAP7	0.885	0.837
AVE=0.745					ICAP8	0.860	0.836
					ICAP9	0.810	0.790
Organisational Learning	OL1	0.840	0.786				
CR=0.880	OL2	0.871	0.778				
Alpha=0.90	OL3	0.815	0.733	**Radical Innovation**			
AVE=0.709				CR=0.876	RADI2	0.789	0.739
				Alpha=0.875	RADI3	0.887	0.789
				AVE=0.703	RADI4	0.836	0.756
Advanced Training	TR1	0.893	0.832				
CR=0.933	TR2	0.914	0.883				
Alpha=0.929	TR4	0.937	0.887				
AVE=0.779	TR5	0.778	0.743				

CR: Composite Reliability; Alpha: Cronbach's alpha; AVE: Averaged Variance Extracted; ITC: Item-Total Correlation.

4.7 Descriptive Analysis – Mean Ratings

The ratings were based on a 7-point Likert scale, that is, with a minimum expected score of 1 and a maximum of 7. In this regard, the median score would be the half of the sum of the minimum and maximum scores, and thus 4.0. From the results (as shown in Table 4.27), it can be observed that all the constructs had a mean score above 4.0, suggesting a somewhat favourable positive response. As shown in Table 4.27, the descriptive statistics of the variables provide their mean, standard deviation and their corresponding correlations. The table indicates that the highest mean among all the variables is TL (5.41) and the standard deviation of this particular variable is higher among the rest of the variables. The table also shows that there is a highest significant correlation between IC and OL (r = 0.62; $p < 0.01$) as well as between TECH and TL (r = 0.09, $P < 0.05$). Apart from this, all other correlations between variables TL, TECH, OL, TR, IC, ICAP and RADI are significant. Among industry variables (industry 1, industry 2, industry 3 and industry 4), the highest correlation is between industry 1 and industry 4 (r = -0.49, $P < 0.01$). As the p-value is less than 0.01 so it indicates that the correlation between industry 1 (Petrochemical) and industry 4 (Pharmaceutical) is significant. The negative sign shows the direction of the correlation, and it shows that there is an indirect association between industry 1 and industry 4 variables. All the results of correlation provide sufficient support for all hypotheses in the testing model.

Table 4:27: Descriptive Statistics and Correlations Matrix (N=237)

	Variables	Mean	s.d.	TL	OL	TECH	TR	IC	ICAP	RADI	Indus. 1	Indus. 2	Indus. 3	Indus. 4	Size
1	**TL**	5.41	1.15	1											
2	**OL**	5.2	1.1	0.45**	1										
3	**TECH**	5.17	1.14	0.09	0.47**	1									
4	**TR**	5.08	1.38	0.53**	0.60**	0.58**	1								
5	**IC**	5.06	1.25	0.50**	0.61**	0.52**	0.81**	1							
6	**ICAP**	5.11	1.11	0.45**	0.62**	0.58**	0.71**	0.70**	1						
7	**RADI**	4.83	1.12	0.29**	0.28**	0.24**	0.49**	0.39**	0.62**	1					
8	**Industry 1**	0.13	0.34	0.1	0.1	0.11	0.13*	0.1	0.12	0.13*	1				
9	**Industry 2**	0.32	0.47	0.03	0.06	-0.03	-0.01	0.07	0.1	-0.04	-0.27**	1			
10	**Industry 3**	0.16	0.36	0.06	-0.05	-0.09	0.02	0.002	-0.13*	-0.18	-0.17**	-0.29**	1		
11	**Industry 4**	0.34	0.48	-0.11	-0.06	0.05	-0.007	-0.13*	-0.13*	-0.03	-0.23**	-0.49**	-0.31**	1	
12	**Organisation size**	46.85	48.8	0.05	0.12	0.08	0.09	0.14*	0.24**	0.09	0.26**	0.63**	-0.36**	-0.53**	1

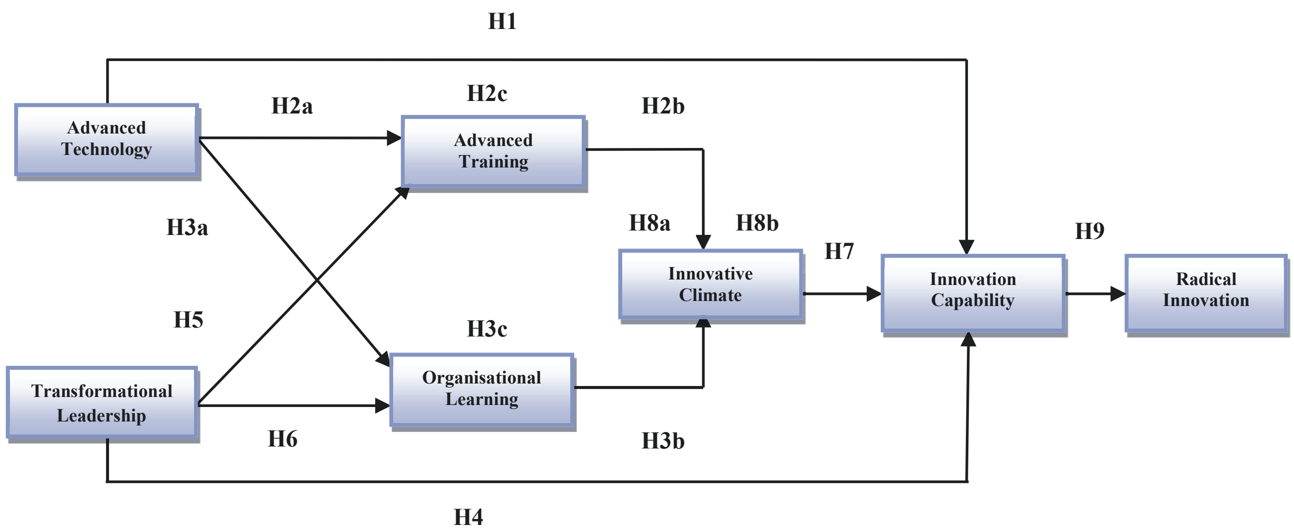
*if r > 0.12 & **if r > 0.16

Note: **TL**= Transformational Leadership, **TECH**= Advanced Technology, **TR**= Advance Training, **OL**= Organisational Learning, **IC**= Innovative Climate, **ICAP**= Innovative Capability, **RADI**= Radical Innovation.

4.8 Hypotheses Testing and Model Fit via Structural Equation Modelling

Having substantiated the need to sustain the covariates as independent constructs, the researcher developed the path diagram/model in SPSS AMOS and the resultant model, which resembles the conceptual framework, is presented in Figure 4.2 below.

Figure 4.2: SEM Path Diagram: Testing the Proposed Model of the Development of Radical Innovation in Large Firms



4.8.1 The Model Fit Testing Via Structural Equation Modeling

EFA and CFA were both used previously to determine whether the data fits the model well. For validating the model, it is essential to test the model variables by using Structural Equation Modelling (SEM). SEM is basically used to simultaneously test the variables and is used for creating a model as well as for path analysis (Byrne 2010). In this research, the use of SEM is suitable for determining multiple associations among variables as it combines observed and latent constructs associations. Apart from that, it also detects the measurement error for the given latent constructs (Medsker et al. 1994). With the aim of testing a theoretical hypothesised model, SEM also is able to determine interrelationships between the constructs. As per the study of Schumacker and Lomax (2004), the basic aim of SEM model is not only to test the hypothesis but to also determine to what extent the data sample substantiates the theoretical and structural model. If the sample data fits well, then SEM allows the researcher to test the relationships among variables; but if it does not fit well, then the researcher may have to modify their theory. This may in turn provide a foundation for theory re-development. SEM allows the researcher to clearly conceptualise (and absorb) theoretical concepts and results by visually presenting the relationship among the variables in a pictorial or graphic form. To conduct SEM analysis, AMOS version 24 was deployed. SEM allows the researcher to test relationships among several variables simultaneously (revealing data consistency) and to construct a measurement model which utilises the observed variables to postulate other numeric variables in a complex relationship framework.

4.8.2 Assessment Indexes

Model building is based on model building assumptions, and with many measurement models available (Hair et al. 1998), it is not always an easy task to determine model fit. Defining SEM model fit in structural equation modelling and multiple regression is also more complicated than for other calculations (such as discriminant analysis, variance). As per the study of Schumacker and Lomax (2004), unlike other models where a single statistical value determines whether the model is a good fit for testing path analysis, SEM focuses on multiple values which alone may not predict the accuracy of the model but in combination they are able to do so. In line with Schumacker and Lomax (2004) and Kline (2005), this study uses a number of criteria, in this instance nine model fit criteria, to determine the overall model fitness for use for measurement and structural analysis.

1. Chi-square (χ^2)

Chi-square test statistic (χ^2) comes under the category of absolute-fit index (Hair et al. 1998) and it is also reported along with the value of degrees of freedom (df) and its probability (p). Chi-square is the sole model fit measure which has a related statistical test of significance (Jöreskog & Sörbom 1993). Chi-square is very sensitive to sample size (Kelloway 1998). According to the study by Anderson and Gerbing (1988), the chi-square value is inaccurate for sample sizes of less than 100 and greater than 1000 observations. This clearly shows that a chi-square calculation for this survey (with its sample size of 237) is likely to be accurate. While one cannot solely reject a model by focusing on the value of chi-square as it is also sensitive to multivariate normality (Jöreskog & Sörbom 1996) and model complexity (Kirchmajer, 2011), when all these abovementioned matters are within the recommended parameters (as in this particular study) then a small chi-square statistic value with respect to its degree of freedom would indicate a good fit whereas a large chi-square statistic value with respect to the degrees of freedom would indicate a very poor fit (Jöreskog & Sörbom 1996; Holmes-Smith 2001; Kirchmajer 2011).

