Management of innovation in an engineering department in the broadcast industry

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DECLARATION

I Teboho Aubrey Phalatse declare that this dissertation is my own work. It is being submitted for the Degree of Magister Philosophiae in Engineering Management at the University of Johannesburg. It has not been submitted before for any degree or examination at any other University. I further declare that all sources cited or quoted are indicated and acknowledged by means of a comprehensive list of references.

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ABSTRACT

Innovation management in the broadcasting industry is a critical component of television station profitability and survival given the rapid rate of technological change as well as increasing competition intensity in this industry in South Africa. The study surveyed a sample of 66 engineers, technical managers and senior managers from South Africa's public and private television stations for their perceptions on the innovativeness of their organisations, the internal and external factors of innovation and how effectively these were being managed and the measures that can be taken to improve innovation management in their respective stations. This data was collected through convenience sampling and analysed using descriptive statistics and Chi-square tests of association. The sample associated the following internal factors with highly innovative organisations: an innovation-centred business strategy; the availability of adequate financial and technical resources to support innovation; highly skilled and experienced staff and a staff reward system that rewards innovation. The external factors associated with highly innovative organisations were responses to new technological changes by competitors and new technological expectations by customers. The study recommended a framework that considered the above factors as a possible guide to innovation management in addition to the development of comprehensive innovation strategies, keeping motivated teams and rewarding innovativeness.

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DMP	Digitalisation Migration Programme
DOI	Diffusion of Innovation
DTT	Digital Terrestrial Television
GTI	General Theory of Innovation
HD	High Definition
HDTV	High Definition TV
IM	Innovation management
IPTV	Internet Protocol TV
MVPD	Multichannel Video Programming Distribution
NTSC	National Television System Committee
OTT	Over-the-Top
PAL	Phase Alternating Line
SABC	South African Broadcasting Corporation
SDTV	Standard Definition TV
TV	Television

CHAPTER 1 INTRODUCTION

1.1 Introduction and Background

A broadcast engineering department plays an integral part in innovation-related change management in television (TV) stations (Obot and Inwang, 2017). In broadcasting, innovation occurs along a chain of value activities whose primary goal is to distribute audio and visual content of quality to the viewers. These value activities, according to Debande (2001) and Plum (2014), are content creation and aggregation, multiplexing, distribution, transmission and reception. The efficiency and effectiveness of each value chain activity affect the overall quality of the presentation to the viewer (Fernández-Quijada, Bonet, Candel and Arboledas, 2015).

The television broadcasting value chain does not function in isolation (Plum, 2014). It is influenced by external and internal or organisation specific events, issues and processes (Debande, 2001). Similarly, innovation within broadcasting engineering departments is also a function of both internal and external forces that include market-related, technological and regulatory external forces (Darji, Mkwanazi and Njisane, 2016). Internal forces that affect this innovation include organisational strategy, resources, culture and size amongst others.

Innovation also involves several independent stakeholders whose actions affect or are affected by technical changes that broadcasting departments may bring (Plum, 2014). Figure 1.1 below shows major stakeholders in broadcasting innovation.

The stakeholders include advertisers, viewers, content providers, regulators, equipment manufacturers, employees, amongst others (Plum, 2014). Thus, the interaction of various stakeholders, value chain activities and internal and external forces affecting broadcast engineering, point towards the need for effective management in the attainment of innovation-related goals.

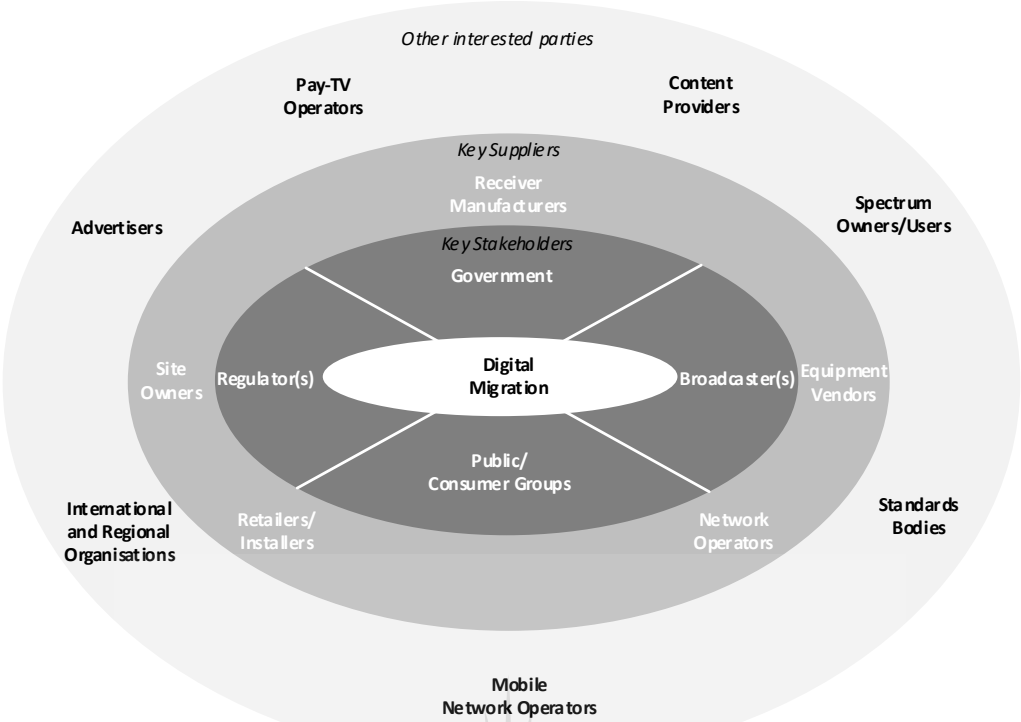

Figure 1.1: Broadcasting innovation stakeholders (Plum, 2014:3)

1.1.1 The South African television broadcasting environment

The South African broadcasting engineering section consists of engineers working with various types of production, distribution and maintenance systems. Overall, TV broadcasting in South Africa churns output on 300 channels. This represents a significant growth in the number of channels, as shown in Figure 1.2 below:

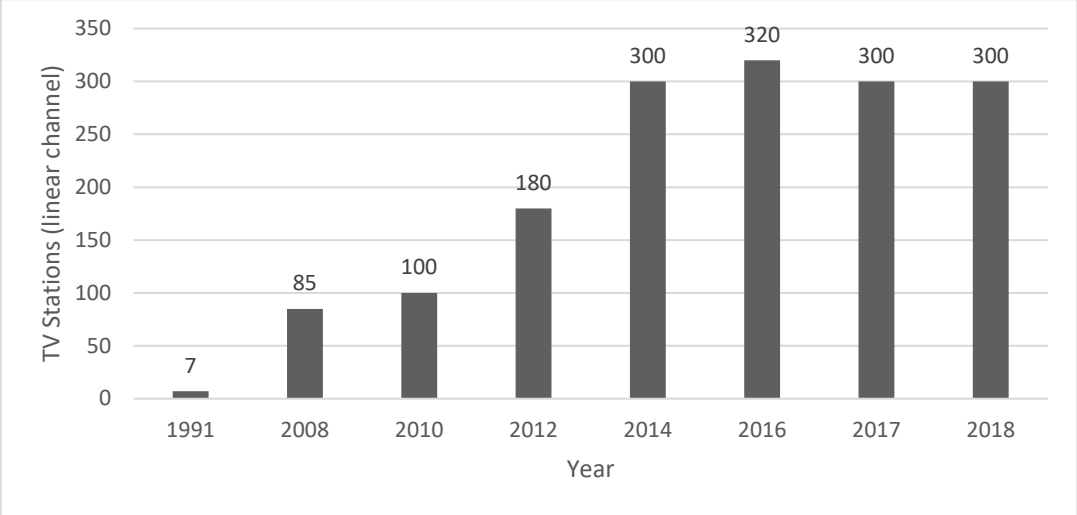

Figure 1.2: Television channel growth – South Africa (OMD, 2018:5)

The number of television stations legally accessible to South Africans has seen tremendous growth from 7 in 1991 to a peak of 320 in 2016 before decreasing back to 300 (OMD, 2018).

The 300 channels above are spread over 12 registered TV broadcasting stations. These stations are shown in Table 1.1 below.

Table 1.1: Registered TV broadcasting stations - South Africa (OMD, 2018:7)

Station	Ownership/language	Comment
SABC1	SABC All official languages	Mainly Free-to-air, also on digital channels
SABC2	SABC All official languages	Mainly Free-to-air, also on digital channels
SABC3	SABC All official languages	Mainly Free-to-air, also on digital channels
SABC Group		
eTV	eTV Mainly English	Mainly Free-to-air, also on digital channels
kykNET	Multichoice Afrikaans	Digital pay TV station. Broadcast on DStv platform.
MNet	Mnet Mainly English	Digital (plus some analogue) pay TV station. Broadcast on DStv platform.
Mzanzi Magic	Multichoice Afrikaans	Digital pay TV station. Broadcast on DStv platform.
Viacom Group	Viacom English	Includes MTV, Comedy Channel, BET. Broadcast on DSTV platform.
DStv	Multichoice Mainly English	Digital satellite paystation, over 170 channels plus 100 audio and radio offerings. Over 6.4m SA subscribers. 70 commercial channels sold by DStv Media Sales.
StarSat	On Digital Media Mainly English	Digital paystation, some 125 channels including Chinese, Indian and audio services.
Open View	eMedia Mainly English	Free digital service, 17 channels plus 8 radio services.

There are four broadcasting stations owned by the state, these being South African Broadcasting Corporation (SABC) 1 to 3 and SABC Group. According to OMD (2018), they have the highest level of viewership with the SABC Group, having an average weekly viewership of 22.6 million. Privately owned stations

include ETV, Kyknet, Mnet, Mzansi Magic, Viacom Group, DSTV, StarSat and Open View. These 12 stations apply different types of broadcasting and business models as well as technologies.

Some stations are free-to-air meaning that their signal is not encrypted and anyone with TV receiver can watch them. These include all SABC channels and eTV. Most are subscription-based where viewers pay a subscription fee to access them like DSTV, Mzansi Magic, Kyknet and StarSat. There is also a free digital subscription station – Open View. Generally, most stations that broadcast their content independently also provide access to their stations through Multichannel Video Programming Distribution (MVPD) stations (Pizzi and Jones, 2014) such as DSTV and StarSat. Thus SA TV stations can also be looked at from an independent airing or contractual airing via an MVPD.

Some TV stations used analogue signals to transmit their content. Most channels utilise different levels of digital signals in line with the Digitalisation Migration Programme (DMP) that was launched by the Department of Communications in 2015. Technological innovation in TV broadcasting has also resulted in internet broadcasting and mobile broadcasting as growing trends in the South African broadcasting environment. Internet broadcasting innovations have exposed South Africans to more than the 300 officially available channels to thousands of stations of various typologies and intentions. This points to a broadcasting environment with a high level of competition for both viewership and advertisers, where broadcasting engineers have an important part to play in ensuring that stations are innovative enough to remain competitive.

As Figure 1.3 below indicates, the many stations available to South Africans can be classified into three main groups, that is, public broadcasters, commercial broadcasters and community broadcasters (Department of Telecommunications and Postal Services, 2014).

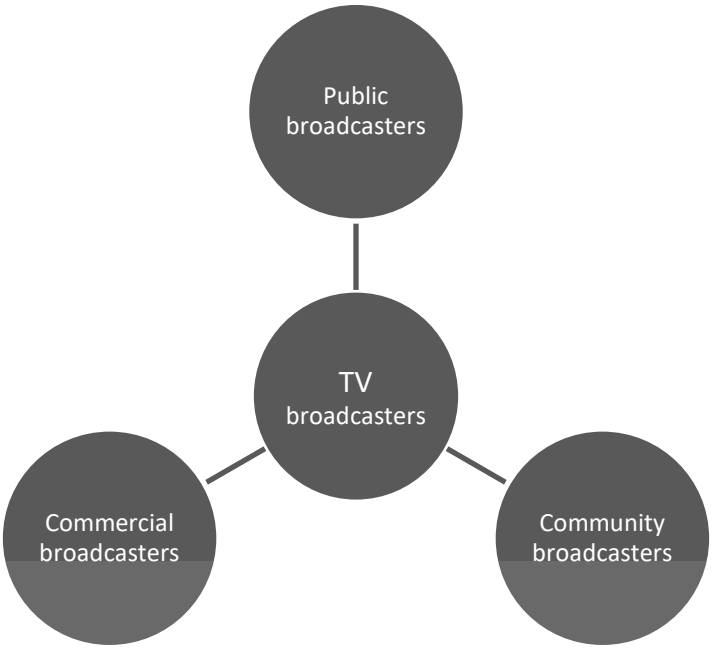

Figure 1.3: Three-tier TV broadcasting system in South Africa (Department of Telecommunications and Postal Services, 2014:56)

Public broadcasters are owned by the state and operate on a free-to-air basis (anyone with a television can receive a signal from these). Commercial broadcasters such as StarSat and DSTV mainly use subscription business models where viewers receive a signal upon payment of a fee. A new concept where digital satellite commercial TV is available from Open View. Community broadcasters appeal to particular geographic communities with content that is expected to be of relevance in that community. The above three categories of TV broadcasters are, however, interlinked. Public broadcasting stations and community stations are also distributed via commercial broadcasters (Department of Telecommunications and Postal Services, 2014).

1.1.2 Broadcast engineering departments

In South Africa, a typical broadcast engineering department is responsible for the designing, operation, maintenance and repair of the technical aspects used for visual and audio content production, recording and distribution (Ferguson, 2007). Pizzi and Jones (2014) further state that a progressive engineering department ensures the efficiency and effectiveness of content distribution by optimising existing technologies.

It is also responsible for updating and upgrading broadcasting equipment to ensure relevance with market expectations (Cavell, 2017).

Swan (2017) asserts that modern broadcasting engineering departments go beyond technical operations and play a significant role in strategic management. They are responsible for contributing information on how stations can improve competitiveness and profitability. In Swan's view, they also interact with business departments in mapping overall station strategies. Swan (2017) presents a typical organisational structure for a broadcasting engineering department shown in Figure 1.4 below.

The structure below shows four significant areas of broadcasting engineering. These are production, transmission, control and information technology (Swan, 2017). The structure also puts chief engineers as departmental heads in broadcasting engineering departments. Other scholars have also identified broadcasting engineering departments staff as video and audio operators, field technicians, transmission operators, quality control technicians, amongst others (Ferguson, 2007).

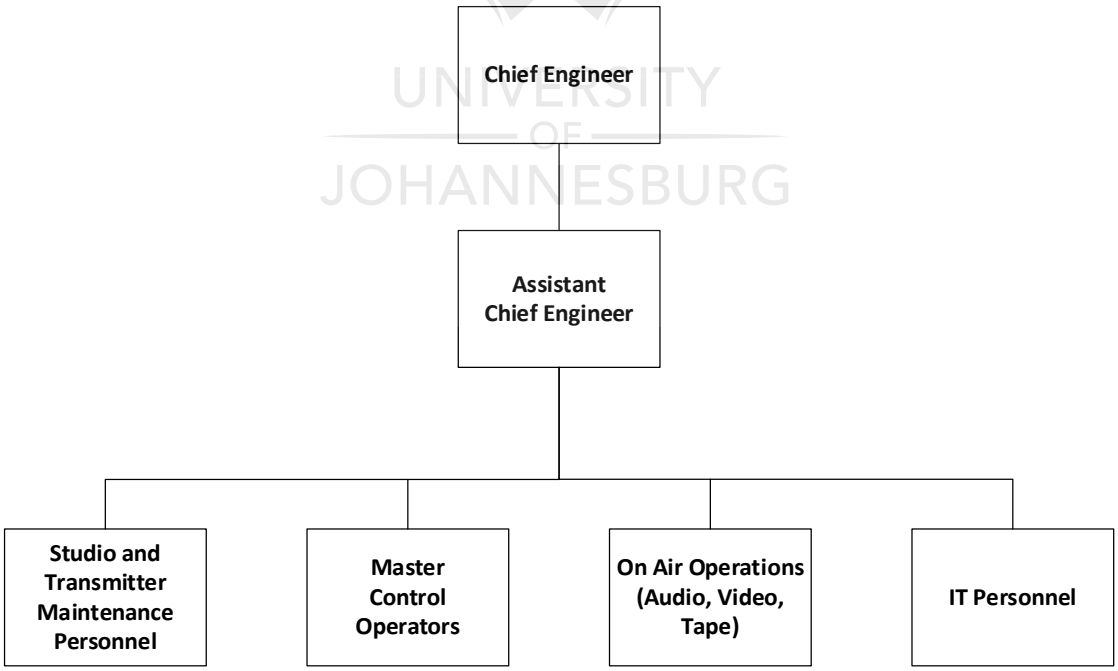

Figure 1.4: A typical broadcasting engineering department organisational structure (Swan, 2017:208)

1.2 Problem Statement

Innovation in an engineering department of a television broadcasting station is crucial for ensuring quality production output, which in turn increases viewer and advertiser satisfaction, enhances station competitiveness and supports profitable growth. Lack of innovation within the engineering department can lead to client dissatisfaction and a decline in station competitiveness (Storsul and Krumsvik, 2013). Technology within the television broadcast industry changes rapidly and thus requires the engineers to be up to speed with new methods, techniques, processes and systems (Gershon, 2017). Engineering teams can fall behind when it comes to being innovative, and this can lead to organisational decline. To facilitate innovation, adequate knowledge of the efficient management of innovation is essential.

In South Africa, television station innovation has become an indispensable necessity due to various paradigm changes in broadcasting technology and consumer preferences environments. Firstly, the television broadcasting environment has seen a rapid increase in mainstream television stations. Between 2000 and 2018, South Africans had access to over 120 television stations through free-to-air and subscription platforms. While free-to-air channels have remained static, subscription television has had the effect of increasing television stations that South Africans have access to. Subscription television directly exposes local stations to global competitions, thus puts pressure on them to keep up with technological change.

Secondly, the gradual integration between broadcasting and information and communications technology or digital convergence has resulted in further competition between television stations and two types of online video channelling systems (Gershon, 2017). The first is conventional television stations that have gone online globally offering their content. The second is formally structured online video content stations such as Netflix and the third is less formal social media streaming platforms such as YouTube. These are considered as disruptive technologies to conventional television, and as such, they require television stations to technologically adapt to stay relevant (Zotto and van Kranenburg, 2008).

Thirdly, the South African broadcasting industry is undergoing a change from analogue to digital terrestrial transmission systems (Department of Telecommunications and Postal Services, 2014). The South African government champions this change under the Broadcasting Digital Migration Programme (BDM). On 2 October 2015, the then minister of communication, Faith Muthambi witnessed the first migration to Digital Terrestrial Television (DTT) in households in the Northern Cape Province (Department of Communications, 2015). Digitalisation challenges broadcasting engineers to streamline their production and transmission processes to ensure compatibility with the digitalised systems (Mvungi, Anatory and Simba, 2013). Thus, digitalisation calls for effective process innovations that make it possible for broadcasters to harness the full capabilities of DTT, including high definition (HD) content, gaming services, messaging amongst others.

Digitalisation is, therefore, a significant externally-imposed change process that is expected to affect broadcasting operations' technological and strategic processes (Mvungi *et al.*, 2013). However, the degree to which broadcasters benefit from digitalisation differs by technical and innovative capabilities of each broadcaster (Omale, Ekhaerafo and Essien, 2016). Omale *et al.* (2016) further state that already there has been significant cases of broadcasters failing to adapt to digitalisation and its innovation expectations.

Thus, various factors in the broadcasting and technological environments demand that broadcasters be innovative. These demands place pressure on innovative management processes, including the pressure to appreciate the factors that affect innovation (Storsul and Krumsvik, 2013). Failure to innovate accordingly is a risk on a broadcaster's competitive advantage and second a threat to the continuity of the entity.

Faced with the ever-changing technological environment, television stations require innovation management knowledge systems and frameworks that will enable them to first adapt to innovative change and secondly to craft the innovations that will keep them competitive. In other words, television engineering departments that oversee the technological changes need to master innovation management as one way of ensuring business survival. The

innovation management process, however, occurs in an environment where there is broad information on innovation. Television stations, however, require innovation management knowledge and frameworks that are specific to their goals, given their strategies and resources. This need necessitates a station-specific investigation that will gather the information that can be used to develop or improve the management of innovation.

The purpose of this study is to investigate how best an engineering department at a pay television company can manage innovation to attain innovation goals that will help the company produce quality output that satisfies clients (viewers and advertisers).

1.3 Research Questions

The research study aims to provide answers to the following research questions in order to achieve the research objectives:

- What factors contribute to innovation within an engineering department in the broadcast industry?
- Can an innovation management framework be derived from literature for the broadcast industry?

1.4 Research Objectives

The study seeks to determine factors that contribute to innovation within an engineering department and to mitigate the adverse effects that the lack of innovation has on engineering departments. This study also aims to deduce a process or framework for the management of innovation in an engineering department within the broadcast industry, which will enable the manager to build a forward-looking team.

1.5 Significance of Study

The study is important in identifying knowledge gaps that exist in innovation management in the engineering broadcasting area. This is important after noting that not many empirical studies have been conducted in this area.

Searching across online journals, there are a few works that closely resemble this study, and these are not from South Africa. These include a study by Fernández-Quijada *et al.* (2015) entitled *"From Rhetorics To Practice: Implementation Of Technological Innovation Within Spanish Public Service Media".* From a South African perspective, the researcher did not find an online journal addressing innovation management in broadcasting.

The research is also important for the academic community, particularly researchers and scholars with an interest in broadcasting innovation. It will provide an important source of reliably researched information thereby adding to the body of knowledge in this area.

1.6 Research Design

This study will be conducted as a case study of an engineering department at one of South Africa's major television broadcasting company. A case study was considered appropriate because of the need to collect detailed information that can be used for innovative strategies and activities at this broadcaster.

A descriptive research design will be applied using a survey strategy. A descriptive study aims at describing a phenomenon of study especially the "what", "why" and "how" type of questions (Saunders, Lewis and Thornhill, 2016; Babbie, 2017). A survey strategy samples participant from a larger population group for participation.

A sample of broadcasting engineers, managers and relevant technical experts will be drawn to respond to a structured questionnaire on innovation management. The collective data will be descriptively analysed to establish the state of innovation management at a pay television company.

The study will be conducted both as a primary study relying on data gathered from a field study and a secondary study through the review of various existing sources. As a secondary study, innovation theories, frameworks and factors will be reviewed and discussed. As a primary study, collected data will be analysed to derive answers to the two research questions.

A quantitative methodology will be applied in the study. A quantitative methodology applies scientific research principles and practices that aim to produce highly reliable, objective results from a study (Bryman and Bell, 2015). It collects numerical data or data that can be reduced to numerical form for analysis (Babbie, 2017). Quantitative methodologies have been chosen for the study because the research questions of the study require descriptive, quantitative conclusions. Large samples will, therefore, be used as per the requirements of a quantitative study, as stated by Babbie (2017).

1.7 Research Plan

The study will follow a general research plan discussed by various scholars, including Babbie (2017) and Saunders *et al.* (2016). This plan is illustrated in Figure 1.5 below.

