A SYSTEM DYNAMICS APPROACH FOR DIGITAL TRANSFORMATION AND COMPLEX POLICY DESIGN FOR THE POSTAL SECTOR IN SOUTHERN AFRICA

By

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DECLARATION

I Kgabo Mokgohloa declare that this Thesis is my own, unassisted work. It is submitted for the Doctor in Philosophy (Science, Engineering, and Technology) at the University of South Africa. It has not been submitted before for any degree or examination at any other University.

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Candidate **Signature**

ABSTRACT

The key motivation of the study was to explore and enlarge understanding of the factors that inhibit and drive the performance of the postal sector in a dynamic setting in the context of Southern Africa. This study was prompted by the unsatisfactory performance of the postal sector in Southern Africa as measured by the Integrated Index on Postal Development (2IPD) an index used by the Universal Postal Union to measure the performance of Posts across the globe on dimensions of reliability, resilience, reach, and relevance. Postal operators across the world are faced with inescapable business model disruptions steered by the digital era, and Southern Africa is not an exception. The dawn of the digital age presents both prospects and threats to business models of the industrial age as digitalisation has resulted in a sustained decline of mail volumes as the core business of the postal service for the past 100 years. The substitution of traditional physical mail with electronic alternatives has been a threat that has unsettled the postal service for over two decades. However, the arrival of the digital age has quickened the decline of mail volumes at an unprecedented speed as the digital age diffuses to almost all sectors of society and the digital economy becomes the preferred platform for conducting business.

A constructivist philosophical worldview, an inductive research approach, a Grounded Theory research strategy, and a qualitative methodological choice were adopted for the first phase of the research which was to identify the inhibitors and drivers that are prevalent in the postal sector. System dynamics was adopted as a modelling and simulation approach for the second phase of the research and aimed to conceptualise the interaction of the variables extracted from the insights gained from literature through a Grounded Theory research strategy. The ten dimensions that arose from the exploratory study were digital culture, adoption, customer insights, digital investments, digital ecosystem, operational efficiency/excellence, shared vision, digital capabilities, digital competitiveness, and diverging interests. These dimensions were further synthesized during the development of the system dynamics model, four key stocks emerged that are prevalent in managing digital transformation in the postal sector.

The four key stocks (variables) that emerged were adoption, digital culture, operations capability maturity, and financial performance. The system dynamics approach revealed that the postal sector can be described as a complex phenomenon due to intricate interdependent variables that interact in a dynamic setting. The complex nature of the postal sector is further

amplified by multiple feedback systems of non-linear relations. The results of the study point to the complex interaction of these variables that inhibit and drive the digital transformation and competitiveness of the postal sector. It is by grasping these complexities that decision-makers and policymakers could pull the levers revealed by this research to direct the postal sector toward a sustainable future.

The system dynamic model (stocks and flows) was developed and validated with postal industry experts, and the verification and validation processes confirmed that the model outcomes are reliable and reflect the reality of the dynamics prevalent in the sector. The results indicate that the factors that inhibit postal development and sustainability of the sector include poor digital culture, poor adoption of the Universal Postal Union digital ecosystem, and underperforming operations capability and this leads to poor financial performance and unsustainability of the sector in Southern Africa and many developing countries globally.

Different policy design and analysis scenarios were evaluated, and the outcomes of the policy design and analysis revealed that there are vital levers that administrators and policymakers could pull to improve the financial performance and overall competitiveness of the postal sector. The levers include but are not limited to factors such as digital financial payment services offered, support services offered, ePost and eGov services offered, e-commerce services offered, change of Chief Executive Officers in 10 years, unavailability of Enterprise Architecture blueprint, number of staff who attended Train-post courses, Information and Communication Technologies (ICT) index, e-Government index, marketing effectiveness, adoption fraction, contact rate, drop out of adopters rate, non-compliance to electronic advance data, compliance to quality of service, operational expenses, rural population, universal service obligation paid, universal service obligation shortfall and other factors.

The study presents a scientific and systemic approach to improve operations capability maturity as measured through the Integrated Index on Postal Development (2IPD) and the financial performance of the postal sector in Southern Africa. The novelty of the new body of knowledge lies in the mathematical equations developed and their application through simulation and scenario analysis to develop a robust solution to improve the business model of the postal sector in Southern Africa through the adoption of a digital transformation agenda and complex policy design. It is noteworthy to point out that the study confirmed the systems thinking principle that “the whole is greater than the sum of the parts”. This was evident in the results when the stocks were improved as stand-alone compared to when the improved stand-alone stocks interacted with each other in a dynamic setting. All stocks exhibited solid improvements when stand-alone scenarios were allowed to interact with each other in a dynamic setting.

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Acronym	Description
DPOs	Designated Postal Operators
2IPD	Integrated Index on Postal Development
UPU	Universal Postal Union
SAPOA	Southern African Postal Operators Association
UTAUT	Unified Theory of Acceptance and Use of Technology
TOE	Technology-Organisation-Environment
SADC	Southern Africa Development Community
CLDs	Causal loop diagrams
APIs	Application Programming Interfaces
ICT	Information and Communications Technology
CPSs	Cyber-Physical Systems
I4.0	Industry 4.0
IoT	Internet of Things
DM	Big Data & Data Mining
IoS	Internet of Services

AI	Artificial Intelligence
USPS	United States Postal Services
DT	Digital Transformation
DCMM	Digital Capability Maturity Model
TRA	Theory of Reasoned Action
TAM	Technology Acceptance Model
TOE	Technology-Organisation-Environment Framework
BOE	Benefits-Organisational Readiness-External Pressures
EDI	Electronic Data Interchange
ADOPT	Adoption and Diffusion Outcome Prediction Tool
UN	United Nations
SDGs	Sustainable Development Goals
VUCA	Volatility, uncertainty, complexity, and ambiguity
OSCAR	Online Solution for Carbon Analysis and Reporting
RA	Relative Advantage
EoU	Ease of Use
IFS	International Financial System
KPIs	key performance indicators
TQM	Total Quality Management
OPEX	Operational expenses
CM	Operations Capability Maturity
DC	Digital Culture
FP	Financial Performance
SD	System Dynamics
PLE	Personal Learning Editions
EDA	Electronic Advance Data (EAD),
DRI	Digital Readiness Index
EA	Absence of Enterprise Architecture
WC	Worst-case
BC	Best-case

CHAPTER 1: BACKGROUND TO THE RESEARCH

1. Introduction

The digital age has provoked Postal services across the globe to expand their services well beyond the original service of the Designated Postal Operators (DPOs) which is the distribution of postal mail items. UPU [1] argues that although some DPOs in several countries across the world struggle with financial turmoil, there are DPOs that are effectively competing at an international level and are financially sustainable. There have been prevalent moves towards digital technologies throughout the developing world, which in turn led to digitalisation across industries including the postal industry. UPU [2] suggests that societal composition is swiftly shifting and the digital age has driven changes in the way society consumes products and services. This shift has led to the progression of the client of the future with exceptional requirements and expectations that the postal sector ought to meet.

However, according to UPU [2], the majority of DPOs are poorly performing on the Integrated Index for Postal Development (2IPD). UPU [2] proposes that the measurement of multiple dynamics of postal development is a complex task, and theorises that to overcome this challenge; the Universal Postal Union (UPU) has been leveraging a wealth of vast data to appraise the performance of DPOs worldwide. One of the major outcomes of these efforts, it argues, was the creation of the Integrated Index for Postal Development or 2IPD. According to [3] 2IPD measures the performance of POs in the four vital dimensions of postal development; reliability, reach, relevance and resilience.