2. Normed Chi-square (χ^2/df)

As mentioned earlier, chi-square is sensitive to sample size and model complexity. More complex models are likely to generate a larger chi-square value which could result in the rejection of the theorised model. The use of a 'normed' chi-square is posited as a way to solve this difficulty. A normed chi-square measure is reached by dividing the chi-square measure (χ^2) by the degree of freedom (df) for the model (Hair et al. 1998; Holmes-Smith 2001). The normed chi-square takes model complexity into account. It also measures model parsimony (Holmes-Smith 2001). While there is no universally accepted value guideline, a value of between 1 and 2 is considered to indicate a good fit for the model, values between 2.00 and 3.00 a reasonable fit, and values of less than 1 a very poor fit (Holmes-Smith 2001).

3. Goodness-of-Fit Index (GFI)

GFI is also somewhat sample size sensitive as larger samples tend to raise GFI values. GFI is not intended to measure percent of error in a model but it is used to measure percent of observed covariances explained by the model's covariances. It often compared to R-square but R-square is intended to measure error in a model and GFI measures error in replicating the variance-covariance matrix. The greater the GFI, the greater the chances of the acceptability of the model based on its 'goodness of fit'. Researchers (Jöreskog & Sörbom 1996; Hair et al. 1998; Huang et al. 2013) indicate that a GFI equal to or exceeding 0.9 is good. While some researchers have suggested that lower values do not necessarily mean a poor fit (Zigmund 2003), such a view is not shared by the majority.

4. Adjusted Goodness-of-Fit Index (AGFI)

The Adjusted Goodness of Fit Index (AGFI) is the ratio of the model's degree of freedom to the total degree of freedom available. Researchers (Holmes-Smith 2001; Byrne 2010) argue that an AGFI value of 0.95 or greater indicates a good model fit; but several other researchers (Hair et al. 1998; Hulland et al. 1996; Zulkiffli 2011; Bagur-Femenias et al. 2013) have suggested that an AGFI value greater than 0.8 is a reasonable fit.

5. Root Mean Square Residual (RMR)

The Root Mean Square Residual (RMR) value is the figure produced by fitting the variance-covariance matrix of the hypothesised model to the sample data's variance-covariance matrix. As the errors are related to observed variances and covariances (and their scope and scale), they are not easy to calculate. Use of the correlation matrix metric is therefore recommended. The greater the value of RMR, the less the model fit. Researchers claim that an RMR value of less than or equal to 0.05 indicates a good fit (Zulkiffli 2011) while an RMR value of 0.08 is still considered acceptable (Hu and Bentler 1999).

6. Root-Mean-Square Error of Approximation (RMSEA)

The Root Mean Square Error of Approximation (RMSEA) measures the incongruity per degree of freedom for the model (and takes into account the error of approximation in the population) (Browne & Cudeck 1993). An RMSEA value of less than or equal to 0.05 indicates a good fit (Hulland et al. 1996; Byrne 2010; Schumacker & Lomax 2004). An RMSEA value between 0.05 and 0.08 indicates an acceptable fit (Rigdon 1996). An RMSEA greater than or equal to 0.1 shows a very poor fit (Byrne 2010). Table 4.32 shows a summary of the aforementioned model fit indices thresholds.

7. The Comparative Fit Index (CFI)

The CFI is also known as the Bentler Comparative Fit Index (CFI) and it aims to compare the null model (which assumes a model's latent variables are unrelated) with the documented covariance matrix, and the predicted with observed covariances. It basically measures the shift of the null model from the SEM model. CFI values range from 0 to 1, with a CFI value near to 1 indicating a very good fit (Hulland et al. 1996); a CFI value of greater than 0.95 a good fit, a CFI value of greater than 0.9 a satisfactory fit and a CFI value of 0.8 to 0.9 an acceptable model fit (Hair et al. 1998).

8. The Norm Fit Index (NFI)

The norm fit index (NFI) of a model is an index that does not require chi-square assumptions. The NFI value indicates the extent to which the documented model improves fit as compared to the null model. For example, an NFI of 0.95 shows that the researcher's model improves fit by 95% in comparison to the null model. NFI values range from 0 to 1, with a value of 1 indicating a perfect fit, an NFI value of greater than 0.95 a very good fit (Hair et al. 1998), an NFI value greater than 0.9 a good fit, and NFI values in the range of 0.8 to 0.9 an acceptable fit (Baumgartner and Homburg 1996).

9. The Incremental Fit Index (IFI)

The Incremental Fit Index (IFI) was developed by Bollen (1990) to deal with the issues of sample size and parsimony. It is computed exactly as NFI is computed but here degrees of freedom are taken into account. An IFI value of near to or equal to 1 indicates a good model fit (Fan et al. 1999). The closer the value of IFI is to 1, the greater the model fit. Table 4.28 shows a summary of the aforementioned model fit indices thresholds.

Table 4.28: Model Fit Assessment Indices

Indices	Recommended Value	References
Absolute Fit Indices		
Goodness of Fit Index- **GFI**	GFI > .95 is good fit .85 < GFI < .95 is acceptable fit	(Schumacker & Lomax 2004)
Root Mean Square Residual- **RMR**	RMR < .05 is good .05 < RMR < .10 is acceptable fit	(Hair et al. 2010; Schumacker & Lomax 2004)
Adjusted Goodness of Fit- **AGFI**	Closer to 1 is good fit AGFI > .8 is acceptable	(Byrne 2013)
Root Means Square Error of Approximation- **RMSEA**	RMSEA < .05 is good .05 < RMSEA < .10 is acceptable fit	(Byrne 2013; Gaskin 2014; Schumacker & Lomax 2004)
Incremental Fit Indices		
Normed Fit Index- **NFI**	NFI > .95 is good fit .9 < NFI < .95 is acceptable	(Byrne 2013; Schumacker & Lomax 2004)
Comparative Fit Index- **CFI**	CFI >.95 is good fit .9 < CFI < .95 is acceptable	(Byrne 2013; Schumacker & Lomax 2004)
Average Variance Extracted - **AVE**	AVE > .5 is acceptable	(Fornell & Larcker 1981)
Non- Normed Fit Index-**NNFI**	NNFI > .95 is good fit .9 < NNFI < .95 is acceptable	(Byrne 2013; Schumacker & Lomax 2004)

The above measures assist the researcher to comprehensively evaluate the validity of the measurement model and determine that a model either has good fit or a poor fit.

4.8.3 Assessment of Overall Model Fit

The hypotheses of the current study were analysed with using SEM AMOS with the maximum likelihood evaluation to determine the data-model fit and validate the hypothesised relationships between theoretical constructs. The overall SEM findings indicate that the hypothesised model was a good fit for the data and achieved a good fit. The chi-square goodness and degrees of freedom values were χ^2 = 85.258, df = 29, p = 0.000 indicating a good fit. Although the chi-square statistics were statistically significant, this is not unusual with large sample sizes (Bagozzi, Yi & Phillips 1991). The comparative-fit index (CFI) of all hypothesised relationships implied in the overall model exceeded the recommended cut-off value of 0.90 (Bentler 1990). The values of the root mean square error of approximation (RMSEA) were either close to or below the value of 0.08 recommended by Browne and Cudeck (1993). And the normed chi-square values (χ^2/df) were all less than 3. All the structural model measures of fit represent sound fit statistics with all goodness-of-fit indices in the desirable ranges: goodness-of-fit index (GFI) = 0.94, adjusted goodness-of-fit index (AGFI) = 0.86, comparative fit index (CFI) = 0.96, root mean square residual (RMR) = 0.03, normed fit index (NFI) = 0.95, non-normalised fit index (NNFI) = 0.92, incremental fit index (IFI) = 0.963, and root mean square error of approximation (RMSEA) = 0.07. Overall, the fit statistics indicating a good fit and suggest the model of this study fits the data well. Table 4.29 illustrates the summary statistics of model fit.

Table 4.29: Summary Statistics of Model Fit

	Fit Index	Acceptable Level	Model Fit Result	Fit Status
1	**χ2/df**	≤ 3.00	2.93	Fit
2	**GFI**	≥ 0.90	0.94	Fit
3	**AGFI**	> 0.80	0.86	Fit
4	**RMR**	≤ 0.05	0.03	Fit
5	**CFI**	≥ 0.80	0.92	Fit
6	**NFI**	≥ 0.80	0.95	Fit
7	**IFI**	≥ 0.90	0,96	Fit
8	**RMSEA**	≤ 0.10	0.07	Fit
9	**NNFI**	≥ 0.90	0.92	Fit

4.9 Mediation Analysis and Findings

The hypotheses pertain to the direct effect between two relevant constructs. However, the conceptual model also implies a number of indirect effects, which will be tested and discussed in this section.

Sobel and Michael's (1982) z-test has been the traditional approach used to test the indirect effects. This test is also known as the normal theory test for indirect effects. However, this normal theory approach suffers from two flaws that make it difficult to recommend: (1) the unrealistic assumption that the sampling distribution of the indirect effect is normally distributed and (2) low statistical power (Hayes 2013, pp. 104–105). Consequently, Hayes' (2013) recommended bootstrapping approach for mediation analysis was followed to test the indirect effects implied by the conceptual model. See Table 4.30 below for the detailed results.

Table 4.30: Results of Mediation Analysis Using Bootstrapping

Path	Indirect Effect	Boot SE	95% Confidence Interval	
TECH - TR - IC	0.333	0.063	0.219	0.467
TECH - OL - IC	0.072	0.030	0.010	0.130
TL - TR - IC	0.296	0.057	0.201	0.426
TL - OL - IC	0.067	0.031	0.011	0.135
TECH - TR - IC - ICAP	0.082	0.052	0.001	0.208
TECH - OL - IC - ICAP	0.011	0.008	0.001	0.038
TL - TR - IC - ICAP	0.073	0.047	0.001	0.189
TL - OL - IC - ICAP	0.011	0.007	0.001	0.035
TR - IC - ICAP	0.192	0.102	0.017	0.413
OL - IC - ICAP	0.055	0.028	0.013	0.129

The results as illustrated in Table 4.30 shows that each of the ten indirect effects is significantly different from zero ($p < 0.05$) as none of the 95% bootstrapping confidence intervals contains the value of zero.

