Innovation challenges faced by research and development organisations in State-Owned Entities: A case of Transnet Engineering

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Abstract

This study examines the performance of Transnet Engineering's (TE) Research and Development (R&D) department and its activities, with a focus on understanding the drivers and challenges to innovation. Transnet SOC Ltd.'s engineering division, TE, manufactures, refurbishes, and maintains rolling stock and port equipment. In this case the R&D department is intended to introduce new or improved technologies and/or services to support the organisation to deliver reliable freight and port businesses. To understand these challenges, the balanced scorecard framework is used to examine the performance of the R&D department. This study followed a qualitative approach where semi-structured one-on-one interviews were conducted with the purposefully selected R&D management members and supporting management teams from business development and the finance department.

While the R&D team seeks to execute and implement novel technologies or services, the research found that there are insufficient processes and policies in place to assist the R&D department accomplish its goals in the aspects of human resources, procurement, marketing, and finance. Nonetheless, the R&D team members are satisfied with the work they are doing, which encourages them to keep acquiring new skills and be a part of the team that develops solutions to Transnet's product issues. Throughout the study, it had emerged that the R&D team is crucial to Transnet to enable the entity to continue to be sustainable and competitive.

KEY WORDS

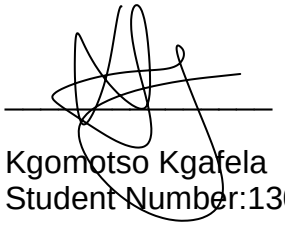
Innovation challenges in South Africa, State Owned Enterprises, Research and Development, innovation processes, technology management

Declaration

I declare that this research is my own work.

It is submitted for the degree of Master of Management in the field of Innovation Studies to the Faculty of Commerce, Law & Management in the Wits Business School of the University of Witwatersrand, Johannesburg.

It has not been previously submitted for any other degree or examination at any other university.



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Abbreviations

B-BBEE	Broad-Based Black Economic Empowerment Act
BSC	Balanced Scorecard
DPE	Department of Public Enterprises
DSI	Department of Science and Innovation
EM	Executive Manager
GERD	Gross Expenditure on Research and Development
HSRC	Human Sciences Research Council
IP	Intellectual property
KPI	Key Performance Indicator
NIS	National Innovation System
NSI	National System of Innovation
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
PE	Principal Engineer
PFMA	Public Finance Management Act
PPPFA	Preferential Procurement Policy Framework Act
R&D	Research & Development
R, D&I	Research, Development & Innovation
SOE	State-owned enterprises
STI	Science, Technology & Innovation
TE	Transnet Engineering
TFR	Transnet Freight Rail
TNPA	Transnet National Port Authorities
TPT	Transnet Port Terminals

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CHAPTER 1: INTRODUCTION

1.1 Background

The National Planning Commission (2012) states that “South Africa needs reliable, economical and smooth-flowing corridors linking its various modes of transport (road, rail, air, seaports and pipelines)”. These routes are now dominated by obsolete, prone to failure railway technology and inadequate intermodal connections (National Planning Commission, 2012). It is with these statements above that characterises the birth of an R&D department within Transnet Engineering, a division of Transnet SOC Ltd.

Transnet SOC Ltd is a publicly owned company (established in terms of the Legal Succession to the South African Transport Services Act, No. 9 of 1989), with the South African government as the sole shareholder under the Public Enterprise Ministry (Transnet SOC Ltd., 2018). Transnet is the guardian of South Africa's ports, railroads, and pipeline infrastructure, and it functions as an unified freight transport enterprise with five operational divisions; Port Terminals, Engineering, National Ports Authority, Freight Rail, Pipelines, and Port Terminals) that supplement each other (Transnet SOC Ltd., 2018).

Transnet Engineering, a division of Transnet SOC Ltd, offers Freight Rail, the National Ports Authority, Port Terminals, and external clients with innovative manufacture, maintenance, and refurbishing of railways and specialised port equipment (Transnet SOC Ltd., 2018). From year 2011 to 2013, parts of Transnet Rail Engineering’s (name changed to Transnet Engineering in year 2013) strategic intent was to (a) Establish and maintain collaborations with Original Equipment Manufacturers (OEMs) and technology suppliers to expand the company's technological base, (b) Invest in

infrastructure, assets, and capacity development to improve railway engineering's strategic capabilities; c) Growing market share and intellectual property whilst expanding technology solutions in the product range, (d) Commit to all facets of change and transformation and, (e) Increase R&D activities to expand technological capabilities and grow the product offering, including the development of a locomotive for African market (Transnet SoC Ltd., 2011, 2012, 2013)

In 2013, TE adopted an Original Equipment Manufacturer (OEM) strategy which aims to change its business model of 'manufacturing for maintenance' to 'manufacturing under own license', thus transformation TE to a fully-fledged OEM through the outputs of the R&D team in order to grow its market share in the African continent and beyond. This research aims to comprehend the performance problems faced by this R&D department from its establishment in 2014 until the year 2020.

1.2 Research Problem Statement

Despite annual financial reports of the biggest four SOEs (Transnet, Eskom and Denel) reporting on R&D spending, there is variance between the targeted spending vs the actual amount spent on R&D activities on a year to year basis. This variance suggests that there are underlying challenges that the SOEs are experiencing in managing R&D activities which ultimately affects the national governments intention through the Department of Science and Innovation (DSI) of growing investments in R&D to drive innovation in South African (CeSTII, 2008a).

Department of Science and Technology (2002), National Planning Commission (2012), and Department of Science and Technology (2019) recognised SOEs as one of the players in the National System of Innovation (NSI) of South Africa. Furthermore, OECD (2015) recognises that publicly financed research by a variety of players,

including scientific councils, universities, SOEs, and private businesses, is critical to the innovation process and Maroto, Gallego, & Rubalcaba (2016) concluded that publicly funded research contributed significantly to technological growth and economic growth in the European Union. Therefore, for South Africa to grow its economy through technological investments, all players within the NSI need to constantly increase their spending on R&D activities.

1.3 Purpose of the Research on Transnet

While the South African national government has set a target of 1.5 percent R&D intensity ratio by 2019, as measured by Gross Expenditure on Research and Development (GERD) as a proportion of Gross Domestic Product (GDP), Nazeem, Molotja, Makelane, & Blankley (2015) and Mustapha & Neo (2015) found out that on a year-to-year basis, there is a disparity between the planned and actual amount spent on R&D activities among the top three SOEs, i.e. Eskom, Transnet & Denel.

HSRC and the Department of Science and Technology (2017) discovered a trend after examining SOEs shareholder compact reports indicating that the SOEs had cut their R&D expenditure by about half as compared to previous years. Furthermore, one of the recommendations that was suggested by HSRC and the Department of Science and Technology (2017) was for further research to be conducted on these SOEs to understand and unpack challenges related to the reasons for the budget cuts on R&D expenditure. The understanding of this challenge at Transnet Engineering's R&D department will lead to potential solutions to assist the government's target on GERD.

1.4 Significance of the Study

This study aims to contribute to the Human Sciences Research Council (HSRC) on R&D investments in SOEs with focus on Transnet's R&D performance from year 2014 to 2020 while unpacking any policy implications and challenges on actual R&D activities. The insights from this study could influence policy makers and other SOEs to work together and develop coherent policies for managing publicly funded R&D.

1.5 Delimitations of the Study

In this study, there are two delimitations that enable a focused approach, namely:

1. The focus of the study was limited to a case study on the R&D department within Transnet Engineering (TE).
2. The population of this case study excludes external participants (i.e. research institutes, universities, other SOE, etc.) and only be limited to TE R&D's executive committee. The committee comprises of R&D's management team and participants from the business development team who primarily interact with TE's customers and the finance team who supports the R&D team with financial analysis and preparation of budgets and financial reports.

1.6 Assumptions

This study assumes the following:

1. The participants have the experience and the necessary knowledge on the history of the R&D department.
2. The chosen population is willing to be interviewed
3. The TE R&D department is the only department conducting R&D activities on behalf of the other Transnet divisions.

4. No other similar study of this nature was conducted in Transnet or by other SOEs with R&D units.

1.7 Methodology Overview

This study will follow a qualitative approach where semi-structured interviews will be conducted with the selected population. Due to the current covid19 pandemic, an online one-on-one interview approach is preferred with the population in order to engage and understand some of the unknown operations of the R&D unit. The data collected will be structured per a specific theme that will emerge from the data. The data will then be interpreted based on the outcome of all interviews.

1.8 Research Question

The study will seek to critically investigate and analyse the following:

- What are the challenges that Transnet Engineering's R&D unit has been facing that is causing it to underspend on its R&D budget?

1.9 Structure of the Chapters

This chapter covers the background information, problem statement, the study's purpose, significance, delimitations, research questions and how the chapters are structured. The literature review will be covered in Chapter 2, and research methods will be covered in Chapter 3. Chapter 4 will give the findings, while Chapter 5 will focus on the interpretation and analysis of the data, and Chapter 6 will offer the conclusions and recommendations.

CHAPTER 2: LITERATURE REVIEW

2.1 Why do SOEs exist in South Africa?

The existence of government owned enterprises dates as far back as the 1867, owing to the discovery of diamonds in Kimberly followed by gold in the Transvaal. The colonial government established enterprises to support the extraction of these minerals and transport them to the harbour for export purposes. Their priorities were to export as much as practicable without engaging in any industrial development other than mining and shipping at the lowest price possible.

South Africa's developing economy has since relied heavily on extracting and exporting of its mineral resources for growth and development and the OECD (2015) illustrates some of earliest rationale for establishing these enterprises as follows:

1. The Post and Telegraph Department was established in 1910 to provide and regulate South Africa's post, broadcast and telecommunications. Postal and telecommunications, however, were separated by law in 1991, resulting in two government owned enterprises, namely; South African Post Office and Telkom SA limited, while the Communication Department remained the regulator.
2. The administration of South African Rail and Harbors (currently known as Transnet) was founded in 1916 as a consequence of the incorporation of the Natal and Cape railway networks into state property in 1877 and 1872 respectively. The discovery of diamonds in Kimberly in 1867 attributed to the expansion of the railway system in Natal and Cape, while the discovery of gold deposits in the Transvaal in 1880 was viewed as a means of developing South Africa through mineral exports.