UPU [4] explains the four dimensions as (a) Reliability is a composite of excellence of service performance, including certainty of service across all classes of postal delivery service with a focus on national and incoming streams of the postal delivery process; it ultimately measures the level of postal operational efficacy (b) Reach is composite of global postal connectedness at a transnational level across all types of international postal delivery services, it ultimately measures the level of internationalization of postal services (c) Relevance comprises of the strength of demand for the full range of postal services in each postal segment including mail, logistics, and financial services; it ultimately measures the level of attractiveness in all main markets (d) Resilience comprises of capacity to innovate, deliver inclusive postal services, and integrate sustainable development targets in postal business models; it ultimately measures the level of flexibility of postal business models.

UPU [2] indicates that 172 nations were evaluated for the development of the 2019 global ranking (based on complete data for 2018). Table 1 depicts the top five countries in alphabetic order with their matching scores on the 2IDP and as follows: France, Germany, Japan, Netherlands, and Switzerland. UPU [5] suggests that these top 5 DPOs are performing exceptionally well on the 2IDP since they have progressively constructed reliable, well-connected, suitable, and flexible postal services. The report further argues that other DPOs, especially in developing countries, are failing relatively to the 2IDP indicators.

The 2IPD according to UPU [6] is grounded on four pillars which are (1) Relevance which appraises the vigour of demand for the full offerings of postal services compared to the finest DPOs in each category of postal activity, (2) Reliability echoes performance in terms of swiftness and certainty of delivery, across all the key segments of physical postal services, (3) Reach implies global connectedness by appraising the extensiveness and deepness of the DPOs' international network. Lastly, (4) Resilience shows the degree of the diverseness of revenue streams, along with the aptness to invent and bring about a postal service which serves the broader society.

Table.1 Top five Designated Postal Operators' performance on Integrated Index for Postal Development, adapted from source [5]

Country	**2IPD score 2018**	**2IPD score 2019**
France	83.3	86.86
Germany	91.3	90.79
Japan	91.6	87.19
Netherlands	93.7	93.67
Switzerland	100	100

The analysis of performance on the 2IPD in UPU reports in [3] and [2], points to Posts in developing countries (Southern Africa included) as stragglers' when equated to the top-performing DPOs on the 2IPD. Table 2 lists the SADC (Southern African Development Community) Designated Postal Operators with their corresponding 2IPD scores.

Table.2 Southern African Development Community Designated Postal Operators' performance on Integrated Index for Postal Development, adapted from source [5]

Country	2IPD score 2018	2IPD score 2019
Angola	21.22	30.54
Botswana	23.72	21.00
Comoros	11.29	11.76
Democratic Republic of Congo	15.87	17.01
Eswatini	24.72	15.80
Lesotho	14.09	13.44
Madagascar	30.96	30.63
Malawi	24.78	13.74
Mauritius	49.17	40.53
Mozambique	4.95	6.28
Namibia	31.28	27.52
Seychelles	30.68	24.00
South Africa	33.34	33.34
Tanzania (Republic)	31.81	39.12
Zambia	7.73	8.75
Zimbabwe	19.53	12.74

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According to SAPOA [7], the Southern African Postal Operators Association (SAPOA) is SADC's premier provider of postal services devoted to connecting people through the distribution of information, mail products, and financial services in the region. While the core business remains mail delivery, interests extend to retail, freight and courier, direct mail, e-commerce, and financial services. With 16,064,394 delivery points and a network of 5,441 branches and outlets, the postal network is larger than that of the member country's banks, reaching the most remote populations.

The Post Sector in Southern Africa is well positioned to deliver vital services to citizens and connect the disadvantaged to the global economy. However, the results of the 2IDP paint a gloomy picture of the region. According to UPU [8], the dynamics of the postal sector are driven by (a) The decline in letter mail volumes across the globe, continuing to put pressure on traditional mail income streams, and (b) Electronic substitution is the biggest driver of to decline of traditional mail (c) Apart from mail products, parcels and express, financial services and logistics and freight are new revenue streams (d) Digitalisation that gave rise to e-commerce (e) e-commerce has, on the other hand, driven competition as many new courier companies are entering the market and ‘eating’ on the traditional market share of the postal sector.

UPU [8] further proposes that while globally, the postal sector faces major challenges but also, at the same time, it is widely reinvented to exploit new opportunities which build on its unique position, reach and capabilities and allow it to leverage its assets in different and innovative ways. Major opportunities include the e-commerce value chain, last-mile delivery, third-party trusted intermediary to deliver various services, helping to ensure wider financial inclusion and activity, augmenting the Micro Small, and Medium Enterprise (MSME) sector (with direct mail and e-commerce, as well as financial products) and supporting the development and delivery of Government services.

UPU [9] argues that Postal Operators face an ever-changing market of the future influenced by a variety of factors from changing regulatory regimes, economic conditions, altered social life, and ever-changing consumer behaviour and in particular the younger generation. They further advance that these factors can be disruptive for postal organisations and suggest that while predicting the future is a mammoth task, the ability to respond on time to the ever-changing world is vital for the sustainability of postal organisations.

SADC countries, which are the scope of this study, are underperforming on the four dimensions of the 2IDP in reach, reliability, resilience, and relevance. These four dimensions are interconnected with quality of service, agile business models, depth and breadth of the postal network in serving its customers, and relevant products and services to serve the current and new generation customers who bring new dynamics such as preference. These new customers are technology savvy and prefer working through mobile technology to make transactions.

UPU [1] concludes that there are sizeable gaps in postal development across the world, and suggests that only a margin of nations (Designated Postal Operators) have succeeded in building dependable, well-connected, suitable, and agile postal services. A systemic deficiency of capital outlay in postal infrastructure might be one of the foremost explanations [8]. UPU [10] suggests that the postal sector covers a wide-reaching network of over six hundred thousand Post Offices, over five million personnel, and physical infrastructure (footprint) covering almost 192 countries.

Chen [11] argues that several studies had been conducted to explore the phenomenon of innovation diffusion and technology adoption. Chen [11] further suggests that, for instance, Venkatesh et al [12] formulated a Unified Theory of Acceptance and Use of Technology (UTAUT) model with four core determinants of intention and usage: Performance expectancy, effort expectancy, social influence, and facilitating conditions; while Tornatzky and Fleischer [13] suggest the Technology-Organisation-Environment (TOE) framework, which unified a threefold context for adoption: technological context, organisational context, and environmental context. However, these approaches are inherently static and may provide decision-makers with an unrealistic prediction of peak-level adoption, and the time it takes to diffuse the innovation or technology throughout the organisation.

The system dynamics approach has proven valuable in comprehending complex interactions in the adoption of technology and innovation diffusion, its application in the postal sector is lacking and the situation is dim when it comes specifically to technology adoption in the postal sector.

The globe is changing at a fast pace and industries must keep abreast with changing technological landscapes, ever-changing customer requirements, and changing regulatory regimes. The postal sector is not immune to these dynamics and these changing landscapes have obligated Posts around the globe to move beyond their traditional service of merely delivering mail and diversify into other avenues as technologies of the 21st century continue to disrupt business models. Mutingi and Matope [14] contend that management of technology innovation and adoption is a complex undertaking as inhibitors and promoters dynamically interact and therefore, comprehending the interaction and effects of these dynamics is extremely imperative.

These complexities could result in poor or no adoption of technology and innovation diffusion in the organisation and could further pose a risk to the sustainability of the postal sector. The entire Posts in Southern Africa stand to gain if these dynamics are well managed and technology that is appropriate to Southern African conditions is adopted to guarantee the sustainability of the Posts.

1.1 Problem Statement

The calamities that have befallen DPOs in Southern Africa have triggered the near collapse of the sector owing to poor performance on the 2IPD. This is supported by the score of each Post in Southern Africa obtained on the 2IPD.