A number of comparisons were also undertaken. First, the indirect effect of TECH → TR → IC was compared with that of TECH → OL → IC and the first indirect effect was found to be significantly larger than the second indirect effect at the 0.05 level. Secondly, the indirect effect of TL → TR → IC was compared with that of TL → OL → IC and the first indirect effect was found to be significantly larger than the second indirect effect at the 0.05 level. Regarding the indirect effect of TECH → TR → IC → ICAP and TECH → OL → IC → ICAP, the first indirect effect was found to be significantly larger than the second indirect effect at the 0.05 level. Fourthly, the indirect effect of TL → TR → IC → ICAP was compared with that of TL → OL → IC → ICAP and the first indirect effect was found to be significantly larger than the second indirect effect at the 0.05 level. Lastly, the indirect effect of TR → IC → ICAP was compared with that of OL → IC → ICAP and the first indirect effect was found to be significantly larger than the second indirect effect at the 0.05 level. To conclude, the above mediation tests confirm the significant indirect effects implied in the conceptual model.

4.10 Hypotheses Testing and Findings

The results of the tested model (as shown in Figure 4.2) used a path diagram with estimated path coefficients. Every proposed hypothesis in Chapter 2 was evaluated through the empirical results of the structural model analysis. There are fourteen hypotheses in the tested model, and results are summarised.

Hypothesis 1 stating that:

Transformational leadership is positively associated with innovation capability is supported.

The rationale for this hypothesis is that transformational leadership is characterised by numerous patterns of behaviour that can develop the openness strategy of a firm through supporting individuals' knowledge and skills needed for enhancing innovation capability. This style of leadership is capable of motivating and intellectually stimulating followers to perform beyond their own expectations, increase intra-organisational integration and overcome difficulties as well as supports followers' willingness to learn through experimentation, exploration, communication and discussion. The results of the structural model analysis show that the path is positive, with a direct effect of 0.212, and significant ($p = .000$). The critical ratio is 4.571, greater than 2.00.

Hypothesis 2a stating that:

Transformational leadership is positively associated with advanced training is supported.

The rationale for this hypothesis is that this style of leadership has the ability to define and employ human resource policies, practices and expectations that can shape employee participation in advanced training activities. Transformational leadership exerts influence and has the capability to justify training programs, attract budget support, recognise and utilise the most efficient advanced training strategies, manage expectations, analyse satisfaction feedback, and estimate professional development needs. The results of the structural model analysis show that the path is positive, with a direct effect of 0.482, and is significant at $p < 0.05$ level. The critical ratio 11.571 is greater than 2.00.

Hypothesis 2b stating that:

Advanced training is positively associated with innovative climate is supported.

The rationale for this hypothesis is that when employees are provided with adequate advanced training programmes, they are more likely to gain a variety of knowledge, technical skills and competencies etc. to effectively perform their tasks. These achievements by employees will be highly supported by their leaders through the provision of the necessary resources, appreciation and rewards, as well as the motivation provided by leaders. The results of the structural model analysis show that the path is positive, with a direct effect of 0.701, and is significant at the $p < 0.001$ level. The critical ratio of 16.839 is greater than 2.00.

Hypothesis 2c stating that:

Advanced training mediates the relationship between transformational leadership and innovative climate is supported.

The rationale for this hypothesis is that transformational leaders tend to act as mentors to generate learning opportunities by offering adequate training programmes. As a result, individuals become more learning-oriented and are encouraged to actively pursue diverse information and knowledge needed to better perform their tasks. Leaders, consequently, are more likely to show their appreciation by providing those individuals with adequate time, resources and incentives to pursue creative ideas. These will contribute to the innovative climate. The results of bootstrapping revealed that the relationship between transformational leadership and innovative climate was significantly mediated by advanced training (B [SE] =0.057 [0.296], 95% CI: 0.201 to 0.426; $p < 0.05$).

Hypothesis 3a stating that:

Transformational leadership is positively associated with organisational learning is supported.

The rationale for this hypothesis is that transformational leadership has the capacity to increase the consciousness of collective interest among members of a firm and support them in accomplishing their goals. Transformational leaders are visionary leaders and, therefore, they are able to enhance organisational learning through encouraging 'intellectual stimulation' and promoting 'inspirational motivation' and 'self-confidence' among employees. The results of the structural model analysis show that the path is positive, with a direct effect of 0.409, and is significant at $p < 0.05$ level. The critical ratio is 8.239 greater than 2.00.

Hypothesis 3b stating that:

Organisational learning is positively associated with innovative climate is supported.

The rational for this hypothesis is that when organisational learning practices within an organisation are encouraged, individuals are more likely to create and share knowledge, generate new ideas, participate in decision making, obtain new skills and competencies. Consequently, individuals' opinions and innovative ideas are respected by a firm as well as supported through the provision of rewards, appreciation, resources such as time and budget, engagement and bonuses. The results of the structural model analysis show that the path is positive, with a direct effect of 0.201, and is significant at the $p < 0.001$ level. The critical ratio is 4.841, greater than 2.00.

Hypothesis 3c stating that:
Organisational learning mediates the relationship between transformational leadership and innovative climate is supported.

The rationale for this hypothesis is that transformational leadership has the ability to analyse, modify and drive systems, designing them to share and transfer knowledge. Through the communication and dialogue within a firm, individuals can obtain new ideas, technical skills, knowledge and competencies, which, in turn, increase their abilities to adequately perform their tasks and improve the firm's performance. Due to their efforts and achievements, these individuals are then further supported by leadership (e.g., supplying motivation, resources and rewards). These enhance the innovative climate. The results of bootstrapping revealed that the relationship between transformational leadership and innovative climate was significantly mediated by organisational learning (B [SE] =0.031 [0.067], 95% CI: 0.011 to 0.135; $p < 0.05$).

Hypothesis 4 stating that:
Advanced technology is positively associated with innovation capability is supported.

The rationale for this hypothesis is that advanced technologies facilitate a firm's capability for the absorption of useful external knowledge and novel ideas through building a knowledge network between the firm and its external environments. These advanced technologies also can facilitate cooperation and coordination between a firm's disparate units (disparate in the sense of function and location) and centres and support the firm to manage these different innovations essentially 'under one roof'. In addition, through the adoption of advanced technologies, firms can improve their understanding of customer needs from an early stage (as well as the acquisition and retention of such information). This will increase the ability of firms to probe, experiment using test runs and so forth, and then commercialise radical ideas and concepts. The results of the structural model analysis show that the path is positive, with a direct effect of 0.353, and is significant at $p < 0.001$ level. The critical ratio is 7.385 greater than 2.00.

Hypothesis 5 stating that:

Advanced technology is positively associated with advanced training is supported.

The rationale for this hypothesis is that the adoption of new advanced technology produces an urgent need for technology-specific experience and skilled workers to effectively adopt these technologies and integrate them within their firms. Individuals can acquire such technical skills, knowledge and competencies through advanced training in order to utilise the new technology and increase the productivity related to the technology adopted. The results of the structural model analysis show that the path is positive, with a direct effect of 0.542, and is significant at the $p < 0.001$ level. The critical ratio is 13.013, greater than 2.00.

Hypothesis 6 stating that:

Advanced technology is positively associated with organisational learning is supported.

The rationale for this hypothesis is that when advanced technology is adopted within a firm, employees should appreciate and understand the absolute benefits of the new technology. This can be done through discussion, interaction, and communication with each other, whether via networks or face to face. The results of the structural model analysis show that the path is positive, with a direct effect of 0.439 and is significant at $p < 0.001$ level. The critical ratio is 8.833, greater than 2.00.

Hypothesis 7 stating that:

Innovative climate is positively associated with innovation capability is supported.

The rationale for this hypothesis is that within innovative climate, individuals are able to share their ideas and suggestions, experiment with new methods, articulate dissimilar ideas without fear of being blamed, and accept the risky ideas of others as well as make suggestions on how to bridge a firm's knowledge gaps. Moreover, innovative climate enhances individuals' ability to participate in the process of innovation through risk taking, decision-making and experimentation. Individuals within an innovative climate can act in ways that are needed to integrate all the necessary mechanisms to achieve desired organisational outcomes at both the firm and unit levels. The results of the structural model analysis show that the path is positive, with a direct effect of 0.394, and is significant at the $p < 0.001$ level. The critical ratio is 7.361, greater than 2.00.

Hypothesis 8a stating that:

Innovative climate mediates the relationship between advanced training and innovation capability is supported.

The rationale for this hypothesis is that when individuals are provided with sufficient advanced training programmes, they are more likely to gain a variety of knowledge, technical skills, experiences, competencies etc. to develop creative solutions and apply these solutions in practical situations. These achievements by individuals will be highly supported by a firm through the provision of the necessary resources, appreciation and rewards, as well as the motivation provided by leaders which enhance individuals' sense-making of their work environment. Within this climate, individuals are more likely to gain relevant knowledge from external sources, integrate all the necessary mechanisms to achieve organisational outcomes (both at the firm and unit levels) as well as develop a willingness to experiment with innovative ideas. The results of bootstrapping revealed that the relationship between advanced training and innovation capability was significantly mediated by innovative climate (B [SE] =0.102 [0.192], 95% CI: 0.017 to 0.413; $p < 0.05$).

Hypothesis 8b stating that:

Innovative climate mediates the relationship between organisational learning and innovation capability is supported.