3. Eskom was founded in 1922, formerly known as the Electricity Supply Commission (ESCOM). The aim was to ensure continued safe and low-cost electricity to support the development of the freight, metal, manufacturing and related industries.
4. The Iron and Steel Corporation (Iscor) was established in 1928 as a result of rising import levies on steel commodities from European producers.
5. Sasol was established in 1950 to process coal locally and enhance national fuel supply in the narrow sense of the Apartheid government under constant threat of sanctions.

After gaining independence from the British, the South African government was in the hands of the elite white Afrikaners, who afterward inherited the idea that government participation in the economy and society was normal (Nellis, 1986). The ANC continued with the same ideology as a way to redress past inequalities and provided all government owned enterprises with social and economic mandates (OECD, 2015).

Nonetheless, when comparing South Africa with a similar developing economy such as that of Brazil, it has been found that the Brazilian government started owning and controlling its national railway enterprise as a result of granting bailouts to several privately-run railway companies. Then from the 1940s, many government enterprises central to economic development were formed in mines, oil, chemicals & electricity (OECD, 2015).

These enterprises can either be wholly or partially owned by the government with a purpose of offering access of basic services to all citizens and ensuring management of strategic resources while being efficient, profitable and sustainable. These

enterprises could be a country's biggest or exclusive supplier of goods or services. Generally, and in this article, these government owned enterprises will be referred to as state-owned enterprises (SOE). There are now just over 700 profit and non-profit SOEs administered by the different ministries, provincial and local governments.

2.2 A declining Investment in SOEs R&D.

The apartheid government began its efforts in the 1980s to transfer South African SOEs from public entities to private ownership and control (OECD, 2015). Many might claim that the founders of Apartheid were planning to maintain ownership and control of the core economic public institutions while handing over the government to the people of the black population. As a result of this decision, South Africa's national R&D investment fell from 1.1 percent of GDP in 1990 to 0.7 percent in 1994, owing to the discontinuation of technology missions in the defence and power generation (Department of Science & Technology, 2002). A directive was issued to the State Ownership Agency now recognized as the Department of Public Enterprises (DPE), to privatize all public companies. Nevertheless, the directive was revised to that of transformation after the African National Congress (ANC) came into power in 1994. Sasol was among some of the companies which were fully privatized. The aim of this new strategy was to include private firms in areas of the SOE value chain and tackle the effects of economic inequalities (OECD, 2015).

The decade post 1994 was difficult for SOEs since majority of government legislations were being reviewed. Capital investment were suspended, no funds were reserved for potential R&D expenditures and major maintenance programs were suspended (OECD, 2015). The resulting economic effect was the phase of de-industrialization that culminated in the closing of many manufactures of machinery.

Around 2004, restructuring of SOEs began and a decision by cabinet was reached, where SOEs could fund their capital programs through their own balance sheet (OECD, 2015). It was with this decision from cabinet that saw Eskom initiating an ambitious new construction program of building two 4,800 MW coal-fired power stations and Transnet started implementing its market demand strategy of investing R300 billion over a seven-year cycle that began in 2011. While decades of deteriorated infrastructure is addressed by SOEs, investments in R, D&I were made but only moderately across the SOEs (OECD, 2015; HSRC & DST, 2017).

The HSRC & DST (2017) report found out that despite annual financial reports of the four largest SOEs in South Africa reporting on R&D spending, there is a common thread of underspending on the R&D budget over the past decade. This underspending affects the government's intention of growing investments in R&D to drive economic development as stipulated in the white paper on science, technology and innovation.

2.3 How are SOEs governed in South Africa?

The Constitution of the Republic of South Africa (1996) was drafted and ratified by the ANC government to ensure that all South Africans are protected by human rights and advocates for steps to combat historical racial imbalances. Under apartheid and colonial rule, South Africa's black people, the majority population, were purposefully kept out of the mainstream economy (Tangri & Southall, 2008). The 1996 constitution gave rise to adoption of policies that advocated for transformation in all areas of the country, including governance of all SOEs.

Some of the key legislative frameworks that were adopted are:

1. Public Finance Management Act (PFMA) of 1999

2. Broad-Based Black Economic Empowerment Act (B-BBEE) of 2003
3. Preferential Procurement Policy Framework Act (PPPFA) of 2000

The PFMA was enacted to control financial management in national and provincial governments, as well as SOEs, by ensuring that there is transparency and effective management of revenue collection, expenses, fixed and current assets, and liabilities. While the PFMA encompasses all areas of public administration, sections 46 to 86 are of interest regarding governance of public entities. Any public entity must have an accounting authority, usually the board of directors, that is accountable to the shareholder to ensure adherence to the PFMA (Preferential Procurement Policy Framework Act, 2000). Consequently, since the Board of Directors is in charge of the company's governance, it must designate a Chief Executive Officer to carry out the essential fiduciary obligations and lead the business in carrying out its mission.

While the PFMA was widely regarded as the holy book of public finance management, the B-BBEE and the PPPFA are two other acts that have an impact on public finance management.

The B-BBEE (2003) strategy aims to foster economic transformation that will allow black people to play important roles in the ownership and administration of public and private enterprises. The PPPFA (2000) seeks to enforce award of business contracts by national and provincial government departments and SOEs to black owned enterprises through a preferential point system.

Despite the great rationale of adopting these and other transformative legislations, there are inconsistencies and contradictions which impact the efficient functionality of the SOEs (Kanyane & Sausi, 2015). In addition, the National Treasury often issues legislative notes aimed at reducing abuse and corruption, however, they affect the

efficient daily operations of SOEs since approval would be required from the finance minister instead of the shareholding minister (Bronstein & Olivier, 2011).

2.4 Why R, D & I in SOEs?

The South African government has committed to using science and technology to convert the country from a mineral-based economy to a development state capable of unleashing possibilities for all South Africans and resolving colonialism's legacy (DST, 2019). The adoption of the Science and Technology White Paper by the government in 1996 was considered as the first step toward the ANC administration's objective.

Following the publication of the white paper, the South African government developed the National R&D Strategy and National Development Plan (NDP) to serve as long-term development goals through investing in science and technology. The actors and institutions who function within this context contribute towards strengthening the National System of Innovation (NSI) in South Africa.

The DST (2019), National Planning Commission (2012), and DST (2002) have recognised SOEs as one of the players of an NSI in South Africa. Publicly financed research by a variety of players, including scientific councils, universities, SOEs, and private businesses, is critical to the innovation process (OECD, 2015).

Maroto, Gallego, & Rubalcaba (2016) concluded that publicly funded research contributed significantly to technological growth and economic growth in the European Union.

SOEs have been delivering the necessary national infrastructure resources such as electricity, mass transport, defence and telecommunication. They generally account as the biggest employer and invests in activities that spur economic advancements. As a result, SOEs must invest in Research, Development, and Innovation (R, D&I) as

catalysts for economic development and growth in attempt to preserve competitiveness, sustainability, efficiency, and profitability.

The position played by SOEs in R&D has been reassessed in published literature, indicating that their effect is far more meaningful than previously considered. According to Benassi & Landoni (2018), SOEs are a powerful mechanism of knowledge governance that work as an open system for R&D, performing both in-house and outsourced research. TÕnurist & Karo (2016) suggests that SOEs have an economic structure in which public incentives and long-term positioning exist side by side with business opportunities and risk-taking activities. In this light, SOEs are active innovators who facilitate and support the innovation ecosystem. They develop and disseminate new knowledge, as well as coordinate other stakeholders required for innovation to be nurtured.

In recent years, there has been a surge in interest in analysing the economic consequences of R&D. The R&D intensity ratio, which estimates GERD as a proportion of GDP, has been adopted by the South African government as a measure of support for R&D. The South African government established a goal of 1.5 percent R&D intensity ratio by 2019 in 2002, indicating that this is critical as a commitment to meeting crucial growth objectives (National Planning Commission, 2012). However, Nazeem et al., (2015) According to the study, GERD has been steadily declining, owing to lower R&D spending by large enterprises, including SOEs. For the 2016/17, Human Science Research Council (2019) (CeSTII, 2008b) indicated that the GERD was standing at 0.82%. It is undoubtedly clear that since the target of 1.5% GERD was set in 2002, South Africa has never achieved it for over 10 years.

To encourage R&D activities, there are a range of policy measures provided by the South African government. One initiative aimed at promoting R&D activity is the R&D tax incentives programme. Nazeem et al., (2015) states that the use of the tax incentives programme, however, has been undoubtedly poor by private businesses. As a result, Section 11D from the Income Tax Act has been amended to allowed SOEs to participate and benefit from the R&D tax incentive (HSRC & DST, 2017). Amendments to the System of National Accounts have also been implemented on how R&D expenditure is managed (Nazeem et al., 2015). In simple terms, R&D expenditure is now capitalized instead of being an expense in that period. This directly ties the expenditure on R&D to a nation's potential economic development (Nazeem et al., 2015).

The largest four SOEs in South Africa (Denel, Transnet, Telkom and Eskom) contribute 99% of all R&D performance and besides the above government efforts, a study conducted by Mustapha, Kruss, & Ralphs (2018) found that R&D activity of SOEs decreased from a peak of 27.9% in 2008/09 to approximately half that amount in 2014/15. Therefore, there is no doubt that there are inefficiencies in the R&D operation of SOEs. This research will focus only on Transnet's R&D activities to understand if there are any inefficiencies.

2.5 National Innovation System for South Africa

When it passed the White Paper on Science and Technology in 1996, South Africa became the first developing country to utilise the concept of NSI in policymaking (Rooks & Oerlemans, 2005). The National System of Innovation is defined by the Department of Arts, Culture, Science, and Technology (1996) as "a set of functioning institutions, organisations, and policies that interact constructively in the pursuit of a

common set of social and economic goals and objectives". At the heart of this NSI definition is the developmental goals of South Africa post 1994.

The government launched the national R&D strategy in 2002 as a leading pragmatic plan to execute the White Paper on STI, which defines South Africa's national science and technology goal. The strategy was aimed at addressing six key weaknesses that were apparent six years after the adoption of the white paper, Namely:

1. Appropriate financing of the national research system: tackles South Africa's weak R&D budget in accordance with OECD countries,
2. Strategic considerations: seeks to build suitable skills amongst NSI actors,
3. Human Resources: seeks to tackle the ageing and decline of scientists, engineers and technologists, and to maximize involvement of women,
4. Decreasing private sector research and development: addressing a decline in private-sector R&D spending,
5. Intellectual Property (IP): establish a consistent IP strategy and competences, in particularly for federally funded R&D, and lastly,
6. The fragmentation of research and technology in government: to integrate the numerous science and technology programs across ministries.