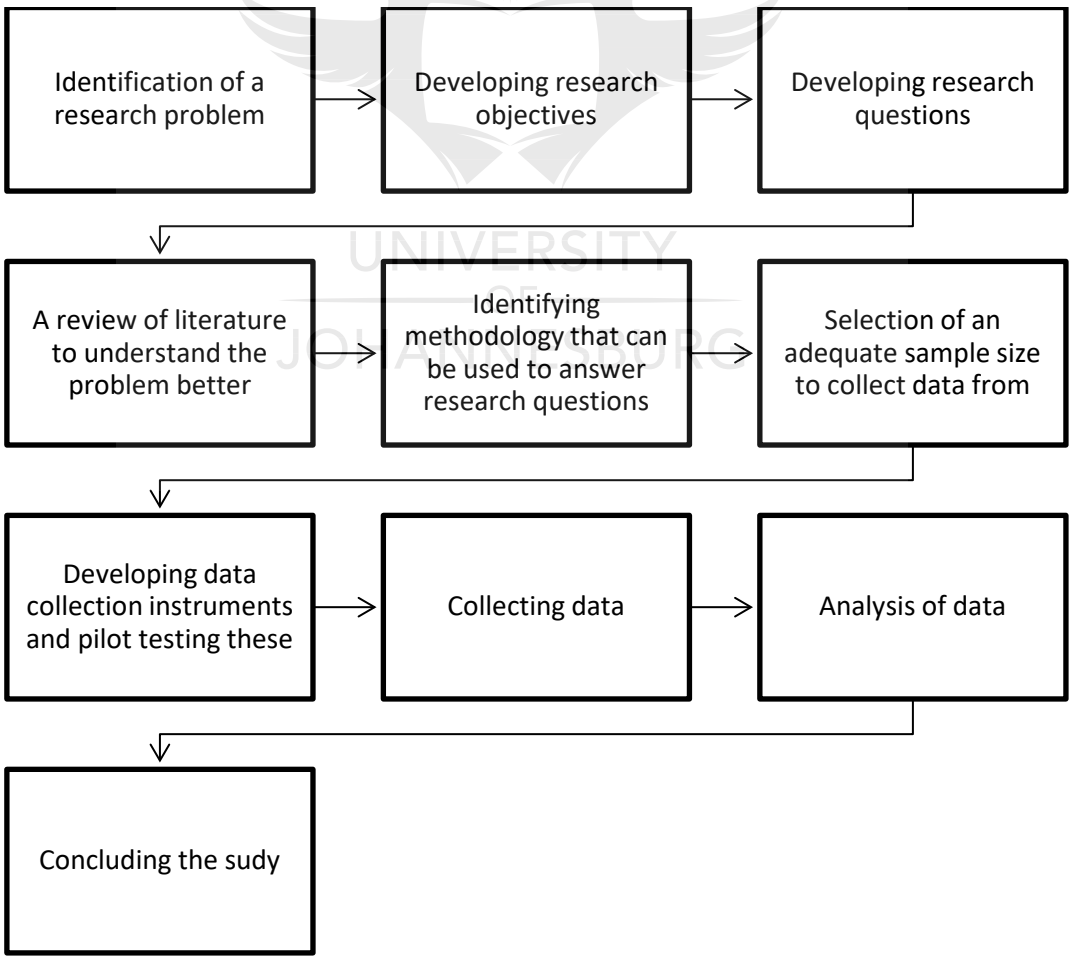

Figure 1.5: Research processes planned (Saunders *et al.*, 2016; Babbie, 2017)

The study will start by identifying a research problem and establishing research objectives and questions. It will select an appropriate research approach to address the research objectives. Relying on research design, a sample framework will be developed as well as data collection tools that will be used to gather data. After the collection of data, the results will be captured, coded and analysed before being reported. Recommendations will be made based on the outcomes of the study.

1.8 Research Report Outlay

The final research report for this study consist of five chapters. These are (excluding the first chapter):

Chapter 2: Reviews various sources that have been written on innovation management in the broadcasting engineering context and organisations in general. It draws upon four broad theories on the development and adaptation of innovative change and types of innovation.

Chapter 3: Presents the methodological processes that were followed in the empirical or field study. It discusses the research approaches followed, the research designs, sampling, data collection and data analysis.

Chapter 4: Is the statistical analysis and results presentation chapter. The results from the collected data are analysed, including the demographic data of the sample.

Chapter 5: Concludes on the findings of the study. It further gives a recommendation on the improvement and enhancement of innovation management within an engineering department of a broadcasting entity.

1.9 Conclusion

This chapter introduced the topic and subject matter of the research as the management of innovation in engineering departments. The context of the study was identified as the television broadcasting industry. The chapter briefly identified the research problem as the need to develop a framework that enables managers to manage innovation effectively. This is in the background

of increasing competition and disruptive technologies that are affecting the South African television broadcasting engineering environment. The next chapter, Chapter 2, reviews various theories and literature sources on innovation management.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

This chapter discusses the subject matters of innovation and innovation management, mainly from the broadcasting and mainstream electronic media contexts. It starts with important definitions before discussing four major theories that affect the planning, development, adaptation and implementation of innovative change. It also discusses major factors that affect innovative management, that is, organisational structure, culture, knowledge management and strategy.

2.2 Innovation Defined

Various sources define innovation as both a process and a concept. The word innovation comes from the word *innovare*, which is Latin for creating something new (Lin, 2006). Innovation is, therefore, an act of coming up with something new (Lin, 2006). As a process, Keeley, Nagji, Walters, Pikkel and Quinn (2013) define innovation as a new option that viably serves its intended purpose. They further comment that it involves the identification of situational challenges and the taking of steps to come up with a systematic and working solution and that this new option need not be an invention.

On the contrary, Corre and Mischke (2005:1) define innovation as, “an invention having at least, some market success”. They further classify success as both technological and marketing breakthroughs made by the product or process introduced. Another definition of innovation comes from Anthony (2012) who states that innovation is any intentionally meaningful change that has a measurable effect on its targeted beneficiaries. These beneficiaries could be customers, co-workers or the community at large. In Grawe’s (2009) view, innovation is a perception of intentionally-brought newness. This newness perception could relate to products, processes, practices and ideas. In agreement, Tohidi and Jabari (2012) also state that whatever change is brought about through innovation, needs not to be entirely new.

Three sets of authors above, that is, Keeley *et al*. (2013), Anthony (2012) and Corre and Mischke (2005:1) agree in the fact that innovation is poorly-defined and the term itself is losing meaning due to multiple, inconsistent and ever-changing definitions. In the above three definitions, the authors all agree that innovation comes by intention and results in greater benefits than the current situations. However, unlike Keeley *et al.* (2013) and Corre and Mischke (2005), Anthony (2012) refutes the view that an innovation has to be at least technological. In Anthony's (2012) view, innovation could be, "anything" (p1); and Keeley *et al.* (2013) state that innovation can be a product, a process, a system, an event, an action amongst others.

Innovation has also been defined from a market perspective. For instance, Baregheh, Rowley and Sambrook (2009) define it as the making and adoption of product and process changes in response to the changing environment. Harmancioglu, Finney and Joseph (2009) define innovation as the adoption of new concepts and processes in organisational systems to ensure survival and continuity.

2.3 Types of Innovation

Several types of innovation can be identified from the broadcasting and the general societal realms. While there are many classifications of innovations, Albors-Garrigos, Igartua and Peiro (2018) opine that the classification of innovation into either radical or incremental appears to be gaining more popularity in the innovation management (IM) discipline. Zotto and van Kranenburg (2008) also agree that the classification of innovation by magnitude (incremental versus radical) is generally more applied in media and broadcasting innovation disciplines. Another type of classification is whether innovation is disruptive or not (Muckersie, 2016).

2.3.1 Disruptive innovation versus sustaining innovation

Innovation is described as disruptive when it results in radical changes that alter existing market dynamics including competition, distribution channels, pricing and customer expectations (Darji *et al.*, 2016; Goodman and Dingli, 2017).

Disruptive innovation can result in the creation of new markets and the destruction of old markets (Christensen, Raynor and McDonald, 2015). Sustaining innovation improves the state of existing production processes without completely altering the market and or technological dynamics associated with a product or service (Christensen, Davidian, Foust and Kaiser, 2011). Table 2.1 below compares and contrasts the differences between sustaining and disruptive technology.

Table 2.1: Sustaining and Disruptive Innovation (Ruturi, 2016:25)

Sustaining Innovation	Disruptive Innovation
Improves or perfects broadcasting technologies, processes and services	Changes broadcasting processes, technologies and services
Improvements are focused on satisfying the current market	New markets for media and broadcasting services are created
Service fees and costs remain the same or may increase	Often results in a substantial reduction in costs
The focus is on service quality	The focus is on enhancing service accessibility and convenience
Makes use of current value chains	Uses or develops new value chains in service distribution (e.g. mobile TVs)
Results in low growth or stagnant markets	Rapidly increases market growth in media and broadcasting services

In Table 2.1 above, Ruturi (2016) generally associates disruptive innovation with the favourable market and industry changes that include improved access for products and services, lower prices and market growth. Hamid and Maulana (2017) argue that disruptive innovation may be a cost burden to the state and society as high regulation costs may be incurred in protecting the public from the unknown effects of new changes.

2.3.2 Incremental innovation

Incremental innovation involves small to moderately sized, continuous changes to production systems, processes and products (Zotto and van Kranenburg, 2008). Under incremental innovation, the business model used by business remains the same, and the business also operates the same technologies in carrying out its objectives (Albors-Garrigos *et al.*, 2018). Incremental innovation, as argued, is easy to replicate and therefore creates short term competitive advantages (Muckersie, 2016).

Satell (2017) uses the term sustaining innovation to describe incremental innovation. Incremental innovation solves small problems rather than disrupts the market and technological status. Satell (2017) asserts that incremental or sustaining technology is not disruptive. However, Kylliäinen (2018) argues that incremental innovation can be both sustaining and disruptive, just like radical innovation. Kylliäinen (2018) asserts the existence of incrementally-sustainable and incrementally disruptive innovation.

Figure 2.1 below shows Kylliäinen's (2018) classification of innovation by product and market effect:

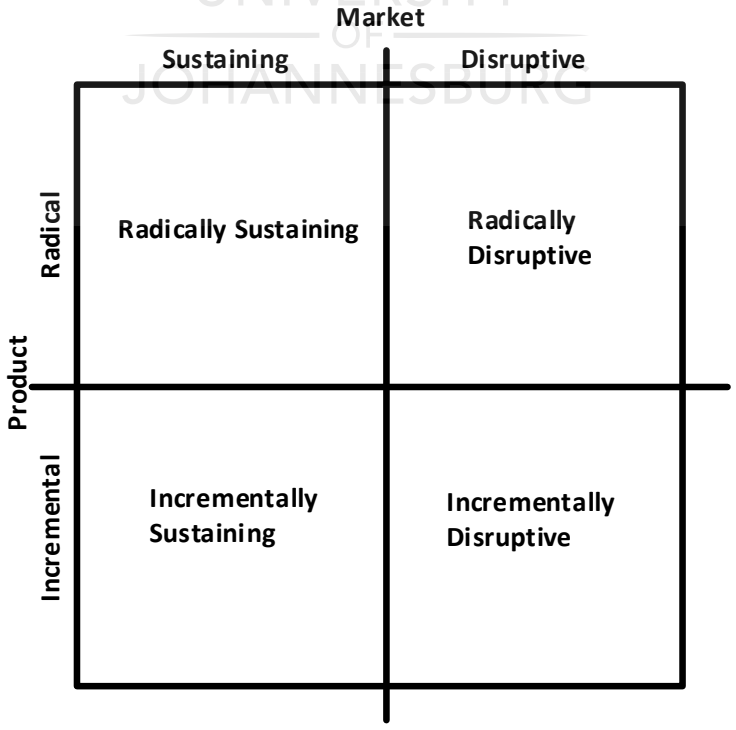

Figure 2.1: Types of innovation (disruptive/sustaining) (Kylliäinen, 2018)

Thus, sustaining and disruptive innovations can both fall under either a radical or an incremental category.

2.3.3 Radical innovation

Radical innovation involves the complete transformation of both an organisation's business model and technology used at the same time (Zotto and van Kranenburg, 2008). It is generally noted as the highest level of innovation. Radical innovation requires major capital investments and therefore carries a higher loss risk than other forms of innovation (Muckersie, 2016). The expected benefits of radical innovation are often enough to justify substantial capital investments into new technologies systems and processes (Albors-Garrigos *et al.*, 2018).

Satell (2017) indicates that all radical innovation is disruptive; that is, it leads to major, paradigm shifts in market structures and competition. Kylliäinen (2018), however, asserts that radical innovation could be disruptive or non-disruptive and still attain its objectives.

2.3.4 Breakthrough innovation

Breakthrough innovation involves changing either an organisation’s business model or technological processes but not both (Muckersie, 2016). Like incremental innovation and radical innovation, it can result in the creation of competitive advantages. Theoretically, these can be held longer than in incremental technologies but shorter than in radical innovation (Kaplan and Vakili, 2015). Breakthrough innovation also benefits from incorporating business models and technologies from other industries (Zhou and Li, 2012). An example of breakthrough innovation on the South African broadcasting landscape is the migration from analogue transmission to digital transmission. This change has not resulted in major changes in models applied by television stations although technologies used to support these models have changed. A breakthrough innovation in the media industry is also exemplified by Netflix. Already existing internet technology was applied in broadcasting while the same subscription-based broadcasting business model was being applied.

2.4 Major Innovations in TV Broadcasting Engineering

Changes in transmission mode are considered to be the backbone of all innovation in TV broadcasting (Department of Communications, 2015; Darji *et al.*, 2016). This is because, at any given time, any existing mode of transmission has got limitations on the types of technological breakthroughs it can support. Thus analogue transmission, for example, cannot support full convergence with multimedia systems and therefore broadcasters applying analogue transmission cannot utilise multimedia systems in delivering content to their viewers (Plum, 2014).

Television transmission has evolved from basic analogue that supports black and white picture transmission to highly digitalised systems that can support an unimaginable number of functions such as interactive television and mobile television (Mvungi *et al.*, 2013; Plum, 2014).

Figure 2.2 below shows the progression of TV signal transmission over time.

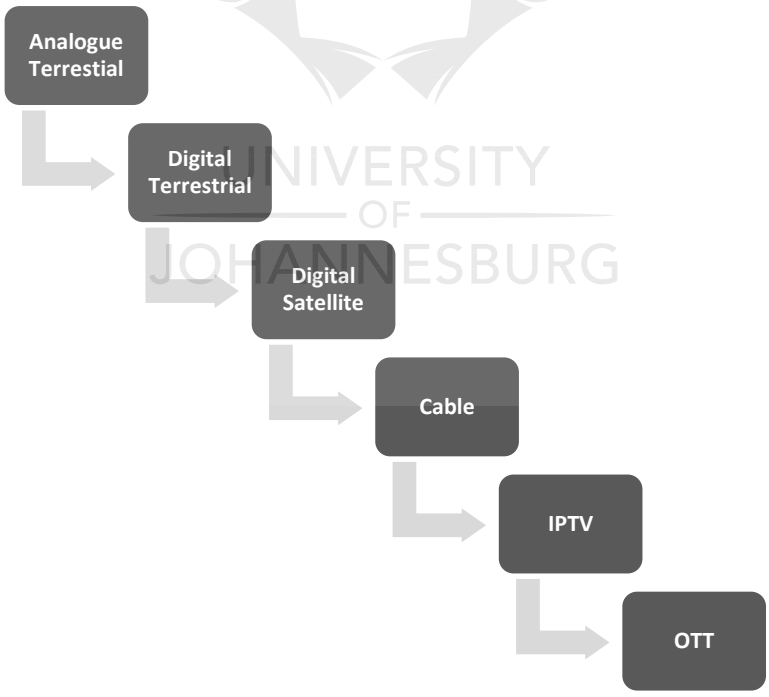

Figure 2.2: Evolution of TV signals(OECD, 2013:13; International Telecommunications Union, 2016)

Analogue transmission, which is the first mode of television signal transmission has undergone major changes from low resolution black and white signals to

National Television System Committee (NTSC), Phase Alternating Line (PAL) and Sequential Colour Avec, memoir (SECAM) in the 1970s (Pizzi and Jones, 2014). Digital TV was introduced in view of the various limitations of analogue TV. Analogue TV produced low-quality output, especially in remote areas and was more prone to interruptions from environmental forces (Department of Communications, 2015). Additionally, it could not support wide applications and innovations because of bandwidth size restrictions and its failure to be integrated with digital systems that were associated with the computer age (OECD, 2013; Pizzi and Jones, 2014).

Satellite TV is a general digital TV that is transmitted from a central source using microwave technology rather than land-based transmitters (International Telecommunications Union, 2016). Pizzi and Jones (2014) assert that both satellite and terrestrial digital television support the transmission of high-resolution output or what is termed High Definition TV (HDTV). Analogue systems still in use in South African public broadcasting systems support a low-resolution TV or Standard Definition TV (SDTV) (Malek, 2009).

Digital terrestrial TV and digital satellite TV both support the convergence of television broadcasting with various internet protocols resulting in the use of these modes of transmission in internet-based broadcasting (International Telecommunications Union, 2016). Two basic forms of internet broadcasting are commonly discussed in the literature. These are Internet Protocol TV (IPTV) where a formal broadcasting system transmits its content via the internet like Netflix and Over-the-Top (OTT) transmission (Malek, 2009; OECD, 2013). While IPTV is controlled by network providers to ensure that viewers receive quality content OTT is not. Independent content providers use OTT to transmit unregulated content over the internet. OECD (2013:15) views OTT as “the most recent and potentially disruptive development in the broadcasting industry” because of its unregulated and unsanctioned nature and because it has the lowest entry barriers into broadcasting.

Digital terrestrial TV, digital satellite TV, IPTV and OTT all support the transmission of content via mobile phones and other signal receiving portable

gadgets (OECD, 2013). This has resulted in what is also termed mobile television (Malek, 2009).

The above technologies, as alluded earlier form the backbone of broadcasting engineering. Most broadcasting equipment and systems change in response to changes in transmission modes (International Telecommunications Union, 2016). This include video and audio equipment like cameras and audio transmitters that have to be upgraded. These changes also bring opportunities to other content producers to enhance the quality of their products to appeal to a more and more demanding viewership. Within all these changes, broadcasting engineers need to ensure that their innovation management regimes enable them to adapt to change and even to introduce completely new broadcasting concepts that can be supported to new technologies (International Telecommunications Union, 2016).

2.5 Innovation Models and Theories

In the literature, various models and theories attempt to define, relate, describe and analyse the processes, types, relationships and outcomes of innovation. Some of these are briefly discussed in this section in relation to the broadcasting engineering field.

2.5.1 The general theory of innovation

The General Theory of Innovation (GTI) is accredited to Greg Yezersky (Institute of Professional Innovators, 2018). The theory was developed to bring attention to the logical path that all artificial productions take, based on the perpetual need for adaptive change or evolution.

In the GTI, Yezersky (2007) starts by defining five types of innovation from the works of Schumpeter (1934). These are new products, new methods of production, new sources of supply, the exploration of new markets, and new ways to organise a business. Innovation involves any one or any combination of the following:

- Products

- Supply Sources
- Methods
- Markets
- Business Structures/Models

The above five types of innovation, in Yezersky's (2007) view, are all systems with one specific aim – to produce a working result. As such, innovation is a process of changing the constituents of a system to bring about the desired value. The theory thus links a systems approach to innovation and describes the steps that occur in innovative change across the five types of innovation (systems) listed above. Three evolutionary laws guide innovation in addition to the five innovation types above:

1. Products, supply sources, methods, markets and business structures/models are all systems
2. Products, supply sources, methods, markets and business structures/models continuously evolve
3. Evolution of systems occur in a principal or major direction

The role of innovation is to bring enhanced effectiveness and efficiency to the systems discussed. The innovation process, along any of the systems, is not haphazard but is systematic; that is, it follows defined stages.

Figure 2.3 below illustrates innovation – which occurs across two levels, the conceptual level and the production level.

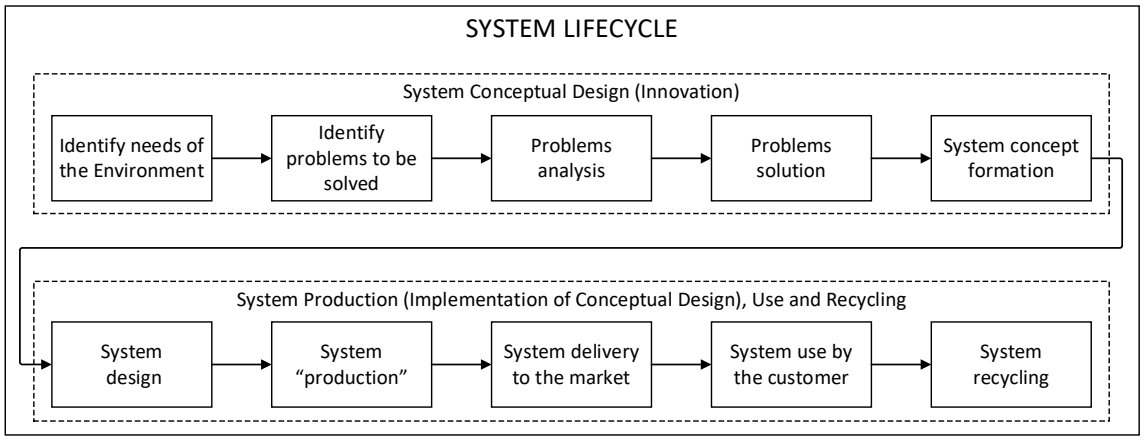

Figure 2.3: Innovation stages using the Systems Approach (Yezersky, 2007:2)

Innovation starts with the identification of needs and problems and proceeds to the production of ideas on the problem and how it can be solved; that is, the formation of a concept. From the conceptual stage, Yezersky (2007) states that the production phase where concepts are put into practice starts until output is achieved. This process is continuous in nature due to the perpetual changes in the environment. The failure to control the above stages and processes is a major cause of "inevitable growth deceleration, stagnation, loss of market share and eventual fall of the market leaders" (p3). Thus, the theory stresses the need for continuous management of innovation processes. The theory also recommends the creation of models and frameworks that can be used as application tools in innovation stating that GTI-based models will help organisations to apprehend the need and nature of change, forecast innovations needed in the future and control innovation.

a) Criticisms of the General Theory of Innovation

The GTI despite its comprehensiveness, has its critiques. One critique is Moldaschl (2010) who opines that the GTI is too general to be relevant and in addition, discusses what society already knows; that is, it is not offering any new information that did not exist before its introduction in 1988.

2.5.2 The diffusion of innovations theory

The Diffusion of Innovations (DOI) Theory is attributed to Everett M. Rogers, who established the theory in 1962. The theory seeks to explain the rate at which innovation is assimilated into society – that is, take up for practical usage (Robinson, 2009). In theory, innovation is perceived to be new to the entity adopting it, regardless of whether it has existed for years (Sahin, 2006). Innovation diffuses to society through five stages that constitute a diffusion model, that is, knowledge stage, persuasion stage, decision stage, implementation stage and confirmation stage. The existence of communication channels enables the transmission of information required for an entity to transform through the five stages. The five stages are depicted in Figure 2.4 below.