The rationale for this hypothesis is that when organisational learning practices within an organisation are encouraged, individuals are more likely to create and share knowledge, generate new ideas, participate in decision making, obtain new skills and competencies. As a result, individuals' opinions and innovative ideas are respected by a firm as well as supported through the provision of rewards, appreciation, resources such as time and budget, engagement and bonuses which subsequently improves the innovative climate. This climate provides a platform for individuals to explore externally available strategic knowledge, integrate and align their firm's organisational connectedness as well as increase their willingness to learn and experiment with innovative ideas. The results of bootstrapping revealed that the relationship between organisational learning and innovation capability was significantly mediated by innovative climate (B [SE] =0.028 [0.055], 95% CI: 0.013 to 0.129; $p < 0.05$).

Hypothesis 9 stating that:
Innovation capability is positively associated with radical innovation is supported.

The rationale for this hypothesis is that innovation capability helps a firm to recognise the most salient product characteristics for their existing and potential markets and realise the nature of customer needs. Innovation capability supports the interconnection between all phases that are required in innovation processes and ensures the flexibility for successful innovation. Moreover, innovation capability enhances the firm's capability to probe, experiment with, and have their R&D units test successive potential products and services until a market-acceptable product or service is formulated. The results of the structural model analysis show that the path is positive, with a direct effect of 0.617, and is significant at the $p < 0.001$ level. The critical ratio of 12.279 is greater than 2.00.

Table 4.31 presents parameter estimates of the final SEM model for the measurement, along with estimate, critical value (*t*-test), and p-value, and the results of hypotheses tests are reported. Table 4.32 presents the results of the mediation hypotheses (H2c, H3c, H8a and H8b). Figure 4.3 presents the final framework for this study.

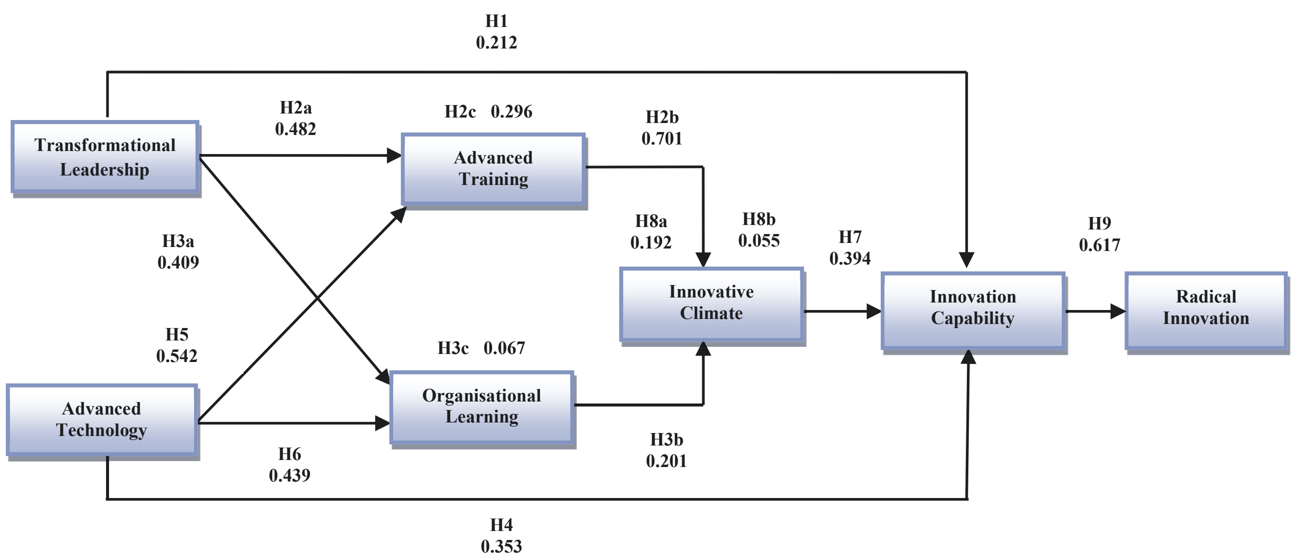
Table 4.31: Parameter Estimates of the Final SEM Model and the Results of Hypotheses Tests

	Hypothesised Path	Standard Coefficient	t-value	p-value	Conclusion
H1	Transformational leadership → Innovation capability.	0.212	4.571	0.000	**H1 is Supported**
H2a	Transformational leadership → Advanced training.	0.482	11.571	0.000	**H2a is Supported**
H2b	Advanced training → Innovative climate.	0.701	16.839	0.000	**H2b is Supported**
H3a	Transformational leadership → Organisational learning.	0.409	8.239	0.000	**H3a is Supported**
H3b	Organisational learning → Innovative climate.	0.201	4.841	0.000	**H3b is Supported**
H4	Advanced technology → Innovation capability.	0.353	7.385	0.000	**H4 is Supported**
H5	Advanced technology → Advanced training.	0.542	13.013	0.000	**H5 is Supported**
H6	Advanced technology → Organisational learning.	0.439	8.833	0.000	**H6 is Supported**
H7	Innovative climate → Innovation capability.	0.394	7.361	0.000	**H7 is Supported**
H9	Innovation capability → Radical innovation.	0.617	12.279	0.000	**H9 is Supported**

Table 4.32 The Results of the Mediation Hypotheses

Hypothesised Path	Indirect Effect	Boot SE	95% CI Lower	95% CI Upper	Conclusion
H2c Transformational leadership → Advanced training → Innovative climate.	0.296	0.057	0.201	0.426	**H2c is supported**
H3c Transformational leadership → Organisational learning → Innovative climate.	0.067	0.031	0.011	0.135	**H3c is supported**
H8a Advanced training → Innovative climate → Innovation capability.	0.192	0.102	0.017	0.413	**H8a is supported**
H8b Organisational learning → Innovative climate → Innovation capability.	0.055	0.028	0.013	0.129	**H8b is supported**

Figure 4.3: The Proposed Model of the Development of Radical Innovation in Large Firms



4.11 Summary of the Chapter

This chapter discussed and presented the results of the data analysis for the current study. First, the reliability analysis was determined to measure the degree of association between the variables of the study. Then, EFA (with SPSS version 24) was applied for each construct separately as well as for the seven constructs (overall) to examine the measuring items' underlying factors and to indicate the latent dimensions originating from the data found in the study. EFA was applied through principal components with varimax rotation and an eigenvalue larger than 1 as the criterion for factor extraction. Secondly, CFA was then employed for factor structure validation through the determination of the relationship between the factors. To control the CMV of the present study, the zero-constraint test was undertaken. The CFA results provided sufficient evidence of good model fit. Thirdly, after establishing the accepted measurement model, SEM (with software AMOS version 24) was applied to determine the data-model fit and validate the hypothesised relationships between theoretical constructs. The overall SEM findings indicate that the hypothesised model was a good fit for the data ($\chi 2/df = 2.93$, GFI = 0.94, AGFI = 0.86, RMR = 0.03, CFI = 0.92, NFI = 0.95, IFI = 0.96 and RMSEA = 0.07). The fourteen proposed hypotheses in the tested model were supported by the findings. Finally, mediation analysis was undertaken, and this found that each of the four indirect effects to be statistically significant. The next chapter will discuss the theoretical and managerial contributions as well as outline the limitations applying to this research and make recommendations for future research.

CHAPTER FIVE: DISCUSSION AND CONCLUSION

5.1 Introduction

This chapter is the concluding part of this thesis. This final chapter discusses the theoretical contributions related to the seven constructs and their relationships. Moreover, the managerial contributions will be discussed. The chapter also notes the limitations of the current study, proposes recommendations for future research, and presents the conclusion.

The remainder of this chapter is structured as follows. Section 5.2 discusses the theoretical and managerial contributions of the study. Section 5.3 presents the limitations that restricted the current study and suggests future research directions. Finally, the conclusion of the study is provided in section 5.4.

5.2 Discussion

This study investigated the perception of individuals on the effect of both transformational leadership and advanced technology on radical innovation for global competitiveness. The results provide empirical evidence that transformational leadership (as a human factor) and advanced technology (as a machinery factor) are two significant drivers for successful radical innovation in large firms. Furthermore, the findings show that radical innovation might not be achieved if a firm does not have distinctive capabilities (including openness, integration and experimentation capabilities) in all relevant aspects. Accordingly, this study suggests that in order to achieve competitive advantage in highly changing environments, large firms must constantly emphasise the means to sustain a steady flow of radical innovations. This can be done by identifying suitable conditions and capabilities that can enable them to understand and support the key drivers to produce radical innovation.

The present study contributes to the radical innovation literature by providing preliminary evidence that transformational leadership and advanced technology are two primary determinants ‘in parallel’ for radical innovation. Moreover, the current study further extends the literature by theoretically and empirically examining the path-dependent influences on radical innovation capability in the context of large firms. The findings reveal that both transformational leadership and advanced technology enhance the positive effects of organisational learning and advanced training on innovative climate. An improved innovative climate then has a direct positive influence on innovation capability, which promotes radical innovation. The theoretical and managerial contributions of the current study will be discussed in sections 5.2.1 and 5.2.2 respectively.

5.2.1 Theoretical Contributions

This study draws attention to the main theoretical implications based on the findings of this study. This section discusses and justifies the significance of the theoretical contributions that the current study has made.

1. Contribution to the Innovation Literature

Despite the importance of radical innovation for firms, its drivers remain not well documented in the literature (Flor, Cooper & Oltra 2017). Further investigations are required to recognise which organisational components can promote this type of innovation in dynamic environments (Perra, Sidhu & Volberda 2017; Sadovnikova et al. 2016; Aagaard 2017). Drawing on the dynamic capability theory, the current study responds to calls for more research and contributes to radical innovation literature by providing empirical evidence that both transformational leadership (as a human factor) and advanced technology (as a machinery factor) are two primary drivers in generating radical innovation in large firms.