Kaplan (2004) compared the South African National Research and Development Strategy to the strategies of East Asian nations that have demonstrated progress in boosting innovation and economic growth. South Africa, unlike its East Asian rivals, does not have a manufacturing policy as part of an industrial growth strategy, according to Kaplan (2004). South Africa's economic plan instead depends on innovation missions that aren't always well-designed or incorporated into laws aimed at promoting a specific industrial sector.

The South African National Innovation System (NIS) is made up of a number of institutions that each play a unique and complementary role in the country's development of scientific knowledge and technical breakthroughs (Manzini, 2012). These institutions are rooted in a multidimensional ecosystem largely made up of a variety of political, cultural, social, technical, economical, and legal factors, both local and foreign. South Africa's NIS character represents how knowledge policies, institutions and organisations, as a network, address national economic problems to achieve common goals (Manzini, 2012). The success of a country's NIS performance could only be assessed when the innovations and knowledge created by the country's enterprises and allied institutions have fostered economic development and enhanced the quality of life for all of its inhabitants.

When compared to Australia, Malaysia, and North Korea, the Department of Science and Technology (2002) recognised the NSI input indicators, such as the number of scientists and level of education, as key flaws of South Africa. An analysis directed by Rooks et al. (2005) also exposed that the R&D investment from South Africa firms is small when compared to European Union (EU) countries with about 45% of innovative South Africa firms spending roughly 2.5% of innovation expenditure as a percentage of sales while over 50% of innovative firms in EU countries spend well over 3 to 4% on innovations expenditure. Adding to the weaknesses, there has been a diminishing presence of South Africa residents in research and technology-based professions and R&D in the private sector is declining as well (Department of Science & Technology, 2002). Other NSI flaws identified by the National Advisory Council on Innovation (2017) include inadequate and non-collaborative means of establishing the country's STI agenda, inadequate policy consistency and coordination, inadequate interactions

among NSI actors, inadequate monitoring and assessment, and inadequate high-level SET and skills required for the economy.

Notwithstanding some of the successes highlighted in the National R&D Strategy and the 1996 White Paper, the South Africa Government, via the DST as the custodian of STI, needed to resolve these limitations in order to enable South Africa to adapt to global megatrends. In March 2019, the DST updated its 1996 white paper on technology and science and issued a supposedly better white paper. The NSI definition was incorporated in the newly updated South African white paper on STI from Freeman (1987) and Metcalfe (1995) which describes NSI as “The network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies”; and “that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such, it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies”.

The rate of technological advancement in an economy is determined not only by the amount of R&D conducted in that country, but also by important factors such as how required resources (such as skills) are structured, both at the national and firm levels, and the availability of technological innovation from both international and domestic sources. The DST is working on a ten-year plan that will focus on implementing the revised white paper.

2.6 R&D Activities and Strategy

There is no doubt that when studying the concept of innovation, you will come across literature that has matured over centuries. Similarly, given this established literature and for the determinations of this research, the OECD/Eurostat (2018) definition of business innovation will be used which is stated as: “A business innovation is a new or improved product or business process (or combination thereof) that differs significantly from the firm's previous products or business processes and that has been introduced on the market or brought into use by the firm”. Hidden within the scope of innovation are all the administrative, financial, and commercial initiatives which support the company's realization of the innovation. As such, when exploring innovation in a firm, focus must be placed on critically analysing all inputs as well as outputs of innovation (Cirera & Muzi, 2020).

Research and development work is often considered by many companies to be very complex, involving significant risk, with unclear return on the investment, and daunting for executives. Companies that excel effectively and consistently in the commercialization of innovative technologies, on the other hand, have the potential to achieve greater features of the product or service, resulting in a larger slice of the pie and better margins, resulting in a significantly stronger competitive advantage. With the above statements, one may say that managing the end-to-end innovation frameworks is the hidden component for success in these organizations. Therefore, the capacity to convert and integrate innovations into commercialized products through the use of efficient processes is at the core of their success for manufacturing firms (Iansiti & West, 1997). This is achieved not only by focusing on the production process of technologies and product, but also by attempting to understand the interplay between those processes, i.e. innovation activities.

When a firm establishes an R&D department to conduct innovation activities, the organization may very well carry out an in-depth study on the key aspects of the innovation strategy and framework to better appreciate the need for effective and successful innovations (Banu, 2018). There are usually two strategic decisions or a combination of the two that need to be considered as a way of meeting a firm's growth goals for technology infrastructure investment: first, the technology can be produced within a country by in-house research and development; second, it can be obtained by outsourcing R&D from firms within the country or outside the country (Ettlie, 1998). The first choice of domestic technology development is very intensive, in terms of both time and resources, because it requires substantial technological and scientific resources and R&D facilities. Furthermore, the shortening of technology development cycles has made it highly challenging for organizations to invest in in-house R&D activities. In most developed countries, firms have always dependent on other industrialized countries to procure technologies, taking their business requirements and capital into account. Thus, many developing-country firms tend to balance in-house R&D with procurement of foreign technologies to alleviate missing capabilities and prospective technological risks.

Establishing a golden link between appropriate technology investment risk, goals, and objectives through Key Performance Indicators (KPIs) seems to be a crucial strategy technique when preparing the efficient management of a R&D firms. Measures of innovation have changed throughout history, with a constant emphasis on error reduction through careful questioning and questionnaire creation (Xavier & Silvia, 2020).

The one common KPI that business executives do not fail to report is their expenditure on R&D for each financial year. While this measure is only an input type measure, it

is almost worthless if there are no output from the expenditure on R&D activities. As such, there needs to be a great deal of balance between all possible input and output measures when measuring R&D activities of firms. The Oslo handbook emphasises measuring innovation results, such as new or improved goods, services, and/or processes introduced to the market as a direct result of R&D (OECD/Eurostat, 2018). KPIs in the general sense should be developed as a structured method focused on constant fine-tuning.

2.7 Balanced Scorecard for R&D

Top executives value performance metrics because they may offer an overview of an organization's performance direction depending on the objectives specified. Since an R&D department or organisation is strategic in nature, its performance must be synonymous with its vision, strategy and objectives, that must be properly identified and made known at all levels of the organization with a view that all activities are geared on achieving them (Jyoti, Banwet, & Deshmukh, 2006). Pearson, Nixon, & I. Kerssens-van Drongelen, Nixon, & Pearson (2000) argue that implementing a strategy involves comprehensive measurement systems tracking improvements in both the financial and non-financial returns. Such measurement systems are focused on integrating the organization's processes (R&D, manufacturing , marketing as well as other conventional business functions) with the corporate strategy, making use of their anticipated returns as their measurements (Pearson, Nixon , & Kerssens-van Drongelen, 2000).

The area of performance measurement has been quickly growing, according to Kennerley & Neely (2002). These include the following performance measurements, amongst others:

Table 1: List of Performance Measurements

#	Performance Measurements:	Reference
1	Capital Asset Pricing Model (CAPM)	Connor and Korajczyk, (1986:385)
2	Balanced Scorecard	Kaplan and Norton (1992)
3	SWOT	Phillips (1999:180)
4	Supply Chain Management (SCM)	Gunasekarana, Patelb and McGaughey (2004:333)
5	Suggested environmental indicators, according to the PSR framework	Lundberg, Balfors and Folkeson, (2009:1020-1021)
6	SCOR-BSC framework	Kanda and Deshmukh (2009:719-720)
7	Customer Relationship Management (CRM) scorecard	Kim and Kim (2009)
8	‘‘Check’’ step in the PDCA cycle	Fukushima and Peirce (2011:33)
9	ADJUST	Sezenias, Faemakis, Karagiannis, Diagkou and Glykas (2013)
10	Decision-oriented performance measurement (DPM) framework	Le and Ahn (2014)
11	VM System Performance Measurement	Lacerda, Ensslin and Ensslin, (2014:143-144)
12	Performance Measurement Matrix	Keegan et al., (1989)
13	Performance Prism	Neely and Adams (2001)
14	QM practices	Zhang and Linderman (2014: 103)
15	Balanced Success Model (BSM)	Harold and Thenmozhi (2014:48)

With all of the above frameworks, I. C. Kerssens-van Drongelen & Bilderbeek (1999) observe that there are limited citations in the R&D literature in using these measuring instruments for returns obtained in R&D organisations. Certain performance assessment frameworks, on the other hand, have been discovered to be more frequent than others. Otley (1999), for example, recommended evaluating operation management control systems using the Economic Value Added and the Balanced Scorecard. Mcadam & Saulters (2000) recommended five frameworks for evaluating performance of public organisations: charter mark; benchmarking; quality management systems and total quality management; balanced scorecard; and business excellence models. In addition, the balanced scorecard tableaux-de-board, and performance prism were the performance measurement frameworks used for implementation of strategy according to Gimbert, Bisbe, & Mendoza (2010).

It can be observed that the balanced scorecard is the common one amongst these researchers. In contrast, I. C. Kerssens-van Drongelen & Bilderbeek (1999) recognise that there are relatively few credible sources in the R&D publications on the efficacy of the use of return measurement techniques and propose that the Balanced Scorecard (BSC) could be used as an integrated R&D return measurement system. Neufeld, Simeoni, and Taylor (2001) add to that notion by suggesting that the BSC is the "most promising method" for assisting organisations in quantifying their performance targets.

The BSC, according to Kaplan and Norton (1992), is a unique framework for integrating indicators drawn from the organizational strategy. These includes indicators of past and future operations relating to financial, customer, internal processes, and learning and growth perspectives obtained from an explicit and thorough translation of the organization's strategy into real objectives and

indicators. In a BSC, Kaplan & Norton (1992) strongly adds that performance of an organisation must be measured from four perspectives (see Table 2 below) as: 1) Customers; 2) Financial; 3) Organisational Learning and growth and 4) Internal business processes perspective.

Table 2: BSC Perspectives explained (Kaplan & Norton, 1992)

Perspective	Description
Customer	Measures the performance of the new knowledge, product, process or technology in meeting the targeted customer's needs.
Internal Business	Measures the processes that the organisation decides to be highly skilled at to fulfil its shareholders and customers.
Learning and Growth	Measures the changes and enhancements that the organisation must make in order to achieve its vision.
Financial	Measures how an organisation wishes to be viewed by its shareholders.