The deficit in performance by SADC DPOs is fueled by an overabundance of factors which include rigid or rather out-of-date business models that are not adjusting to the digital age and associated technologies that are disrupting present business models enormously. The outdated business models cannot contend in the 21st century and this results in the majority of DPOs in Southern Africa posting losses year in and year out. The lack of financial sustainability of the DPOs leaves the respective governments in their respective countries with no option but to bail out these institutions, which becomes a burden to taxpayers.

DTPS [15] highlight that in South Africa, which is the biggest economy in the Southern Africa Development Community (SADC) region and the second biggest economy in Africa, the postal sector contributes just below 3% of the Gross Domestic Product. According to [16], the South African Post Office made a whooping loss of R1.6 billion in the 2020 financial year. In [17], the report positions Swiss Post as the leading Postal Service in the world with a 2IPD making of one out of one and an operating profit of CHF 405 million equivalent to about R6 billion. Southern African Posts perform poorly on the 2IPD as compared to their tier-one Posts.

Kuznaz *et al.* [18] support this phenomenon by advancing the argument that, disruptive technologies are currently disrupting the business models of yesterday and today. They further propose that because of the digital revolution and exponential growth of data gathered through sensors across the value chains, logistical value chains are also impacted by Industry 4.0. Lastly, [19] argues that every aspect of the supply value chain and commerce is disrupted at an increasing rate and that the velocity of innovation and tightened competition means that businesses can no longer operate within traditional business models. These realities hold in many developing countries and in our case, it holds in Southern Africa based on the 2IDP rankings. The articulated research problem gives rise to the purpose or aim of the research which is expressed below.

1.2 Research Aim

This study endeavoured to develop a system dynamics model for digital transformation and complex policy design in the postal sector in Southern Africa to inform policy/decision-making. Further, to develop scenarios from the model to inform policy makers on the most optimal levers to pull to assure the sustainability of the postal sector. In the 21st century where technological and digital landscapes change at an unprecedented pace, a novel dynamic tool capable of predicting the competitiveness (financial sustainability) of the postal sector and the extent to which associated variables impact competitiveness, will be valuable to inform policy and decision making in the postal sector in Southern Africa.

To develop the model, it is important to articulate the research objectives that must be attained at the end of this study. These research objectives are articulated below.

1.3 Research Objectives

This research aims to develop a system dynamics model to inform policy and decision-making with which digital transformation can be steered in the postal sector in Southern Africa to assure financial sustainability. This was done by identifying the key drivers (inhibitors and promoters of digital transformation) that prevail in the postal sector in Southern Africa and exploring their interactions in a dynamic setting. In doing this, viewpoints from stakeholders in the industry such as Posts, regulators, and governments were included to enrich insights and create a unity of purpose. Lack of unity of purpose amongst stakeholders often creates friction which eventually leads to an unstructured approach to digital transformation and affects the performance and sustainability of the postal sector.

The purpose of the study prompted the following key research objectives:

- To review existing literature on industry 4.0, digital transformation, innovation diffusion, technology adoption, and system dynamics application in technology adoption and use insights from academic and industry literature to determine prevalent inhibitors and drivers of digital transformation in organisations.
- Develop a system dynamics conceptual model of intermingling digital dynamics (variables) based on insights from both academic and industry literature.
- To analyse and design policy interventions to ensure the financial sustainability of the postal sector in Southern Africa.

To attain the research objectives, it is important to articulate the research questions that must be answered by the study. The research questions are derived from the research objectives and are articulated below.

1.4 Research Questions

The abovementioned purpose (aim) and objectives raise broad research questions that must be answered by the study:

- What are the digital postal dynamics (variables) in organisations and DPOs globally and in Southern Africa?
- How do these variables interact with each other in a dynamic setting?
- What policy designs can be derived from the resulting model to aid policymakers and DPOs in Southern Africa to better manage the digital transformation to deliver value to society and contribute to the financial sustainability of the postal sector?

1.5 The Motivation for the Study

The postal sector has for more than 100 years contributed greatly to economic development and connecting communities. However, the majority of DPOs in developing countries are faced with a consistent decline in traditional mail volumes resulting in shrinking revenues as technology advancements continue to disrupt business models of the past.

With the advent of the 4th Industrial Revolution and Industry 4.0, businesses across the globe are undergoing digital transformation intending to remain competitive and in business by responding to new customer trends and creating value for customers and stakeholders.

The primary motivation for this research is to enlarge the comprehension of the dynamic interface of digital transformation variables (inhibitors and enablers) in the postal sector in Southern Africa. These insights are captured in a system architecture map (SAM) and further analysed in a system dynamics model to simulate the behaviour of the interaction of these variables or determinants. The novel system dynamic model insights will be utilised to derive guidelines for policymakers and postal operators which are likely to improve the digital transformation pathways in Southern Africa, with the sole goal of leveraging digital transformation to improve postal sustainability.

1.6 Scope and Limitations of the Study

This section is absorbed into how the postal sector in Southern Africa could better manage the adoption of technology and diffusion of innovation. This research relies mainly on observations and secondary data from various stakeholders in the postal value chain to extract insights on various drivers and determinants. The research does not employ any questionnaires or interviews. The prevalent postal sector material conditions in the selected Posts (3 out of 15 Posts) are used as a composite representative of Southern Africa and as a result, it is proposed that the model developed in this research will assist Posts across Southern Africa to better manage digital transformation in the quest for financial sustainability in the 21st century.

1.7 Importance of the Study

The outcome of this research is envisaged to improve digital transformation pathways and respective dynamics and will most likely result in the competitiveness of the postal industry in Southern Africa and beyond. Competitiveness in the context of the DPOs refers to the financial sustainability of the sector based on the current unsustainable trajectory prevalent in the postal sector in developing countries. The findings of this research will positively contribute to Southern Africa considering the pertinent role (both historical, present, and future) that the postal sector plays in society at large. The system dynamics model will be utilised to understand core dynamic behavioural patterns of the postal sector system in Southern Africa. The model will enable the simulation of policy intervention experiments and understanding of the effects over time. In addition, this research will advance literature encompassing digital transformation dynamics of the postal sector in Southern Africa, especially because of the limited literature on the postal sector globally and in Southern Africa in particular.

1.8 The Organisation of the Research

The research is arranged into six chapters. Chapter 1 presents the background of the research and outlines the research topic, research aim, research objectives, and scope and limitations of the study. Chapter 2 explored (i) Traditional technology adoption models such as the Theory of Reasonable Action, the Technology Adoption Model, the Technology Adoption Model 2, the Unified Theory of Acceptance and Use of Technology, the Technology-Organisation-Environment framework, the Benefits Organisation and Readiness model, and the Adoption and Diffusion Outcome Prediction Tool. (ii) The concept of Industry 4.0 such as (a) The three industrial revolutions (Industry 1.0 which was centred on mechanisation following the introduction of steam power, Industry 2.0 which was centred on mass production following the introduction of electrical energy, and Industry 3.0 which was centred on automation following the introduction of computers and electronics) that heralded the current Industry 4.0 which is centred on Cyber-Physical Systems, the Internet of Things, and pervasive networks). (b) Industry 4.0 framework, design principles, core competencies, and technologies that characterise Industry 4.0 (iii) The concept of digital transformation such as digital framework, digital innovation, digital disruption, digital ecosystem, and digital capability. (iv) Factors at play that drive or impede the adoption or diffusion of technology such as factors that inhibit or drive ICT adoption, critical success factors for ICT adoption, driving forces and barriers of Industry 4.0, factors that influence innovation diffusion and adoption, digital transformation barriers and drivers in the postal sector, barriers to digital adoption and diffusion in the postal sector, and factors that drive digital readiness index in the postal sector. (v) Thinking paradigms including reductionist thinking and systems thinking, integrated model of systems thinking, system boundaries, linearity and non-linearity.