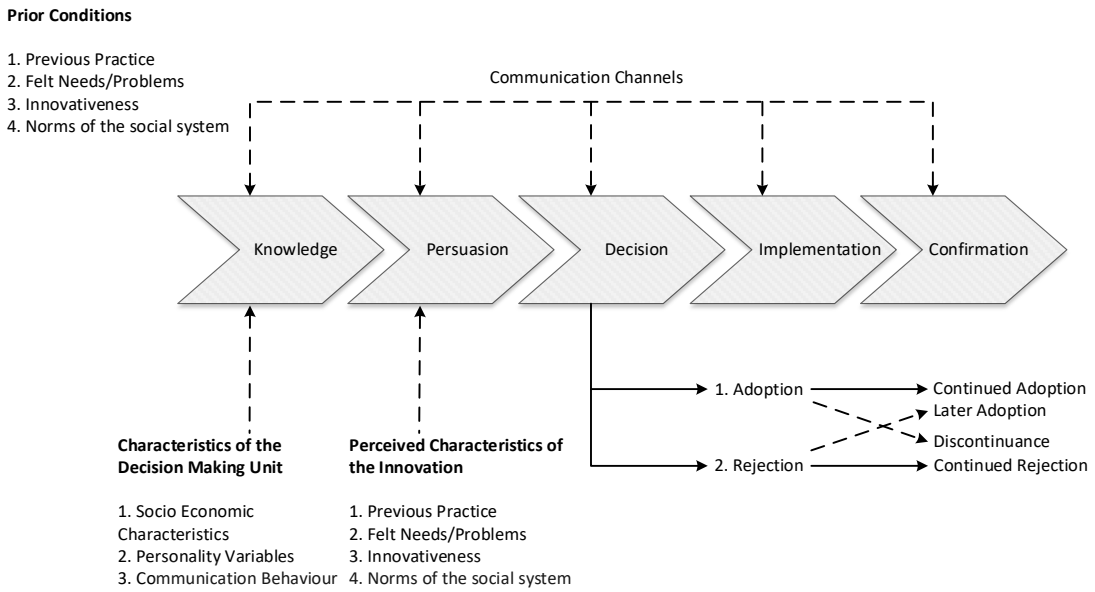

Figure 2.4: Rogers Innovation Diffusion Model (Rogers, 2003:170)

In the knowledge stage, an entity learns about an innovation and begins to question how it works, how it affects them and many other curiosity-based questions (Rogers, 2003). Once an entity has knowledge about an innovation, it becomes possible to persuade it to use or apply the innovation (Robinson, 2009). Technologies permeate society at different rates determined by five factors. These, according to Rogers (2003) are:

- Relative advantage: whether the innovation has any better merits and benefits than existing technology.
- Compatibility: whether it fits well with current systems applied by the entity.
- Complexity: whether it is conceived as difficult to simple to apply practically.
- Trialability: whether it can be tried and tested by the entity prior to full application
- Observability: whether its outcomes can be readily observed

In Roger's view, an innovation with positive attributes will be adopted at a faster rate by both individuals and organisations. Additionally as illustrated in Figure 2.5 below, the model classifies five types of adopters to any innovation (Rogers,

2003; Ashley, 2009). These are innovators, early adopters, early majority adopters, late majority adopters and lastly laggards.

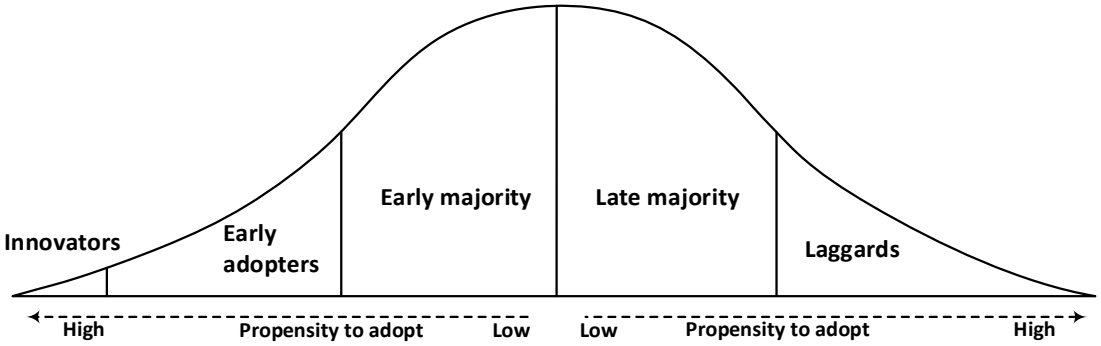

Figure 2.5: Innovation Adoption Categorisation (Robinson, 2009:5)

Innovators have a high propensity to take an innovation and generally constitute a very small percentage of the market. They are followed by early adopters and early majority adopters who apply new technology in large proportions (Rogers, 2003; Robinson, 2009). After early majority adopters, another category of the market that take the technology, albeit after strong resistance and with an element of reluctance is the late majority group and finally the laggards. The degree to which an entity is affected by the five factors that influence innovation diffusion affects the time it takes for it to finally accept and use a technology (Rogers, 2003).

In theory, the diffusion of innovation occurs in three domains, the micro-domain consisting of the individual, the meso level dealing with an organisation or social system which an individual is a part of and the macro-level associated with larger society such as a market or an industry (MacVaugh and Schiavone, 2010).

a) Implications to organisations

Organisations can fail to take advantage of new technological innovation as a result of having poor industrial intelligence. The model also stresses that innovation within an organisation can be new to the organisation, although it might have been already present in the market (Rogers, 2003). In so doing, it makes organisations aware that innovations that might solve its current problems or assist it in taking advantage of existing opportunities might already

be there in the industry (Sahin, 2006). All that is needed is to search, analyse and adapt accordingly. This is because the adoption of technology is a function of information and communication channels and time (Sahin, 2006).

Additionally, the model also makes the organisation aware of how their customers can fail to optimise its innovations fully (Sahin, 2006). It guides organisations to consider the five factors that make customers adopt the technology, in the same sense as they make it adopt new technologies in the industry (Ashley, 2009). Finally, the theory shows that innovation within an organisation can be affected by personal factors, organisational factors and market/industry factors and that organisations need to take all these into account when managing the innovation development and adaptation processes (MacVaugh and Schiavone, 2010).

b) Criticisms of the Diffusion of Innovations theory

The diffusion of innovations theory places more focus on the product than on the society, hence had been described as a push factor theory by some scholars. Focusing on the product or the innovation at the expense of the targeted entity can result in organisations failing to appreciate how the socio-cultural, personal and economic demographics of the targets impede of support innovation (Chile, 2017). Another criticism comes from MacVaugh and Schiavone (2010) who state that the theory assumes that all adoptions to innovation occur because of the market's need to maximise utility they will get from it (the innovation). Additionally, MacVaugh and Schiavone (2010) also believe that the stages and domains within which innovation is adopted are independent as assumed by the theory. The theory does not show how the various domains that affect the adoption of innovation overlap. Despite these criticisms, various scholars including Ayodele (2012), believe that the DOI is a very relevant, applicable and proven theory of innovation citing various examples of places where it has succeeded including the adoption of Polio vaccination in the eighties.

2.5.3 The disruptive innovation theory

The Disruptive Innovation Theory was developed by Clayton M. Christensen, a Harvard professor of innovation in 1997 (King and Baatartogtokh, 2015). Christensen (1997) states that established business eventually fails in the long-term not because they are not innovative, but because of the type of innovation they focus on. Established business, described as incumbents, in theory, focus their strategies and resources towards developing value for high-end markets through sustaining innovation. Sustaining innovation is the regular perfective improvements to products and services over time. While incumbents are focusing on sustaining innovation and the quest to deliver value to high-end customers, they create niche markets that are not well-served by their products. These low-end markets offer attractive entry opportunities to new companies, (referred to as disruptors) in theory to provide new products and services that meet the needs of the low-end market at a lower value but using new technologies (Christensen, 1997). Unfortunately, because the new technologies, just like with sustaining innovation, also continue on a positive perfective path that until their products and services are of such a quality that even the high-end markets that the incumbents have been concentrating on switch to the disruptors products (Christensen *et al.*, 2011).

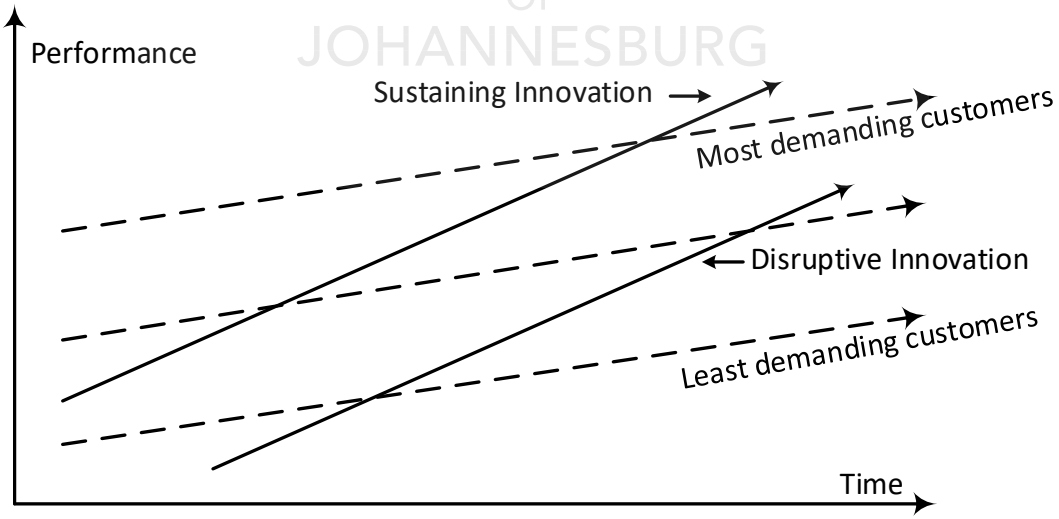

Figure 2.6: The Disruptive Innovation Model (Christensen *et al.*, 2015:49)

In the model depicted in Figure 2.6 above, it can be noted that sustaining innovations target to surpass the expectations of the most demanding

customers. The point at which disruptive technology crosses the performance expectations of the middle-dotted line (mid-value clients also targeted by the incumbent, is where disruption starts up until the disruptors product innovation trajectory crosses the high-value clients demanding high levels of performance (Christensen, 1997). At these points, disruptive technology, just like sustaining technology will be creating more performance value than is required by the client (Christensen *et al.*, 2011:7287).

a) Implications in broadcasting engineering

Disruptors eventually create conditions that change the traditional business and market model as associated with a product or service (Christensen *et al.*, 2015). In the broadcasting industry, the proliferation and growth of digital technology are considered to be a major disruptor to conventional television (Aggarwal, Arthofer, Lind, Rose, Rosenzweig and Stephan, 2016). The advent of online video streaming and sharing on-demand are reducing the dominance of television as the prime source of visual media. This is coupled with an increase in high-quality online content, the decreasing cost of producing this as well as a very innovative and supportive telecommunications network to channel online productions to consumers (Aggarwal *et al.*, 2016) – conditions described as conducive for disruptive technologies to flourish and take over (Chile, 2017). The improvement of telecommunications network speed and the growth of wired broadband solutions will continue to put market pressure on traditional broadcasting (Wessel, 2012).

The broadcasting industry has enjoyed oligopolistic structures for decades where new entrants were inhibited by various barriers including huge capital and technological outlays. The digital convergence error where telecoms, information technology and media are conglomerating into one have eroded old oligopolies, increased viewer and audience options and disrupted previously successful models challenging media houses to be more innovative than ever (Zotto and van Kranenburg, 2008). However, Wessel (2012) further projects that the disruptive effect of telecommunications is technology-driven channelling which will become more apparent in the next 15 to 20 years. During

this time, traditional broadcasting has adequate time to innovate itself in response to these changes and to possibly save itself from irrelevance.

b) Criticisms of the Disruptive Innovation Theory

One critique of the theory states that the pattern of events that are projected to occur, as shown on the model in Figure 2.6 does not resonate with what happens in practice (Denning, 2015). The theory, despite its wide popularity in both the academic and business circles, does not closely mimic reality and can therefore not be relied on (Denning, 2015). The same author also cites the argument that incumbents will continue on the same trajectory until new disruptors finally catch up and surpass them. In Denning's (2015) view, this implies that incumbents, which are companies that have existed for years, will not know how to competitively react when faced with a disruptive threat and would, "chose to die" (p1). Another set of criticisms come from King and Baatartogtokh (2015); they state that the theory relies on examples of disruptive technology that fail to justify or conceptualise its assumptions fully. Secondly, the theory lacks analytical views of possible options on how the disruptive process may be altered, for example, possible reactions of incumbents to changing the market and industry conditions and finally, the theory makes too many generalisations which still need to be tested for their applicability. Proponents of the theory, however, include Selhofer, Arnold, Lassnig and Evangelista (2012) who believe it is one of the best theories for supporting innovation policy management in many economic sectors.

2.5.4 Open versus closed innovation

Innovation management includes decisions on whether an organisation operates an open innovation system or a closed innovation system (Wallin and Krogh, 2010). Open innovation was first discussed by Chesbrough (2003), who stated that organisations could benefit by coordinating with external entities in their innovation quest. These entities included major customers, knowledge institutions and even competitors. Open innovation as a trend was supported by the high mobility of expertise, the ability to license innovations to competitors

and the growing numbers of competent co-operating partners (Chesbrough, 2003).

While open innovation appears to be trendy because of its risk-sharing effects, several barriers to it can be identified (Oumlil and Juiz, 2016). These are personal, organisational/managerial, cultural and environmental. Its weaknesses are that it does not work well when organisations are attempting to develop strong competitive advantages based on the particular innovation that is opened up (Wallin and Krogh, 2010). It is also costly to coordinate the process across various entities engaged in the innovation process and often creates workflow challenges (Ullrich and Vladova, 2016). Regardless, organisations need to invest in innovation if it is to result in solutions that will increase value to customers (Goodman and Dingli, 2017). These investments need to be made regardless of the present risks that returns may be realised much later or might never be realised at all (Goodman and Dingli, 2017).

2.6 Innovation Management

There are two broad perspectives on innovation management: the macro and the micro perspective (Bui, 2015). The macro perspective relates to innovative changes to a whole industry or market, for example, digitalisation in the broadcasting industry. On a micro perspective, innovation relates to changes by an internal adopting unit, for example, a department that is adopting a new type of audio system that has already been introduced into the market but had not been adopted by the organisation (Bui, 2015). Thus adaptation of existing technology by a department can be viewed as innovation. In agreement, Keeley *et al.* (2013) state that innovation does not necessarily have to be new. It can mean the adoption of technologies and processes that are already existing in the world but are new to a particular industry. Their agreement is, however, partial as they restrict newness to an industry.

According to Sánchez, Lago, Ferràs and Ribera (2011), innovation management is the process of bringing about economically and technically viable change in processes, methods, products and services. They further state that innovation management involved the integration of cross-disciplinary organisational functions and factors in the bringing out of targeted new change.

Birkinshaw, Hamel and Mol (2008:825) define innovation management as *"the invention of a management practice, process, structure or technique that is new to the state of the art and is intended to dsds organizational goals."*

2.7 Characteristics of Innovation Management

Several scholars have identified features or characteristics that are associated with effective innovation management in organisations. Hamel and Breen (2007) assert that effective innovation management encompasses three core characteristics. In their view, innovation management processes must be systematic, novel and continuous. This is emphasised in Figure 2.7 below.

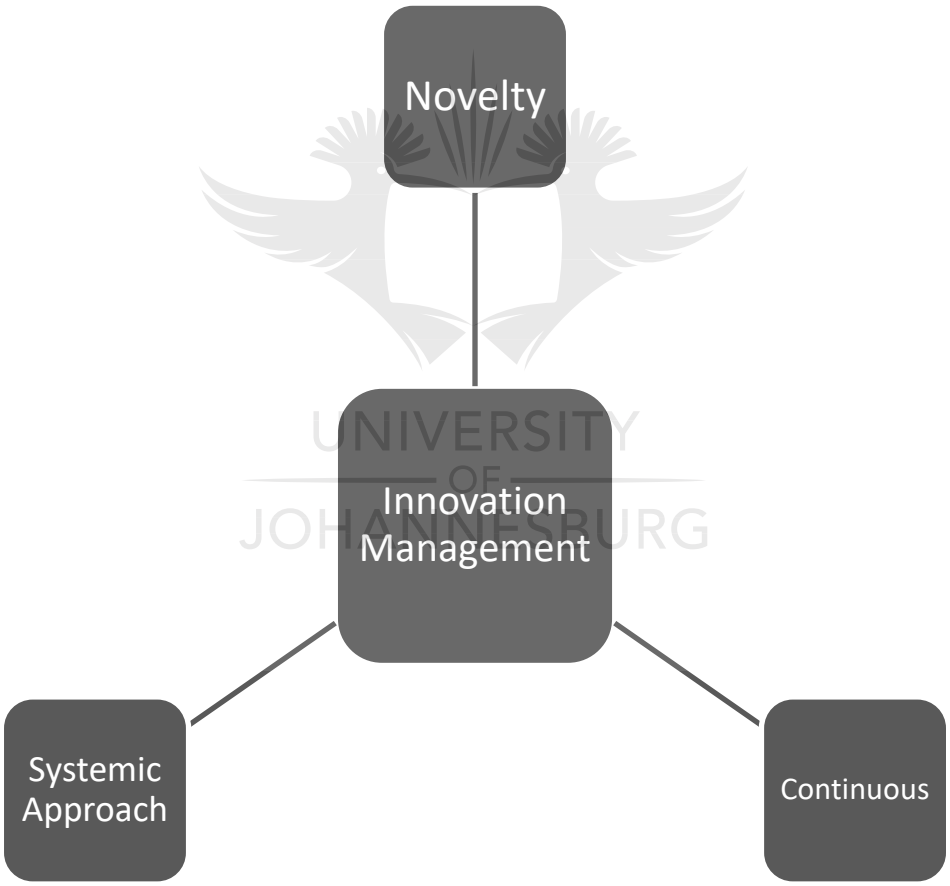

Figure 2.7: Hamel and Breen's three pillars of innovation management (Hamel and Breen, 2007:27)

Regarding novelty, Hamel and Breen (2007) argue that innovation and its management are driven by the urge to challenge the current state of products, processes and situation. They also believe that innovation management is a

systemic process that involves all concerned and affected departments and units to ensure relevance. Finally, innovation management was continuous. It does not stop once a solution is attained as the novelty view sets in.

Skalkos (2012) further discusses the systemic view of innovation management. Skalkos (2012) states that Innovation Management (IM) activities occurred across all management functions and disciplines within an organisation. This included marketing department, operations, accounting and so on. IM was, therefore, a broad and cross-functional discipline that cannot independently exist but existing in various units. Albors-Garrigos *et al.* (2018) however disagree with this classification and view of IM arguing that IM and its features and characteristics can be viewed independently from functional departments. IM was, therefore, an independent discipline much like marketing and finance (Albors-Garrigos *et al.*, 2018).

2.8 Internal Factors Affecting Innovative Management in Engineering

Innovation management (IM) is a crucial factor in the establishment of a competitive advantage as well as meeting growth and profitability objectives for businesses (Igartua, Garrigós and Hervas-Oliver, 2010). As such, organisations need to have a defined innovation strategy as well as effective tools to monitor such a strategy (Igartua *et al.*, 2010). On a broader scale, innovation management within the broadcasting and the general business environment affects economic growth, employment levels and eventually, the standard of living of a society (Dodgson, Gann and Phillips, 2014).

Within the broadcasting industry, innovation is often confused with creativity. This is because the broadcasting process and the media industry at large focus on creativity as an important outcome (Zotto and van Kranenburg, 2008). Creativity refers more to “novel and useful ideas at individual or group level”, while innovation operates on a broader organisational scale (Zotto and van Kranenburg, 2008:36). Innovation management, as a discipline, is still new, and its areas of focus are still developing, leading to many knowledge gaps (Goffin and Mitchell, 2017).

2.8.1 Business and innovation strategy

Innovation strategy is a susbset of a business strategy that guides the innovation goals and objectives (Goffin and Mitchell, 2017). It also links innovation with other departmental and functional objectives such as human resources, finance and administration. In human resources, for example, the innovation strategy identifies important skills that need to be developed through training and recruitment (Goffin and Mitchell, 2017). In the media industry, an organisation may adopt a defensive innovation strategy where it focuses on defending actual or perceived innovative advantages, the prospector strategy where it is always on the hunt for opportunities and a analyse strategy where it "reacts to environmental dynamics by selecting and adopting innovations and business models" that fits its interests (Zotto and van Kranenburg, 2008:74-75). Innovation strategy responds to four environmental factors or drivers, that is, the customers, the technology, the environment and competitors (Goffin and Mitchell, 2017).

2.8.2 Knowledge management and innovation

Knowledge has become the primary driver of innovation management, ahead of research which was, in the past, noted as the centre of innovation (Igartua *et al.*, 2010). Knowledge management refers to, "the process of the creation, dissemination and application of knowledge (or) the ultimate goal of knowledge management includes knowledge sharing among employees in order to enhance added value in the organisation" (Shirazi, 2016:1458). Organisations needed to develop adequate knowledge management systems to capacitate the transformation of knowledge into innovative ideas that enhance an organisation's competitiveness (Igartua *et al.*, 2010). Knowledge transfers between technology institutions, institutions of higher learning and companies are becoming an important trend in innovation management by providing critical research that can form the crux of innovation (Goodman and Dingli, 2017). A broadcaster's knowledge assets can be improved by hiring personnel who already hold the required levels of knowledge (Shirazi, 2016). Swan (2017) adds that recruitment, orientation and training broadcasting engineers are critical for both the competitiveness and innovativeness of television stations.

The same writer acknowledges skills challenges in the sector and recommends that organisations needed to be creative in staffing their broadcasting engineering sections by engaging engineers from their competitors, from smaller stations and other sectors.

2.8.3 Organisational structure

The organisational structure in which broadcasting engineers interact also has a bearing on the management of innovation (Igartua *et al.*, 2010). Innovation is fostered in an organisational structure that supports a high degree of interaction and collaboration amongst internal stakeholders (Pfeffermann, Minshall and Mortara, 2013). Thus, engineers should productively interact and communicate with marketing and sales personnel on changing client requirements and how they can be met through new innovations. In Gershon's (2017) view bureaucracy stands as a threat and a risk to innovation in the media. Tall structures are however crucial in television and radio stations because of the need to control multiple functions and units (Oumlil and Juiz, 2016). In contrast, Swan (2017) states that no particular structure can support or inhibit innovation in all organisations due to the fact that organisations are unique. Every organisation, therefore, needs to find a structure that meets its unique innovation needs.

2.8.4 Organisational culture

The culture of an organisation has a strong bearing on how it manages innovation. Giving an example of CNN, Zotto and Kranenburg (2008), state that a culture that supported challenging the norm enabled the creation of a 24-hour news channel that defied the concept of television news being a minor part of daily viewing. In agreement, Gershon (2017:12) states that a company's culture can "stand in the way of innovation". Organisations can get caught up in the old ways of doing things and get surpassed by innovative competitors. This necessitates changes in organisational cultures to meet new innovative needs (Gershon, 2017). Netflix, an online streaming company, is cited by Gershon as one company that had succeeded through developing an open and liberal culture that empowers innovation through valuing the output of one's work

rather than focusing on the processes that one worked with. A similar type of culture is discussed by Brem and Viardot (2017:242) who summarise it as supporting, “a feeling of openness, freedom and collaboration”. The same writer encourages organisations to create such a culture through training.

2.8.5 Innovation and leadership

There is also a strong view that an organisation’s leadership has a bearing on how innovation is managed and how innovative that particular entity is (Horth and Vehar, 2015). Denti and Hemlin (2012) in agreement state that an organisation’s leadership facilitates the innovation process by supporting followers with strategies, resources and motivation to generate new ideas for the benefit of the organisation. Leaders were also important in creating team spirit and group cohesion that was critical in innovation. This was because innovation was not a personal process but often involved groups of interdisciplinary professionals working in cohesion (Denti and Hemlin, 2012). Horth and Vehar (2015) further state that between 20% and 67% of an organisation’s creativity is directly related to how the executive leadership addresses or approaches leadership. They see a danger in having a corporate leadership that lacks either the focus for or an understanding of innovation management arguing that such leaders will not be able to see future performance growth as current levels of innovation are what determines future sales, market share and profitability performance.