Figure 1 below illustrates a typical BSC with possible performance indicators applied to an R&D organisation (Jyoti, Banwet, & Deshmukh, 2006).

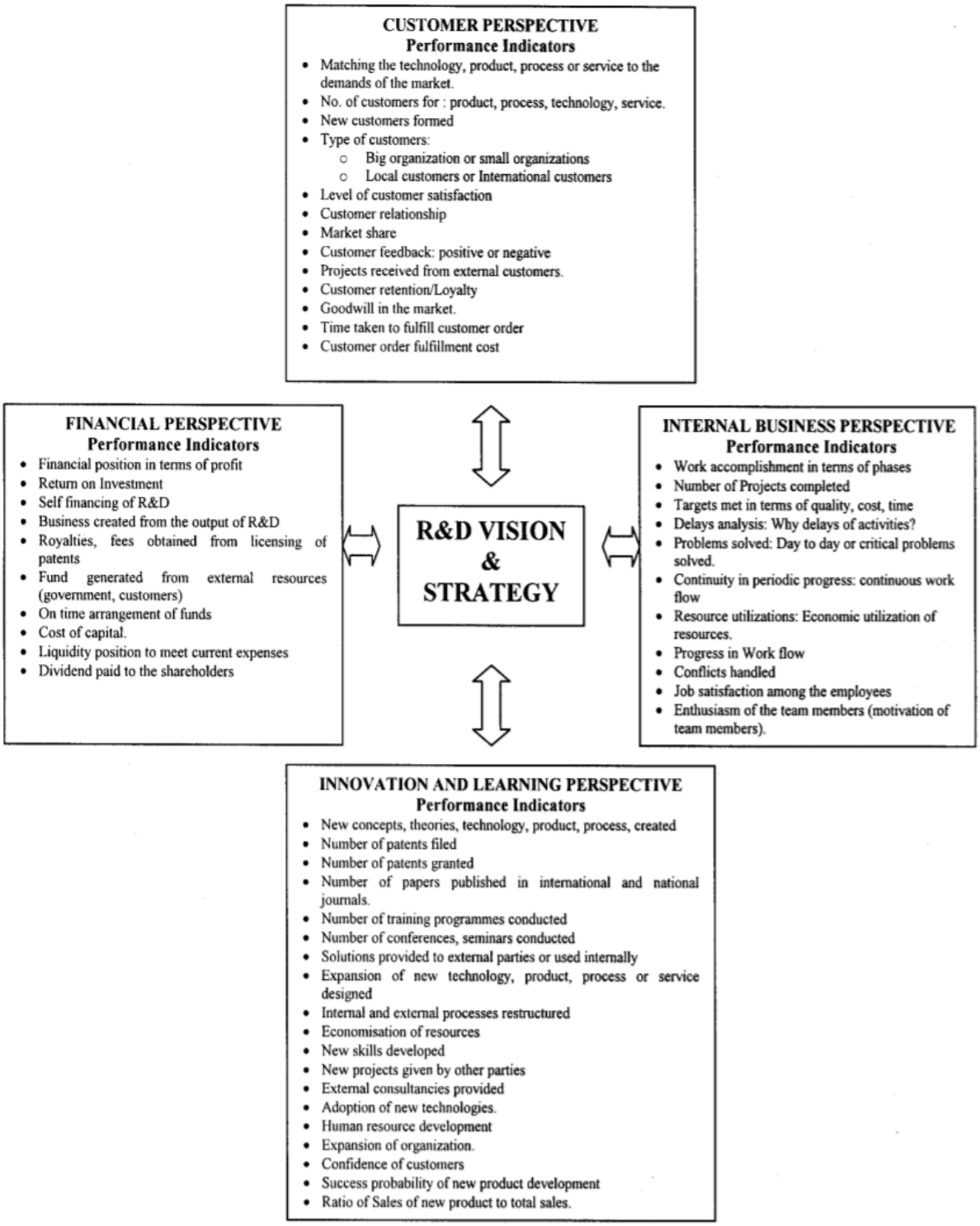

Figure 1: BSC framework for R&D Organisation (Jyoti, Banwet, & Deshmukh, 2006).

From the financial perspective of the BSC, R&D expenditure has been the one KPI that is used to gauge R&D performance by SOEs and is being reported on their shareholder compact report. However, some SOEs have stopped reporting on this KPI as a result of the recurring underspending on it (Mustapha et al. 2018). While there is no report why some of the SOEs have dropped reporting on R&D, Mustapha et al. (2018) proposed that performance metrics must be enhanced to portray the SOEs focus on R&D and that in-depth studies be undertaken on a case-by-case basis to fully grasp the levels of R&D activity.

According to Teresa, Eva, and Daniel (2008), “When R&D activities are undertaken, a series of inputs are consumed, a scientific or technological process is put into action, and later a series of outputs derived from these inputs and processes are obtained; for R&D-based companies, successful outputs are essential for survival and future growth of the company in commercial and financial terms”. It is at the back of this statement that the BSC ultimately combines financial and non-financial metrics, analyse both operational and process results, and assess organizational performance from top to bottom. The BSC will be used as a framework to analyse the interview responses from Transnet’s R&D team.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Research Methodology

This study follows a qualitative case study approach. The quantitative and qualitative methods of conducting research are in constant tension in the field of research methodology. This dispute usually arises as a result of qualitative approach being labelled as "unscientific," "opinionated," or "merely exploratory" (Kohlbacher, 2006). However, it does seem that in the field of social sciences, the qualitative approach of analysis is the most common, as the issues raised in the field are more concerned with interpreting problems than with performing experiments and reporting statistically on findings. This understanding is also explained by Creswell (2014); qualitative research methods focuses more on the insight from the findings than on the quantification of facts.

3.2 Data Collection

Data from a case study can be collected through a variety of approaches, including archival documents, physical artefacts, interviews, direct observations, and documentation (Yin, 2003). Interviews were used as the data collecting method for this research. Interviews can be structured or unstructured, depending on the quality of the data to be retrieved (Welman & Kruger, 1999). Interviews are considered a flexible means of gathering data that may be used by both quantitative and qualitative types of study. The structured interview approach was seen as the acceptable way to acquire the necessary data from the selected population in order to engage and understand some of the unknown operations of the R&D unit.

In this study, the questions that have been modelled are geared towards understanding the issues relating to the performance of the department rather than

conducting experiments or trials that produces statistical results. The interviews were conducted virtually and were one-on-one. Availability and access to the participants was a driving factor, since the researcher had a prior relationship with the respondents. This also meant that the credibility of the results was likely to be high as a result of a better unrushed response rate and it also meant that both the researcher and participants were more likely to be open and seek clarity during the interview session.

3.3 Selection of Participants

For qualitative or even quantitative analysis, there are a variety of sampling techniques to choose from. Quantitative research methods, on the other hand, use probability sampling and a large sample size to generate a fair representation with high causal inference (Marshall, 1996). In qualitative research, non-probability sampling is frequently employed to focus on certain attributes. Due to the availability of the respondents, the study's schedule, and the research aim, purposeful sampling, a popular sampling approach for case study analysis, was used. The approach chosen is the most appropriate for the case company's situation and the study issue.

The population of this case study was the TE R&D executive committee and a management level below the executive level. While the R&D team responded to all the interview questions, additional participants included were the business development team (Acting Senior Manager: Business Development and Manager: Business Development) who primarily interact with TE’s customers and the finance team (Finance Manager) who supports the R&D team with financial analysis and preparation of budgets and financial reports. However, the business development team were asked to only respond to the customer perspective of the balanced

scorecard framework while the finance manager responded to only the financial perspective.

The organisational structure of the respondents from the R&D department was as follows:

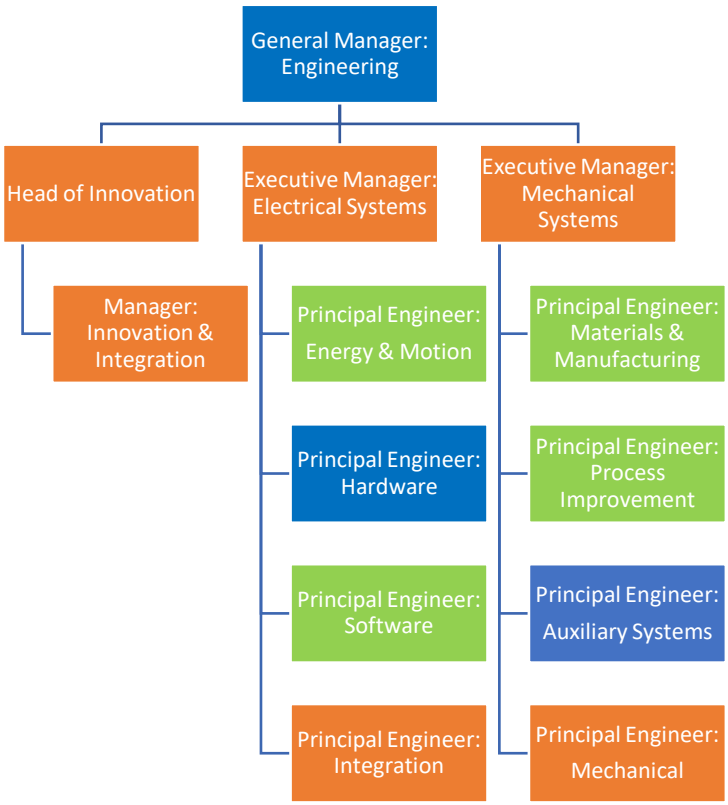

Figure 2: Research & Development Organisational Structure

It is important to note that within the organisational structure of the R&D team, the Executive Manager: Electrical System position was occupied by the Principal Engineer: Integration on an acting basis since it was vacant and the Principal Engineer: Mechanical was acting on the Executive Manager: Mechanical Systems. The Innovation and Integration Manager was also acting as the Head of Innovation. The General Manager, Principal Engineer: Hardware and Principal Engineer: Auxiliary systems were all unavailable to participate in the study.

3.4 Theoretical Framework

While “The Balanced Scorecard is a multi-dimensional framework,” according to Kaplan & Norton (2009) and Maltz, Shenhar, & Merino (2002), very few citations towards its design and deployment in organisations that regard R&D to be strategic have been uncovered (García-Valderrama, Mulero-Mendigorri, & Revuelta-Bordoy, 2008). In these few citations, according to Kerssens-van Drongelen & Bilderbeek (1999), the BSC should be utilised as part of a comprehensive approach to evaluating R&D returns. Subsequently, García-Valderrama, Mulero-Mendigorri, & Revuelta-Bordoy (2008) claimed that the BSC is a "most promising approach" for measuring performance and achieving excellence goals in all sorts of organisations.