Chapter 2 concluded by identifying the research gap that emanates from the limitations of traditional technology adoption models which are characterised by linearity which is not sufficient to grasp and deal with non-linearity which emerges from complexities associated with factors that impede or drive the adoption of technology, and digital transformation.

Chapter 3 explored the research methodology and its respective tenets as articulated by the research onion developed by Saunders *et al.* (2009) which systematically articulates the philosophical worldview, the research approach, the research strategy, the research methodological choice, the time horizons, and the data collection procedures and analysis methods. A literature review was undertaken in Chapter 2 to identify the drivers and inhibitors of digital transformation in the postal sector. Thereafter, the drivers and inhibitors underwent an exploratory study in the form of a Grounded Theory research strategy which was used to synthesize literature on Industry 4.0, technology adoption models and digital transformation to develop theory. The outcome of the Grounded Theory research strategy resulted in the emergence of ten key variables that encapsulate digital transformation in the postal sector. These variables are adoption, shared vision, digital competitiveness, digital ecosystem, digital capability, digital investment, diverging interests, customer insights, digital culture, and operational efficiency. The ten variables that emerged from the exploratory study (Grounded Theory) were used to develop a conceptual model that defined digital transformation dynamics in the postal sector in Southern Africa.

Chapter 4 articulates the model conceptualisation which is grounded on the research undertaken in Chapter 3 from where ten dimensions (variables) emerged. A conceptual model was developed and presented in Figure 43. The dimensions (variables) of the sub-system diagram were further developed into causal loop diagrams or rather “influence diagrams” which unambiguously demonstrate the dynamic feedback relationship between variables within each sub-system. In the process of developing the “influence” diagrams, both exogenous variables (outside the boundary) and endogenous variables (within the boundary) were identified. The endogenous variables excluding the digital ecosystem, which is exogenous but the subject of the study, were synthesized into causal loop diagrams or “influence” diagrams to describe their interaction in a dynamic setting. The influence diagrams were supplemented by a detailed explanation of the interconnectedness and the loop dynamics for each of the variables presented as causal loop diagrams or CLDs.

This chapter further articulates the stocks and flows built from the CLDs. The ten dimensions were further refined and streamlined and described in Table 45. The resultant dimensions were consolidated and a new causal loop diagram, comprised capability maturity, adoption, digital culture, and financial performance (competitiveness). The emergent CLD is depicted in Figure 63 and grounds the hypothesis in the context of the dynamics that are at play in the postal sector. The restated hypothesis theorises that the adoption of the UPU (Universal Postal Union) APIs (Application Programming Interfaces) by key customers of the DPOs will reinforce a robust digital culture which will strengthen the capability maturity of the postal sector and the three stocks will reinforce financial performance (competitiveness) of the DPOs which will ensure the sustainability of the postal sector. This chapter further quantifies the variables and develops the mathematical expressions for respective stocks and flows. The next chapter delves into the simulation results and discussions of these key findings.

Chapter 5 commences with the model verification and validation. The consequential simulation model depicted in Figure 69 was effective in provoking outcomes that stakeholders confirmed represented the reality of digital transformation dynamics outcomes in the postal sector. The model was subsequently verified, validated, tested, and improved upon based on feedback from industry experts and policymakers as depicted in Figure 74. The outcome of the study revealed that the poor performance of the postal sector in Southern Africa is a result of poor digital culture, poor UPU ecosystem adoption by key customers, poor operations capability maturity, and poor financial performance. Policy analysis was undertaken which revealed that several scenarios (Scenario 1 to 7) can be used to improve the competitiveness (financial performance) of the postal sector.

Lastly, Chapter 6 articulates the conclusions by recapping the salient aspects covered in each chapter and further provides recommendations for policymakers and Designated Postal Operators on which policy interventions could improve the sustainability of the postal sector based on the findings of the study.

Figure 1 is a diagrammatic illustration of the structure of the research and captures the interconnectedness between the chapters.

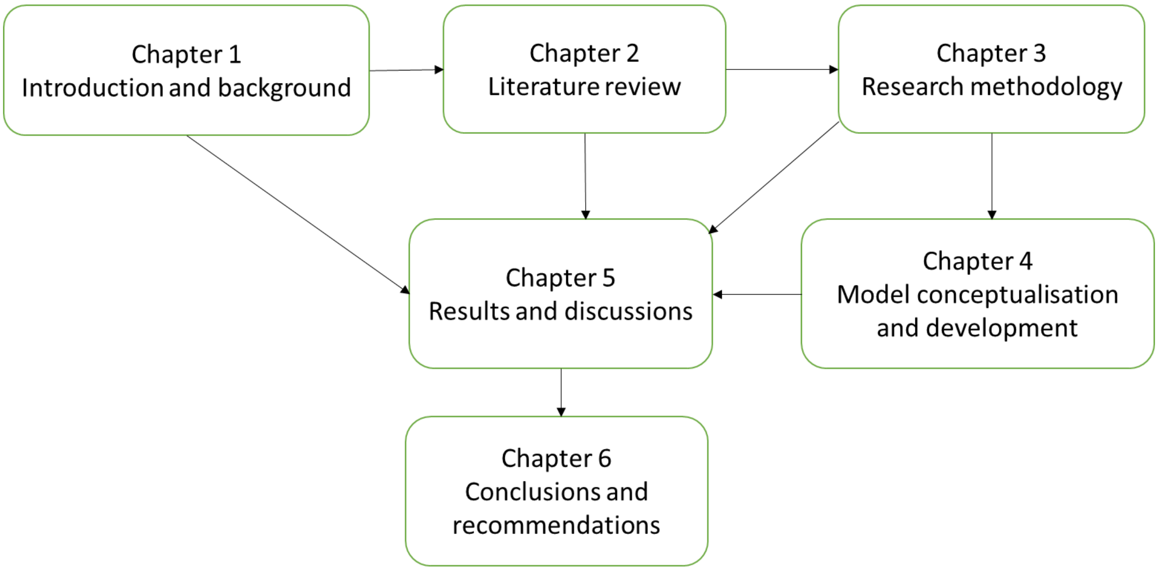


Figure 1: Structure of the research depicting links between chapters

1.9 Summary of Chapter 1

In summary, DPOs globally are faced with many challenges; the digital age has disrupted business models of businesses across the world. The DPOs are part of the global village and are affected drastically by these 'winds of change'. These disruptions led to some Posts, especially in the industrialised countries, adopting the Fourth Industrial Revolution technologies and delving into digitalisation of the business processes of the Post and as a result reaping a financial benefit. The positive spin-offs in industrialised countries are not the same as in developing and less developed countries and Southern Africa where the financial sustainability of Posts is negatively affected.

This research study proposes a system dynamics model that will capacitate DPOs in Southern Africa to navigate digital transformation pathways and ensure the financial sustainability of the DPOs in the SADC Region and beyond. The subsequent chapter reviews the literature on adoption and diffusion, digital transformation, Industry 4.0, and systems thinking. The exploration of the literature review sheds light on the barriers to digital transformation and financial sustainability. The findings from the literature review will be used as the measure and guiding ingot upon which this research is directed.

CHAPTER 2: LITERATURE REVIEW

2. Introduction

In this section, literature on Industry 4.0, technology adoption, innovation diffusion, digital disruption, and digital transformation are explored, reviewed, and discussed to extract insights from previous research. Further, system dynamics theory and its applicability to technology adoption and innovation diffusion are explored and explained. The first principles and importance of system dynamics theory are studied while the systems dynamics methodology to technology adoption and innovation diffusion is examined.