On innovation and leadership style, Zuraik (2016) asserts that leadership is important in innovation but states that the current challenge is that no particular leadership style has been directly associated with innovation. This poses challenges for management and directors of the organisation who might be trying to suit their leadership styles to processes that support innovation. However, Zhang, Zheng and Darko (2018) disagree and state that research has shown the transformational leadership was the most innovative management supportive leadership style. In their views, this was because innovation required high levels of employee motivation as well as cooperativeness features that transformational leaders are associated with. Ali and Ibrahim (2014) also agree that transactional leadership styles facilitated

innovation in employees but also pointed out that transformational leadership and situational leadership styles also supported innovative growth in organisations.

2.8.6 Innovation and other resources

Several views have been expressed in the relationship between innovation and organisational resources. For instance, Paradkar (2011) states that while there is a strong conception that assets and capital status of a business are what enhances its innovation capabilities, new and small businesses should not despair as there is also proof that intangible assets are more crucial in innovation. These are superior business and market knowledge and research output that an organisation has in its possession. In agreement, Kamasak (2015) states that there has been an important shift from tangible resources as a major determinant of innovation to intangible resources. Kamasak (2015) cites the development of superior knowledge of the business and technical environments as important intangible assets for innovation.

In contrast, Demirkan (2018) puts financial resources at the centre of innovation. Without adequate cash resources, an organisation will find challenges in both coming up with its own innovations and implementing new industry innovations. Demirkan (2018) also cites human resources as a key factor in firm innovation. In his research, he found that there was a significant negative relationship between human slack resources and innovation. Organisations, therefore, needed additional workforce to free up staff to work towards innovation.

2.8.7 Innovation and human resources factors

The quality of human resources at an organisation's disposal has a positive effect on innovation (Green and Mason, 2015). Firstly, organisations with highly skilled, and well-experienced staff generally stood a better chance at innovation in comparison to those whose key staff was not well skilled and experienced to meet expected business and technical needs (Green and Mason, 2015; Borrás and Edquist, 2015). Borrás and Edquist (2015) divide skills and knowledge

types into internal and external competencies. Internal competencies were skills, knowledge and capabilities that an organisation held. These were developed firstly by hiring persons who met specific skills, knowledge and experiential requirements and secondly by developing these capacities in-house. External competences could be hired from outside to support innovative processes in an organisation.

Secondly, skilled staff needed to be motivated both extrinsically and intrinsically in order to support innovation (Chiu, 2018). Motivation was generally a strong mediating factor between innovation and human resources (Chiu, 2018) (Chiu, 2018). Earlier on, motivation was strongly associated with leadership style with transformational leadership being cited as being more capable of motivating employees towards innovation (Ali and Ibrahim, 2014; Zhang *et al.*, 2018). Chiu (2018) also puts in leadership style as a moderator in the leadership between innovation and intrinsic and extrinsic motivation. Assertion or persuasion in the leader affected how employees current motivation levels determined their innovativeness.

To conclude, Table 2.2 below summarises the internal factors that affect innovation management, as discussed above.

Table 2.2: Summary - Innovation Management Internal Factors

No	Factor	Description
1	Business and innovation strategy	Innovation strategy aligned with a business strategy (Zotto and van Kranenburg, 2008; Goffin and Mitchell, 2017).
2	Knowledge management and innovation	Knowledge and research as a primary driver of innovation management (Igartua *et al.*, 2010; Shirazi, 2016; Goodman and Dingli, 2017).
3	Organisational structure	The organisational structure effects on the management of innovation (Igartua *et al.*, 2010; Pfeffermann *et al.*, 2013; Oumlil and Juiz, 2016; Gershon, 2017).
4	Organisational culture	The culture of an organisation has a strong bearing on how it manages innovation (Zotto and van Kranenburg, 2008; Gershon, 2017).

No	Factor	Description
5	Leadership	Leadership has a bearing on the management of innovation (Igartua *et al.*, 2010; Denti and Hemlin, 2012; Ali and Ibrahim, 2014; Zhang *et al.*, 2018).
6	Other Resources	Intangible resources (Paradkar, 2011; Kamasak, 2015): tangible cash and human resources (Demirkan, 2018).
7	Human Resources factors	Skill, knowledge, experience (Green and Mason, 2015; Borrás and Edquist, 2015). Motivation (Ali and Ibrahim, 2014; Chiu, 2018; Zhang *et al.*, 2018)

2.9 External Factors Affecting Innovation

Innovation in broadcasting engineering is influenced by external forces and factors (Adams, Bessant and Phelps, 2006). External factors are any forces outside the organisation's direct control that influence how an organisation operates (Goffin and Mitchell, 2017). These factors include political, economic, sociological, technological, ecological and legal forces, generally referred to under the PESTEL of PESTLE framework (Perera, 2017). External forces of innovation are also described as macro-environmental factors by some scholars like Yam (2016) and Lynch (2009).

Xuhua, Addai, Spio-Kwofie, Ampimah and Danso (2016) and Blind (2016) argue that the external environment forces the organisation to innovate due to its dynamic nature. Organisations then appeal to their internal environmental factors in an attempt to harmonise with external environmental changes. In agreement, Brown (2009) also asserts that innovation is a response to environmental change while Christensen *et al.* (2015) also present a view that it is the environment that is disrupted or affected by innovation.

This section identifies and discusses some of these factors in relation to how they affect innovation management in a broadcasting engineering department.

2.9.1 Customers

Customers have been identified as major drivers of innovation in broadcasting engineering and the media industry in general. Customers have varying needs and expectations. In addition, these needs are always changing over time. Regardless of this diversity and dynamism, organisations needed to ensure that customers remained satisfied enough to be retained (Annacchino, 2007). To ensure customer retention, it is necessary to observe changing preferences and innovate fast enough to meet these changes. Three general processes are therefore important in innovating to meet customer needs. These are customer needs identification, justification and innovation (Annacchino, 2007). Xuhua *et al.* (2016:52) hold a view that "engaging and learning from customers can accelerate the speed of innovation and reduce uncertainty surrounding new product development which improves the innovation performance". Thus, broadcasters that take time to listen to customer concerns are likely to be more innovative towards meeting customer needs than those that do not.

Broadcasting engineering entities do not directly deal with mainstream customers. However, their input is crucial in ensuring that the final consumer of TV broadcasting is satisfied. Two major client groups are identifiable in TV broadcasting (Anderson and Gabszewicz, 2006). These are the advertisers and viewers. Their existence to a station is interdependent. For advertisers to come in as customers, they need to be assured of a good viewership (Budacia, 2012). On the other hand, for viewers to stay loyal to a television station, they need quality programming which is sponsored by advertisers or is acquired using advertising revenue (Anderson and Gabszewicz, 2006).

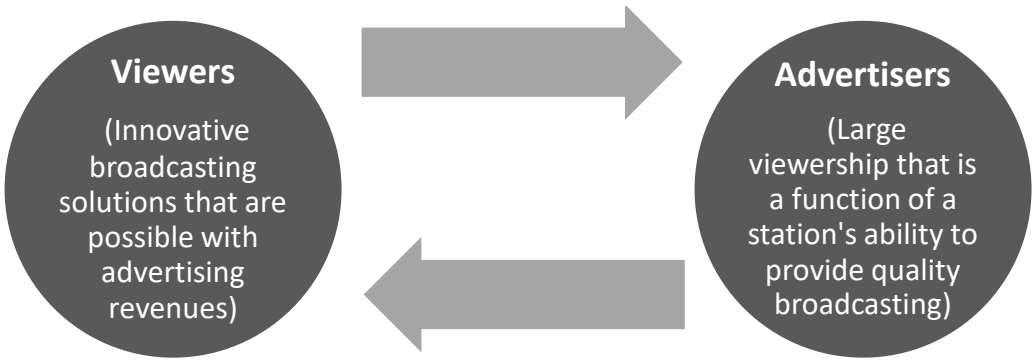

Figure 2.8: The relationship between TV stations customer groups (Anderson and Gabszewicz, 2006)

Thus, there is a need to ensure that two different market groups are satisfied with a station's product offering. Puijk (2015) asserts that digitalisation as a trend has exposed viewers to new television broadcasting services. These include high definition viewing and mobile television, trends which engineers must adapt to in order to retain current viewers.

For advertisers, new advertising trends in television, particularly interactive television, have been noted as major innovative trends that will determine whether advertisers remain loyal to a station (Lowrey, Shrum and McCarty, 2005). It is, therefore, broadcasting engineer's role to ensure that stations can implement innovative processes and systems that effectively support interactive television and other newer trends.

2.9.2 Competition

Closely related to customer needs, the actions of competitors have been identified as a major driver of innovation. Competition affects television broadcasting innovation in several ways. Firstly, broadcasting engineers will need to ensure that their production and distribution systems can match those of competitors in the same market segments. Broadcasting engineers achieve this through two main ways. The first one is the development of new technologies that are not available in the broadcasting industry. The second involves adopting already existing technologies and applying them such that a TV station produce quality content that matches or surpasses that of competitors (Ivaldi and Zhang, 2017). The second approach to innovation management is more common with television stations because of low risks and low costs in comparison with the first.

With digitalisation and convergence, TV broadcasting stations have been exposed to a rapidly changing and highly disruptive competitive environment (International Telecommunications Union, 2016). TV stations face three broad types of competition. The first is competition for general media attention. This is broad and includes competition with the print media, radio stations, outdoor media amongst others. The second is the traditional competition for viewership and advertiser from fellow TV stations (Ivaldi and Zhang, 2017). The third is

competition from rapidly evolving multimedia channels provided via internet-based systems. These levels are illustrated in Figure 2.9 below (PWC, 2012):

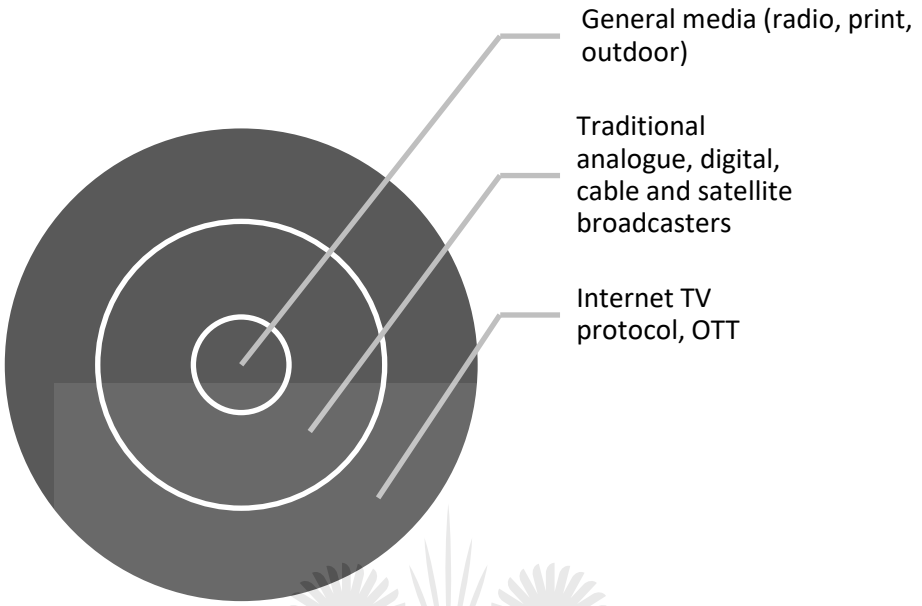

Figure 2.9: Competition levels for TV stations (PWC, 2012; OECD, 2013)

The advent of internet protocol television (IPTV) and Over-the-Top television (OTT) has expanded the audio-visual industry resulting in viewers having access to thousands of TV stations and other audio-visual content sources (OECD, 2013).

For broadcasting stations, innovation requires quick adoption of digitalisation and convergence technologies to enable their content to be distributed via new and more convenient channels, including the internet (OECD, 2013). This is in addition to keeping track of other competitive moves that competing stations are adapting to stay ahead in the business.

2.9.3 Technology

Technological changes in the broadcasting environment directly affect innovation management in TV stations (Cavell, 2017). Technological change may create obsolescence on broadcasting value chains forcing stations to adopt innovations or in some cases to come up with their own (Darji *et al.*, 2016). The digitalisation of television transmission is a typical example of innovations that are slowly driving analogue transmission into extinction

(OECD, 2013). TV stations have no option but to convert their transmission systems into digital modes as analogue modes will no longer be supported by newer transmission systems and receivers (Storsul and Krumsvik, 2013). Technological changes can, therefore, spur radical innovation where technological systems that were previously relied upon can be scrapped and replaced by completely new and incompatible modes (Mvungi *et al.*, 2013; Department of Communications, 2015).

Several technological changes have affected broadcasting engineering. The most important of these changes amongst broadcasting engineers mainly relate to changes in TV transmission signal (Joshi and Maskara, 2012). Changes in the mode of signal transmission do not only affect how viewers get their content but also affect the whole broadcasting value chain (Wessel, 2012; Cavell, 2017). Production quality and standards need to change to meet the capacities and requirements of the new transmission mode. This means studio equipment and facilities and processes used in transmission need to be upgraded to support new quality parameters (Joshi and Maskara, 2012).

2.9.4 Regulation

Television stations operate under general and sector-specific regulations that, amongst other things, demarcate the quality and standard of broadcasting output. These regulations also determine the signal of transmission broadcasters use and safety and suitability of equipment (Department of Communications, 2015). In South Africa, given the converging nature of ICT and broadcasting, TV broadcasting regulations are generally slipped between the Department of Communication and the Department of Telecommunications and Postal Services (Department of Telecommunications and Postal Services, 2014).

Regulations affect innovation through setting and upgrading operational standards and processes of broadcasters. Blind (2016) argues that the relationship between regulation and innovation is generally ambiguous. Citing the works of Carlin and Soskice (2006), Blind asserts that regulation affects different types of innovation differently. As a result, a conclusion regarding

whether regulation affects innovation positively or negatively can only be reached on a situation-by-situation basis. In some instances, regulation may forbid the use of a particular technology of innovation. This prohibition is however expected to motivate innovation of technologies that can circumvent regulatory penalties. Thus, as argued by Blind (2016), unfavourable regulation can spur innovation as much as the regulation that is deemed favourable for innovation.

Stewart (2010) states that regulation-inspired innovation can be classified into two: compliance innovation and circumventive innovation. The former involves broadcasting engineering departments adopting and developing newer processes in order to comply with a change in broadcasting standards and regulations. The latter, as also discussed by Blind (2016), involves changes in processes, systems and products aimed at going around prohibitions. An example of circumventing innovation is internet television and Over-the-top broadcasting systems that attempt to go around restrictive state regulations on the registration on television stations (OECD, 2013).

Market regulation affects entry, exist and competition regimes within the broadcasting engineering. Innovation can be affected by market regulation if it may result in anti-competitive or unethical market behaviours. These include:

- Posing significant entry barriers to new market players
- Creating operational bottlenecks for other market players
- Formation of monopolies that render market competition ineffective in affecting prices

To conclude, Table 2.3 below summarises the external factors that affect innovation management, as discussed above.

Table 2.3: Summary - Innovation Management External Factors

No	Factor	Description
1	Customers	Customers as major drivers of innovation (Annacchino, 2007; Xuhua *et al.*, 2016).

No	Factor	Description
2	Competition	The actions of competitors as major drivers of innovation (Ivaldi and Zhang, 2017; International Telecommunications Union, 2016).
3	Technology	The effect of change in technology on innovation management (Cavell, 2017; Storsul and Krumsvik, 2013; Mvungi *et al.*, 2013; Wessel, 2012).
4	Regulation	The relationship between regulation and innovation (Blind, 2016; Stewart, 2010).

2.10 Innovation Management Framework

Based on the above findings, an innovation management framework which presents relevant factors is proposed.

Figure 2.10 shows the proposed innovation management framework.

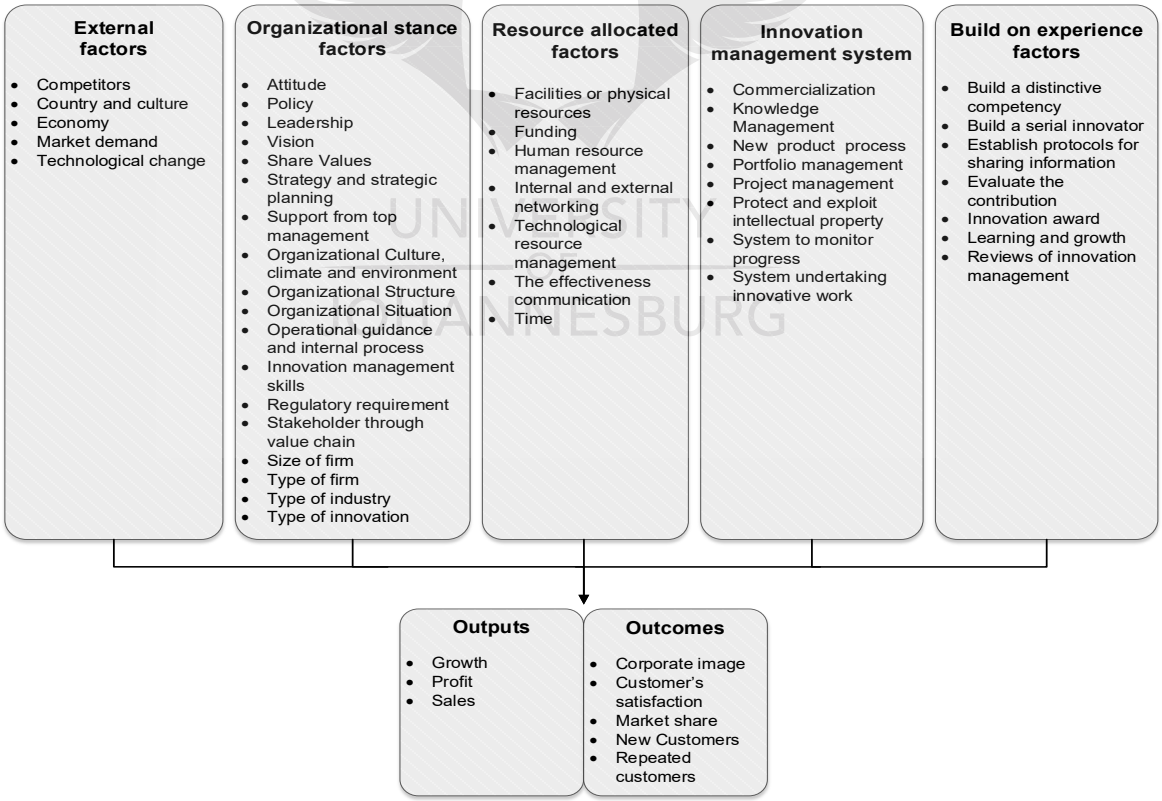

Figure 2.10: Proposed innovation management framework (Nagano, Stefanovitz and Vick, 2014:73)

2.11 Conclusion

The chapter discussed four theories relating to innovation and its adoption in organisations. These were the General Innovation Theory, The Diffusion of Innovation Theory, the Disruptive Innovation Theory and the open innovation theory. From the literature, it was established that these theories attempted to explain or predict how organisations reacted to innovative change. The General Innovation Theory and the Disruptive Innovation Theory attempt to predict how innovation occurs and how it should be managed. The Diffusion Theory attempts to explain how innovation is assimilated by its intended beneficiaries who might be internal or external customers. Many factors affect innovation management. Organisational structure, culture, strategy and knowledge development were discussed as major internal factors that affected innovation management in broadcast engineering. The next chapter discusses the methodology that was applied in further studying innovation management from a practical or field approach.

CHAPTER 3 RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the research approaches and processes that were applied in the primary research on the management of innovation within a broadcasting engineering unit. To recap the primary part of the study focused on understanding the factors that affected innovation in broadcasting departments. It aimed to bring to the fore such factors so that managers in the departments will be able to understand innovation. The study also aimed at developing an innovation management framework from primary and secondary research studies. A quantitative research approach was applied to answer the above research question and to meet the study's objectives.

3.2 Research Paradigms

A research paradigm is a philosophical approach that guides the theoretical and conceptual development of a particular discipline. In research, a paradigm, therefore, guides the theoretical underpinnings, the reasoning and approaches that can be applied in an inquiry. While many research paradigms classifications can be found in the literature, the most common and resilient involve typifying paradigms in positivist, interpretivist and pragmatist paradigms. Other researchers like Wells and Stage (2015) have also insisted on classifying paradigms into qualitative paradigms and quantitative paradigms albeit these two are strongly described as approaches rather than philosophies (Bryman and Bell, 2015). This study classifies research paradigms into three types hinted above: Positivism, Interpretivism and Pragmatism.

3.2.1 Positivism

This study was guided by a positivist way of thinking. Positivism is a scientific research approach that puts maximum emphasis on objectivity and high reliability of research processes and findings (Saunders *et al.*, 2016). Positivists believe that natural science approaches yield reliable, objective results because of structured processes and systematic control of the research environment and variables (Bryman and Bell, 2015). The final result of this

approach is a reliable conclusion that provides an objective outcome whose interpretation is the same regardless of who is making it. Positivism is, therefore associated with a single truth pertaining to the phenomenon under study (Saunders *et al.*, 2016).

Several reasons motivate the using a positivist in guiding this study. Firstly the engineering environment is scientific and mathematical in nature. Research, therefore, has more meaning and greater acceptance in this field if it also applies the same natural science research approaches common to the discipline – these approaches relying heaving on Positivism. The second reason relates to the need for accurate results that can effectively and objectively answer the study's research questions and give practical recommendations that can be applied in improving innovation management in broadcasting (Babbie, 2017). Finally, a positivist philosophical view makes it acceptable to infer the findings from the study to other settings (Beaudry and Miller, 2016). Positivists, therefore, believe in the use of quantitative research methods because of their focus and emphasis on scientific designs and objective processes.

Contrary to Positivism, Interpretivism puts subjectivity and flexibility of research processes and outcomes at the fore of research processes. Interpretivists do not believe that there is an absolute truth from findings and that what is held as the truth depends on the beholder. Interpretivists, therefore, call for flexible research designs that are not meant to be generalised to broader contexts because of vast differences in people. Interpretivists, therefore, believe in qualitative research methods because of their flexibility to meet the different needs of participants and their emphasis on the collection of subjective, textual data.

3.2.2 Epistemology and ontology

In addition to research philosophies, this study was also guided by knowledge development theories – which in some literature are sometimes also referred to as research philosophies. One such philosophy is epistemology, which can be defined as a study of acceptable knowledge and knowledge development

processes within a particular discipline (Scheurich, 2014). Scheurich (2014:3) further explains that epistemology refers to " how we know what we know and the rules of knowing". As highlighted earlier, the engineering and other technical fields strongly value objectively researched output that relies on approved and commonly acknowledged scientific methods. In this regard, the epistemology of the engineering and technical fields is positivist in nature, that is, it attempts to provide research conclusions from an objective rather than subjective research processes.

Ontology is a philosophical view that deals with determining the nature of reality as accepted by society. Ontologists question what it is real and how it comes to be so. They differ from epistemologists who are mostly concerned with how acceptable knowledge is developed rather than what constitutes or does not constitute reality (Saunders *et al.*, 2016). Saunders *et al.* (2016) assert that there are two ontological views, the subjectivism and objectivism. From an ontological view, this study identifies with objectivism.