On the contrary, the BSC has its own challenges. One of the problems of the BSC is the difficulty of comparing the returns or performance attained by organisations using this framework; given the huge variety in the use of various measures for each perspective, and the lack of records that might provide such comparison data (García-Valderrama et al., 2008). The second problem is the challenges encountered in the use of some of the standard measures for assessing the performance of enterprises in their R&D operations (Schwartz, Miller, Plummer, & Fusfeld, 2011). The third but last problem discussed here comes from a lack of agreement among managers on which measures would be included in the reports created for strategic management, including a misalignment between the measurements and the company's strategy (García-Valderrama et al., 2008). Similarly, according to Neely et al. (2000), the BSC is far from the only paradigm that takes both financial and non-financial aspects into account in a balanced manner.

Nonetheless, Bremser, Barsky, University, & Commerce (2004); García-Valderrama et al. (2008); García-Valderrama, Mulero-Mendigorri, & Revuelta-Bordoy (2009); I. C.

Kerssens-van Drongelen & Bilderbeek (1999); I. Kerssens-van Drongelen, Nixon, & Pearson (2000) claim that using BSC provides a holistic performance measurement framework for implementing the organisational strategy while addressing all of the important aspects of performance management in the R&D environment. It is in these arguments that the BSC framework was chosen for this study.

The three challenges of the BSC as mentioned are mitigated by the theoretical framework chosen. The framework has preselected measures for the four perspectives and this way, there are no uncertainties on which measurement indicators to utilize. The interview questions were derived from the preselected measures which enables the participants to respond in a structured manner. This study examines R&D activities and performance; looking at four perspectives of the BSC to understand budgeting methods, human resources capabilities and capacity to execute projects, and financial performance of the unit.

3.5 Data Analysis

Data analysis, according to Yin (2003), entails "examining, categorising, tabulating, testing, or otherwise recombining both quantitative and qualitative evidence to answer the study's initial propositions." To enable the ease of interpreting the data, the recorded responses from the interview needs to be organised. To avoid misinterpretation of the responses, the interviewees were willing to confirm the response that the interviewer was noting after each question. While the majority of the questionnaires were structured in a way that the responses was “yes”, “no” or “not aware”, they also required the respondents to elaborate on their responses.

The first step of data analysis is to organise the responses in a tabular format to allow comparison of the different responses. The second step is to read through the data

question by question to note similarities and differences between the responses and the last step is to then interpret these differences and similarities to ultimately answer the research questions.

CHAPTER 4: RESEARCH FINDINGS

The tabulated responses from the interviews will be displayed per the balanced scorecard perspectives and analysed based on the various responses. The four perspectives are as follows:

1. Customer Perspective
2. Internal Process Perspective
3. Learning and Innovation Perspective
4. Financial Perspective

As mentioned in the data analysis section of chapter three, the tabulated responses are the summary of the majority of the responses are coded with “yes”, “no” or “not aware” for ease of interpretation.

4.1 Customer Perspective:

Table 3: Customer Perspective Responses

#	Question	Acting EM: Electrical	Acting EM: Mechanical	BD Manager	Acting Senior BD Manager	Acting Head of Innovation	Acting PE: Software	PE: Energy & Motion	PE: Materials & Metallurgy	PE: Process Improvement
1	Is Transnet Engineering matching the technology, product, process or service to the demands of the market?	Yes	No	No	No	Yes	No	No	No	No
2	Are you aware of the number of customers that Transnet Engineering has for the product, process, technology or service that it produced?	Not Aware	Not Aware	Yes	Yes	Not Aware	Yes	Yes	Not Aware	Yes
3	Has Transnet Engineering formed any new customers in the past two financial years?	Yes	Not Aware	Yes	Yes	Yes	Not Aware	Not Aware	Not Aware	Yes
4	What type of customers does Transnet Engineering have:	• Big and small organisations • Local and International	• Big and small organisations Local and International	• Big and small organisations Local and International	• Big and small organisations Local and International	• Big and small organisations Local and International	• Big and small organisations Local and International	• Big and small organisations Local and International	• Big and small organisations Local and International	• Big and small organisations Local and International
5	Is the level of customer satisfaction above average?	Not Aware	No	No	No	No	Not Aware	No	No	No

6	Does Transnet Engineering constantly engage with its customers in order to manage the relationships?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7	Is Transnet Engineering's market share increasing?	Not Aware	No	No	Not Aware	Not Aware	Not Aware	No	No	No
8	Is Transnet Engineering's customer feedback positive?	Yes	Yes	No	No	No	Yes	No	No	No
9	Does Transnet Engineering receive projects from external customers?	Yes	Not Aware	Yes	Yes	Not Aware	Not Aware	No	Yes	Yes
10	Customer retention/Loyalty. Does Transnet Engineering have a high customer retention rate?	Not Aware	Yes	No	No	Not Aware	No	No	No	No
11	Does Transnet Engineering have Goodwill in the market?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
12	Does Transnet Engineering fulfil customer order on time?	No	No	No	No	No	No	No	No	No
13	Is Transnet Engineering's achieving a customer order fulfilment cost as planned?	Not Aware	Not Aware	Not Aware	Not Aware	Not Aware	Not Aware	Not Aware	No	Not aware

On the customer perspective, two employees from the business development department who are responsible for customer engagements were interviewed. These are acting senior business development manager for the Eastern and Western region in Africa and the business development manager for Southern African Development Community (SADC).

The response of the two business development managers supports the other five R&D management teams in that, TE R&D does not seem to be matching the demands of the markets in terms of technology, products, processes or services. However, the acting EM: Electrical Systems believes that TE does meet the products as demanded by the markets, but the processes of industrialisation and commercialisation of those products are slower than normal.

Five respondents are aware of the number of customers for the products, services, technologies and service that TE produces. The other four respondents are not aware of the number of customers but cited that majority of the current work was done to support the biggest internal Transnet division, i.e. Transnet Freight Rail (TFR).

The two business development managers as well as three R&D managers are aware that TE acquired new customers within the past two financial years. However, the other four R&D managers are not aware of any new customers acquired. TE has various customers ranging from small to big organisations that are either local or international and this was backed by all the respondents. Furthermore, seven out of the nine respondents agree that the customer satisfaction is below average for TE while the remaining two are not aware of the level of customer satisfaction. It is evident from the responses that all

respondents agree that TE does engage with its customers in order to manage the relationship.

TE's market share is not increasing as per the responses from five of the respondents while the remaining four are not aware if TE's market share is increasing or not. Just like the customer satisfaction level being below average, TE's customer feedback is also not positive according to the responses from six of the respondents while the remaining three highlights that there’s is some customers that provides good feedback for R&D services. According to the responses from five of the respondents, there are projects that TE received from external customers. The remaining four respondents are not aware of such projects from external customers since the major customers of TE are internal to Transnet.

In terms of customer retention rate, two of the respondents are not aware if TE has a high customer retention rate while the other seven respondents agree that TE does not have a high retention rate. However, with regards to TE fulfilling customer orders on time, all the respondents agree that it is never on time and again, all the respondents are not aware if the costs to fulfil customer order as planned are achieved. On the positive side with regards to the reputation of Transnet in the markets it operates in, all 9 respondents do believe that TE has goodwill in those markets.

4.2 Internal Processes Perspective

Table 4: Internal Processes Perspective Responses

#	Questions	Acting EM: Electrical	Acting EM: Mechanical	Acting Head of Innovation	Acting PE: Software	PE: Energy & Motion	PE: Materials & Metallurgy	PE: Process Improvement
1	Do you track project accomplishment per phase?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	Since inception, how many projects have been completed by the R&D team?	2	6	Not Aware	1	Not Aware	Not Aware	5
3	How many targets has Transnet Engineering met in terms of quality, cost and time?	Not Aware	Not Aware	Not Aware	Quality: Yes Cost: No Time: No	Quality: No Cost: No Time: No	Quality: No Cost: No Time: No	Quality: Yes Cost: No Time: No
4	To analyse project execution delays, what has been delaying completion of Transnet Engineering R&D activities?	• Procurement delays	• Procurement • Human Resources • Bureaucracy	• Procurement • Human Resources • Finances	• Lack of Human Resources • Unrealistic timelines • Procurement Delays • Lack of engagements with external stakeholders	• Lack of capabilities • Lack of engagements with external parties • Lack of resources • No detailed plan	• Lack of capabilities • Lack of secured funds	• Lack of resources • Lack of capabilities • Bureaucracy • Procurement processes • No agility
5	What critical day to day problems does the R&D team solve?	• Product Integration • Improvement of processes	• Procurement issues • Bureaucratic Processes	• Procurement Human • Resources Finances	• Procurement Issues • Lack of skills development	• Constant reprioritising of tasks • Constantly following up on tasks • Processes glitches	Not Aware	Daily execution of R&D projects

6	Does the R&D team have a continuous workflow?	Yes	Yes	Yes	No	Yes	No	Yes
7	Are all R&D resources utilised economically? Resource loading percentage.	No	No	No	No	No	No	No
8	Is there progress throughout the workflow?	yes	Yes	Yes	Yes	Yes	Yes	Yes
9	Does the R&D team experience work conflicts? And how many has it handled/resolved?	Yes All Resolved	Yes All resolved	Not Aware	Yes All resolved	Yes Partially resolved	Yes All resolved	Yes All resolved
10	Is there job satisfaction among R&D employees?	Not Aware	Yes	No	Yes	Yes	Yes	No
11	Are the team members motivated?	Yes	Yes	No	Yes	Yes	Not Aware	No

Only the R&D management team was interviewed when it came to the BSC's internal perspective. In tracking the progress of R&D projects accomplishment per phase, the team agree that all their projects are tracked in phases. The acting head of innovation added that there is a portfolio review committee whose function is to track projects between stage gates. The respondents were asked for the number of projects that the R&D team has completed and all the them provided different estimates with two respondents not being sure of the number of completed projects.

When it comes to the targets that were achieved by the R&D team in terms of quality, time and costs, the team had mixed responses as well and only two respondents agree that the quality aspect has been met and another two responded with a no. However, in terms of cost and time question, four respondents agree that the teams have not achieved the set targets and the remaining five respondents were not aware of any project targets that were set for quality, time and costs.