2.1 Theory of Industry 4.0

2.1.1 Framing Industry 4.0

Santos [20] argues that the manufacturing sector has continually been vital to the economic development of nations. Since the end of the 18th century, industries have gone through huge changes that transfigured the way goods are manufactured and have returned abundant benefits, principally related to efficiencies, and output. Currently, after three preceding industrial revolutions, the amalgamation of cutting-edge technologies and the digital age is completely altering the business landscape and it is characterised as the 4th Industrial Revolution (4IR) or Industry 4.0 [21].

Fonseca [22] argues that the 4th Industrial Revolution is categorised through improved digitalisation and integration of manufacturing and logistics processes, and the employment of the internet and “smart” items (machines and products). The adoption of modern Information and Communications Technology (ICT) is integrating the physical and cybernetic worlds, in what is called the cyber-physical systems (CPSs), and comprise online networking of social machines, connecting ICT with mechanical and electronic components that communicate between themselves through a network. Figure 2 depicts the evolution and stimulus of the four “Industrial revolutions” and their major distinctiveness and features.

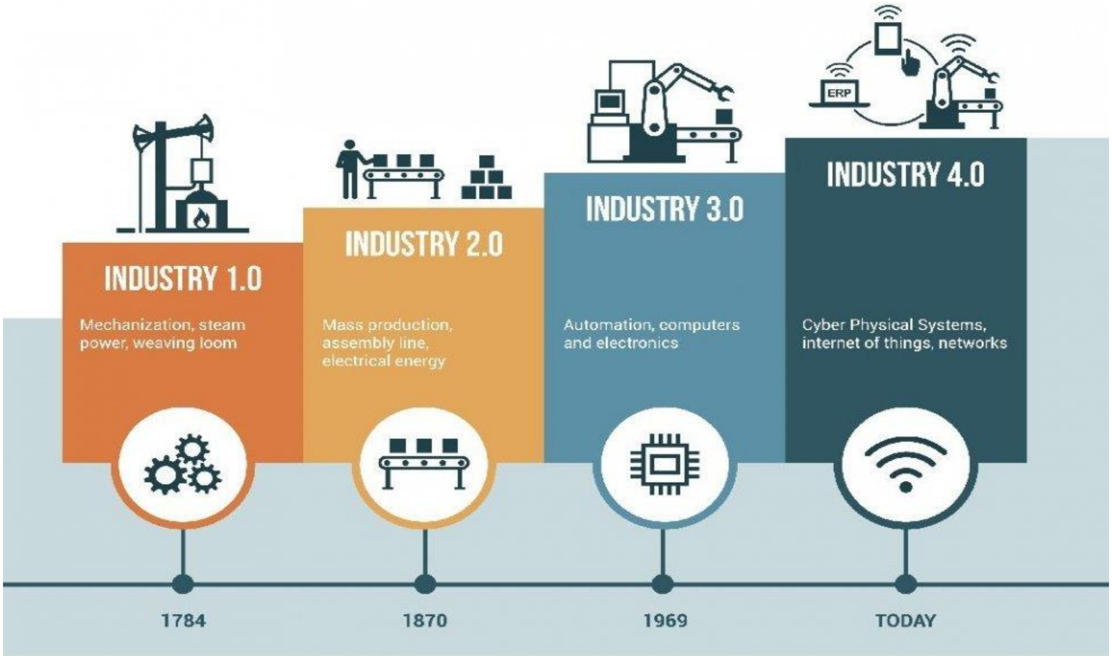


Figure 2: Industrial Revolution Phases [21]

Rojko [23] argues that the Industry 4.0 concept was coined in Germany, due to the reputation of Germany's high-tech, competitive industries as part of the high-tech 2020 strategy. Rojko [23] advances that Industry 4.0 is part of the long-term far-sightedness of the German government to further improve the competitiveness, efficiencies, effectiveness, and profitability of the German manufacturing industry. Santos [20] suggests that Industry 4.0 emanated from Germany with the State as the vanguard of sagacity into the future. This view is further reinforced by Rojko [23] who proposes that it comes as no surprise that the Industry 4.0 concept stems from Germany, as Germany is the industrial capital of Europe, and the German Government has made it its strategic thrust to leverage the digital technologies steered by the Fourth Industrial Revolution, and their application, in their vastly competitive manufacturing industry.

2.1.2 Constituents of Industry 4.0

Santos *et al.* [24] argue that the tactical goal of Industry 4.0 (I4.0) is to leverage digital technologies such as big data and big data analytics, the Internet of Things, Artificial Intelligence (AI), Augmented and Virtual Reality, Advanced Robotics, Advanced Materials (Including Nanomaterials), Block-chain and other technologies associated with Industry 4.0.

I4.0 is envisioned for the attentive assemblage and application of real-time data and information through networking all individual fundamentals of a system, to lessen the complexity of operations, while swelling the efficiency and effectiveness with a long-term cost reduction target. It is affixed in the enlargement of research and development in prevalent applications of Information and Communication Technologies to put into practical use the promising outcomes of the Internet of Things (IoT), Embedded Systems, Cyber-Physical Systems (CPS), and big data in industries; the excess of the 21st-century technologies and their fusion is distinctive to the notion of I4.0 [24].

Selma *et al.* [25] propose that I4.0 is defined as the new technological and digital transfiguration for instinctive systems based on the astonishing proliferation of the speed of information processing, digital storing ability, and enormous progress of information and communication systems. The term "I4.0" means the smart manufacturing facilities in which "smart" digitally boosted devices are remotely connected to permit communication of resources and materials through the manufacturing and logistics value chain. This industry is characterised by agility, efficiency, and effectiveness [26]. Selma *et al.* [25] advance that Industry 4.0 is defined as a technology-inspired revolution, the emphasis being on self-directed systems with capacity and capability for rapid information processing, big data storing capacity and capability, and the exponential upsurge in complex ICT.

Nagy *et al.* [27] suggest that I4.0 means intelligence in the connectedness of systems and processes while Sanders *et al.* [28] support this definition and argue that I4.0 means the synthesis of the biological, physical, and virtual (cyber) systems. I4.0 comprises the design, progression, amalgamation, and application of 21st-century digital technologies in the industry [29]. Maslarić *et al.* [30] propose that digitalisation is Industry 4.0 in action. The first three revolutions are characterised by steam-powered mechanical systems, electrical-powered mass production, and electronic-powered automation respectively, so is digitisation which includes the synthesis (fusion) of biological, physical, and virtual (cyber).

World Economic Forum [31] proposes that the supply chain epitomizes an organisational value chain, and digital technologies enable the efficient movement of goods, services, and information through the pipeline. In the context of the Fourth Industrial Revolution, supply chains retain a high level of ability to guarantee logistics perceptibility in real-time as goods, services, and information flow through the business value stream and make it conceivable to accrue real-time data and make decisions as conditions dictate. Fourth Industrial Revolution technologies as espoused by Industry 4.0 are not only radically disrupting the supply chain ecosystem but also transforming the world of work. The World Economic Forum [32] posits that these technologies are transforming the skills and profiles required. Enhancing capabilities is no longer adequate, as a new set of complex abilities needs to be acquired to monitor the complex technologies and master new processes as a result of the digital revolution.