3.3 Research Methods

The study applied a mono-method. This was defined by Saunders *et al.* (2016) as the use of a single research method in an inquiry. The method used in this study was a quantitative one.

3.3.1 Quantitative versus qualitative methods

As discussed above, positivist philosophical views align closely to quantitative research methods, while interpretivist views align well with qualitative methods (Sahajan, 2014).

Table 3.1 below shows the differences between quantitative research methods and qualitative research methods taking note that some research scholars, including Scheurich (2014) classify these as designs, that is, qualitative designs and quantitative designs.

Table 3.1: Quantitative versus Qualitative research (Bryman and Bell, 2015; Saunders *et al.*, 2016)

Quantitative Methods	Qualitative Methods
Data produced is mostly numerical	Mainly produces textual data
Large samples are required to enable generalisations	Comparatively smaller sample sizes
It tests theories, propositions and hypotheses developed	Develops new bases upon which theories can be made
Data is objective and quantifiable	Emphasizes on data subjectivity
Occurs in artificial settings	Occurs in natural settings
There is a high validity of findings and high reliability of data	Reliability and validity are argued to be low
Generalises from a sample population	Generalises from one setting to another

From Table 3.1 above, it can be noted that quantitative research is more geared towards producing reliable, valid and therefore more acceptable conclusions.

3.3.2 Quantitative study approach

A quantitative study approach was chosen for the study. A quantitative approach is based on a positivist paradigm that states that knowledge is objective rather than subjective (Sahajan, 2014). As such, researchers needed to device research strategies that were systematic enough to extract the objective realities from the situation under study (Hair, Celsi, Money, Samuoel and Page, 2016). Positivism, unlike its opponent interpretivism (which takes knowledge as subjective), therefore encourages the use of structured data collection methods, systematically calculated sample sizes and statistical and numerically-based data analysis procedure (Saunders *et al.*, 2016). A quantitative approach has multiple benefits and applications in research. Some of these that are important to this study are (Babbie, 2017):

1. The inference of results to a population from which the sample was drawn

2. Coming up with highly reliable results due to its emphasis on structured approaches and limited researcher biases and involvement
3. The construction of models and frameworks bases on research and data analysis outcomes
4. The quantification of views to assess the commonest held views and the least common views
5. To establish associations, correlations and dependencies among cases and results- thus enabling the understanding of results from various angles
6. To assess the level of dependency that the research can be given using reliability and validity assessments

This approach was therefore selected because of the above capacities. The research questions of the study were also more answerable using a quantitative methods approach.

3.4 Research Design

Various research design are accommodated under quantitative approaches (Bryman and Bell, 2015). These are case study, exploratory, explanatory, causal, experimental, and descriptive studies (Beaudry and Miller, 2016). Explanatory studies aim at explaining the state and nature of a phenomenon of interest while an exploratory study aims at getting preliminary data on a new or less understood phenomenon. Exploratory studies are, however, more commonly associated with qualitative approaches (Bryman and Bell, 2015). Table 3.2 compares exploratory and descriptive research designs in terms of use in making decisions from research results.

Table 3.2: Exploratory versus descriptive research designs (Kumar, 2014)

	Exploratory research	**Descriptive research**
Amount of uncertainty characterising decision situation	Highly ambiguous	Partially defined
Key research statement	Research question	Research question

	Exploratory research	Descriptive research
Stage when research is undertaken	Early-stage of decision making	Later stage of decision making
Structured/Unstructured	Unstructured	Structured
Nature of results	Identify areas of theory development and areas requiring further research	They describe/confirm/reject assertions related to a phenomenon under study

As shown in Table 3.2 above, a descriptive survey approach aims at answering research questions that describe the phenomenon or "who, why, what, when, where and how" questions (Saunders *et al.*, 2016). The study applied a descriptive research design making use of a survey strategy as discussed by Saunders *et al.* (2016). A descriptive survey strategy is effective in inquiries that meet the following criteria as discussed by Hair *et al*. (2016) and Babbie (2017):

- Research questions can be answered from data gathered from a sample's responses;
- The sample has the ability to provide accurate information to the researcher and has an adequate understanding of the research phenomenon under study;
- The sample has the willingness to participate in the study
- The sample is identifiable, locatable and accessible to the researcher

The researcher has access to a sample that meets the above characteristics. This sample consists of broadcasting engineering experts who deal with innovative technologies and processes and are also willing to participate in the study.

This design, as applied in this study, attempts to explain the nature and interaction of factors that affect innovation (Babbie, 2017). It will explain how specific factors support or inhibit innovation. On a descriptive platform, it will describe how and why engineering departments approach innovation managements in certain ways. The exploratory approach was not selected for the study because judging from the literature; innovation management is a

widely studied phenomenon (Walker, 2010). There are various models, including the Disruptive Innovation Theory, the General Innovation Theory and Diffusion of Innovation Theory that present a host of factors that affect innovation management. However, it is important to explain and describe these from the Pay-TV company perspective.

3.5 Research Horizon

The study can be classified as a cross-sectional study. In a cross-sectional study, research questions are answered based on data collected and relating to a single point in time (Kumar, 2014). In contrast, in a longitudinal study, data is collected and analysed over a series of time. This data can, therefore, provide a basis of comparing changes in variables over time (Hair *et al.*, 2016). The cross-sectional rather than the longitudinal approach was used because the research was concerned with the current status of innovation management and not how it has moved. Additionally, time constraints made a longitudinal study a challenge as a significantly longer period was required to assess time-related changes in the variables under study.

3.6 Research Reasoning

This study was designed as both deductive and inductive. The study aimed to establish results through an empirical approach and then test or measure these results against established theories (Babbie, 2017). A deductive approach works from a developed set of theories to answering research questions and getting research conclusions (Babbie, 2017). It therefore tests or confirms the applicability and truthfulness of theoretical underpinnings of a study (Creswell, 2014).

Several theories of innovation, as well as theoretical arguments, were discussed in the study and there was a need to test their full or partial applicability as a way of answering research questions. In the literature review, four comprehensive theories were studied. Additionally, there were other sources that were not necessarily theories or models that were also compared with the outcomes of the research. If the findings do not conform to any theory

in guiding innovation management, a new framework was to be established based on the results.

3.7 Population and Sampling

A population is a full set of candidates that meet the research inclusion criteria (Hair *et al.*, 2016; Babbie, 2017). It is also a complete set of elements from which a research sample is drawn (Saunders *et al.*, 2016). Figure 3.1 below illustrates Saunders *et al* 's (2016) relation to a sample.

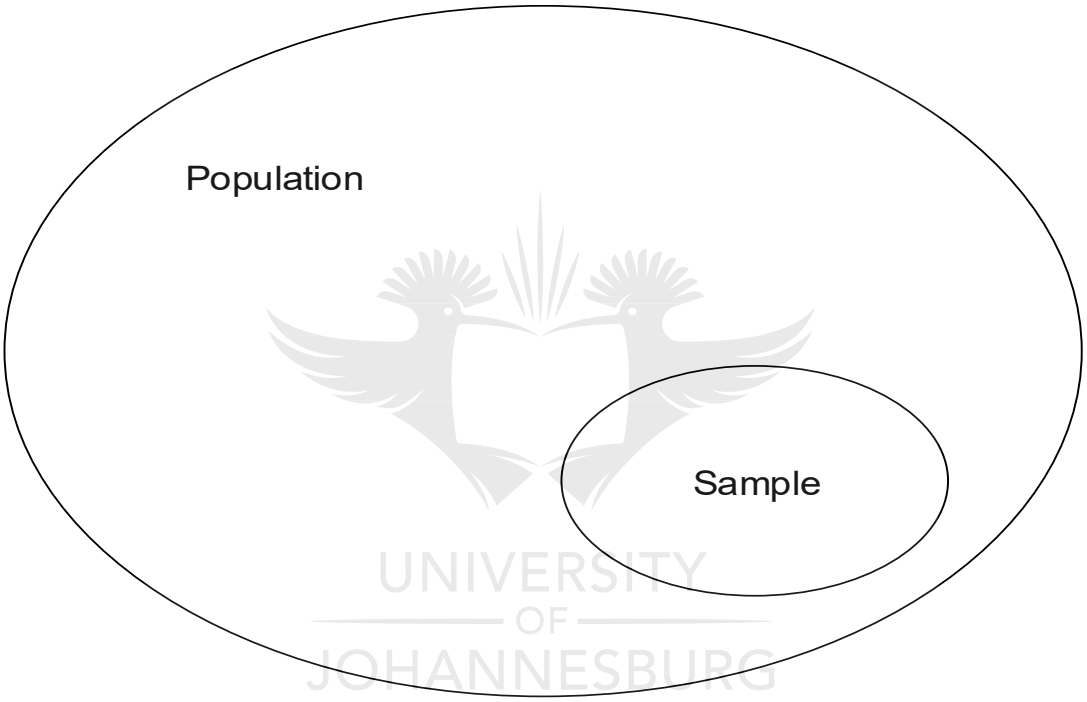

Figure 3.1: Sample and population (Saunders *et al.*, 2016:275)

The population of the study was persons who worked in the strategic, technical and operational areas of broadcasting and were therefore directly affected by broadcasting innovation management.

Table 3.3 below shows the population of the study in numbers.

Table 3.3: The study population

Population group	Number	%
Broadcasting engineers	102	82%
Technical managers	16	13%
Senior managers	7	6%
Total	**125**	**100%**

This population was located in a major broadcasting entity operating in South Africa.

3.7.1 Sampling

A sample is a subset of research interest drawn from a specific population (Hair *et al.*, 2016; Babbie, 2017). Two broad types of sampling can be identified from the research literature. These are probability sampling and non-probability sampling.

Figure 3.2 below illustrates these:

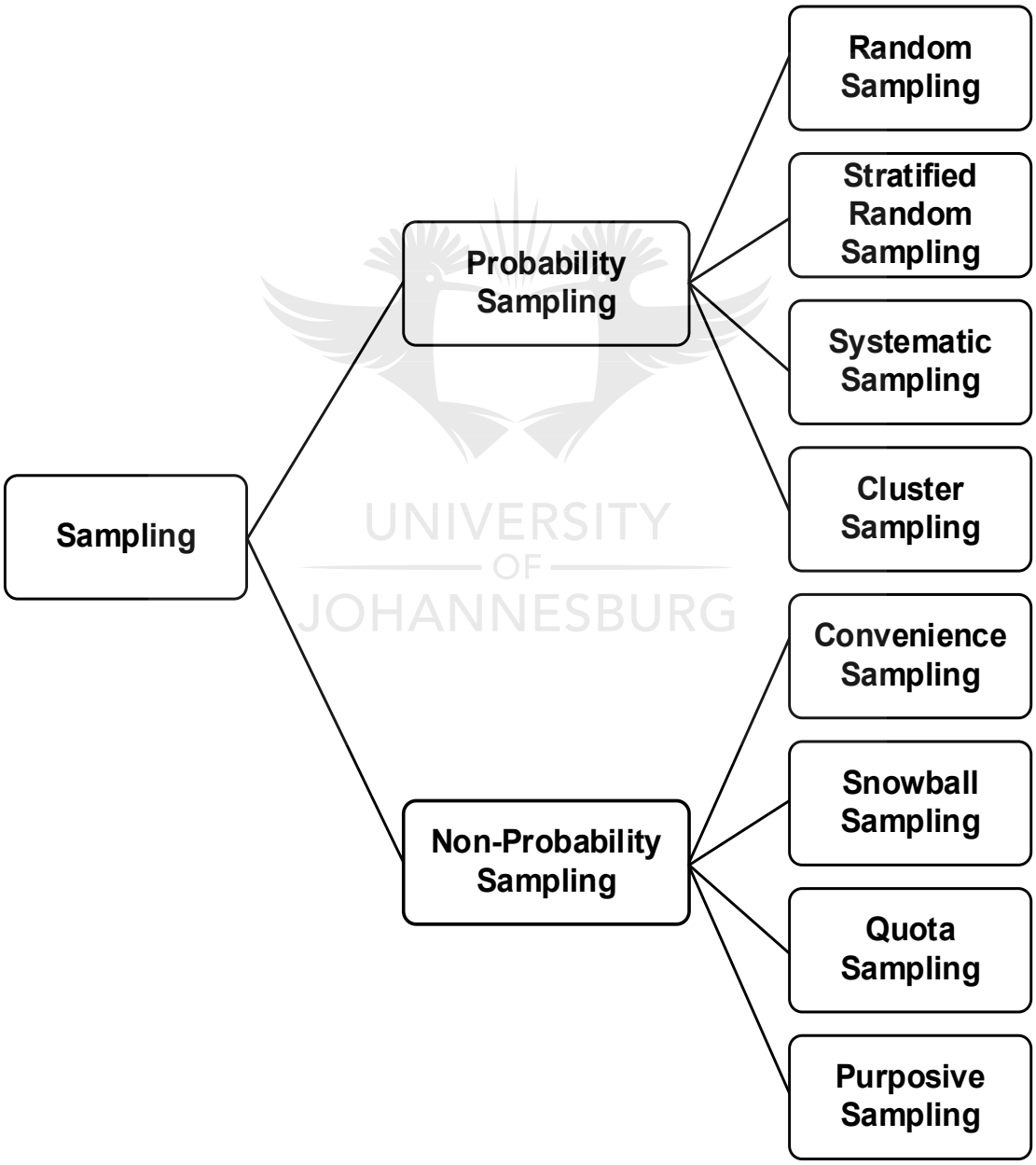

Figure 3.2: Types of sampling (Saunders *et al.*, 2016; Babbie, 2017)

On probability sampling, every unit in the population of interest stands an equal chance of being selected and its probability of participating in the study is known (Hair *et al.*, 2016; Saunders *et al.*, 2016). In non-probability sampling, population units do not have a known probability of being picked into the sample, and neither do they have an equal chance (Hair *et al.*, 2016; Saunders *et al.*, 2016). While descriptive survey research designs are mostly associated with probability sampling, it has become a common practice to use non-probability sampling as well due to population access challenges (Saunders *et al.*, 2016).

Positivists hold a strong view that probability sampling enhances the reliability and objectivity of research outputs (Wells and Stage, 2015). This is because unlike non-random sampling, researcher biases, which may affect the scientific precision of results are eliminated (Scheurich, 2014). The study, therefore, applied a probability sampling approach, specifically random sampling. However, as highlighted earlier, non-probability sampling can also be more appealing under some circumstances, especially when a more knowledgeable research frame can be developed through this method. Several research scholars, including Beaudry and Miller (2016) caution researchers to guard against biased selections when applying non-probability sampling methods in quantitative studies. This study applied convenience sampling as its non-probability sampling method.

a) Convenience sampling

Convenience sampling was used in selecting the sample. This is a non-probability sampling method where respondents are selected based on a specific convenience factor (Saunders *et al.*, 2016). In this study, the convenience factors used were knowledge of broadcasting engineering and innovation management and the willingness to participate. The advantage of this approach is that its targeted persons who were able to give meaningful information because of the experience, knowledge and expertise (Bryman and Bell, 2015). This resulted in the collection of detailed, rich and very useful data. Its disadvantages, however, were that it had the potential of introducing

researcher bias due to the subjective selection of respondents (Bryman and Bell, 2015).

3.8 Data Collection

Data was collected using a structured questionnaire. These were directly administered to the selected respondents who were given 7 days to respond. Follow-ups were made on all questionnaires that had not been collected by the 7th day. Structured questionnaires were appropriate from the study because of the following reasons (Creswell, 2014):

- They support the descriptive nature of the study
- They collect large volumes of data within a short space of time
- They facilitate a structured analysis that can result in objective and reliable results

The researcher personally administered the questionnaires to the sample. This was under the reasoning that this method increased the response rate. Firstly, the presence of the researcher often appealed for urgency in responses. Secondly, a researcher is able to explain some difficult concepts on the data collection instrument, and finally, the researcher can have a positive personal effect that encourages participation (Kumar, 2014).

3.8.1 Questionnaire design

The structured questionnaire that was used had two major sections. The first section was a demographic and general information section. This was designed to collect independent variable data such as department, gender, level of education and profession. The second section collected data on innovation management constructs, both internal and external.

The following types of questions were presented:

a) Multiple-choice questions

These required the respondent to pick one response that best described their situation. These were used to collect nominal data, especially on demographics (Sahajan, 2014).

b) Rating questions

These questions were presented in Likert Scale format to measure perceptions (Creswell, 2014). They were used to collect data on the respondents view in relation to innovation.

c) Ranking questions

These are questions that classify responses in order or degree (Hair *et al.*, 2016). In the study, these were used to rank the level of innovation that the organisation under study can be classified as belonging to.

d) Open-ended questions

Open-ended questions allow the sample to respond openly without being guided by pre-determined response categories (Creswell, 2014) Open-ended questions were provided on the following questions:

- *Please comment on how innovation can be improved at your organisation:*
- *Please List up to 4 Important Innovations that have occurred at your organisation in the past three years:*

A sample of the questionnaire used is attached as Appendix B for reference.

Table 3.4 below is derived from chapter 2.

Table 3.4: Identified factors and frameworks to Questionnaire in Appendix B

Research questions	Factors and Frameworks Identified in the Literature	Questionnaire Number	Literature review section
What factors contribute to innovation within an engineering department in the broadcast industry?	Business and innovation strategy	4.1 and 4.4	2.8.1
	Organisational structure	4.3	2.8.3
	Organisational culture	4.2	2.8.4
	Leadership	4.5	2.8.5
	Human Resources factors	4.6	2.8.7
	Other Resources	4.7, 4.8, 6.3 and 6.5	2.5.1;2.8.6
	Customers	5.3 and 6.1	2.9.1
	Competition	5.1, 5.2 and 5.3	2.9.2
	Technology	5.5 and 6.5	2.9.3
	Regulation	5.4 and 6.5	2.9.4
Can an innovation management framework be derived from literature for the broadcast industry?	Disruptive innovation versus sustaining innovation	1 to 7	2.5.1
	Hamel and Breen's 3 pillars of innovation management	1 to 7	2.4
	The General Theory of Innovation (GTI)	1 to 7	2.5.1
	The Diffusion of Innovations Theory	1 to 7	2.5.2
	The Disruptive Innovation Theory	1 to 7	2.5.3

3.9 Data Analysis

Data were analysed using descriptive statistical tests, mostly frequency analysis. This involved the analysis of the number and percentage of respondents who chose to respond in a particular way per statement. An overall comment was then made based on the modal response. Frequency analysis was used to analyse statements because of various reasons. Firstly, it enabled the researcher to identify and describe perceptions of the respondents in relation to the innovation management factors under study (Sabo and Boone, 2013). Secondly, it enabled the identification of dominant factors in the innovation management equation and thirdly, it enabled a comparative analysis between the outcomes from some of the statements in the study and those found in the literature (Martin and Bridgmon, 2012). In short, frequency analysis was highly supportive of the descriptive nature of the study.

3.9.1 Chi-square tests of association

Chi-square tests of association test the strength of the association between dependent and independent variables in a sample (Martin and Bridgmon, 2012). It is important in establishing how responses are associated with a given independent variable (Sabo and Boone, 2013). In the study, for example, Chi-Square tests help to identify whether persons of a race or gender's responses form a significant identifiable pattern. They thus explain hidden data patterns that cannot be easily seen through frequency analysis. A Cramer's V test was done for all statistically significant Chi-Square tests (Martin and Bridgmon, 2012). The Cramer's V tests give the strength of association between the dependent and independent variables with a 0 indicating that there is no association and a 1 indicating a full association. A 5% level of significance was used as a cut-off for statistical significance as a result of common practice (Lussier, 2011).

3.10 Validity and Reliability

Validity and reliability are data collection quality control process for quantitative studies (Babbie, 2017). A study is said to be reliable if it produces consistent

results if done again. It is valid if it effectively measures what it purports to measure (Saunders *et al.*, 2016).

3.10.1 Scale reliability

To test for reliability, Cronbach's Alpha tests were used across statements that were designed to measure the same constructs. Cronbach's Alpha works by assessing whether the results from a construct of interest show a consistent pattern (Geiger and Shelton, 2019). An alpha above 0.7 is considered an indication of acceptable internal consistency of results (Geiger and Shelton, 2019).

3.10.2 Face and construct validity

Face validity which measures the degree to which a data collection tool collects data that effectively measures what it is designed to measure was tested through a pilot test (Babbie, 2017). Three persons were asked to fill in the questionnaires and the results were analysed to see if this was what the researcher intended to collect. It was concluded that the questionnaire was able to collect data that would result in answering the research questions and meeting the research objectives. Construct validity which is the degree to which a construct is well interpreted in the questionnaire statements was also assessed in the pilot test (Sahajan, 2014). The researcher relied on the literature and various theories that discussed the constructs of the study – these including innovation, innovation management, innovation factors and innovation challenges.

3.11 Pilot Study

A pilot study is a smaller version of the main study conducted to test the readiness of the main study, the effectiveness of data collection process as well as its ability to produce required outputs (Kumar, 2014; Creswell, 2014; Hair *et al.*, 2016). Saunders *et al*. (2016:597) assert that a pilot study is important for ensuring the reliability and validity of data collection tools. A pilot test was therefore conducted for the study with 5 participants who were approached to

answer the questions on the structured questionnaire. The pilot study served the following purposes:

- To ensure that the data collection tools were appropriate to collect data relevant to the research topic;
- To ensure that the constructs relevant to innovation management were effectively measured through the posed questions;
- To ensure that the data could be analysed using the proposed means and methods
- To ensure questions on the data collection tool were clear and concise
- To time the data collection period per respondent and ensure it does not go over 20 minutes
- To proactively identify any other research instrument errors

After the pilot test, some questions were simplified while some were removed or combined.

3.12 Conclusion

This chapter identified the research as being driven by deductive reasoning within a quantitative approach. The research design for the study was noted as both explanatory and descriptive. The research aimed to provide reliable, valid data that was of an objective nature. Convenience sampling based on knowledge and expertise as well as willingness to participate was applied. Data were analysed using frequency analysis and Chi-square tests. The next chapter presents the data analysis results that were obtained from the collected data.

CHAPTER 4 DATA ANALYSIS

4.1 Introduction

In this chapter, data collected through a semi-structured questionnaire and analysed on Statistical Package for the Social Sciences (SPSS v.17) is presented and discussed. The study's two research questions guided the data analysis and discussion processes. These were:

- What factors contribute to innovation within an engineering department in the broadcast industry?
- What management framework can be derived from literature and the primary study to guide broadcasting engineering innovation?

The first section of the chapter presents descriptive statistics results from the survey including the sample's demographic characteristics.

4.1.1 Management level

Figure 4.1 below shows the distribution of the study's respondents by management level.