In terms of project execution delays, there was a common theme that procurement delays, lack of resources and capabilities tend to delay execution of projects. Bureaucratic processes and human resources are also a factor in delayed projects. For instance, one of the respondents mentioned that the procurement department doesn’t know how to handle new technology procurement requests or once off requests, especially when the technology doesn’t exist in South Africa. In addition, the R&D team is always forced to follow the open tender methodology instead of confining the contract to a particular technology supplier. This also involves the R&D team's incapacity to engage on a

technical level with their colleagues (from the private or public sector) without using a request for information tender approach.

The respondents were then questioned about critical day-to-day challenges that the management team had to overcome, and there was a recurring theme concerning procurement issues and needing to constantly reprioritise activities to deal with process inefficiencies. Nonetheless, five of the respondents agreed that there is a continuous workflow within the R&D teams when executing projects while two respondents don't agree, citing that there are some teams that operate in silos.

An undisputed respond from all respondents came when they agree that their resources are not utilised economically and that there is progress throughout the workflow since their projects are tracked in phases. Furthermore, the team was asked about critical daily conflicts and the six respondents of the R&D management team agreed that they experience minimal work conflicts while only one respondent was not aware of any conflicts. Lastly, four respondents agree that employees in R&D are satisfied with their jobs and are consequently motivated while two explained that some employees are not satisfied and only one respondent was again not aware of any employee that was not motivated nor satisfied with their job.

4.3 Learning and Innovation Perspective:

Table 5: Learning and Innovation Perspective Responses

#	Questions	Acting EM: Electrical	Acting EM: Mechanical	Acting Head of Innovation	Acting PE: Software	PE: Energy & Motion	PE: Materials & Metallurgy	PE: Process Improvement
1	How many new concepts, theories, technologies, products, services have been created to date?	Many concepts and theories	Many concepts and theories	Not Sure	Few	Many Concepts and theories	Few	Many Concepts and theories
2	How many patents have been filed?	Few: Less than 5	Few: Less than 5	Few: Less than 5	0	More than 5	Not Sure	Not Sure
3	How many patents have been granted?	Few: Less than 5	One	Not Sure	0		Not Sure	Not Sure
4	How many papers have been published in international and national journals?	Estimates 30	Not Sure	Not Sure	0	Estimates 9	Not Sure	Not Sure
5	How many training programmes have been conducted by the team?	Estimates minimum of 3	Not Sure	Not Sure	0	2	Not Sure	Not Sure
6	How many conferences, seminars have been conducted by the team?	None	None	None	None	None	None	None
7	How many solutions have been provided to external parties or used internally?	Estimates minimum of 3	None	Not Sure	3	20	Not Sure	Not Sure
8	Has there been any expansion of new technology, product, process or service designs?	Yes	Yes	Not Sure	No	Yes	No	Yes

9	Has the R&D team restructured any internal or external processes?	Yes	Yes	Yes	No	Yes	Yes	Yes
10	Is the R&D team using its resources economically?	No	No	Yes	Yes	No	No	No
11	Has there been any new skills that were developed?	Yes	Yes	Yes	Yes	Yes	Not Sure	Not Sure
12	How many new projects that have been given by other parties to R&D	Few	About half of the projects	Not Sure	Many Projects	20% of the projects	Not Sure	2
13	How many times has the R&D team received consultancy services from external parties?	Few	Not Sure	Not Sure	Multiple times	Multiple times	None	4
14	What is the adoption rate of new technologies?	Not sure	Low	Low	High	3 technologies	Slow	Slow
15	Does the R&D team have Human Resource development plans?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
16	Has the organisation expanded/grown as a result of R&D?	Yes	No	No	No	No	No	No
17	Do customers have confidence in Transnet Engineering as a result of the R&D unit?	Yes	Not Sure	Yes	Yes	Yes	No	Not Sure
18	What is the success probability of new product development?	Very high	minimal	High	Very high	Not Sure	Not Sure	Minimal
19	What is the ratio of sales of new products to total sales?	Not sure	Not Sure	Not sure	Not Sure	Not sure	Not Sure	None

The R&D management team agrees that they have developed numerous thoughts and theories throughout the years, but they have not been effective in creating several products, services, or technology. When asked about filing and registration of patents, the respondents highlighted that on average, less than five patents have been filed across the different teams in R&D. Four of the R&D managers are aware that less than five patents have been registered while three are not sure on the number of patents. However, they are aware that there are a couple of patents that have been filed by other teams. Nonetheless, from the less than five patents filed, only one has been granted and was confirmed by the acting EM of Mechanical Systems. He also added that another patent registration is in progress.

While majority of the management teams are not sure of any articles that were published in academic journals, the Acting EM: Electrical Systems estimates that there are about 30 articles were indeed published. One of the Principal Engineers confirmed two articles and one book that was published, and the other members of the management team were not aware of any publications from the R&D teams.

When asked about any training programmes offered by the R&D teams, the principal engineer for energy and motion was the only one who confirmed that they have and are offering an introductory training programme on energy systems for Engineer-in-Training (EIT) employees at the current moment. And a unanimous response of no was received when the respondents were asked about conferences that the teams have organised.

The acting EM: Electrical systems together with the acting principal engineer for the software team estimates that three solutions have been provided to external parties while the PE of Energy and motion explained that there has been a lot of solutions with majority

of these solutions not been recorded as official projects since they are shared through meaningful conversations. When asked if there has ever been an increase in new technologies and products as a result of the R&D team, the EM: Electrical systems and principal engineer for energy and motion stated that there has been an increase totalling six products and technologies.

All team members have highlighted that there is a constant restructuring of processes when they were asked if there has been any restructuring of processes. There is also a view from the management team that their resources have not being utilised economically. The acting EM: Electrical Systems mentioned that there are external factors and regulations that tends to cause this issue. The acting EM: Mechanical Systems explained that human resources are balanced and managed well however, there are some administrative tasks that are given to engineers to completed instead of hiring administrative staff. He further explained that some equipment experience downtime due to parts taking long to be procured.

New skills have been generated inside the R&D team, which is confirmed by all team members. With the development of each new product or technology, the various project team members gain new skills. The team receives requests between 20% to 50% of their projects from other parties while the remaining projects are geared towards a market push approach for mostly internal consumption within Transnet. In terms of consultancy services from external parties, the R&D team confirmed that they do receive support from consultants on areas that they are not fully capable in.

According to the replies, the adoption rate of new technologies in TE is very low and sluggish. "This could be as a result of the lifecycle of rolling stock equipment ranging from

10 to 30 years", as highlighted by acting head of innovation. The R&D management team all agree that there are human resource development plans for all their staff members. They also believe that TE's R&D activities haven't resulted in considerable organisational growth. In terms of customer trust in TE as a consequence of R&D, the R&D management team feels that certain customers have become more confident in TE since the R&D department was established.

The responses for the success probability of new product development came with mixed responses, with three responses saying there is a high probability, two responded with minimal probability and the last two were not sure. Lastly, in terms of the ratio of new products to total sales in TE, the R&D management team were all not sure if that ratio exists based on the infancy of the department and the fact that the very few products/solutions were commercialised internal to TE and the resultant impact was almost minimal compared to the revenue that TE makes

4.4 Financial Perspective

Table 6: Financial Perspective Responses

#	Questions	Acting EM: Electrical	Acting EM: Mechanical	Finance Manager	Acting Head of Innovation	Acting PE: Software	PE: Energy & Motion	PE: Materials & Metallurgy	PE: Process Improvement
1	In terms of financial position, has R&D contributed to the profits of the Company?	Yes	Yes	Yes	Yes	No	Yes	No	No
2	Is there quantifiable return on investment?	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
3	Does R&D self-finance itself?	No	No	No	No	No	No	No	No
4	Has there been any business that was created from the outputs of R&D?	Yes	Yes	No	Yes	No	No	No	Yes
5	Has there been any collection of royalties or fees collected from licensing of patents?	Not Aware	No	No	No	Not Aware	Not Aware	No	No
6	Has there been any funds that were received from external resources (government, customers, etc.)?	No	No	No	Not Aware	Not Aware	Not Aware	No	No
7	Has the R&D unit been receiving funds on-time as arranged/agreed upon?	Yes	Not Aware	Yes	Yes	Yes	Yes	No	Yes
8	Is Transnet Engineering achieving the minimum cost of capital	No	Not Aware	No	No	Not Aware	Not Aware	No	No
9	In terms of Transnet Engineering's liquidity position, is it able to meet its current expenses?	Yes	No	Yes	No	No	No	Yes	No
10	Have Transnet Engineering been paying dividends to the shareholders?	Not Aware	No	No	Not Aware	Not Aware	Not Aware	Not Aware	Not Aware

On the financial perspective, the finance manager supporting the research team was interviewed as a finance expert. Five out of the eight respondents said “yes” to the first question about the financial perspective, which asked if R&D had made any contribution to TE's earnings. The finance manager and the two acting executive managers supported the above statement in that there were very few products that were sold to TFR which renders the total financial contribution from the R&D to be minimal compared to the revenue that TE generates. However, the knowledge and capabilities within the team also contributed in assisting other departments in operating more efficiently and possibly making profits for TE. While the Principal Engineer: Manufacturing and Materials said “no”, he explained that company processes and structures are not geared towards supporting revenue generation from R&D and that ideas that everyone comes up with are not supported by market intelligence. Interestingly, the Principal Engineer: Process Improvement responded with a “no” while supporting the response highlighting that there are several products that are close to commercialisation.

There is a general feel from the management team that there is some Return on Investment (ROI) when they were asked about a quantifiable ROI. The EM: Electrical systems further elaborated to say the ROI achieved over the past years is small. The acting PE of the Software team mentioned that there has not been any financial ROI, however there is non-financial ROI and the PE of the Manufacturing and materials team believes that it is impossible to quantify any ROI in an R&D department. On the question regarding R&D financing itself, every interviewee responded with a “no” citing that currently the R&D department is not geared towards financing itself.

When the respondents were asked if there has been any business that was created from the results of R&D, half of the respondents replied with a “no” with an explanation

that the R&D department is still in its infancy. The other half respondents said “yes” with the acting EM: Electrical explaining that the power electronics business gained a few products to repair as a result of R&D's involvement and the acting EM: Mechanical mentioned that the port business has gained new products that were developed by the R&D teams.