Schwab [33] suggests that new technologies fundamentally modify the nature of work, and automation abolishes repetitive work and as a result, substitutes labour resources with capital resources. Kuznaz *et al.* [18] propose the concept of Industry 4.0 as the sum of all the disruptive technologies that are geared towards delivering value to the customer, effectively, efficiently, first time every time. Kuznaz *et al.* [18] further, propose that the technologies supporting Industry 4.0 are the summation of all the 21st-century disruptive innovations derived from and implemented in enterprise value chains to address the trends for speed, logistics transparency convenience, digital privacy, and security in the provision of products and services along the value chain, as demanded by new customers.

Santos [20] suggests that it is now commonly known that digital technologies will have a significant imprint on present-day organisations and the creation of organisations of the future. Figure 3 depicts the I4.0 framework and allied digital technologies which are grounded on three outcomes, these outcomes are:

1. Digitalisation and integration of vertical and horizontal value chains;
2. The digitalisation of product and service offerings; and
3. Digital business models and customer access.

Reinhard *et al.* [34] suggest that data and analytics are fundamental proficiencies of I4.0 and are aided by digital technologies such as mobile devices, cloud computing, IoT platforms, augmented reality, client interaction and client profiling, location recognition technologies, advanced human-machine interfaces, big data analytics, and innovative algorithms, smart sensors, 3D printing, and verification and scam detection.

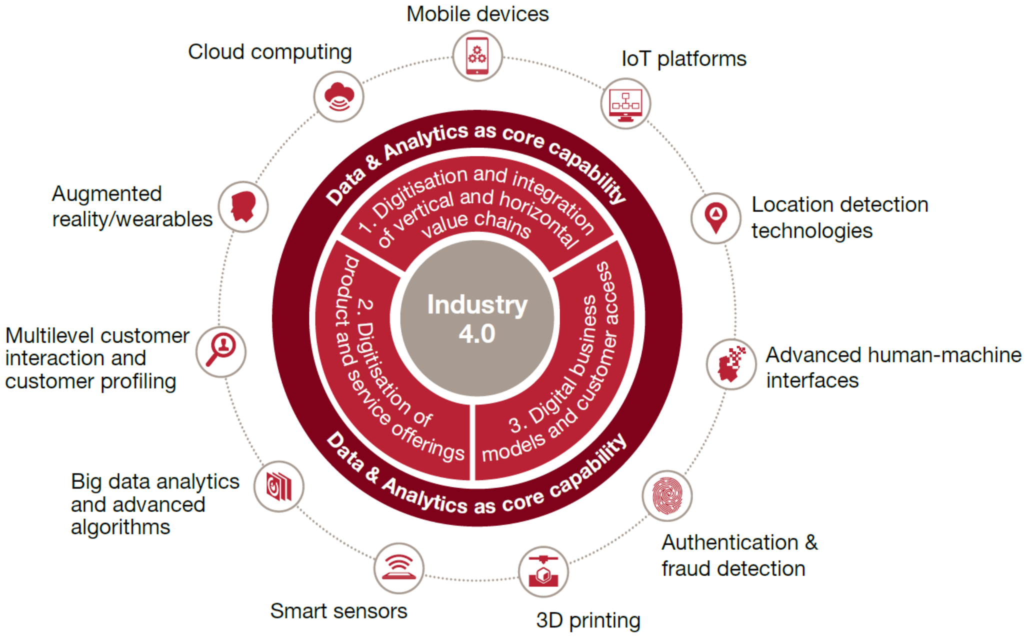


Figure 3: Industry 4.0 framework and contributing digital technologies [33]

Figure 4 depicts the I4.0 environment in which the key importance to I4.0 is its interface with other smart set-ups such as those of smart mobility, smart grid, smart logistics, smart homes, and smart buildings. The interconnectedness between the social web and organisational web is of vital importance as all these novel networks and interfaces offered by I4.0 within an "internet of things", internet of services, internet of data, and internet of people" means that organisations and society as we know them are set to endure a tremendous transformation in the future [35].

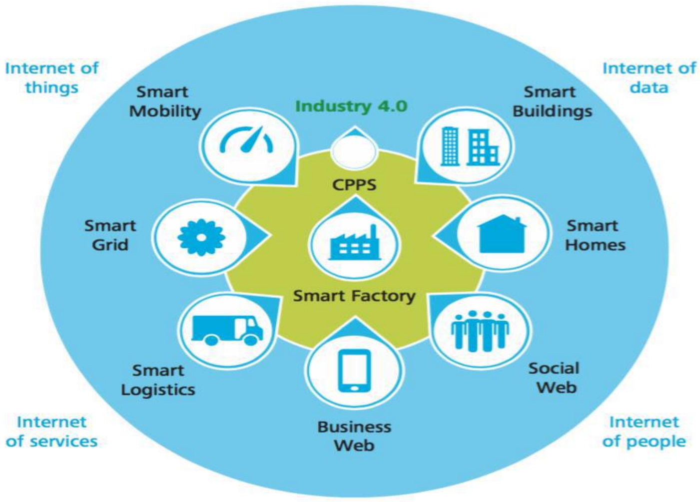


Figure 4: Industry 4.0 environment [34]

Galindo [36] argues that the main components that form the concept of I4.0 are:

a) A cyber-physical system (CPS) is the term that defines the fusion of digital (cyber) with real (physical) workflows. In production industries, this means that the physical production stages are escorted by digital processes, using the concept of ubiquitous computing. CPS comprises sensors and actuators that collect and send data. These CP systems are based on the “Industrial Internet” as a means of communication.

b) The Internet of things (IoT) is part of the CPS that aids communication with other Cyber-physical systems and between the CPS and the users. It enables the creation of networks that incorporate the entire production process, thereby enabling horizontal as well as vertical integration.

c) Big Data & Data Mining (DM) is a vital issue due to the diversity, capacity, and swiftness required to process the data from the CPS.

d) Internet of Services (IoS) enables service vendors to provide their services via the Internet. It comprises partakers, infrastructure for services, business models, and the service itself.

Hermann *et al.* [37] and [38] postulate that six design philosophies encompass I4.0 and they are interoperability, virtualization, decentralization, real-time capability, service orientation, and modularity. These design principles are imperative considerations toward the efficacious operation of I4.0 in respective industries and are depicted in Table 1.

Hermann *et al.* [38] and Lasi *et al.* [21] further elaborate on the Industry 4.0 design philosophies and describe them as follows:

a) Interoperability is a remarkably dynamic enabler of I4.0. In I4.0 organisations, CPS and humans are connected over the IoT and the IoS. Development and implementation of standards is a key success factor for communication between CPS of various producers.
b) Virtualization means that CPS can monitor physical processes. These sensor data are interconnectedness to virtual plant models and simulation models. Thus, a virtual version of the physical world is created.
c) The rising demand for individual products makes it increasingly difficult to control systems centrally. Embedded computers enable CPS to make decisions on their own and as a result, decentralization is key.
d) For organisational success, data must be gathered and evaluated in real-time.
e) The services of organisations, CPS, and humans are accessible over the IoS and can be employed by other participants. These services can be offered both internally and across organisational borders.
f) Modular systems can amenably alter to changing requirements by replacing or expanding individual modules. Therefore, modular systems can be simply adapted in case of cyclical variations or changed products and characteristics.

Table 1: A design principle for each of the main 4 Industry 4.0 components [36]

	Cyber-Physical Systems	Internet of Things	Internet of Services	Smart Factory
Interoperability	X	X	X	X
Virtualization	X	-	-	X
Decentralization	X	-	-	X
Real-Time Capability	-	-	-	X

Service Orientation	-	-	X	-
Modularity	-	-	X	-

Macaulay [39] argues that today, the internet is often considered a “given” due to its ubiquitous presence and accelerating influence on how we live, work, and communicate with one another. The globe is moving forward at a fast pace, and the recognition goes to progressing technology. One such concept is IoT (Internet of things) with which automation is no longer a virtual reality. IoT connects various inorganic objects through the internet and aids them to share information with their community network to automate processes for humans and makes their lives easier [40].