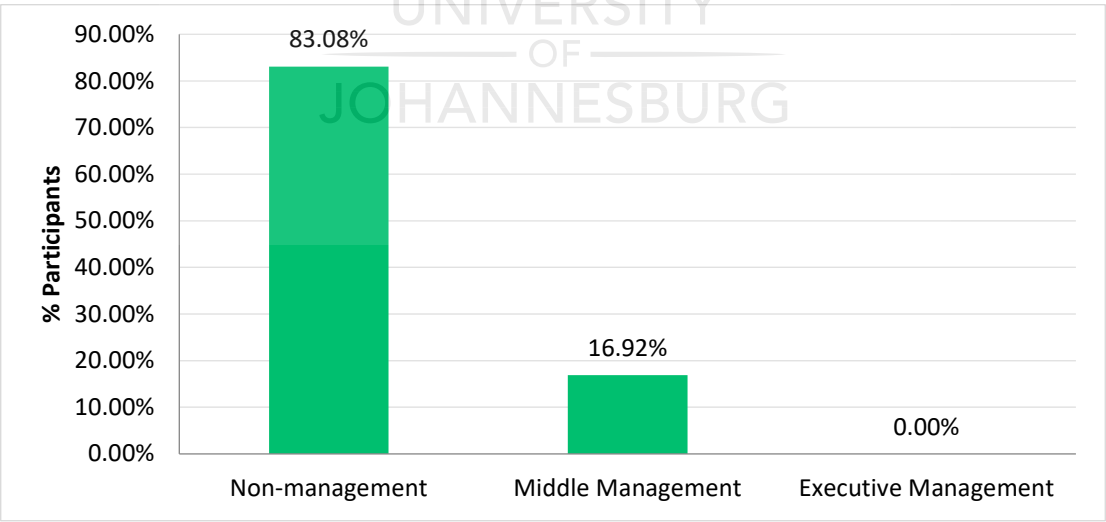

Figure 4.1: Sample distribution by management level

Out of 66 respondents, 83.08% classified themselves a non-management and 16.92% classified themselves as management. There were no executive

management participants. The majority of participants were, therefore, non-management.

4.1.2 Formal academic qualification

Figure 4.2 shows the sample distribution by formal academic qualification.

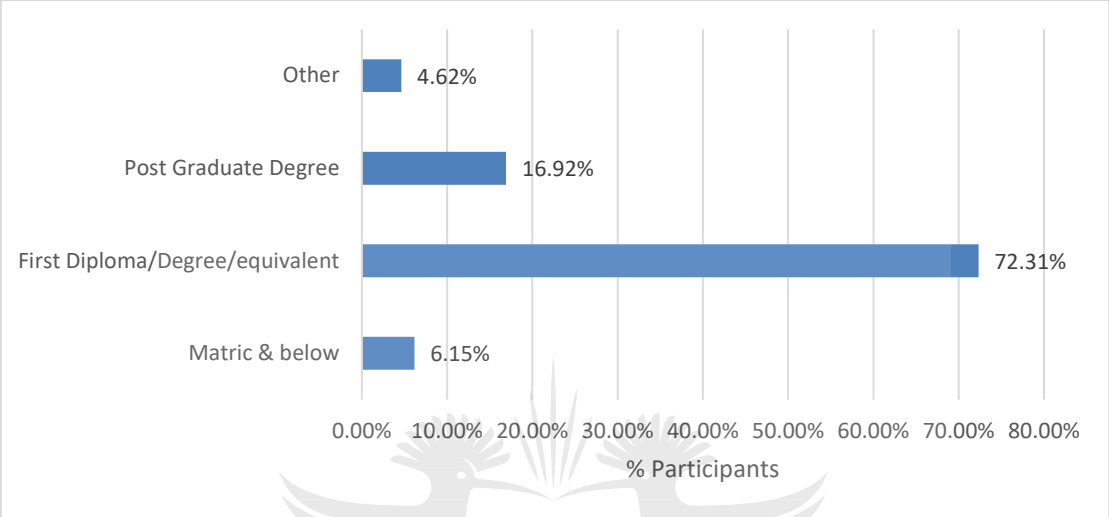

Figure 4.2: What is your highest formal qualification?

Out of 66 participants who responded to this question, 72.31% held a first diploma or degree of the equivalent as their highest formal qualification. In the same sample, 16.92% held a post-graduate degree, 6.15% a matric certificate as their highest formal qualification. The remaining 4.62% classified their qualification as "Other", and none among them further specified the nature of these qualifications. The sample was therefore dominated by participants with a first diploma, first degree or equivalent.

4.1.3 Participants' industry

The study participants were requested to select the broadcasting industry segment they worked in. Figure 4.3 shows their responses.

Out of 66 respondents, 72.31% worked for commercial broadcasters, 21.54% for a public broadcaster, 3.08% for community broadcasters and the remaining 3.08% for unspecified broadcasting stations. The majority of participants in the study, therefore, worked for commercial television stations.

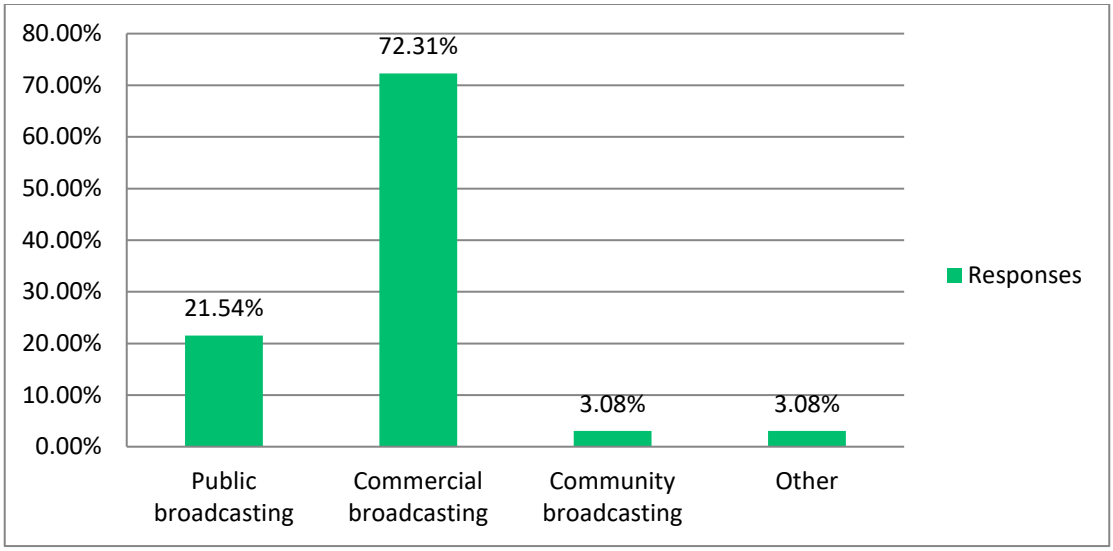

Figure 4.3: Broadcasting industry segment

4.1.4 Area of speciality

The sample's areas of speciality were divided into five broadcasting engineering areas, as shown in Figure 4.4 below:

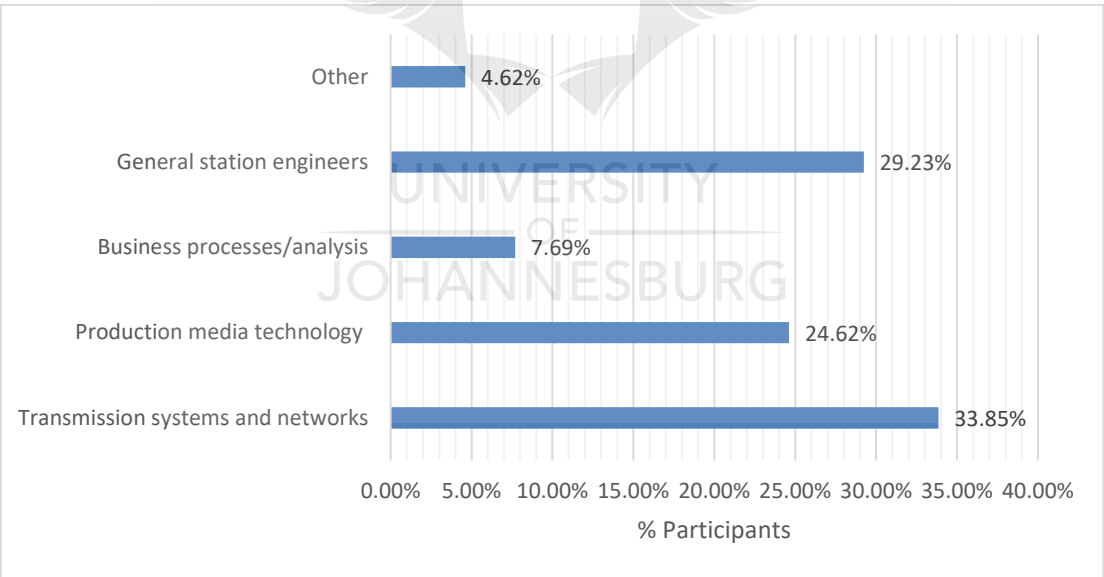

Figure 4.4: Current work speciality area

From Figure 4.4 above, out of 66 responses, it can be noted that 33.85% of the sample worked as transmission systems and network engineers, 29.23% as general station engineers and 24.62% as production media technology engineers. Other engineers (7.69%) specialised in business processes while 4.62% classified their work speciality areas as "Other".

4.1.5 Personal contribution to innovation

Figure 4.5 below shows the sample's responses to 2 statements meant to test their propensity to contribute to innovation within their industry and respective stations.

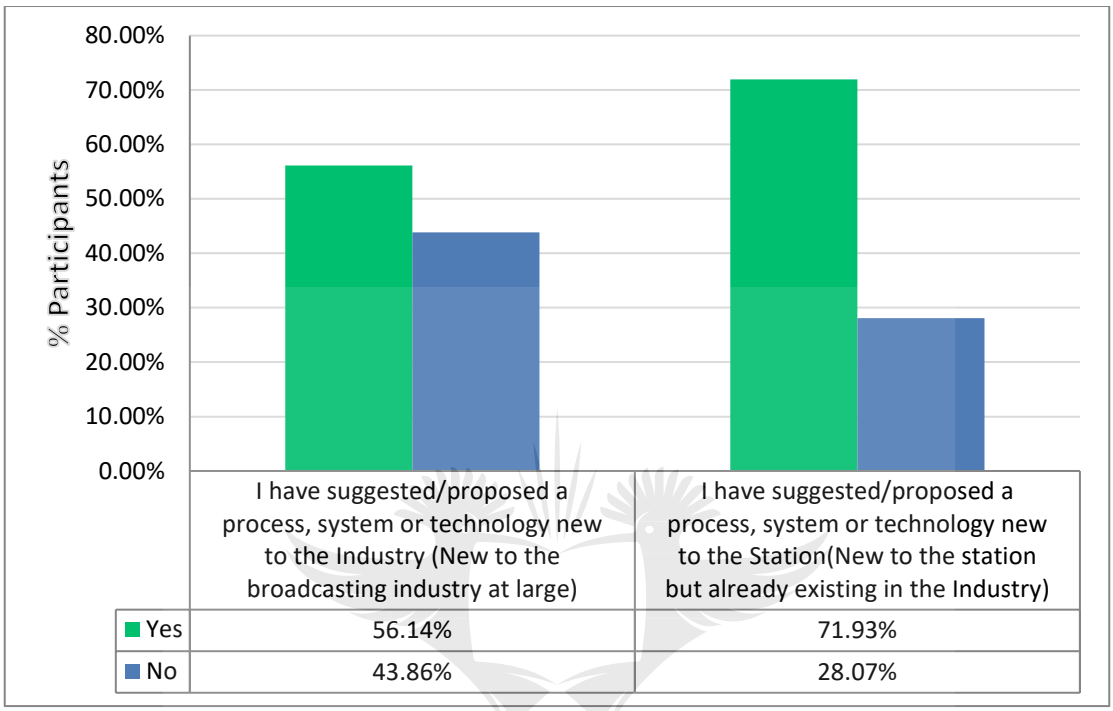

Figure 4.5: Personal contribution to innovation in the past three years

Out of 66 participants who responded to these questions, 56.14% stated that they had suggested/proposed a process, system or technology new to the Industry (New to the broadcasting industry at large). The remaining 43.86% said that they had not. Also, 71.93% of the sample stated that they had suggested/proposed a process, system or technology new to the station (new to the station but already existing in the Industry). The above results show that the majority of participants had proposed incremental innovative changes in their respective organisations while over half had proposed radical or completely new innovations that were not found in the industry. Both results generally point towards a sample with a strong affinity to innovation.

The sample was well vested in two types of innovation identified by Bui (2015). These were the micro or internal aspect where they were innovative in a way that supported their specific firms and the macro aspect where their innovativeness span into the industry at large. The results also show that

engineers were mostly incrementally innovative, that is, they were able to take changes from the broader industry and apply it to their specific organisations as discussed by Muckersie (2016). Over half however implied that they had suggested breakthrough or radical types of innovation that were completely unknown to their industries at large. The sample, therefore, painted a capacity to come up with a wide spectrum of innovation from sustainable and incremental innovations to radical and breakthrough innovations if given the right level of organisational support.

4.1.6 Organisational innovative description

The sample also rated the level of innovativeness that their stations had on a Likert scale. Their ratings are shown in Table 4.1 below:

Table 4.1: My organisation can best be described as (n = Number of respondents).

Answer Choices	%	n
Highly innovative: (Over 5 technological Innovations in past 3 years)	36,21%	21
Moderately Innovative (3.5 technological Innovations in past 3 years)	48,28%	28
Lowly Innovative (1-2 technological Innovations in past 3 years)	12,07%	7
Not Innovative (0 technological Innovations in past 3 years)	0,00%	0
Not sure	3,44%	2
	Valid	**58**
	Missing	**14**

Out of 58 participants who responded to this statement, 48.28% believed that their stations were moderately innovative; 36.21% said they were highly innovative and 12.07% rated them as lowly innovative. The remaining 3.44% were not sure. None among the participants viewed their organisations as being not innovative. The sample, therefore, most believed that their organisations were moderately innovative having implemented 3 to 5 major technological innovations in the last three years.

The view that broadcasting innovation was not as rapid as required, given the transformation in information telecommunication technology as shared by OECD (2013) was also hinted in the above results. The larger sample observed innovation not as being rapid and far-reaching enough but as moderate. Matlabo (2017) also commented on the slowness of technological adaptation within the South African broadcasting industry.

4.1.7 Sources of innovation in broadcasting organisations

The participants were requested to select a description that best suit their organisation's innovation sourcing.

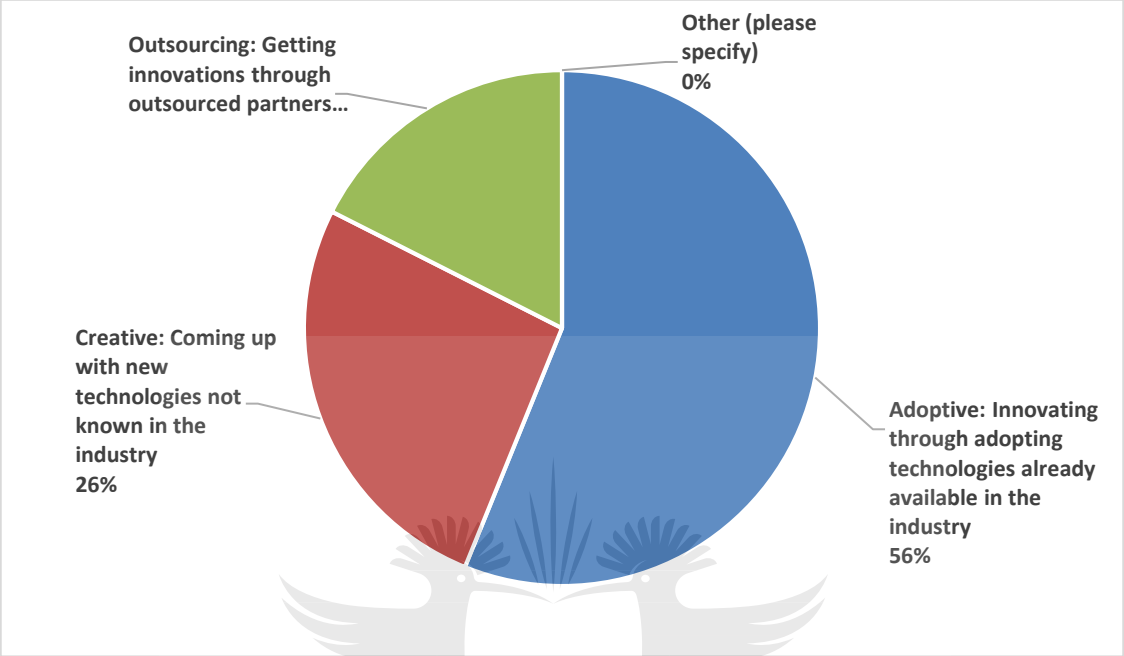

Figure 4.6: My organisation can best be described as:

Of the 58 participants who responded to this statement, 56% described their organisations as being adaptive (they adapted technologies already existing in the industry). Also, 26% said that their organisations came up with new technologies that were not available in the industry, while 18% stated that theirs got innovative technologies through selected outsourced partners. The sample, therefore, indicated that technological innovation in the industry was mostly adaptive – being copied from one station to the next with a minority of entities coming up with new and creative technologies. The results show that the industry was mostly incremental (Muckersie, 2016). Breakthrough innovations were, however, not uncommon as part of the sample confirmed that some technologies introduced by their organisations were entirely new for the market. Additionally, over half the sample stated that they had suggested at least one breakthrough innovation to their organisations in the past three years.

4.2 Internal Factors Supporting Innovation

Table C.1 in Appendix C shows the sample's rating of internal factors that support innovation at their organisations. Mean scores ranged from 1, strongly disagreeable to 5, strongly agreeable. A higher mean score means that the sample is mostly agreeable that a given factor supports or promotes innovation – the higher the mean score, the more agreeable the sample is.

Skewness, kurtosis and standard deviations shown in Table C.1 were used to assess if responses were normally distributed and could, therefore, be ranked reliably using mean scores. A kurtosis, skewness and standard deviation between -1 and +1 were used to indicate normality. The responses below were qualified as being normally distributed as shown by a kurtosis, skewness and standard deviation ranging within the +/-1 band (Warner, 2013). The above rules were applied in all Likert scale questions in the rest of the chapter.

The frequencies of the responses in each of the variables in Table C.1 are further discussed. The frequencies represent the proportion of the 58 respondents (who responded to the statements) that selected a particular response on a 5-point Likert scale with *strongly agree, agree, not sure, disagree and strongly disagree*, as options.

Figure 4.7 below shows that Leadership that encourages innovation as a factor had the highest mean score of 4.00 (sd=0.84) indicating the sample agreed more on it as a factor that promotes innovation in their respective organisations. On the same factor, 26.32% of the sample strongly agreed and 56.14% agreed that it promoted innovation in their organisations. The sample was therefore mostly agreeable on the importance of leadership in innovation.

Leadership was followed in agreeability rating by *highly skilled and experienced staff* shown in Figure 4.7 below. This factor had a mean score of 3.9 (sd=3.9) and a 17.54% and 59.65% frequency on the "strongly agree" and "agree" option respectively. The sample was mostly agreeable on the importance of this factor in innovation management.

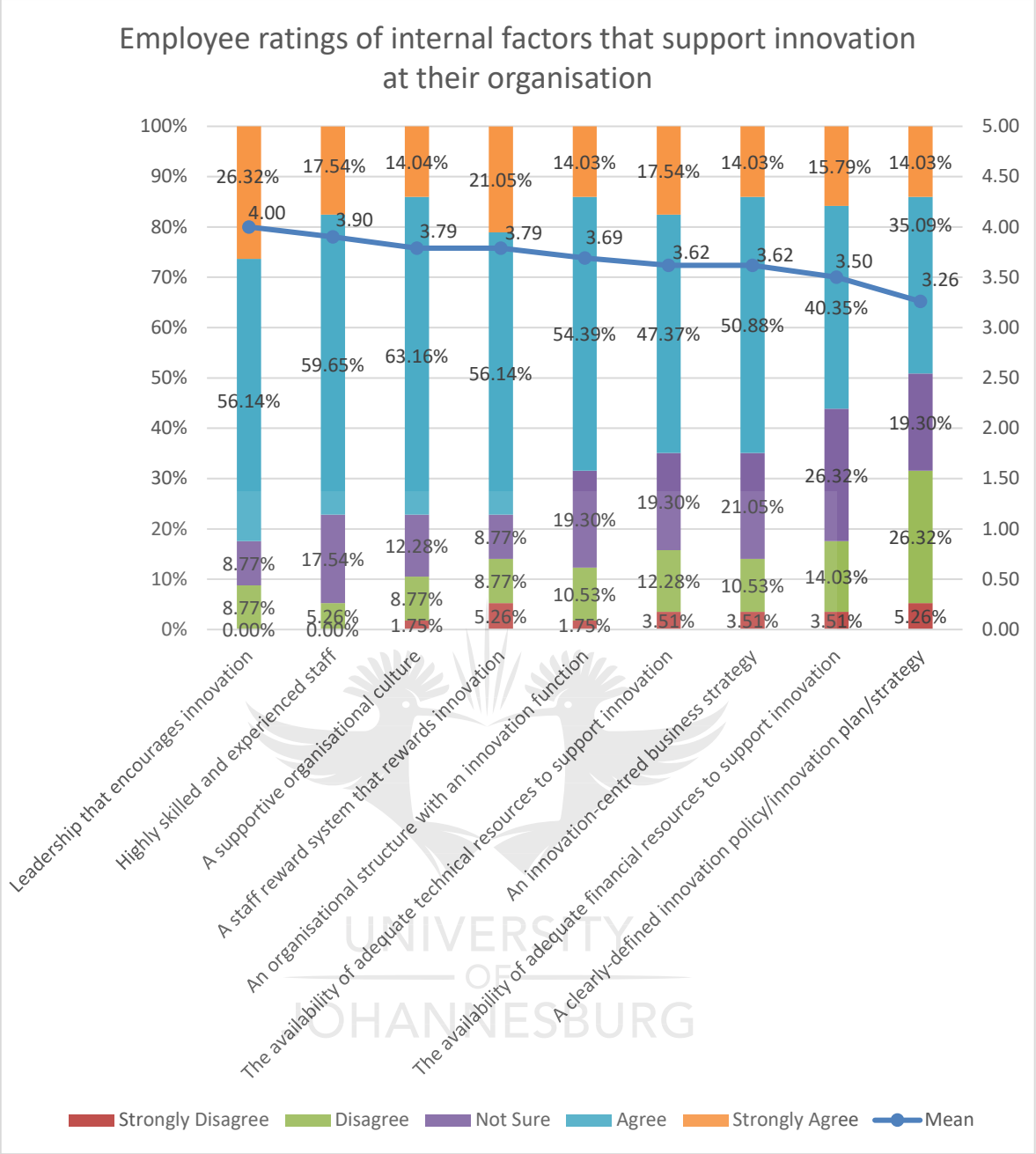

Figure 4.7: Employee ratings of internal factors that support innovation at their organisation

The third factor which the sample was mostly agreeable on was *a supportive organisational culture* shown in Figure 4.7 above. It had a mean score of 3.79 (sd=0.85), a strongly agree frequency of 14.04% and an agree frequency of 63.16%. The sample was therefore mostly agreeable about the importance of this factor in supporting innovation management.

A staff reward system that rewards innovation was ranked fourth by mean score (x=3.79, sd=1.04) in the mean rankings. The participants responded to this

factor as shown in Figure 4.7 above. The factor had a 21.05% frequency on “strongly agree” and 56.14% of “agree”. The participants were, therefore, agreeable that this factor was strongly supportive of innovation in their respective organisations.