When asked if they received royalties or payments from licensed patents, the R&D team and the finance manager both said “no”. furthermore, on the question of received any grants or funds from external sources, they all responded with a “no” again. The question on whether the team receives funds as requested and on time, they all agree that the team receives funds on-time and as required. However, the question on the ability of TE being able to meet its costs of capital, five responded with a “no” while the others were “not ware”.

In terms of the liquidity position of TE, six respondents (including the finance manager) responded with a “no” and the remaining responded with “not sure”. "Transnet Engineering is facing working capital challenges, however it is able to meet its current expenses with as a result of a credit facility from Transnet Group", explained the finance manager. With the shareholder of Transnet being the South African government under the department of public enterprises, six of the respondents are not aware if there are any dividends that are paid to the government. However, two respondents, including the finance manager, are aware that there are no dividends that are paid to the shareholder. "

CHAPTER 5: DISCUSSION OF THE RESULTS

The previous chapter included the interpretation of the responses from the respondents while this chapter will include the discussion. The primary goal of this research is to identify and assess the challenges that the TE R&D department has in terms of performance, which may lead to probable underspending on R&D.

The discussion of the results will have to follow the balance score card framework as well. The first perspective will be learning and growth, followed by internal processes, then customer perspective and financial perspective.

5.1 Learning and growth

While the scope of learning and growth perspective is to find internal weaknesses, the ultimate aim is to find new areas of improvement and new opportunities for the organisation. The R&D team has made progress toward the first objective of the financial perspective, as seen by the replies in Table 6: Financial Perspective Responses. To innovate means to introduce something new and one of the performance measures that relates to the introduction of something new is patents being filed and then granted as well as the adoption of new technologies by the organisation. According to Zachariadis (2003), R&D efforts are regarded as inputs to the development of patents or inventions, with patents acting as intermediates in the creation of productivity-enhancing technologies. In this case only one patent has been granted since the inception of the department with an average of less than five being filed and the adoption rate according to the respondents is slow.

Firms use a variety of techniques to protect ideas and innovations with varied values or depending on the difficulties of formalising scientific and experimental knowledge, such as confidentiality, lead times, and long-term or confinement contracts (Lee,

2015). This means that not all R&D outputs are protected with a patent, therefore a patent cannot be used to measure innovation performance alone.

In improving the company or its competitiveness, the respondents clearly show that there have been solutions that were provided to the external parties and others used internally. According to Lee (2015) “non-R&D-performing firms in manufacturing industries are regarded as new-to-firm product innovators while new-to-market product innovators are regarded as R&D performers”. As a result, TE's R&D department may be thought of as a performing a combination of R&D and non-R&D innovations. An R&D product innovator is one that does R&D and has produced "any new or considerably enhanced good or service (generating revenues)" (i.e. product innovation), and a non-R&D product innovator is one which doesn't perform R&D but also has a product innovation (Lee, 2015). The issue with TE comes where there is no growth or any improvement in its competitiveness. This could be due to the department producing new-to-firm products instead of producing new-to-market products. On the positive side, TE’s customers seem to have a positive outlook on the organisation as a result of the existence of the R&D department. Additionally, the clear continuous restructuring of processes is highlighted by the respondents as well as the use of consultancy services indicate that the organisation is taking strides in improving itself.

On the front-end of the innovation process, there has been a couple of theories and concepts that have been developed which suggests that there is information sharing, freedom to express and support of ideas from employees. This supports the perspective from Corcoran (2017) that employee learning and collaborating (knowledge sharing) at work is the fuel source for employee-driven innovation. Learning includes collaborations. However, the absorptive capacity of a company, or its ability to acquire and absorb new information, is viewed as critical to the success

of technology-based partnerships (Hung, Qiao, & Lee, 2014). Therefore, there is signs of intense collaborations within the teams and some level of interlinking different disciplines to create ideas and solutions.

External collaborations and partnerships add to the front-end innovation process and knowledge creation However, due to the delimitation of being unable to interview external partners and the interviewees not able to divulge information on their partners, there is still a sense of some activities that are outsourced and in some instances there are partners that co-develop with the R&D team. As such, Cirera & Muzi (2020) suggested that when exploring innovation in a firm, focus must be placed on critically analysing all inputs as well as outputs of innovation. In this case, inputs include all internal and external collaborations.

In efforts to increase the knowledge and learning, there seems to be a well-developed human resource development plan for the team and a way to constantly develop new skills in the team as highlighted by the respondents. However, sharing of knowledge by hosting conferences, developing training programmes or publishing of journals is almost non-existence. Nevertheless, the R&D team does attend rail related conferences and specialised training.

There is no proof from the respondents that manufacturing processes or products have ever improved as a consequence of the R&D outcomes since the organisation has not developed or expanded as a consequence of the R&D outputs. Consequently, to compete with rapid development of technology, shorter product life cycles, and increased intense competition, organisations must have effective commercialisation processes and new product development (Hung et al., 2014). The interpreted results from this perspective suggests that there are efforts by the leadership team to create

an environment with competent employees who are solution providers to possible opportunities and seek areas to improve within the organisation.

5.2 Internal Business Process Perspective

This perspective describes internal processes that the organisation has to perfect in order to fulfil its customers and/or shareholders expectations. The intention of this perspective according to Jyoti et al. (2006) is to achieve an optimum flow of information with no delays nor disputes within the organisation. The intricacy of many process indicators, such customer satisfaction and organizational development measurements, necessitates the use of special methods such as project progress tracking management and organisational audits (Eric Söderquist & Godener, 2004). Similarly, in R&D, there is a need to analyse process performance and effectiveness in terms of multidisciplinary teams, project planning, execution, and management, concurrent engineering, stage overlaps, intense communication, and design for production (Eric Söderquist & Godener, 2004). As a result, according to all respondents, there is a clear view that project timelines are tracked frequently and that there is a continuous workflow with progress on the multi-projects handled by the R&D department.

The responses on Table 4 also indicate that there are efforts to improve the cost effectiveness in the supply chain of the product by solving the critical day to day problems and project execution delays which are mostly towards procurement issues, bureaucracy process issues and lack of resources amongst others. However, the team has not been able to execute a project within the budgeted cost and targeted time frame and this shortfall is an indication of the problems that are upon the organisation as highlighted above.

While there is evidence from the responses that the R&D team members are motivated and satisfied with the job they are employed to execute, there is an issue of uneconomical use of the resources within the department as well as an uneven work allocation. Nonetheless, the team is able to resolve any conflicts that may arise and still work closely together while continuing to show progress on the work given.

With internal business process perspective, there are obvious signs of project delays as only an average of less than 5 major projects have been completed since the inception of the department.

5.3 Customer Perspective

The aim of this perspective is to attain a competitive advantage through the application of R&D findings according to García-Valderrama, Mulero-Mendigorri, & Revuelta-Bordoy (2008) while Jyoti et al. (2006) emphasis that an R&D organization's goal is to provide targeted solutions to a customer's specific issue. The solution must, without a doubt, offer some value for the customer while also adding value to the organisation. To measure performance under the customer perspective, there are five objectives that need to be checked and validated. The participants in Table 2 concur that the R&D department's results do not fulfil the customer's demands. This directly means that there is a lack of customer orientation, which refers to having deep insights of one's target customers (consumer) in order to consistently provide higher value to them (Dhewanto & Sohal, 2015).

There is evidence that TE is failing to align technology, product, process, or service to market needs. Having to remember that there are two ways in introducing technologies or services. There is either a technology push or a market pull. The word "market pull" refers to a product or process that was developed in response to unmet consumer

gaps in the market. These needs must first be identified, and afterwards the necessary development activities must be carried out (Herstatt & Lettl, 2004). Conversely, a "technology push" defines a scenario in which a new technology or a new blend of current technologies has become the main driver behind a market-leading product and/or problem solution. However, from the interviews there seems to be more of a technology push approach than market pull. The disadvantage of a technology push is that the end user might not be ready to introduce technologies that do not solve the immediate short-term challenges. Hence, it does seem that the organisation does not know its' customers and/or doesn't understand the needs of its customers for its R&D outputs.

However, there is evidence from the same responses of constant customer engagements and that there are projects that are received directly from customers. There is some mismatch of some sort that needs to be understood since there is contradictory information from the responses regarding the first objective of matching the needs of the customer and the second objective of creating the demand for the new product/process/technology. Nevertheless, it does seem that there are efforts of customer engagements.

Not surprisingly so, the market share of TE has not been growing and it does seem like the organisation is losing its customers as the retention rate is not high even though in the past two financial years it managed to gain some customers. From the responses on Table 3, it difficult to deduce whether there is value that is provided to the customers nor if there is some level of improved quality and features of the resultant products since the customer satisfaction is low which could be owing to the fact that TE does not fulfil customer orders on time and that the customer feedback is not positive.

The responses on the customer perspective reveal a dire situation in that there is a clear mismatch of what the customer needs and what the organisation produces from the R&D department. There seems to be a lack of knowledge of the external markets and factors within which TE operates in that delay projects to be completed on-time.

5.4 Financial Perspective

The gist of the financial perspective is to illustrate the financial performance of the organisation to its shareholders and any other affected stakeholder (García-Valderrama et al., 2008) and on the other hand, for an R&D department, its financial perspectives indicates the financial results from the outcomes of the R&D activities. Although various organisations have different R&D strategies and goals, the performance metrics will undoubtedly vary. However, in order for an R&D department to be self-sustaining, its products must produce income that can be used to finance future operations.

While the scope of this research did not ascertain the strategic direction of the R&D department, it does seem from the responses on Table 6 that the team is supposed to contribute to the revenue of TE at some point. Likewise, the team has managed to maximize TE's shareholders wealth as well as contribute to revenue of TE. On the other hand, the team has not been able to attain the lowest cost of capital, implying that the department is not cost efficient in its activities. Gwynne (2012) suggests that reviewing how R&D spending generates value can assist organisations in determining where to spend and avoiding wasteful expenditures.

TE fully funds all the operational costs of R&D without any external funding or any collection of royalties. What is amazing and almost unexpected is that to date, when looking at the annual financial results from year 2014 to 2020, Transnet has invested

just over one billion Rands on R&D (Transnet SoC Ltd., 2015, 2017, 2019, 2020; Transnet SOC Ltd., 2014, 2018; Transnet SOC Ltd, 2016). However, some of the respondents mentioned that towards the end of the financial year, the finance team employ a cost saving initiative that impacts the approved budget and almost forces the R&D team to find ways to not spend on some planned activities. This in essence forces the team to defer expenditure to the following financial year for most of the multi-year projects which of course delays the completion dates. While 50% of the response on the question four on table 5 suggest that there have been businesses that were created from the outputs of R&D, the other 50% suggest that there has not been any.