The majority of previous studies investigated the effects of both transformational leadership and advanced technology on radical innovation empirically but separately (e.g., Escrig et al. 2015; Birasnav, Rangnekar & Dalpati 2010; Jobar et al. 2010; Lee, Dedahanov & Rhee 2015). However, this study is unique in substantiating the genesis of radical innovation described in existing literature by using conceptualisations of both transformational leadership and advanced technology adoption to study their impacts on radical innovation ‘in parallel’ in the context of large firms. This is the first study that has tested a framework on how these two factors interact with the internal organisational building blocks (organisational learning, advanced training, innovative climate, and innovation capability) in producing radical innovation.

The study extends previous studies by providing further empirical evidence that transformational leadership is a critical contributor to radical innovation (e.g., Cortes & Herrmann 2017; Kao et al. 2014; Nijstad, Selman & Dreu 2014; Bass & Riggio 2006). Moreover, this study goes beyond these previous studies by providing new insight into the mechanisms through which transformational leadership can influence radical innovation in the context of large firms. Several different pathways have been proposed in regard to the effect of transformational leadership on radical innovation (Makri & Scandura 2010; Eisenbeiss et al. 2008). However, this study is unique as it examines four distinctive mediating components (organisational learning, advanced training, innovative climate and innovation capability) to build a framework that successfully generates radical innovation. To the best of my knowledge, this is the first study that relates the concept of transformational leadership and the role of these four mediating factors to produce radical innovation in large firms.

At the individual level, the proposed model, supported by empirical findings, indicates that transformational leadership, through behaviour that inspires motivation, intellectual stimulation and individualised consideration, has a direct role in motivating and inspiring followers to participate in the process of learning activities (advanced training and organisational learning), and expands the firm's existing knowledge stocks by giving employees the confidence and opportunity to apply their newly acquired knowledge and skills to the workplace. This, in turn, contributes to the creation of a supportive climate for innovation within a firm. An improved innovative climate then has a direct positive influence on innovation capability (Jung et al. 2003; Scott & Bruce 1994) and, ultimately, innovation output. Viewed at the individual level, when followers are supported by adequate resources, rewards and motivation, they are more likely to learn new skills (O'Connor & McDermott 2004), gain knowledge from a variety external sources, connect innovative activities with other parts of an organisation and overcome difficulties (Voet 2014) as well as be more willing to experiment with new ideas (O'Connor et al. 2008), which can promote radical innovation in dynamic environments.

Moreover, this study enriches previous studies by providing explicating that advanced technology adoption, in combination with appropriate leadership style, can be a key driver of radical innovation. That is, it is neither a mediator nor a moderator (as in some previous studies) but a key driver in its own right. Prior studies provided mixed results regarding the effect of advanced technology adoption on innovation performance (Lee, Dedahanov & Rhee 2015). While some studies report an insignificant relationship between the advanced technology and radical innovation (e.g., Gao et al. 2007; Hakala 2011), the bulk of the growing body of literature (e.g., Batra et al. 2015; Hsu et al. 2014) focuses on technology as a moderator in supporting variables to enhance innovation performance. For example, Chen et al. (2014) examined the moderating role of technology adoption on the relationship between transformational leadership and corporate entrepreneurship for innovation performance. Their findings show that advanced technology significantly moderates the link between these two constructs and creates the appropriate conditions for the smooth translation of transformational leadership into actual entrepreneurial activities within a firm. In contrast, this study demonstrates that advanced technology adoption in its own right is a significant complementary tool in supporting transformational leadership in implementing strategies, practices, operations, and processes to facilitate radical innovation. It does this by contributing directly to the suite of innovation capabilities necessary for the production of radical innovation. While it is feasible that other variables excluded from the current study are pertinent (Lee, Dedahanov & Rhee 2015), the results reported here indicate that when advanced technology is adopted within a firm, it can enhance the firm's capability to obtain valuable resources (internally and externally) and support its ability to build new technical solutions and offer new advanced products to meet customer needs with novel superior technology.

The results further contribute to the innovation literature by identifying and empirically proving the mediating effect of innovative climate on the relationship between organisational learning and innovation capability performance in the context of large firms. Prior studies have demonstrated a direct positive effect of organisational learning on innovation performance (e.g., Liao et al. 2009; Hussain et al. 2018). Most of these studies consider that organisational learning injects new ideas into the organisation, improves the capability to understand new ideas and encourages creativity and the capacity to spot new opportunities (e.g., Li et al. 2018). Despite the fact that the arguments are largely coincident as regards the positive connection between organisational learning and innovation performance, this relationship has not been widely viewed from an empirical standpoint (Montes, Moreno & Morales 2005). Instead, studies have essentially focused on analysing the direct impacts of organisational learning on the different kinds of innovation (e.g., Jyoti, Chahal & Rani 2017; Liao, Fei & Liu 2008), without explaining how these learning activities can influence organisations' capability to change their climate for innovation performance. Different from most research, this study enriches the innovation literature by revealing the role that organisational learning has in creating a climate that fosters innovation capability performance. Viewed at the individual level, when organisational learning practices within an organisation are encouraged, individuals are more likely to create and share knowledge, generate new ideas, participate in decision making, obtain new skills and competencies (e.g., Shanker et al. 2017; Aizpurúa et al. 2011). Accordingly, individuals' opinions and innovative ideas are respected by a firm as well as supported through the provision of rewards, appreciation, resources such as time and budget, engagement and bonuses which subsequently improves the innovative climate. This climate provides a platform for individuals to explore externally available strategic knowledge instead of just internal, local and limited sources. Consequently, they are more able to integrate and align their firm's organisational connectedness as well as increase their willingness to learn and experiment with innovative ideas, thereby producing superior innovation capability.

It can accordingly be said that, in line with Jian, Li & Yeung (2018), organisational learning does not have a direct effect on the innovation performance. Instead, it contributes to innovation capability outcomes indirectly through the innovative climate. This pattern of correlations underlines the importance of innovative climate as a mediating variable that appears to function as a portal to enhance innovation capability. The findings extend previous studies highlighting the major role of the innovative climate for enhanced innovation outcomes (e.g., Panuwatwanich, Stewart & Mohamed 2008), with identifying such the linear link. Without an innovative climate, it is unlikely that organisational learning practices would have an effect on innovation capability. Thus, to enhance the innovation capability of a firm via organisational learning, it is imperative that large firms ensure an innovative climate is in place and supported by all personnel in the firm.

A further contribution to the innovation literature of the current study is the finding that innovative climate is a significant mediating factor in the relationship between advanced training and innovation capability performance in the context of large firms. To the author's knowledge, this study is the first attempt in the innovation literature to establish the mediating mechanism of innovative climate in the relationship between advanced training and innovation capability. Prior research has revealed mixed findings about the relationship between advanced training and innovation performance (e.g., Chen & Huang 2009, Sung & Choi 2014). The results presented in the model address calls to articulate mediating mechanisms through which advanced training creates value for organisations (e.g., Glaveli & Karassavidou 2011). The model shows that the influence of advanced training on innovative performance is indirect, rather than direct — mediated by some variables such as organisational commitment (Ahmad & Schroeder 2003), productivity (Faems et al. 2005), and knowledge management (Rahman et al. 2013). In addition, the vast majority of studies did not examine the direct effect of advanced training activities on the work atmosphere within an organisation (either at an individual or micro level) that could affect innovation capability performance (Glaveli & Karassavidou 2011), with just a few studies empirically examining whether the relationship between advanced training and innovation capability performance is mediated or moderated by other variables (e.g., Tharenou et al. 2007; Makkonen & Lin 2012; Jørgensen, Becker & Hyland 2014). A recent exception was a study conducted by Sung & Choi (2014) on 260 Korean companies to examine the effects of advanced training on organisational innovation moderated by innovative climate. Their findings show that the positive link between the two constructs is stronger within organisations when the innovative climate is strong.

However, at the individual level, the findings of this study show that when employees are provided with sufficient advanced training programmes, they are more likely to gain a variety of knowledge, technical skills and competencies etc. to effectively perform their tasks. These achievements by employees will be highly supported by a firm through the provision of the necessary resources, appreciation and rewards, as well as the motivation provided by leaders. This will, in turn, enhance the innovative climate (e.g., Scott & Bruce 1994). Within this climate, employees can feel a deeper sense of respect and engagement and experience a climate conducive to innovation and they will conform to the firm's norms and values and comply with socially desired attitudes. Accordingly, employees are more likely to gain relevant knowledge from external sources, integrate all the necessary mechanisms to achieve organisational outcomes (both at the firm and unit levels) as well as develop a willingness to experiment with innovative ideas. The present results reveal that advanced training programmes do not directly influence innovation capability; however, they indirectly influence innovation capability through their contribution to innovative climate. In other words, employees' knowledge, skills and competencies which are acquired through advanced training must first be shared and integrated within the work environment before contributing to innovation capability (Sung & Choi 2012; Park et al. 2013). The findings thus offer further support for the argument that an organisation's innovation capabilities depend on associations among employees rather than individual knowledge and skills alone (e.g., Nidumolu, Subramani & Aldrich 2001). Thus, it can be argued that the effectiveness of advanced training for enhancing innovation capability may take place when the work environment is engaged at the same time.

One of the major questions guiding this study was the extent to which learning factors mediate the impact of transformational leadership on innovative climate. This study contributes to the innovative climate research by empirically providing two mechanisms (advanced training and organisational learning) that fully mediate the relationship between transformational leadership and innovative climate. Numerous studies have provided a strong basis for the direct positive impact of transformational leadership on innovative climate (e.g., Haakonsson et al. 2008; Jung et al. 2003; Wang et al. 2011). However, few studies have been found in the literature examining this association by utilising some mediating factors (e.g., Brimhall et al. 2016). Thus, it is important to identify other related factors that might connect this relationship. One exception was a study conducted by Sarros, Cooper & Santora (2008) on 1,158 managers in Australian private sector organisations by employing the same measure of innovative climate as Scott and Bruce (1994) (as adopted in this study) to investigate this relationship. They reported that organisational culture was a significant mediating factor in the relationship between transformational leadership and innovative climate. Nonetheless, studies examining the association between these two constructs through the mediating effects of different strategic variables are rare (e.g., Jaiswal & Dhar 2015). To my knowledge, no study has shown the causal path of the influences of transformational leadership on innovative climate by empirically examining the mediating effects of learning factors simultaneously in one framework.