The fifth factor with the highest agreeability by mean ranking was *An organisational structure with an innovation function* (x=3.69, sd=0.9) shown in Figure 4.7 above. Among the participants who responded to the ratings, 14.04% strongly agreed and 54.39% agreed with its importance in supporting innovation. The majority of the sample was therefore positive on the organisational structure as a factor that supports innovation in their organisations

The availability of adequate technical resources to support innovation was ranked sixth by mean score (x=3,62, sd=1,02) shown in Figure 4.7 above. On this factor, 17.57% strongly agreed that it was important in supporting innovation while 47.37% agreed. The sample was therefore mostly positive about the importance of this factor in innovation. The mean score of the factor was negatively affected by a comparatively higher portion of the sample who did not agree with it, (19.3% not sure, 12.28% disagree and 3.51% strongly disagree).

The 7th ranked factor by mean scores was *An innovation-centred business strategy (x=3,62, sd=0,97).* The participants’ responses to this factor are shown in Figure 4.7 above. On this factor, 14.04% and 50.88% of the participants strongly agreed and agreed with the importance of this factor respectively. The mean score of the factor was negatively affected by a comparatively higher portion of the sample who did not agree with it, (21.05% not sure, 10.53% disagree and 3.51% strongly disagree).

The 8th ranked factor by mean scores was *The availability of adequate financial resources to support innovation (x=3,50,sd=1,03).* The participants’ responses to this factor are shown in Figure 4.7 above. Amongst 58 participants, 17.54% strongly agreed with its importance in supporting innovation with another 47.37% agreeing to this. The mean score of the factor was negatively affected

by a portion of the sample who did not agree with it, (19.3% not sure, 12.28% disagree and 3.51% strongly disagree).

The last-ranked factor by mean score was, *A clearly-defined innovation policy/innovation plan/strategy (x=3,26, sd=1,15)* shown in Figure 4.7 above. Amongst 58 participants, 14.04% strongly agreed with its importance while 35.09% simply agreed. Its mean score was reduced by 26.32% who disagreed, 19.3% who were not sure and 5.26% who strongly disagreed with it. Half the sample, therefore, agreed on its importance.

The above results, therefore, show that the sample was mostly positive that leadership, as a factor, in their organisations promoted innovation followed by *skills and experience in staff.* A supportive organisational culture, a staff reward system that rewards innovation and an organisational structure with an innovation function were also positively ranked. The above rankings show the factors that the sample perceived as being applied to support innovation in their organisations. Later, Chi-square tests will show whether these factors were indeed associated with innovativeness.

Going back to the literature, the above results were not much of a surprise as several scholars discussed and confirmed their importance in influencing innovation. Business and innovation strategy was discussed as essential for innovative development by Zotto and van Kranenburg (2008) and Goffin and Mitchell (2017); Leadership by Denti and Hemlin (2012) and Zhang et al. (2018); organisational culture by Zotto and Kranenburg (2008) and Gershon (2017) and skill and knowledge by Green and Mason (Green and Mason, 2015) and Borrás and Edquist (2015). The above analysis was, however, important in confirming that these factors that were discussed outside the broadcasting engineering department context were also crucial in the enhancement of innovation amongst broadcasters.

4.3 External Factors of Innovation

Table C.2 in Appendix C shows Likert scale results by frequency as well as mean rankings for five external factors of innovation. The table shows the

sample's levels of agreeability on whether or not innovation in their organisation has been in response to these five factors.

The Likert-scale ratings of each of the external factors are shown in Figure 4.8 below and briefly discussed.

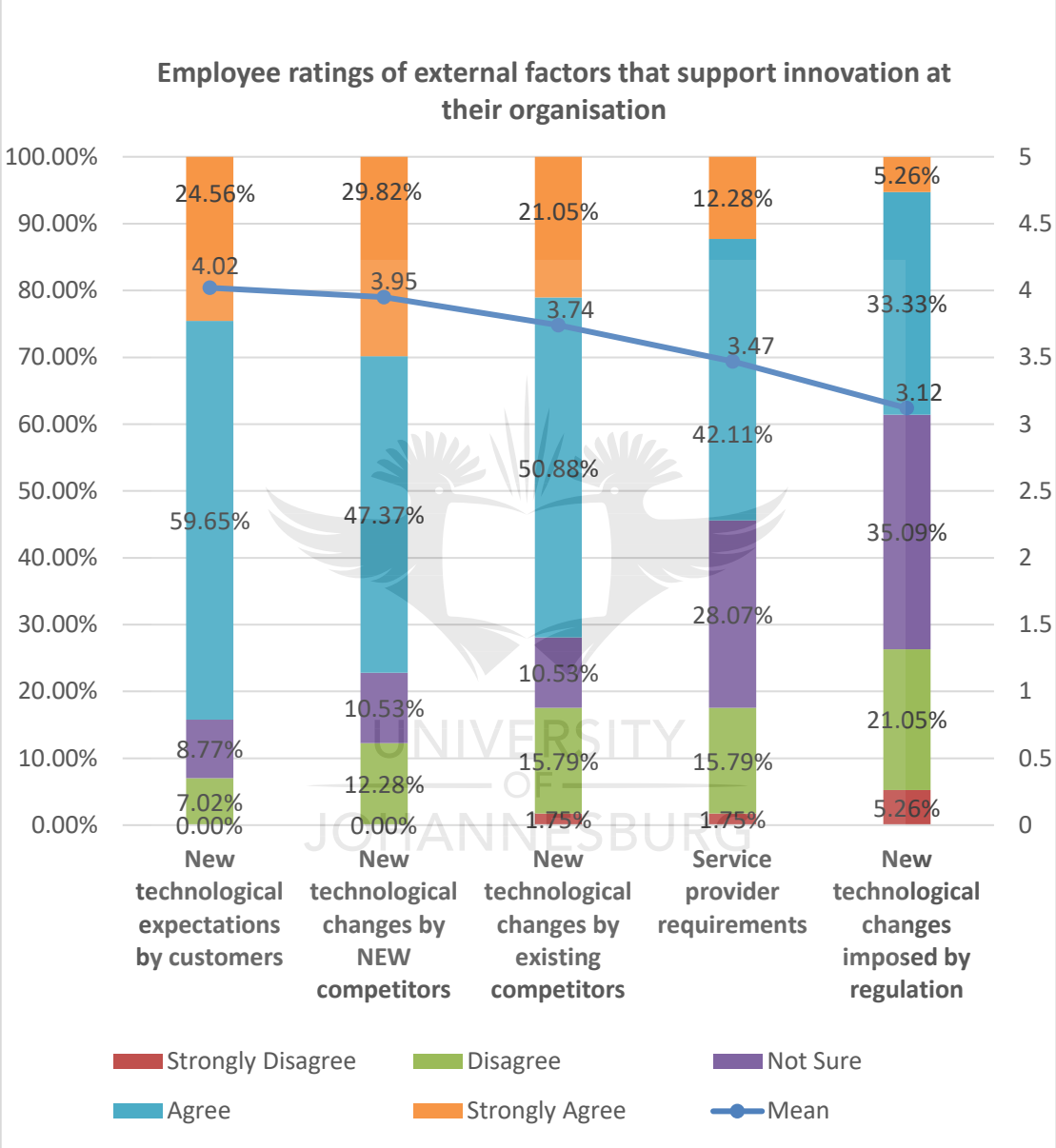

Figure 4.8: Employee ratings of external factors that support innovation at their organisation

New technological expectations by customers, as a factor, had the highest mean (x=4.02, sd=0.78) shown in Figure 4.8 above. This indicates that overall, the sample was more positive that innovation was mostly in response to this factor than the other four. On the same factor, 24.56% of the 58 respondents

strongly agreed that it was a major driver of innovation on their organisations while 0% strongly disagreed. The view that customers were the most important driver of innovation is also held by Annacchino (2007) and Xuhua *et al.* (2016). The latter advises that organisations can learn about potentially successful innovations through learning about their customer needs.

Response to competitors' new technological changes as a factor was ranked second with a mean of 3.95 (sd=0.94) shown in Figure 4.8 above. Out of 58 respondents, 29.82% strongly agreed that it was a driver of innovation in their organisations. The majority of the sample was therefore positive about the factor's important influence in innovation.

New technological changes by existing competitors, as a factor, had a mean of 3.74 (sd=1.02) shown in Figure 4.8 above. In the same sample, 21.05% strongly agreed that innovation in their organisations was in response to new technological changes by existing competitors. The majority of the participants were therefore convinced that the need to respond to competition was critical in driving innovation in their broadcasting organisations. Ivaldi and Zhang (2017) and the OECD (2013) like the sample share the view that the need to outpace competitors in an industry whose competition intensity is growing has become an important factor behind innovation in broadcasting and business in general. The OECD (2013) further clarified these competitors to include new forms of transmission, especially internet-driven ones.

The mean for *service provider requirements* as a factor behind innovation, was 3,47, sd=0,96). Likert-scale responses on the importance of the factor as a driver of innovation are shown in Figure 4.8 above. It is noted that 12.28% strongly agreed on the importance of this factor while another 42.11% agreed. Its mean score was however reduced by 28.07% (not sure), 15.79% (disagree) and 1.75% (strongly disagree).

The mean score for *New technological changes imposed by regulation* was 3,12, (sd=0,97). The Likert scale responses on this factor are shown in Figure 4.8 above. The frequency recorded on " strongly agree", as a response was

5.26% and 33.33% on “agree”. Less than half the sample was positive about the importance of this factor with most respondents being “not sure” about it.

The above statistics, therefore, shows that the sample was mostly positive (agreeable) that innovation was driven by the need to meet customer expectations. They also observed technological changes by competitors as important factors that drove innovation. Regulatory forces were ranked lowest by mean by their mean scores were above the median of 2.5 indicating that even though the sample ranked them lowly, it was mainly agreeable that they also drove innovation in their organisations

4.4 Organisational Objectives Behind Innovation

The survey collected data on the major objectives behind innovation in broadcasting entities. Table C.3 in Appendix C shows the statements presented to collect this data, the mean scores and the frequencies.

The participants were mostly positive that profitability was the main objective behind innovation in their respective organisations, (x=4.28, sd=0.52). This was the highest-ranked objective by mean score. The participants’ responses on the profit motive as a major driver of innovation are shown in Figure 4.9 below. Out of 58 participants, 25% strongly agreed on its influence as a driver of innovation in their organisations while another 65.5% agreed. No participants disagreed or strongly disagreed with the importance of this factor.

The second positively ranked factor was *The need to grow the viewership market share* (x=4.16, sd=0.56) shown in Figure 4.9 below. Amongst the participants, 22.4% strongly agreed that *The need to grow the viewership market share* was the driver behind innovation in their organisations and 69% agreed. There were no responses on strongly disagreed and disagreed. The results, therefore, show a wide consensus on the need to grow the viewership market as an important goal behind innovation.

The mean for *The need to grow the advertising market share*, as a factor was 4.14 (sd=0.54). The participants' responses are further shown in Figure 4.9 below. It is noted that 22.4% strongly agreed while 72.4% agreed on this factor

as a driving goal behind innovation. The majority of the sample, therefore, confirmed the influence of this goal in driving innovation in their organisations.

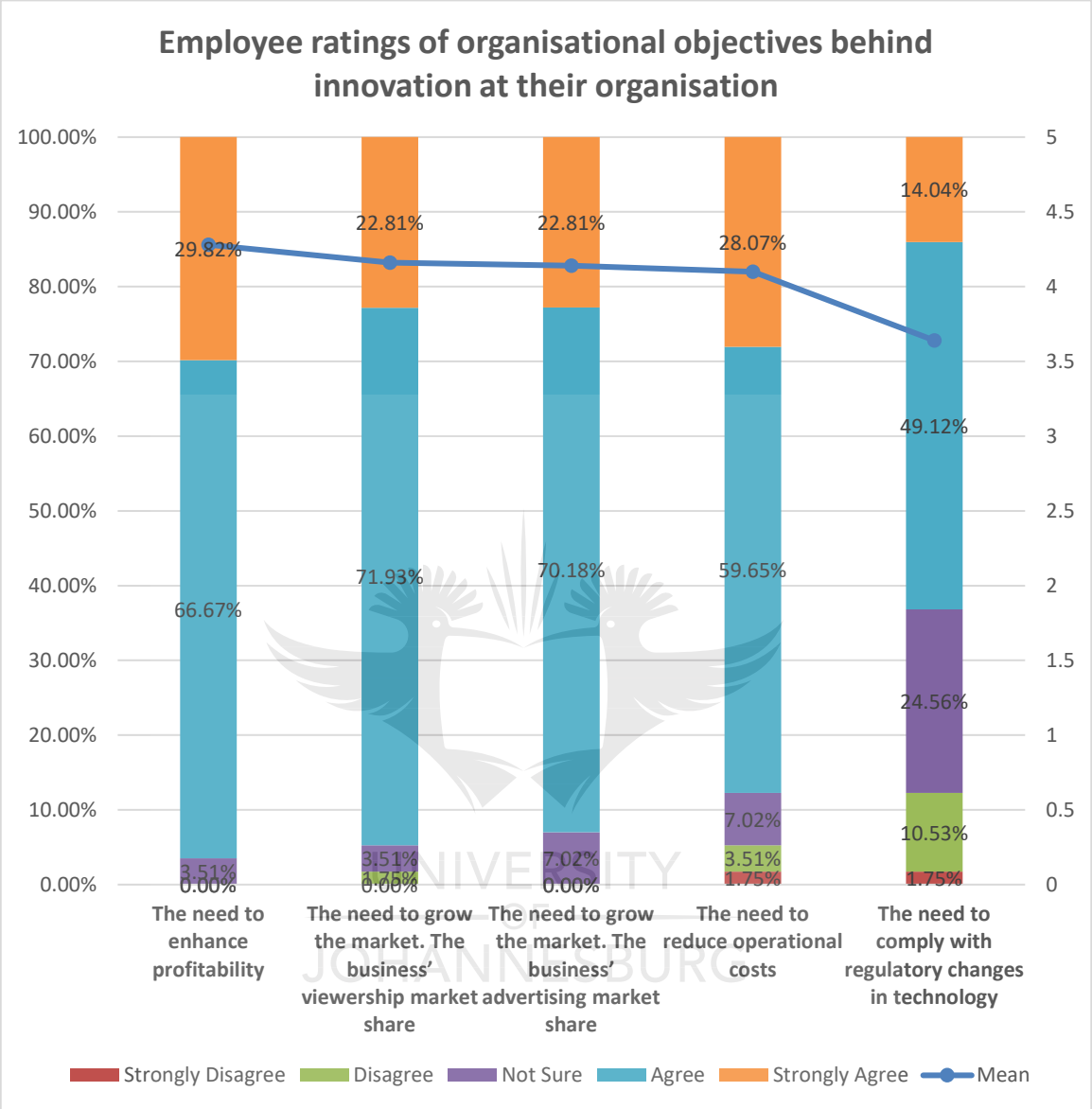

Figure 4.9: Employee ratings of organisational objectives behind innovation at their organisation

The last two factors were: *The need to reduce operational costs* (x=4,10, sd=0,81) and *The need to comply with regulatory changes in technology* (x=3,64, sd=0,91) shown in Figure 4.9 above. These factors had frequencies of 28.07% and 14.04% on the "strongly agreed" response, respectively.

In total, close to 90% of the sample was agreeable on the need to reduce operational costs' importance in driving innovation. Operational costs were,

therefore, an important factor behind innovation in broadcasting organisations. Generally, the participants were mostly positive on the importance of the five factors or goals as drivers of innovation.

The study confirms views by Baporikar (2015) who comments that while the profit is regarded as a major goal behind innovation, other factors are also important and connected to profitability. As shown above, the sample was highly positive on the importance of profit as a goal behind innovation but also scored other factors among them market share and cost management as important.

4.5 Perceptions of How Innovation can be Improved

The sample was requested to comment on how innovation could be improved in their respective organisations. An open-ended section was provided for these comments. The various comments were coded into categories shown in Figure 4.10 below:

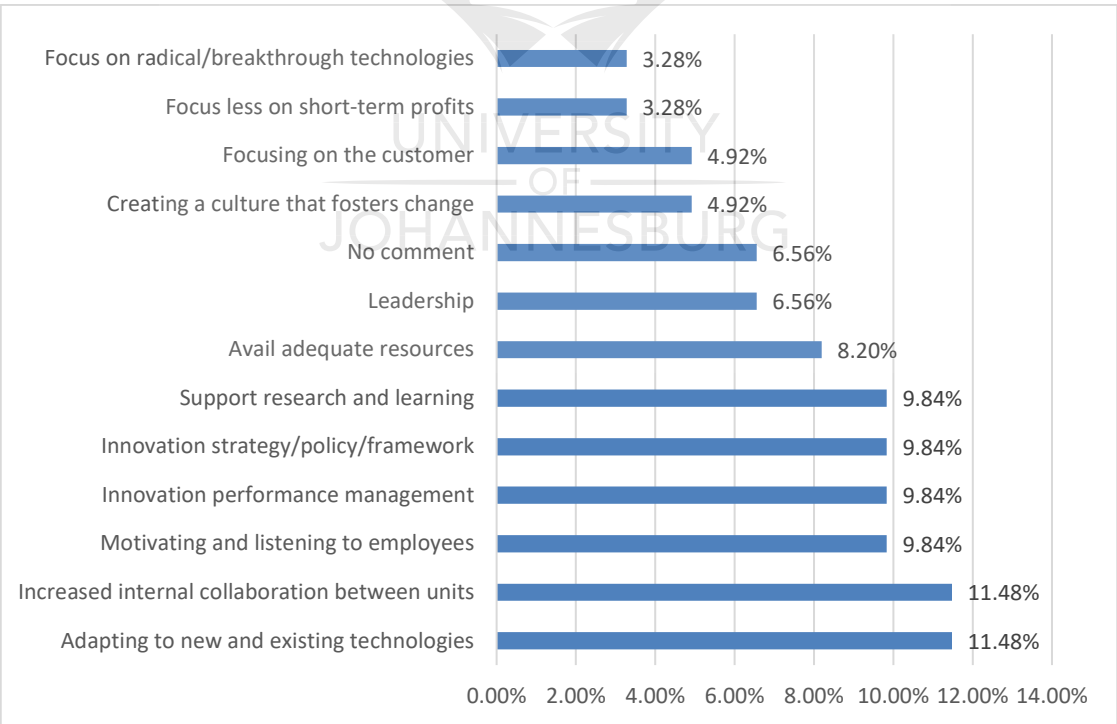

Figure 4.10: Please comment on how innovation can be improved at your organisation

The above comment categories and their frequency of occurrence are briefly discussed below.

4.5.1 Adapting to new technologies

Out of a total of 61 responses, 11.48% commented that innovation could best be improved through adapting to new technologies and increasing the general adaptivity rate to change in the industry. For instance, Participant 43 stated that:

> *The organisation can best utilise the tools that are already being offered by suppliers -Participant 43*

This comment helps in further explaining why most participants rated their organisations as moderately innovative, introducing less than five major innovations a year. The rate at which they adapted to ongoing industry and technological market changes was slow, even for readily accessible technologies.

4.5.2 Increased internal collaboration

Another 11.48% commented that increased internal collaboration between various units in the organisations could improve innovation. According to them, innovation was multi-disciplinary and therefore required equally multi-disciplinary co-ordination:

> *Architects need to sit down with the Engineers on the floor to understand what is needed – Participant 45*

> *It can be improved by all department working in collaboration, as we currently work in isolation and we end up in duplications-Participant 22*

In the literature, Sousa, Pellissier and Monteiro (2012) also point at the need for various units to collaborate as this brings in different ideas, resources and perspectives that are needed in change.

4.5.3 Motivating and listening to employees

There were views that currently, employee contribution towards innovation was not given due consideration. Organisations, therefore, could enhance innovation by listening to employees. This was also associated with employee motivation as ignored employees felt demotivated to participate in innovation. Participants below were cited as saying:

> *Innovation can be improved by motivating the team, encourage diversity and provide proper tools – Participant 35*

> *Listen to what employees have to say -Participant 53*

In total, 9.84% of the responding sample held similar views. Like, the participants, Baporikar (2015) also highlighted the importance of developing an effective communication system that includes listening and considering the views of individuals and teams as important factors that can support innovation.

4.5.4 Innovation performance management

In the sample, out of 61 responses, 9.84% of the responses pointed at performance management and rewarding systems as potential drivers of innovation among staff. Below are selected citations on this view:

> *Deploy innovation incentive on a departmental basis – Participant 19*

> *Innovation can be incentivised to promote more innovation – Participant 38*

The sample deplored the current ineffective rewarding systems that did not encourage innovation and commented that improving these could result in more innovative organisations. The above views were associated with a section of participants who had earlier on rated their organisations rewarding systems as less positive in supporting innovation.

4.5.5 Innovation strategies, policies and frameworks

Some respondents (9.84%) were of the view that their organisations can benefit more through innovation if they formulated and implemented clear and detailed innovation strategies, policies or frameworks. Their views are represented by one participant cited below:

> *Develop a clearly defined innovation policy/innovation plan/strategy supported by the Executive-Participant 8*

These participants were sceptical that the current strategies in their organisations support or fostered innovation.

4.5.6 Other factors or comments

Other comments made by the sample were categorised as follows: Support research and learning (9,84%) also discussed as important by Stowe and Grider (2014); Avail adequate resources to departments (8,20%) and Leadership should be supportive (6,56%) and Creating a culture that fosters change (4,92%). Another 4.92% also believed that focusing on the customer could support or facilitate innovation and 3.82% believed that focusing less on short-term profits could also achieve the same objective. Organisations could also be bold enough to support radical or breakthrough innovations (3.28%). Overall, the above suggestions added on to the Likert scale questions that had rated the sample's responses without any further elaboration.

4.6 Association Between Innovation Levels and Internal Innovation Factors

In this section, Chi-square tests of association (X^2) are used to assess whether there was any statistically significant association between an organisations' perceived level of innovativeness and the various internal factors that are believed to be important for innovation. Cramer's V (φ^c) tests were used as post hoc tests to further quantify the statistically significant associations that were identified by the Chi-square tests of association. Table 4.2 below was used to interpret Cramer's V test scores.

Table 4.2: Interpretation of Cramer's V test scores (Akoglu, 2018:92)

Phi and Cramer's V	Interpretation
> 0.25	Very Strong
> 0.15	Strong
> 0.10	Moderate
> 0.05	Weak
> 0	No or very weak

Table 4.3 below shows the output of these tests for statistically significant associations only.

Table 4.3: Association between innovation levels and internal innovation factors (n = Number of respondents).

n=58	Mean	Chi-Square	Df	Sig.	Cramer's V	Sig.	Comment
An innovation-centred business strategy	3,61	46,88	12	0,00	0,52	0,00	Very strong
The availability of adequate financial resources to support innovation	3,51	33,22	12	0,00	0,44	0,00	Very strong
The availability of adequate technical resources to support innovation	3,63	32,88	12	0,01	0,44	0,01	Very strong
Highly skilled and experienced staff	3,89	26,62	9	0,00	0,39	0,00	Very strong
A staff reward system that rewards innovation	3,79	22,38	12	0,03	0,36	0,03	Very strong

Chi-square tests of association (X^2) showed that there were very strong associations between perceived level of innovativeness in an organisation and the above factors that supported innovation. Cramer's V(φ^c) tests further classified the associations by strength. Perceived level of innovation, which was also the independent variable of the test, was classified as:

1. Highly innovative: (Over 5 technological Innovations in past 3 years)
2. Moderately Innovative (3.5 technological Innovations in past 3 years)
3. Lowly Innovative (1-2 technological Innovations in past 3 years)
4. Not Innovative (0 technological Innovations in past 3 years)

The above results show that the strongest association was between the level of innovation and *an innovation-centred business strategy* $\varphi^c(12)=0.52$, $p<0.05$. This was followed by *The availability of adequate financial resources to support innovation,* $\varphi^c(12)=0.44$, $p<0.05$; *The availability of adequate technical resources to support innovation,* $\varphi^c(12)=0.44$, $p<0.05$; *Highly skilled and experienced staff* $\varphi^c(9)=0.39$, $p<0.05$ and finally *A staff reward system that rewards innovation,* $\varphi^c(12)=0.36$, $p<0.05$.