It's difficult to assess the R&D department's strategic trajectory over time from a financial standpoint, but what emerges is that the department has been expanding its resources and capabilities.

5.5 Summary

With regards to the expectations from the BSC framework, the R&D team is not performing well across the four perspectives. For instance, there is a visible disconnect between what the customer wants and what the R&D department produces. There appears to be a lack of understanding of external markets, and the internal business issues affect customer-related initiatives as well. Moreover, with internal business process perspective, there are obvious signs of project delays even though there is a clear view that projects are tracked frequently. It was clear that project delays are mostly caused by procurement issues and bureaucracy process. The learning and growth perspective, on the other hand, is doing fairly well because the findings suggest that the leadership team is working to create an environment of competent employees who can propose solutions to potential opportunities and identify areas for improvement within the organization. Finally, there appears to be financial indecision

because there was no multi-year funding strategy in place since R&D budgets are approved annually.

The findings of this study and the outcomes of the literature review validated the research question which was aimed at uncovering challenges related to the underspending on allocated R&D budget of Transnet Engineering. For instance, the literature indicated that it is well within the boundaries of SOEs or any organisation to establish R&D departments that ultimately support the developmental agenda of the country. Furthermore, the literature on South Africa's NSI revealed flaws (i.e. poor and non-collaborative means of developing the country's STI agenda, inconsistent policy, inadequate interactions among NSI stakeholders, etc.) that are consistent with the findings around government policies that inhibit project progress.

CHAPTER 6: CONCLUSION AND RECOMMENDATION

The main aim of this study is to identify and evaluate the challenges in relation to TE R&D department's performance that contribute to the possible underspending on R&D as highlighted by the policy study that was conducted by HSRC. This study is a success in that the challenges were evident through the interview responses. It has been evident that the R&D department is needed in an SOE such as Transnet to enable the entity to continue to be sustainable and competitive.

6.1 Key Results

As an R&D department within an SOE, there is no immunity to the legislations such as the PFMA, B-BBEE and PPPFA that governs public funds in that all transactions need to be fair, transparent, competitive and cost effective. However, when embarking on any R&D project there is no guarantee of its success because of the inherent high risks associated to development of new product or services. Nonetheless, this studies key findings are as follows:

- Procurement issues hamper project progress.
- Government policies aimed at fostering transparency are prone to multiple interpretations.
- Transnet SOC Ltd does not have a comprehensive strategy and a succinct mandate for R&D.
- R&D projects are not supported by comprehensive market studies and are not aligned with what customers need.
- The R&D department is not receiving the support it expects from other internal departments

6.2 Recommendations

- For any novel technology developments up to the phase of a once off prototype and where development of protectable patents is concerned, it's recommended that the procurement activities be exempted from following the PFMA, B-BBEE and PPPFA.
- An R&D specific procurement policy and framework ought to be developed to govern R&D activities. The development of this policy and framework should be developed in consultation with relevant government ministries such as the National Treasury, DPE, DSI, etc.
- Transnet must develop and adopt an R&D mandate and strategy that clearly identifies the cause of actions needed to support all processes required to carry out R&D-related activities. This should include activities that are must be performed by all support departments such as finance, supply chain, human resources, etc.
- On the R&D finance and budget issues, it is recommended that the budget be linked to a reference, such as a certain percentage of Transnet's revenue. Transnet, for example, can set aside 1 to 1.5 percent of its annual revenue for R&D. This will enable the team to plan multi-year technology projects without the risk of budget cuts.
- The hybrid model (combination of in-house product development, outsourcing and joint development) is still recommended because outsourcing has the advantage of shortening the development process, whereas in-house development requires significant investments and time to reach maturity for developing commercially viable products.

- The R&D department must prioritize the market pull strategic approach over technology push. At the same time, comprehensive market studies must be conducted in order to inform the type of projects to invest in.

6.3 Limitations

This study endured two limitations as highlighted below:

- The study was limited to the R&D department of Transnet Engineering.
- The population of this study excluded participants outside of Transnet Engineering.

6.4 Future Work

Understanding that Transnet is one of the many SOEs in South Africa, the challenges that are revealed by this study might not be unique to Transnet because all SOEs are governed by the same policies. Therefore, it is proposed that a single study focusing on uncovering performance challenges of SOEs that have R&D departments should be conducted.

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ANNEXURE A: ETHICS CLEARANCE CERTIFICATE

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

SCHOOL OF GRADUATE SCHOOL OF BUSINESS ADMINISTRATION ETHICS COMMITTEE
CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER WBS/FI1302378/293**
PROJECT TITLE	Innovation challenges faced by Research and Development organisations in State Owned Entities: A case of Transnet Engineering
INVESTIGATOR	Mr Kgomotso Kgafela
SCHOOL/DEPARTMENT OF INVESTIGATOR	MM (Innovation Studies)
DATE CONSIDERED	24 November 2020
DECISION OF THE COMMITTEE	Approved unconditionally
RISK LEVEL	LOW RISK
EXPIRY DATE	30 JUNE 2021

ISSUE DATE OF CERTIFICATE 15 December 2020 **CHAIRPERSON** __ _____
(Dr MDJ Matshabaphala)

cc: Supervisor: Dr Hillie

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.

I fully understand the conditions under which I am are authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

Signature _____ **Date** 15 / 12 / 2020

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

ANNEXURE B: CONSENT FORM

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Consent Form

Research Title: Innovation challenges faced by Research and Development organisations in State Owned Entities: A case of Transnet Engineering

By: Kgomotso Kgafela

I, ……, agree to participate in this research project. The research has been explained to me and I understand what my participation will involve. I agree to the following:

(Please circle the relevant options below).

I agree to participate through the official role I am currently occupying in my organisation	YES	NO
I agree that the researcher may use my quotes in his research report	YES	NO
I agree that the interview may be audio recorded	YES	NO
I agree that the information I provide may be used anonymously after this project has ended, for academic purposes by other researchers, subject to their own ethics clearance being obtained.	YES	NO

…… (signature)

…… (name of participant)

…… (date)

…… (signature)

…… (name of person seeking consent)

…… (date)

ANNEXURE C: INTERVIEW QUESTIONS

Interview Questions

Research Title: Innovation challenges faced by Research and Development organisations in State Owned Entities: A case of Transnet Engineering
By: Kgomotso Kgafela

Interviewee's Details

Name & Surname: _____ Name of the Employer: _____

Position held in the organisation: _____

Relationship: ☐ Transnet Engineering's Executive Member

☐ Research & Development Management

☐ Transnet Engineering's customer

☐ R&D Partner

Interview Questions:

1. **Financial Perspective**

1.1 In terms of financial position, has R&D contributed to the profits of the Company?

1.2 Is there quantifiable return on investment?

1.3 Does R&D self-finance itself?

1.4 Has there been any business that was created from the outputs of R&D?

1.5 Has there been any collection of royalties or fees collected from licensing of patents?

1.6 Has there been any funds that were received from external resources (government, customers, etc.)?

1.7 Has the R&D unit been receiving funds on-time as arranged/agreed upon?

1.8 Is Transnet Engineering achieving the minimum cost of capital

1.9 In terms of Transnet Engineering's liquidity position, is it able to meet its current expenses?

1.10 Have Transnet Engineering been paying dividends to the shareholders?

1.11 Any comments with regards to the financial perspective of the R&D Unit?

2. Customer Perspective

2. 1 Is Transnet Engineering matching the technology, product, process or service to the demands of the market?

2.2 How many (number of) customers does Transnet Engineering have for the product, process, technology or service that it produced?

2.3 Has Transnet Engineering formed any new customers

2.4 What type of customers does Transnet Engineering have:
Big or small organisations
Local or International customers

2.5 What is the level of customer satisfaction?

2.6 Does Transnet Engineering constantly engage with its customers in order to manage the relationships?

2.7 What is Transnet Engineering's market share?

2. 8 Is Transnet Engineering's customer feedback negative or positive?

2.9 How many projects has Transnet Engineering received from external customers?

2.10 Customer retention/Loyalty. Does Transnet Engineering have a high customer retention rate?

2.11 Does Transnet Engineering have Goodwill in the market?

2.12 What is the average time taken to fulfil customer order?

2.13 What is Transnet Engineering's customer order fulfilment cost?

2.14 Any comments with regards to the customer perspective?

3. Internal Processes Perspective

3.1 Looking at the different project phases, what work has been accomplished in each phase?

3.2 Since inception, how many projects have been completed?

3.3 How many targets has Transnet Engineering met in terms of quality, cost and time?

3.4 To analyse delays project execution delays, what has been delaying completion of Transnet Engineering R&D activities?

3.5 What critical day to day problems does the R&D team solve?

3.6 Does the R&D team have a continuous workflow?

3.7 Are all R&D resources utilized economically? Resource loading percentage.

3.8 Is there progress throughout the workflow?

3.9 Does the R&D team experience work conflicts? And how many has it handled/resolved?

3.10 Is there job satisfaction among R&D employees?

3.11 Are the team members motivated?

3.12 Any comments with regards to the internal process perspective?

4. Innovation and Learning Perspective

4.1 How many new concepts, theories, technologies, products, services have been created to date?

4.2 How many patents have been filed?

4.3 How many patents have been granted?

4.4 How many papers have been published in international and national journals?

4.5 How many training programmes have been conducted by the team?

4.6 how many conferences, seminars have been conducted by the team?

4.7 How many solutions have been provided to external parties or used internally?

4.8 has there been any expansion of new technology, product, process or service designs?

4.9 Has the R&D team restructured any internal or external processes?

4.10 Is the R&D team using its resources economically?

4.11 Has there been any new skills that were developed?

4.12 How many new projects that have been given by other parties to R&D

4.13 How many times has the R&D team received consultancy services from external parties?

4.14 What is the adoption rate of new technologies?

4.15 Does the R&D team have Human Resource development plans?

4.16 Has the organisation expanded/grown as a result of R&D?

4.17 Do customers have confidence in Transnet Engineering as a result of the R&D unit?

4.18 What is the success probability of new product development?

4.19 What is the ratio of sales of new products to total sales?

4.20 Any comments with regards to the learning & innovation perspective?

1. **General Comments**

Do you have any additional comments with regards to TE's R&D unit?