USPS [41] suggests that the Internet of Things (IoT) is a sensor technology that enables objects to collect and communicate data through the Internet in real-time is one of the latest technological advances clutching many organisations and is apt for the postal sector due to its possible applications in the postal value chain.

Rahman and Asyhari [42] propose that the IoT archetype is intended at framing a complex information system with the amalgamation of sensor data acquisition, efficient data exchange through networking, machine learning technologies, AI (artificial intelligence), big data, and big data analytics, and cloud computing. Contrary-wise, gathering information and upholding the confidentiality of third parties, and then taking cognizance of privacy and security provision in IoT, remains a serious concern among stakeholders in the IoT space [42].

USPS [41] further argues that the current proliferation of IoT applications is fueled by a convergence of factors such as ubiquitous connectivity and the decreasing cost and improved performance of sensors and analytics. These technology trends are coupled with increased customer demand for more data on the products and services they purchase. The flow of information is becoming increasingly critical to the flow of things.

The digital age provides both trials and prospects for the DPOs, the major challenge facing DPOs is that they can no longer operate with outdated business models since digitalisation of the Post is something that is not optional but mandatory if the Post must survive another 100 years.

Reinhard *et al.* [34] note that the core of industry 4.0 is threefold:

(a) Digitalisation and integration of horizontal and vertical value chains have two aspects. The first characteristic encompasses the amalgamation of processes vertically across the organisation, from research and development and procuring, through production, logistics, and after-service. Data that relates to production processes, process effectiveness, and quality management, as well as production planning are available in real-time, supported by augmented reality, and optimised in an integrated network. The second aspect encompasses horizontal integration which springs beyond the internal operations from suppliers to customers and all key value chain partners. It includes technologies from track and trace devices to real-time integrated planning with execution.

(b) Digitalisation of products and service offerings includes the widening of current products, e.g., by adding smart sensors or communication devices that can be used with data analytics tools, as well as the creation of new digitised products which focus on completely integrated solutions. By integrating new methods of data collection and analysis, companies can generate data on product use and refine products to meet the increasing needs of end customers.

(c) Digital business models and customer access which involves the expansion of offerings through the provision of digital technologies such as comprehensive data-driven solutions, and integrated platform solutions. Disruptive digital models are often fixated on creating additional digital revenues and streamlining client interface and access. Digital products and services often aim to serve clients with comprehensive solutions in a diverse digital ecosystem.

2.1.3 Digital Transformation (DT)

The world is on the crossover of a digital era that is altering society and organisations across the globe. Digitalisation is plummeting the costs of gathering, storing, and processing data, consequently changing the way industry and commerce function around the globe. Digital technologies provide a platform for enterprises to participate in the global market through e-commerce. This new digital revolution requires changes to existing legal and regulatory frameworks and has vast implications for the transformation of Posts [43].

Arpe and Kurmann [44] state that the terms digitisation and digitalisation are often erroneously used interchangeably, digitisation is defined as a technological process of altering and adapting "analogue" information into a "digital" arrangement. Digitalisation on the other hand can be defined as the application of digital technologies altering organisational business processes, products, services, structures, as well as business models. Digitalisation is the foremost driving force behind widespread large-scale changes in a multiplicity of industries [45].

Arpe and Kurmann [44] argue that Digital Transformation (DT) is defined as a business process devised to assimilate digital technologies by concurrently restructuring organisational business processes, products, services, structures, and business models. According to [46], the genesis of digital transformation stems from the shared effects of several digital innovations produced by innovative participants, edifices, values, ideologies, and understandings that adjust, endanger, and substitute, or complement current guiding principles of the game within organisations, ecosystems, industries, or fields.

Stonehouse and Konina [47] argue that DT is perceived as a multi-tiered technological transformation in organisations that includes both the employment of digital technologies to augment current processes and their effectiveness and the journey into digital innovation, which possesses the possibility to alter the operating model of an organisation. Subsequently, Arpe and Kurmann [44] argue that digital technologies trigger changed customer expectations which in turn trigger digital innovation while digital innovation generates new business opportunities and facilitates industry disruption. They further assert that digital transformation affects organisational building blocks (Strategies, client relationships, corporate models, corporate structures, and inter-firm and organisational processes) and requires organisational key success factors (Client and product knowledge, defines responsibilities, digital-savvy culture and vision, a cooperative organisation with flat hierarchy, and an inspirational leadership). This synthesis is presented in Figure 5. Digital technologies contribute to the revolution of significant segments of our economy and society [48].

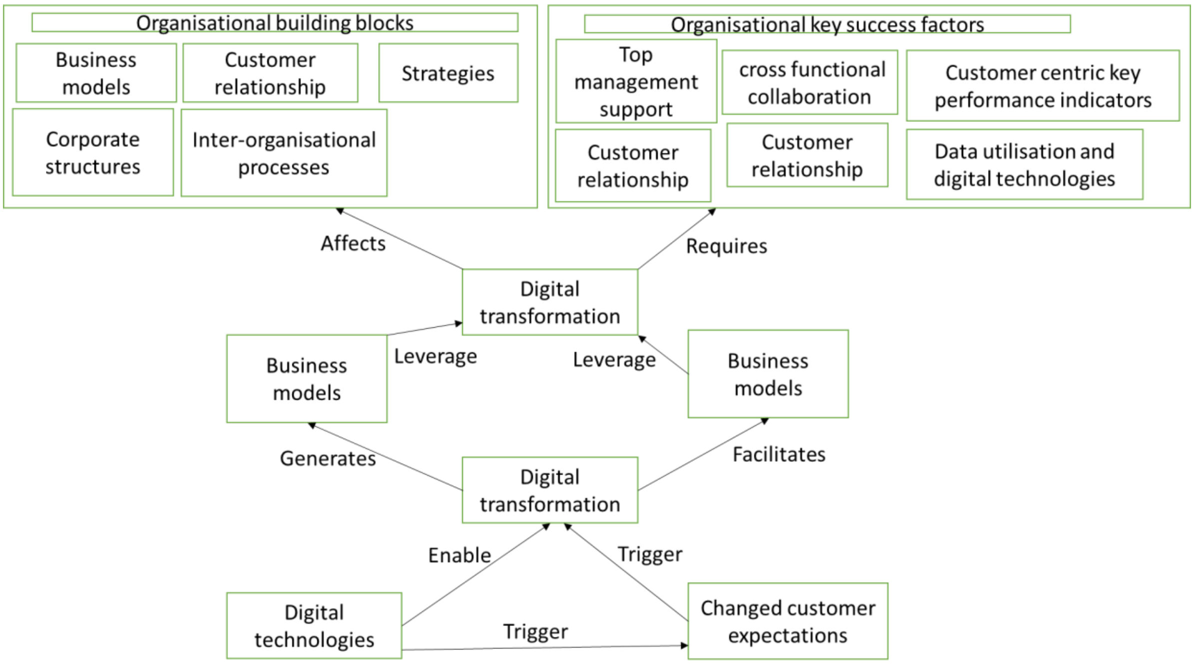


Figure 5: Digital framework [43]

2.1.3.1 Digital Innovation and Digital Disruption

Skog *et al.* [49] argue that the terms digital innovation and digital disruption are often erroneously used reciprocally, and further suggest that digital innovation is the process of blending cyber and physical components to produce innovative artefacts; integrating these dimensions to create and enable market offerings and embedding them in wider socio-technical settings to support their dissemination, operation, and use. This definition is supported by Ciriello *et al.* [48] who advance that "innovating digitally" is characterised by innovating products, services, and operating models through digital technology throughout the organisations.