The above results show that participants who described their organisations as highly innovative were most likely to highly rank (higher mean scores) the above five factors as supporting innovation in their organisations.

The results are partially in agreement with Baporikar's (2015) and Stowe and Grider's (2014) views that innovative organisations are most likely to have detailed innovation management strategies and policies in place, value skills development, have reward systems that encourage risk-taking and have developed a culture of innovation. Unlike the sample, Baporikar (2015), however, argues that organisations did not need a lot of financial and technical resources to be innovative stating that scarcity can motivate both individuals and teams to come up with innovative solutions.

The Chi-square tests result also agrees with the views of (Zennouche, Zhang and Wang (2014) that innovation development should be centred on both the individual and the organisation. The individual can be made more innovative through skills, knowledge and experience as well as the right levels of motivation. The organisation can be made more innovative through detailed innovation strategies and policies. The sample associated both these two innovation focus areas with highly innovative organisations.

Overall, the Chi-squares tests identified five internal factors (business strategy, financial support, technical resources, skills and expertise and reward systems) and two external factors (competitors and customers). Broadcasting organisations should emphasise these factors as they, according to engineers surveyed, were strongly related to how innovative an organisation can become.

4.7 Association Between Innovation Levels and External Innovation Factors

Table 4.4 below shows Chi-square tests of association (X^2) and Cramer's V (φ^c) tests results for a perceived level of innovation in a broadcasting department (independent variable) and the main factors responsible for innovative change (dependent variables).

Table 4.4: Association between innovation levels and external innovation factors (n = Number of respondents).

n=58	Mean	Chi-Square	Df	Sig.	Cramer's V	Sig.	Comment
New technological changes by existing competitors	3,74	25,32	12,00	0,01	0,38	0,01	Very strong
New technological changes by new competitors	3,95	17,82	9,00	0,04	0,32	0,04	Very strong
New technological expectations by customers	4,02	16,85	9,00	0,05	0,31	0,05	Very strong
Service provider requirements	3,47	14,87	12,00	0,25	0,29	0,25	Not significant
New technological changes imposed by regulation	3,12	8,92	12,00	0,71	0,25	0,71	Not significant

Using an interpretation scale by Warner (2013), there were very strong associations between perceived level of innovativeness and the following external factors*: New technological changes by existing competitors*, $\varphi^c(12)=0.38$, $p<0.05$; *New technological changes by new competitors*, $\varphi^c(12)=0.32$, $p<0.05$ and *New technological expectations by customers,* $\varphi^c(12)=0.31$, $p<0.05$. The above three factors were, therefore strongly associated with the perception of innovativeness. Participants who rated their organisations as highly innovative tended to rank the above factors positively – that is, agreeing or strongly agreeing that these factors as being important drivers of innovation in their organisations. There was no statistically significant association between perceived level of innovation in a broadcasting department and service provider requirements and new technological changes imposed by regulation.

The very strong association between the perception of innovativeness in an organisation and the need to respond to competition refutes the views by Negassi, Lhuillery, Sattin, Hung and Pratlong (2019) that competition cannot always be associated with innovation. The results conform to the views by Muckersie (2016) who observed competition and customer focused-entities as being more likely to be innovative than less customer-focused entities. The findings point at competitiveness, firstly to gain viewers and secondly advertisers as important innovation external factors from the perceptions of the sample.

4.8 Association Between Perceived Innovation Levels and Objectives or Reasons Behind Innovation

Table 4.5 below shows Chi-square tests of association (X^2) and Cramer's V (φ^c) tests results for a perceived level of innovation in a broadcasting department and the perceived reasons for innovation. Overall, the questionnaire provided the sample with five predetermined reasons obtained from the literature review these being advertising market share; viewership market share; profitability; reduced operational costs and regulatory compliance.

Table 4.5: Association between perceived innovation levels and objectives/reasons behind innovation (n = Number of respondents).

n=58	Mean	Chi-Square	Df	Sig.	Cramer's V	Sig.	Comment
The need to reduce operational costs	4,09	26,18	9,00	0,00	0,39	0,00	Very strong
The need to enhance profitability	4,26	17,35	6,00	0,00	0,39	0,00	Very strong
The need to grow the market. The business' viewership market share	4,16	20,37	12,00	0,01	0,34	0,01	Very strong
The need to comply with regulatory changes in technology	3,63	9,47	6,00	0,15	0,29	0,15	Not significant

n=58	Mean	Chi-Square	Df	Sig.	Cramer's V	Sig.	Comment
The need to grow the market. The business' advertising market share	4,16	13,69	12,00	0,32	0,28	0,32	Not significant

The above results show that there was a very strong association between perceived level of innovation and (1) the need to reduce operational costs and (2) the need to increases profits, both with a Cramer's V of 0.39 ($p<0.05$). There was also a strong association between the same perception and the view or need to grow the viewership of a station ($\varphi^c(12)=0.31$, $p<0.05$). Participants who viewed or perceived their organisations as highly innovative were most likely to rate profitability, cost reduction and viewership market share as the main motives behind their organisations' innovation drives.

4.9 Final Framework

The Business Dictionary (2019) defines a framework as a "Broad overview, outline, or skeleton of interlinked items which supports a particular approach to a specific objective and serves as a guide that can be modified as required by adding or deleting items." The study, as mentioned in Chapter 1 also aimed at providing a framework that can be researched upon and developed further to guide organisations in innovation management.

By applying the findings of the inferential statistics above, the study produced the following framework that managers can build upon to enhance innovation management. The framework is based on statistically significant associations between the perception of innovativeness in an organisation *(My organisation can best be described as 1.Highly innovative,2.Moderately Innovative,3.Lowly Innovative, 4.Not Innovative, 5.Not sure*) and the rating motives/reasons, external factors and internal factors that supported innovation.

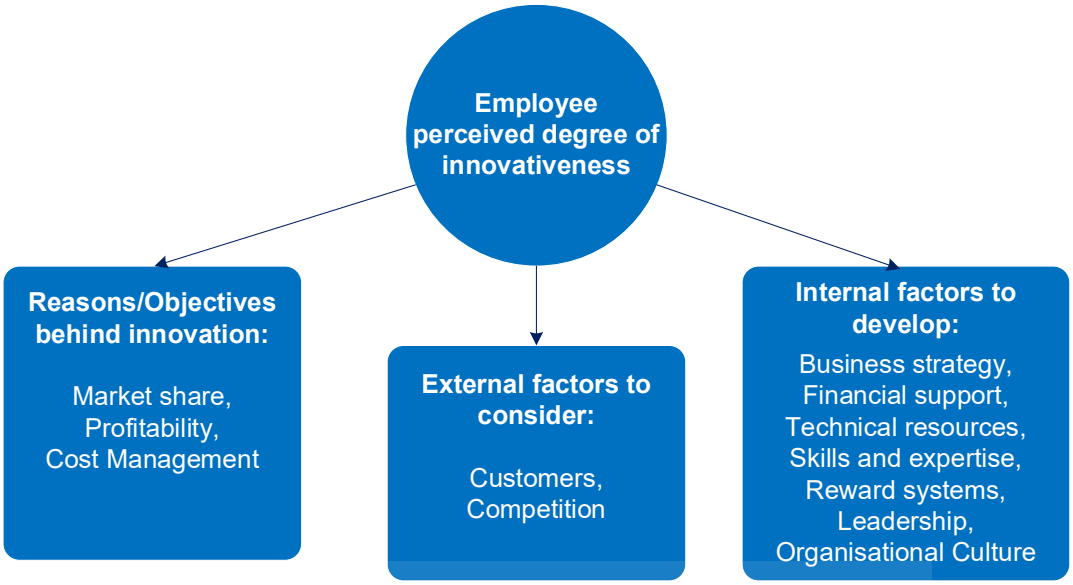

Figure 4.11: Innovation Management Framework

According to the tests of associations, surveyed engineers viewed the degree of innovativeness in an organisation as strongly associated with the objectives behind innovation, the consideration of external factors affecting innovation and the existence of identified internal factors. The above group of factors are part of a framework that management teams can consult to enhance how they manage innovation. The sample points towards the fact that profitability, market share and cost management are important objectives that management can start with. The mere existence of technology (according to the findings) therefore is not to be a key objective that should drive innovation.

Managers should also consider customers and competitors as key external stakeholders that must be considered as part of innovation management. Organisations perceived as highly innovative by the sample took due consideration of the activities of competitors as well as the interests of customers. They also considered regulatory forces and roles of technology suppliers but not as important as customers and competitors. Finally, engineers who perceived their organisations as being highly innovative had significantly high positive scores on internal factors: business strategy, financial support, technical resources, skills and expertise and reward systems.

The above framework also takes consideration of the open-ended views on how innovation can be improved that were presented earlier in the document. The

views correspond with the findings from the tests of associations. The nine factors or categories that were identified all fit under the internal and external factors that were noted as being statistically significantly associated with the perception of whether an organisation was innovative or not.

4.10 Conclusion

In conclusion, the participants were very positive that innovation was driven by or in response to internal capacities, external factors and organisational objectives. The internal capacities that the sample rates as being existent in their organisations were a leadership that encourages innovation, highly skilled and experienced staff, a supportive organisational culture; a staff reward system that rewards innovation and an organisational structure with an innovation function among other. Chi-square tests showed that of these capacities, an innovation-centred business strategy; the availability of adequate financial resources to support innovation; the availability of adequate technical resources to support innovation; highly skilled and experienced staff and a staff reward system that rewards innovation were strongly associated with the perception of innovativeness in the sample's respective organisations. The study also noted that engineers held the perception that the need to manage costs, the need to enhance profitability and the need to meet customer needs were associated with highly innovative organisations. The next chapter concludes on these findings and provides recommendations on how innovation management in broadcasting departments can be enhanced.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This study was designed to develop a better understanding of the management of innovation within an engineering department. The problem statement of the study is how best can the engineering department at a pay television company manage innovation to attain innovation goals that will help the company produce quality output that satisfies clients (viewers and advertisers). It was motivated by the everchanging technological environment that traditional television broadcasters find themselves in. The study had two broad research questions that guided the data collection and analysis these being:

- What factors contribute to innovation within an engineering department in the broadcast industry?
- Can an innovation management framework be derived from literature for the broadcast industry?

The research processes that were carried out were able to answer the above research questions effectively. In the next section, conclusions on the research questions are briefly discussed.

5.1.1 Conclusions to research questions

Quantitative data analysis results used in conjunction with discussions from the literature review guided the conclusions that were made by this study.

5.1.2 Research question 1

The first research question was What factors contribute to innovation within an engineering department in the broadcast industry? Firstly, the sample identified external factors they believed to be behind innovation in their respective organisations. Using mean scores, it was concluded that these factors were (in order of agreeability) new technological expectations by customers, new technological changes by new competitors and new technological changes by

existing competitors. the least agreed upon factors were service provider requirements and new technological changes imposed by regulation.

The internal factors that were highly ranked as influencing innovation in respective broadcasting organisations were: leadership that encourages innovation, highly skilled and experienced staff, a supportive organisational culture, a staff reward system that rewards innovation and an organisational structure with an innovation function. It was further concluded that of the factors that were noted as influencing innovation, only five were associated with the perception of innovativeness. These were: an innovation-centred business strategy; the availability of adequate financial resources to support innovation; the availability of adequate technical resources to support innovation; highly skilled and experienced staff and a staff reward system that rewards innovation.

Another conclusion made on this research question was that of the five identified factors, specifically new technological changes by existing competitors, new technological changes by new competitors and new technological expectations by customers were perceived to be associated with highly innovative organisations. Broadcasting organisations, therefore, needed to focus on these factors when managing innovation.

5.1.3 Research question 2

Research question 2 was Can an innovation management framework be derived from literature for the broadcast industry? The conclusion to this question was that innovation management can be done under three broad facets or focus areas: (1) the management of objectives behind innovation, (2) the management of internal factors and (3) the management of external factors. The objectives that were strongly associated with highly innovative organisations were cost reduction, market share growth and profitability. Organisations that valued these three ahead of other objectives were associated with being highly innovative. Under the internal management facet, organisations that strongly valued five factors: an innovation-centred business strategy; the availability of adequate financial resources to support innovation; the availability of adequate technical resources to support innovation; highly

skilled and experienced staff and a staff reward system that rewards innovation were associated with being highly innovative. Finally, organisations that valued their viewers as customers took cognisance of competitors were also associated with being highly innovative. A framework that can support positive innovation management should, therefore, consider the above factors.

5.2 Recommendations

Based on the conclusions above, the following recommendation is hereby made:

- Television broadcasting organisations should formulate and implement innovation strategies that are a sub-set of their business and operational strategy. These strategies, as discussed in both the literature and the empirical study, will give direction to the innovation processes including the setting up of innovation goals and objectives and the availing of necessary resources.
- Innovation requires adequate financial and technical resources. Management should ensure that engineering departments are well-financed and technically resourced to research or and develop new innovative technologies.
- Broadcasting organisations should develop a culture of innovation that fosters collaboration among staff, acceptance of change and learning and research.
- Managers should also take care of the human side of innovation. This includes ensuring that broadcasting engineers are motivated to innovate. Rewarding systems can also help to encourage the spirit of innovation. Overall, management must strive to create a positive working environment where engineers feel that they are listened to as a way of encouraging innovation.

Managers are also recommended to adopt the innovation management framework presented in Chapter 4. This framework was derived from the perceptions of engineers who work directly inside television broadcasting stations hence its importance. The framework provides guidance factors across

three innovation management areas: objectives, external factors of innovation and internal capacities or enablers.

5.3 Limitations of Study

The study was carried out in observance of strict ethical considerations as well as research design guidelines identified from the literature. Regardless, some limitations to the study can be noted. These are:

- The study was carried out as a perception study relying on the views of the sample to answer research questions. These perceptions could possibly not be fully reflective of innovation management in the respective organisations the sample professionals worked from.
- The study's discussion of results was strongly influenced by limited research on innovation within broadcasting engineering departments in South Africa. The views expressed as part of the discussions were affected by this as research from other disciplines had to be consulted.

Despite the above limitations, the researcher is confident that the research remains critically important to the broadcasting engineering community in South Africa.

5.4 Recommendations for Further Studies

The following empirical studies are recommended as a way of building up on this study:

- Studies on how innovation strategies can best be developed and aligned to business strategies in the television broadcasting industry.
- Financial and technical resources challenges that affect innovation management in the television broadcasting industry.
- The management of internal collaboration in innovation in the television broadcasting industry.

These studies will build up on current knowledge on the body of knowledge on innovation management within the broadcasting engineering community.

5.5 Conclusion

This study was able to successfully collect the perceptions of qualified engineers currently working in various capacities in the television broadcasting industry. Through these perceptions, it was concluded that innovation management centred on three main facets: the objectives behind innovation, the external environmental factors of innovation and internal capacities that organisations needed to harness innovative opportunities effectively. The study identified an innovation-centred business strategy; the availability of adequate financial resources to support innovation; the availability of adequate technical resources to support innovation; highly skilled and experienced staff and a staff reward system that rewards innovation as being strongly associated with innovative organisations. Innovative organisations were also cognisant of their customers and competitors and did not always innovate simply because the technology was available but because customers observed value in the innovation and that innovation could have a positive effect on organisational returns.

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APPENDIX A: PARTICIPANT INFORMATION LETTER

PARTICIPANT INFORMATION LETTER

TITLE OF RESEARCH PAPER:

MANAGEMENT OF INNOVATION IN AN ENGINEERING DEPARTMENT IN THE BROADCAST INDUSTRY

RESEARCHER:

Teboho Phalatse

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Dear Participant,

You are invited to participate in the research study described below.

WHAT IS THE PROJECT ABOUT?

The study seeks to determine factors, challenges and barriers that affect innovation in the engineering department in the broadcast industry and to mitigate the adverse effects (if any) that innovation may have on the department and the organisation at large. It aims to deduce a process or framework for the management of innovation within the engineering section of the broadcasting industry, which will enable better appreciation of innovation. It will also assess organisational responses to various changes in the multimedia industry in South Africa, including those that are putting mainstream broadcasting at the risk of losing its market share.

WHO IS UNDERTAKING THE PROJECT?

The research study is being conducted by Teboho Phalatse under the supervision of Dr Hannelie Nel. The research study is conducted to fulfil the requirement of M.Phil Engineering Management (CW) at the University of Johannesburg.

WHAT WILL I BE ASKED TO DO?

You are invited to participate in an online survey of approximately 10 minutes.

CAN I WITHDRAW FROM THE STUDY?

Participation in the research study is entirely voluntary and anonymous. If you agree to participate you have the right to withdraw from participation at any time without any consequence to you.

WILL ANYONE KNOW THE RESULTS OF THE PROJECT?

Information gathered for this research study will be held in confidence, and your name will not appear against any responses.

Thank you.

APPENDIX B: SURVEY QUESTIONNAIRE

Magister Philosophiae: Engineering Management – University of Johannesburg

Research title:

Management of Innovation in an Engineering Department in the Broadcast Industry

Please be assured that data collected from this study shall only be used for the purpose of completing the study for the above topic. You are encouraged to provide as honest and frank answers as possible. Information collected herein will be held in confidence and your name will not appear against any responses. You are also free to withdraw your participation from this study at any time without any consequence to you.

SECTION A: General Information

Please select one response that best describes your situation (Use X to indicate your selection).

Management level		**Formal academic qualification**		**Industry**	
1. Non-management		**1.**Matric & below		**1.**Public broadcasting	
2. Middle Management		**2.**First Diploma/Degree/equivalent		**2.**Commercial broadcasting	
3. Executive Management		**3.**Post Graduate Degree		**3.**Community broadcasting	
		4.Other		**4.**Other	

Please indicate your position/title_____

SECTION B: Innovation management views and experiences

Please note that Innovation referred to in this Section INNOVATION refers to and is limited to Technical processes, procedures, methods, equipment and systems used in broadcasting.

These could be new to the industry or new to your organisation or both

1. Within the past 3 years:	**1.No**	**2. Yes**
I have suggested/proposed a process, system or technology new to the Industry (New to the broadcasting industry at large)		
I have suggested/proposed a process, system or technology new to the Station(New to the station but already existing in the Industry)		

2. My organisation can best be described as:	**Please Select One response**
1.Highly innovative: (Over 5 technological Innovations in past 3 years)	
2.Moderately Innovative (3.5 technological Innovations in past 3 years)	
3.Lowly Innovative (1-2 technological Innovations in past 3 years)	
4.Not Innovative (0 technological Innovations in past 3 years)	
5.Not sure	

3. My organisation can best be described as:	**Please Select One response**
1.Adoptive: Innovating through adopting technologies already available in the industry	
2.Creative: Coming up with new technologies not known in the industry	
3.Outsourcing: Getting innovations through outsourced partners	
4.Other:	
5.Other:	

4.Innovation at my organisation has been strongly supported by the following:	1. Strongly Disagree	2. Disagree	3. Not Sure	4. Agree	5. Strongly Agree
An innovation-centred business strategy					
A supportive organisational culture					
An organisational structure with an innovation function					
A clearly-defined innovation policy/innovation plan/strategy					
Leadership that encourages innovation					
A staff reward system that rewards innovation					
The availability of adequate technical resources to support innovation					
The availability of adequate financial resources to support innovation					
Highly skilled and experienced staff					

5. Innovation at my organisation has been in response to:	1. Strongly Disagree	2. Disagree	3. Not Sure	4. Agree	5. Strongly Agree
New technological changes by existing competitors					
New technological changes by NEW competitors					
New technological expectations by customers					
New technological changes imposed by regulation					
Service provider requirements					

6. Innovation at my organisation has been in response to:	1. Strongly Disagree	2. Disagree	3. Not Sure	4. Agree	5. Strongly Agree
The need to grow the market. The business' advertising market share					
The need to grow the market. The business' viewership market share					
The need to enhance profitability					
The need to reduce operational costs					
The need to comply with regulatory changes in technology					

7. Please comment on how innovation can be improved at your organisation:	8.Please list up to 4 Important Innovations that have occurred at your organisation in the Past 3 years:

APPENDIX C: QUESTIONNAIRE ANALYSIS

Table C.1: Descriptive analysis of Employee ratings of internal factors that support innovation at their organisations (n = Number of respondents).

n=58	Mean	Std. Dev.	Skewness	Kurtosis	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
Leadership that encourages innovation	4,00	0,84	-0,93	0,79	0,00%	8,77%	8,77%	56,14%	26,32%
Highly skilled and experienced staff	3,90	0,74	-0,63	0,70	0,00%	5,26%	17,54%	59,65%	17,54%
A supportive organisational culture	3,79	0,85	-1,16	1,70	1,75%	8,77%	12,28%	63,16%	14,04%
A staff reward system that rewards innovation	3,79	1,04	-1,22	1,22	5,26%	8,77%	8,77%	56,14%	21,05%
An organisational structure with an innovation function	3,69	0,90	-0,82	0,59	1,75%	10,53%	19,30%	54,39%	14,04%
The availability of adequate technical resources to support innovation	3,62	1,02	-0,70	0,06	3,51%	12,28%	19,30%	47,37%	17,54%
An innovation-centred business strategy	3,62	0,97	-0,83	0,51	3,51%	10,53%	21,05%	50,88%	14,04%
The availability of adequate financial resources to support innovation	3,50	1,03	-0,45	-0,28	3,51%	14,04%	26,32%	40,35%	15,79%
A clearly-defined innovation policy/innovation plan/strategy	3,26	1,15	-0,17	-0,97	5,26%	26,32%	19,30%	35,09%	14,04%

Table C.2: Descriptive analysis of Employee ratings of external factors that support innovation at their organisations (n = Number of respondents).

n=58	Mean	Std. Dev	Skewness	Kurtosis	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
New technological expectations by customers	4,02	0,78	-0,94	1,22	0,00%	7,02%	8,77%	59,65%	24,56%
New technological changes by NEW competitors	3,95	0,94	-0,80	-0,07	0,00%	12,28%	10,53%	47,37%	29,82%
New technological changes by existing competitors	3,74	1,02	-0,79	-0,06	1,75%	15,79%	10,53%	50,88%	21,05%
Service provider requirements	3,47	0,96	-0,33	-0,40	1,75%	15,79%	28,07%	42,11%	12,28%
New technological changes imposed by regulation	3,12	0,97	-0,25	-0,39	5,26%	21,05%	35,09%	33,33%	5,26%

Table C.3: Descriptive analysis of Employee ratings of organisational objectives behind innovation at their organisation (n = Number of respondents).

n=58	Mean	Std. Deviation	Skewness	Kurtosis	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
The need to enhance profitability	4,28	0,52	0,24	-0,44	0,00%	0,00%	3,51%	66,67%	29,82%
The need to grow the market. The business' viewership market share	4,16	0,56	-0,57	3,33	0,00%	1,75%	3,51%	71,93%	22,81%
The need to grow the market. The business' advertising market share	4,14	0,54	0,10	0,29	0,00%	0,00%	7,02%	70,18%	22,81%
The need to reduce operational costs	4,10	0,81	-1,43	3,58	1,75%	3,51%	7,02%	59,65%	28,07%
The need to comply with regulatory changes in technology	3,64	0,91	-0,64	0,27	1,75%	10,53%	24,56%	49,12%	14,04%