The findings of this study demonstrate that transformational leadership has a direct positive impact in shaping individuals' participation in advanced training activities (e.g., Kuvaas and Dysvik 2010; Towler et al. 2014). This can be done through providing individuals sufficient resources to enable learning and offering adequate training programmes as well as by giving individuals the confidence and opportunity to apply this newly acquired knowledge and skills to the workplace. It may be the case that individuals are more likely to be appreciated by their leaders who will then provide adequate time for employees to pursue creative ideas as well as adequate resources and reward for innovation-oriented activities. These will contribute to the innovative climate (Hulsheger et al. 2009).

Organisational learning is another important mediator mechanism between transformational leadership and innovative climate. The findings show that transformational leadership and the intellectual stimulation, individualised consideration and inspirational motivation that such leadership involves has a direct positive effect in facilitating organisational learning practices (e.g., Lei et al. 1999). Through the communication and dialogue within a firm, individuals can obtain new ideas, skills, knowledge and competencies, which, in turn, increase their abilities to adequately perform their tasks and improve the firm's performance. Due to their efforts and achievements, these individuals are then further supported by leadership (e.g., supplying motivation, resources and rewards). These enhance the innovative climate (Paul et al. 2002). It can accordingly be said that transformational leadership is a critical factor in influencing learning activities (organisational learning and advanced training) which enhance the innovative climate. In other words, if transformational leadership ignores learning activities, large firms cannot improve the innovative climate. This is because learning factors (on the basis of acquiring knowledge, technical skills, competencies, etc.) are the only channels through which transformational leadership can have an impact on innovative climate. This study identifies an important interaction between transformational leadership and the innovative climate via learning factors.

One of the key questions addressed in this study is the extent to which learning factors (advanced training and organisational learning) mediate the impact of advanced technology adoption on innovative climate. This study contributes to the literature on the antecedents to the role of the innovative climate in the context of large firms by showing the extent to which advanced training and organisational learning act as two mechanisms that mediate the effects of the advanced technology adoption on innovative climate performance — an area not previously examined. This study makes a contribution to this area by supporting a more comprehensive theoretical framework with empirical findings.

Several studies have empirically investigated the effects of the new advanced technologies adoption on organisations' success. The bulk of these studies have explored the effects of advanced technology adoption at macro-level (e.g., Batra et al. 2015) such as on organisational performance (e.g., Liaoning et al. 2016) and innovation performance (e.g., Mutlu & Sürer 2016). However, empirical studies that investigate the effect of advanced technology on employee training and learning are rare (e.g., Straub 2009) at the level of micro-level processes (Siadaty, Gasevic & Hatala 2016).

Antonietti (2005), for example, examined the effects of advanced technology adoption on the economic growth of firms. The author found that investment in specific human capital via formal training programs is a significant mediator on the effects of advanced technology on economic growth. In addition, Wilbon (2015) investigated the influence of advanced technology on firm survival. The author found that organisational learning fully mediates the relationship between advanced technology and firm survival. Nevertheless, to the best of my knowledge, there has not been any work done to examine a relationship between advanced technology adoption and innovative climate performance via learning factors (advanced training and organisational learning) together as mediators. The findings of the study add new empirical evidence that further our understanding of influences on innovative climate performance and perhaps contribute to such a framework.

The findings of this study indicate that when advanced technology is adopted within a firm, the activities and practices in terms of learning activities (advanced training and organisational learning) are increased (e.g., Black & Lynch 2004; Antonietti 2005; Edmondson et al. 2003). A plausible explanation of this positive effect is that the adoption of new advanced technology produces an urgent need for technology-specific experience and skilled workers to effectively adopt these technologies and integrate them within their firms (Bartel & Lichtenberg 1987). Individuals can acquire such technical skills, knowledge and competencies, whether through formal learning (e.g., seminars, conferences and workshops) or informal learning (e.g., communication, dialogue, discussion and interaction), in order to utilise the new technology and increase the productivity related to the technology adopted. Through these learning activities, individuals are more able to perform their tasks well. Consequently, the innovative climate will be improved due to employees feeling supported by leadership in their endeavours by the provision of learning resources, rewards etc. (Scott & Bruce 1994). The results suggest that the prevalent use of advanced technologies coupled with learning activities can help large firms enhance their innovative climate performance. Specifically, large firms wanting to improve the innovative climate will benefit from having a robust advanced technological orientation as this provides the suitable conditions for learning activities which, in turn, strengthen the innovative climate.

Furthermore, the current study contributes to the radical innovation literature by providing preliminary evidence that innovation capabilities (openness, integration and experimentation) are significant mediators on the effect of advanced technology on radical innovation performance. This study is the first in the literature to empirically examine the relationship between these constructs. Though earlier research has acknowledged that innovation capability plays a significant mediating role for the improvement of radical innovation, there was little empirical examination of the interrelationship between these two areas (Chang et al. 2012; Jiménez & Valle 2011). For instance, Tzokas et al. (2015) examined the mediating role of absorptive capability (a firm's capacity to utilise externally held knowledge) on the relationship between advanced technology adoption and innovation production to increase the overall performance. Their findings indicate that the firm's absorptive capacity (as a mediator) plays a significant role in terms of product innovativeness when utilised in combination with the firm's advanced technology. Nevertheless, no study in the literature appears to empirically examine the influence of advanced technology adoption with regard to different types of innovation capabilities for radical innovation performance simultaneously within a single study. This study, therefore, addresses this knowledge gap in the existing literature by investigating within a single study the effect of advanced technology adoption on innovation capabilities (openness, integration and experimentation) and their subsequent impact on radical innovation performance.

The findings of the present study indicate that when advanced technology is adopted within a firm, it can contribute to a firm searching for and gaining valuable knowledge and novel ideas by establishing strong relationships, developing communication and improving cooperation with external parties (e.g., industrial associations, customers, research institutes and suppliers). Consequently, the firm can recognise the most salient product characteristics for their existing and potential markets, realise the nature of customer needs, understand consumer preferences and estimate the market size (Savino et al. 2017; Dong 2016), thereby facilitating radical innovation. At the same time, the results show that advanced technology improves the infrastructure of a firm in terms of acquiring, integrating, reconfiguring and disseminating valuable resources that are embedded in the social, structural and cultural context (Barua et al. 2004). This, in turn, enhances the connection between units and centres and increases the perception of individuals as co-productive, and ultimately facilitates the realisation of such operational activities. Thus, radical innovation will be strengthened. Additionally, the results show that through the adoption of new technology, a firm is able to draw insights from diverse knowledge pools as well as increase knowledge sharing, encourage employees to work in open systems, and facilitate social relationships with other parties within industry. These improve experimentation capabilities and consequently, radical innovation performance. Finally, this study provides further empirical support for the claim that firms must have adequate innovation capabilities to produce radical innovation (e.g., Slater et al. 2014). Firms without innovation capabilities, they are unable to produce radical innovation as innovation capabilities are the only channels for the production of radical innovation.

5.2.2 Managerial Contributions

In addition to the theoretical contributions, a set of implications arise from the study's findings that are relevant for practitioners and the decision-making of executives, giving them valuable knowledge that can support them to achieve radical innovation in their firms. In the era of intense global competition and dynamic market environments, large firms have become susceptible to their competitors, particularly from small and medium firms (Tripathi 2013). Hence, large firms should identify suitable conditions and capabilities that will enable them to understand and support the key drivers that are able to produce radical innovation for global competitiveness (Sainio et al. 2012; Gómez & Alcamí 2015) and so implement them in their workplace. The findings of this study can be used in at least three ways by managers and practitioners as a framework for large firms to support decision-making regarding these challenges so that they can adopt the path of radical innovation for global competitiveness.

Firstly, this study assists managers and decision-making executives in large firms to obtain new insights into the desired leadership style that will create effective mechanisms and develop efficient procedures to enhance radical innovation. The findings of this study strongly suggest that transformational leadership as a human factor is one of the most important individual factors in supporting radical innovation in a practical way (e.g., Aragón-Correa et al. 2007). This style of leadership is characterised by numerous patterns of behaviours that can develop the capabilities of a firm. These behaviours include providing intellectual stimulation, inspirational motivation, and individualised consideration where individuals can become more creative and innovative (Gumusluoğlu & Ilsev 2009; Wang & Howell 2010). Managers in large firms, particularly in Saudi Arabia, should be able to realise the strategic importance of this style of leadership as a human factor in stimulating radical innovation.

With regard to Saudi Arabia, this study identifies the underlying parameters through which a framework for radical innovation can be developed for large Saudi firms. As mentioned earlier, Saudi Arabia is not known for its innovation (Iqbal 2011), having relied on natural resources, yet the government is starting to formulate effective policies and strategies to shift into a knowledge-driven economy by supporting innovations in many directions (International Monetary Fund 2016). The Saudi government is robustly pushing large firms to start turning the wheel of innovation in the country by supporting large firms with incentives, such as direct share investment and subsidies, designed to boost their global competitiveness (Alshuwaikhat & Mohammed 2016). Nevertheless, large Saudi firms have achieved less than what the country's national development plans expected with regard to producing successful innovations. There have been several reasons for this dilemma. Among the most significant of these reasons has been identifying the leadership qualities needed to lead innovations in large Saudi firms (Iqbal 2011). Leadership styles are typically more reflective of protective, directive approaches rather than of a transformational style. The former is not seen as generally supportive of innovation.

Furthermore, most organisations in the Middle East, including in Saudi Arabia, are characterised by a highly stratified and powerful bureaucracy and stagnation in relation to change; both are considered a major obstacle to innovation (Jabbar & Dwaivedi 2004). These facts emphasise the importance of adopting a transformational leadership style that can inspire and empower innovative actions among staff as a way to overcome this bureaucracy and support the changes required to generate innovation (Al-Shoaib et al. 2009). In aggregate, this study sends a message to managers in large firms that it is essential to consider this style of leadership when radical innovation is a firm's particular goal and its objective is to stay competitive in dynamic market environments. Without effective leadership, it is often thought that a firm's radical innovation would not increase because of the important role effective leadership plays in bringing together and supporting attributes and activities both internally and externally that enhance radical innovation.

Secondly, this study assists managers and decision makers to gain new insights into the importance of advanced technology adoption as a complementary tool in supporting transformational leadership to facilitate radical innovation in large firms. Managers and policy makers in large firms should be able to understand that the adoption of advanced technology is not an internal static process. It is not only about some interactions between some resources both inside and outside large firms but can also be seen as a functional dynamic capability that supports their firms in the continuous development of their resources, capabilities and processes as well as increasing the exploration and exploitation of opportunities to produce radical innovation.

In the context of large Saudi firms, the results of the study are consistent with Iqbal's (2011) model of innovation in Saudi Arabia. The author points out that in order to transform the current Saudi Arabian economy into an innovation-based economy, large Saudi firms should have a strong technological orientation. Thus, large Saudi firms should understand the strategic importance of advanced technology adoption to produce innovation and increase their global competitiveness. With a strong technological orientation, large Saudi firms would be more able to efficiently strengthen the production processes, resolve technical dilemmas and physically perform innovations within the production processes. In addition, it is worth noting here that the adoption of advanced technology would provide the large Saudi firms with the potential capability to identify customers' latent requirements and satisfy them by providing technology-based innovation. It can be accordingly said that where less advanced technology is adopted within firms, the firms will be unable to contribute the desired product quality and uniqueness or demonstrate market responsiveness. This may well reduce market demand for their products and decrease the customer acceptance of the products (Cui et al. 2006). Consequently, such firms would be less likely to achieve a competitive position in the global marketplace.

Thirdly, the results indicate a number of important implications for managers who aim to create the most successful organisational climate for supporting individual innovativeness. Innovative climate (as an internal support factor) has been recognised as a core prerequisite for enhancing the innovation capability of a firm (Castro et al. 2013). It has been suggested that within a firm an ideal climate to facilitate innovation capability is one that can create a positive cognitive (psychological) basis for individuals to innovate (Scott &

Bruce 1994). This study provides a practical tool in terms of recommendations for managers who seek to enhance the health of their innovative climate practices. The study findings provide two significant indicators that have been associated with improving the innovative climate within a firm. These are: advanced training as a formal learning factor and organisational learning as an informal learning factor. Therefore, in order to create an effective climate for innovation within a firm, managers should exert efforts to strengthen the learning activities (advanced training and organisational learning) by building effective structures, programs and systems where these learning activities are increased. To enhance the innovative climate necessary for innovation capability, managers should also be more encouraging and supportive, supplying motivation, sufficient resources, rewards systems, formulating an appropriate decision-making policy and fostering productive interpersonal relationships, and consolidating progress made.

5.5 Limitations and Future Research

Despite the theoretical and practical contributions that this study has made, they are subject to a number of limitations which provide opportunities for future research and should be noted.

Firstly, a general limitation of the current study is that a cross-sectional research method where all the variables were measured in the population at one time is employed. This limitation may reduce the possibility of drawing firm conclusions regarding the directions of causality implied in the model (Shklovski, Kraut & Rainie 2004). Thus, the causal relationships posited between variables must be concluded with caution. The future research can test the effective causal inferences of models with employing longitudinal data (Davidsson et al. 2010). For example, understanding of how transformational leaders affect their employees' behaviour for radical innovation outcomes could perhaps progress a step further when such behaviour is examined in a longitudinal study that produces reliable longitudinal data. A longer interval between instrument presentation would allow for relationships to develop, changes to occur and be more accurately observed. Therefore, the adoption of the longitudinal research method is required to more sufficiently examine the causal effect of transformational leadership on radical innovation activities since large firms may expand, address new challenges or respondents' attitudes may change over time. It is, therefore, necessary to suggest that future research can address this limitation by utilising the longitudinal research method in order to gain richer and more reliable data. This could be supplemented with data obtained from firms' reports or longitudinal industrial databases that might indicate innovation outcomes.

Secondly, as dependent and independent data were collected from the same source by utilising the same method, CMV was considered a potential concern in this study (Avolio et al. 1991). Therefore, several actions were undertaken to avoid CMV in the data. These actions included deriving the measurement instrument from past research and modifying each item to fit the study. This modification was reviewed by several participants as well as refined through a pilot study to remove any possibility of ambiguity or confusing questions. However, the results of EFA indicated the existence of CMV in the data. As shown in Table 4.20 (p. 150), the variance explained by the first factor is 59.24%. To safeguard the study from CMV, research has suggested a threshold limit for the first fixed factor be less than 50%. But in this study the variance explained by the single factor exceeds the threshold limit by 9.24%, indicating the presence of CMV in the data. Various researchers have suggested that it is better to address common method bias in the research to protect the findings from contaminated data (Craighead et al. 2011). It has been suggested that there are two main ways to control for CMV, namely procedural remedies and statistical remedies (Podsakoff et al. 2003; Podsakoff, MacKenzie & Podsakoff 2012). This study embraced statistical remedies and CFA was performed to examine and control the severity of CMV in this study. Through CFA analysis, CMV has been controlled and has only a limited effect. Thus, this limitation can be addressed in future studies by looking at incorporating multiple sources of respondents (for example, 15 or 20 large firms rather than 7) or by using multiple research methods to successfully overcome this limitation.

Thirdly, from a methodological point of view, the sample of firms could be a potential issue. This study concentrated exclusively on individuals' perceptions (237 employees) in seven large firms in Saudi Arabia only. Although the seven sample firms were the most powerful industries in terms of their ability to produce radical innovation and participants were qualified and each in a position to effectively evaluate the behaviour of their firms, it is not adequate to conduct a detailed analysis for detecting significant results at the organisational level. Therefore, it is desirable to explore how variables at the organisational level and individual level interact in affecting radical innovation in large firms. Hence, future studies should be based on larger sample sizes, thus permitting more powerful hypotheses tests.

Fourthly, since the sample of the current study was comprised of only seven large firms from four different sectors (Oil and Gas, Petrochemical, Medical and Food Production) in Saudi Arabia alone, the generalisability of the findings could be limited. The limited number of organisations and industries precluded the use of the more sophisticated approach of hieratical linear modelling (Raudenbush & Bryk 2002) than the traditional approach adopted in this study to account for possible dependence of observations between individual-level constructs and firm & industry-level control variables. To maximise the generalisability of this study, the researcher of current study has already sought to identify the most powerful industries in terms of their ability to produce radical innovation. In addition, to obtain valid and reliable results, participants included only employees (e.g., managers, supervisors and scientists) who were working in innovative activities in their firms and with first-hand knowledge regarding innovation processes. Therefore, participants were qualified and in a position to effectively evaluate the behaviour of their firms (or their strategic business unit) with regard to its attitude towards radical innovation and the relevant effective variables.

To overcome these limitations, and cross-validate our findings, it is recommended for the future research that the current study is replicated in other countries (characterised by diverse national traits). For instance, consideration should be given to undertaking research in the Arabian Gulf Countries or in some Middle Eastern countries which are regarded as emerging markets and achieving remarkable progress in terms of economic growth and innovation. Moreover, the findings would be more likely to be generalised if the study is replicated in varied industries and across a wider population. To account for possible dependence of observations between individual-level constructs and firm and industry-level control variables, future studies should collect data from more firms and industries to allow the use of the more sophisticated approach of hieratical linear modelling (Raudenbush & Bryk 2002). This would further improve the current knowledge in this area and increase our understanding regarding the effect of transformational leadership and advanced technology on radical innovation in large firms as well as to reconfirm the conclusions made in the current study.

Finally, while this study examined the influence of both transformational leadership and advanced technology on radical innovation as an outcome, the study does not address to what extent organisational radical innovation and other innovative components contributes to organisational performance. Although earlier studies have confirmed strong links between radical innovation and organisational performance (e.g., Aagaard 2017; Perra, Sidhu & Volberda 2017; Agostini & Nosella 2017), this study draws attention of future research to the need for measuring and addressing the indirect effect of innovative climate and advanced training on organisational performance and so provide a richer understanding of the area and add credence to the findings of the study.

5.6 Conclusion

The current study has developed a model at the individual-level to expand our understanding regarding the effects of transformational leadership as a 'human factor' and advanced technology as a 'machinery factor' 'in parallel' on radical innovation. The model was developed from the review of the existing literature on the constructs related to the tested model and shows the expected relationships that shape the basis of the fourteen hypotheses of the study. The results of the present study provide empirical evidence that transformational leadership (as a human factor) and advanced technology (as a machinery factor) are two significant contributors for successful radical innovation in large firms, whereas the constructs (namely advanced training, organisational learning, innovative climate and innovation capability) are mediating factors in its production. Furthermore, the findings indicate that radical innovation might not be achieved if a firm does not have distinctive capabilities (including openness, integration and experimentation capabilities) in all relevant aspects.

Since the large firms have become susceptible to their competitors, they must constantly emphasise the means to sustain a steady flow of radical innovations by identifying suitable conditions and capabilities that can enable them to understand and support the key drivers to produce this type of innovation. The study provided a number of implications for practice and can assist managers in large firms in making strategic decisions that support them to navigate their radical innovation in a better direction. Finally, the limitations of the study have been identified and a number of recommendations have been provided for future research to extend the findings and reconfirm the conclusions made in the current study. It is hoped that this study has contributed toward a broader-level understanding of how radical innovation can be encouraged in rapidly changing environments for global competitiveness within the specific sphere of large firms.

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APPENDICES

Appendix A: CONSENT FORM FOR FOCUS GROUPS

I ____________________ agree to participate in the research project titled **Transformational leadership and advanced technologies on radical innovation: Advanced training, organisational learning, innovative climate and capacities in large firms** being conducted by Wafa Ashoor (wafa.a.ashoor@student.uts.edu.au, mobile: +61   University of Technology, Sydney CCW Building | PO Box 123 Ultimo| NSW 2007) of the University of Technology, Sydney for her degree of Doctor of Philosophy.

I understand that the purpose of this study is to identify and investigate transformational leadership practices that achieve innovation in large Saudi Arabian firms.

I understand that I have been asked to participate in this research because I have valuable local knowledge and insight on the topic and that my participation in this research will involve participation in a group discussion which may take anywhere between 45 minutes to 60 minutes. I understand that I may feel inconvenienced or uncomfortable about some of the issues raised. However, I am also aware that I may choose not to answer a question and can also choose to use a pseudonym to protect my identity.

I am aware that my participation in this research is voluntary and I can withdraw anytime, and any data associated with my participation in the group discussion will be destroyed if I request so. Also, I am aware of my right to request to see transcripts of my own participation before any detailed analysis is concluded or published.

I am aware that I can contact Wafa or her supervisor Dr. Karen Wang if I have any concerns about the research. I also understand that I am free to withdraw my participation from this research project at any time I wish, without consequences, and without giving a reason.

I agree that Wafa has answered all my questions fully and clearly.

I agree that the research data gathered from this project may be published in a form that does not identify me in any way.

____   ____/____/____

Signature (participant)

____   ____/____/____

Signature (researcher or delegate)

NOTE:

This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer (ph: +61 2 9514 9772 Research.Ethics@uts.edu.au) and quote the UTS HREC reference number (**2015000117**). Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

Appendix B: Online Questionnaire Survey

Wafa Ashoor
PhD Candidate
School of Management
University of Technology, Sydney
PO Box 123, Broadway NSW 2007
UTS HREC reference number: 2015000117

January 2016

Dear Participant

You are invited to participate in a study titled "**How transformational leadership and advanced technologies foster radical innovation: The role of advanced training, organisational learning, innovative climate and capabilities in large firms**". This study is being conducted by Wafa Ashoor from the Business School at The University of Technology, Sydney (UTS) and investigates how various organisational factors influence on innovation capability for global competitiveness in Saudi's large companies.

In this study, you will be asked to complete an electronic survey anonymously. Your participation in this study is voluntary and you are free to withdraw your participation from this study at any time. The survey should take only 15 to 20 minutes to complete. No single respondent will be identified and all answers will be numerically coded and statistically. Archived data will be accessible only to the supervisors and the researcher; and its results will be analysed as a whole rather than on an individual basis.

If you have any questions regarding the survey or this research project in general, please contact me via the phone number given below or Email: wafa.a.ashoor@student.uts.edu.au or my advisor Dr. Karen Wang, at UTS on (+612 95143577) or Email: Karen.Yuan.Wang@uts.edu.au.

By completing and submitting this survey, you are indicating your consent to participate in the study. Your participation is highly appreciated.

Thank you very much for your contribution!

Yours sincerely,

Researcher's Name: Wafa Ashoor, Doctoral Candidate, UTS

Note: This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer (ph: +61 2 9514 9772, Research.Ethics@uts.edu.au) and HREC reference number **2015000117**. Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

How transformational leadership and advanced technologies foster radical innovation: The role of advanced training, organisational learning, innovative climate and capabilities in large firms

- The information you provide in this questionnaire is definitely anonymous, and, only the researcher, who must follow the ethical code, can access it. Also, it is technologically secured under the specific username and password for the researcher's access only.

- Please answer all questions on this questionnaire reflecting your actual views to make your questionnaire valid. Please check the box that best describes "**how things actually are**" rather than on "**how things ought to be**" in your company.

- Each of the following eight sections (1-8) has specific instructions. Please read them carefully before answering the questions.

- Your completed questionnaire will contribute to significant research on radical innovation performance in large companies, particularly in Saudi Arabia.

- I highly appreciate your help to complete this questionnaire.

Section 1: The following questions are related to your perception of your leader (senior manager /director). Please choose the appropriate number for each item which reflects your actual view and where 1 means 'very low' and 7 means 'very high'.

1= very low 7 = very high

My unit leader:

1.1	Supports innovation by making sure that available resources flow smoothly to innovation projects.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1.2	Makes long-term investments in technology, manufacturing, etc., to support ongoing innovation.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1.3	Gives clear feedback on new innovative ideas.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1.4	Articulates a vision of innovation for our company.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1.5	Has a clear sense of where he wants us to be in the future.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1.6	Encourages new initiatives.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1.7	Pays explicit attention to innovation and its role in future development.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1.8	Supports innovation by ensuring that structure, processes and other organisational mechanisms support the innovation teams.	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Section2: This section is about the organisational learning in your company. Please select the appropriate number which reflects your actual view.

1= strongly disagree 7= strongly agree

2.1	Our company has acquired and shared much new and relevant knowledge that provides competitive advantage.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
2.2	Employees have acquired some critical capacities and skills that provide competitive advantage.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
2.3	Organisational improvements have been influenced fundamentally by new knowledge entering the company (knowledge used).	**1**	**2**	**3**	**4**	**5**	**6**	**7**
2.4	Our company is a learning organisation.	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Section3: This section is about the emphasis of your company's strategies in providing training programmes. Please choose the appropriate number which reflects your actual view.

		1= strongly disagree 7= strongly agree
3.1	Employees were given enough information during the training for the innovation.	**1 2 3 4 5 6 7**
3.2	The training programmes for the innovation were given to employees throughout our company (inside the company).	**1 2 3 4 5 6 7**
3.3	Training was readily available to employees who want to learn more about the innovation.	**1 2 3 4 5 6 7**
3.4	The training employees received related to the innovation was adequate.	**1 2 3 4 5 6 7**
3.5	Our company provides sufficient overseas training programmes for the innovation such as conferences or seminars.	**1 2 3 4 5 6 7**

Section4: This section is about the technology in your company. Please select the appropriate number which reflects your actual view.

		1= strongly disagree 7= strongly agree
4.1	We use sophisticated technologies in our new products development.	**1 2 3 4 5 6 7**
4.2	Our new products always involve state-of-the-art technology.	**1 2 3 4 5 6 7**
4.3	We actively solicit and develop technologically advanced new products.	**1 2 3 4 5 6 7**
4.4	Technical innovation, based on research results, is readily accepted at our company.	**1 2 3 4 5 6 7**

Section 5: This section is about the work environment in your company. Please select the appropriate number which reflects your actual view.

		1= strongly disagree 7= strongly agree
5.1	Our unit leader trusts people to take work-related decisions without getting permission first.	**1 2 3 4 5 6 7**
5.2	The reward system in our company encourages innovation.	**1 2 3 4 5 6 7**
5.3	Our company's ability to function creatively is respected by the leadership.	**1 2 3 4 5 6 7**
5.4	Assistance in developing new ideas of employees is readily available in our company.	**1 2 3 4 5 6 7**
5.5	There are adequate resources devoted to innovation in our company.	**1 2 3 4 5 6 7**
5.6	There is adequate time available to us pursue creative ideas.	**1 2 3 4 5 6 7**

Section 6: This section is about the innovation capability of your company. Please select the appropriate number which reflects your actual view.

		1= strongly disagree						7= strongly agree
	Openness capability: Our company							
6.1	Participates in industrial networks such as industrial associations, standard organizations and industrial forums.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
6.2	Invites scientists and gurus to predict the future of industry.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
6.3	Has the high level of cooperation with universities/research institutes, to develop brand new ideas.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	Integration capability: In our company							
6.4	Knowledge gained in previous projects is applied to new projects.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
6.5	Cross-functional learning and fertilization are encouraged.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
6.6	Technology capabilities, new product development and marketing, are upgraded and integrated.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	Experimentation capability: In our company							
6.7	New methods and tools are developed to improve R&D performance.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
6.8	New proven concepts are commercialised into market.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
6.9	New ideas are adopted and developed as reliable products.	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Section 7: The following questions are related to the innovation results has your company achieved in the last three years. Please select the appropriate number which reflects your actual view.

Radical innovation: (significant change) projects over the last 3 years:

		1=Strongly Disagree						7=Strongly Agree
7.1	Introducing the products has meant significant changes in our production process.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
7.2	We are well known by our customers for radical product innovations.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
7.3	The number of radical product innovations introduced to the market by your company rose in the last three years.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
7.4	Compared with our competitors, our products are based on a significantly different technological solution.	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Section 8: The following questions are about your personal background. Please select the appropriate response:

1. What is your gender?

1. Male
2. Female

2. How old are you?

1. Less than 30
2. 30-39

3. 40-49
4. 50-59
5. 60 and above

3. Years of working in the current company:

1. Less than 2 years
2. 2-5 years
3. 5 to 10 years
4. More than 10 years

4. Industry type:

1. Oil & Gas
2. Petro Chemicals
3. Food Producers
4. Construction
5. Telecom
6. Pharmaceuticals
7. Mining

5. Number of employees in your company:

1. 200 – 4,000
2. 4,001–8,000
3. 8,001–24,000
4. 24,001–200,000

6. Number of R&D personnel in your company:

1. Less than 20
2. 21 – 50
3. 51 – 200
4. More than 201

7. Your Position in the company:

1.Senior Management (Director)
2. Middle Management (Manager)
3. Assistant Manager
4. Supervisor
5. Engineer
6. Senior scientist
7. Scientist
8. R&D employee
9. Other

8. Please indicate the highest level of education you have completed:

1. Technical/Vocational Training
2. Professional Degree
3. Bachelor Degree
4. Master Degree
5. Doctorate Degree

END OF SURVEY
THANK YOU VERY MUCH FOR YOUR PARTICIPATION