Digital disruption, on the other hand, can be defined as the swiftly developing processes through which digital innovation profoundly changes traditionally sustainable logic for value creation by unbundling and integrating connections among resources or generating new resources [49]. Disruptive digital innovation establishes a new market and ultimately disrupts an existing market [48]. Once digital innovation is adopted and extensively diffused, it may enable, harmonize or even inhibit the actions of others to fulfil its value logic [49]. Skog *et al.*

[49] further contend that value logic is the foundational reasoning for devising, integrating, and entrenching a digital innovation to successfully develop and extract value.

2.1.3.2 Digital Ecosystem

Badr and Biennier [50] propose that imitating biotic ecosystems, digital ecosystems denote intricate and symbiotic systems and their fundamental structures by which all elements interact and exhibit completely self-organising, scalable, and sustainable behaviour. This view is supported by Briscoe and Wilde [51] who define digital ecosystems as “the cyber counterparts of biotic ecosystems, leveraging the self-organising properties of biotic ecosystems, which are well-thought-out to be vigorous, self-organising and scalable architectures that can inevitably solve complex, dynamic problems". Digital ecosystems exceed the orthodox, methodically defined cooperative settings from united, disseminated, or hybrid models into an unlimited, pliable, domain cluster, demand-driven, collaborating environment [52]. Digital ecosystems are socio-technical interconnectedness between autonomous digital technologies and associated players that are interrelated based on the explicit context of the application [49].

The concept of digital transformation is summarised in Figure 6. The conceptual model developed by Skog *et al.* [49] illustrates underlying dimensions that actualize digital disruption. The model comprises four dimensions (Discovery, development, diffusion, and impact). The process begins within the organisation where feasibility (Technologically & financially) and ideas capable of digital disruption are explored and the deviant idea that deviates substantially from dominant logic is developed into a usable output and presented to a wider socio-technical network. This exposure of digital innovation to wider socio-technical network results in the adoption and use of digital innovation by an increased population of actors. Skog *et al.* [49] propose that digital innovation can adjust currently workable fundamental conditions for organisations as soon as it is excellently diffused and capable of imposing a deviating logic on a wide scale to the socio-technical network.

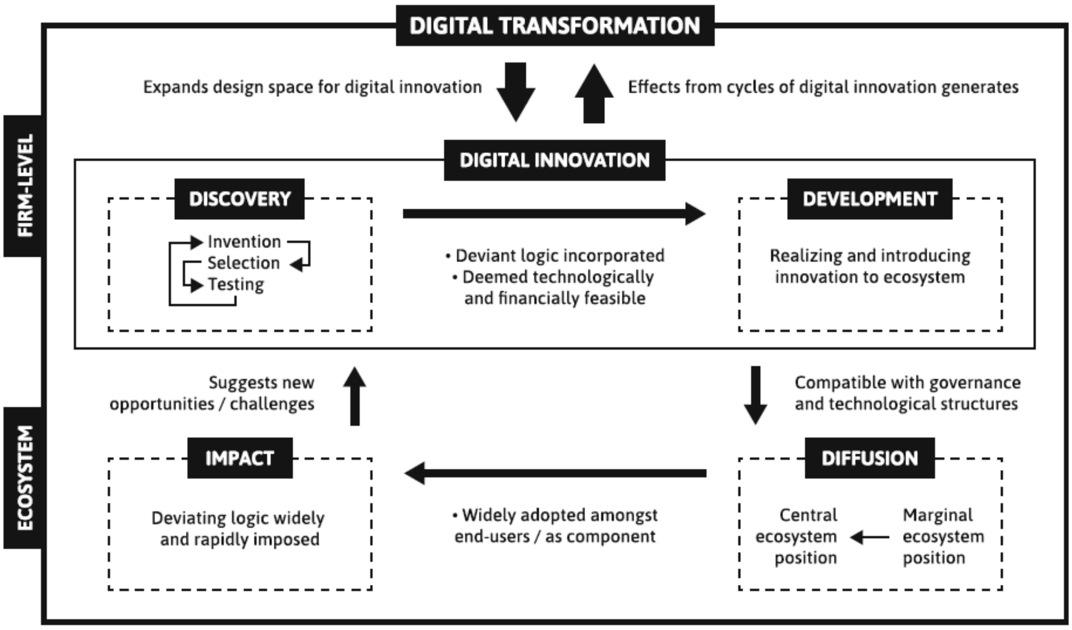


Figure 6: Conceptual model of digital disruption dynamics [48]

2.1.3.3 Digital Capability

Mihardjo [53] proposes that there are three critical elements of the digital journey which are digital headship, business model innovation, and client experience orientation. Kozina and Kirinić [54] suggest that Digital Capability Maturity Model (DCMM) is just one of the contemporary methodologies to appraise the digital capabilities in any organisation and advances that there are three dimensions to the DCMM which are articulated below. Kozina *et al.* [54] further argue that DCMM appraises digital business transformation management over five levels of maturity (Initial, reactive, defined, managed, and excellence). Additionally, an assessment of the digital business transformation journey according to the DCMM can be performed within six extents of digital capabilities:

(a) Innovation capability;
(b) Transformation capability;
(c) Information Technology excellence;
(d) Customer centricity;
(e) Effective knowledge worker; and
(f) Operational excellence.

Kozina *et al.* [54] propose that the structure of the Digital Capability Framework is based on three dimensions which are:

(a) Key areas of digital capabilities (1st dimension);
(b) Maturity levels (2nd dimension); and
(c) Digital business transformation management (3rd dimension).

The three dimensions are portrayed in Figure 7.

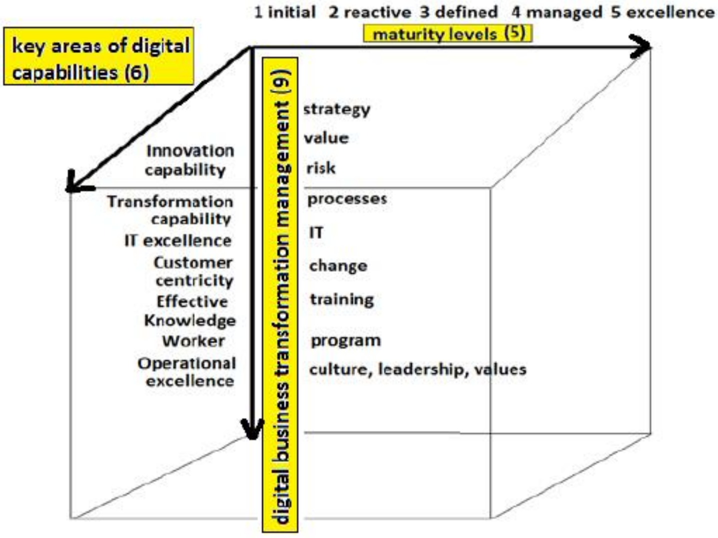


Figure 7: The structure of the digital capability framework [53]

Posts could significantly profit from adopting I4.0 principles and associated digital technologies in the expedition to adjust to trials and prospects offered by the digital era and could significantly improve performance on the 2IPD ratings to guarantee the financial sustainability of Posts, now and in the future. Digital technologies can significantly improve the financial sustainability of Posts in Southern Africa and beyond.

2.1.4 Innovation Diffusion Theory

Kuehne *et al.* [55] argue that the most perceptible and foremost attempt to dichotomise the dynamics inducing the adoption and diffusion of practices is by Rogers (2003). However, the framework by Rogers is suitable for the conceptualisation of adoption and diffusion from a qualitative perspective as opposed to a quantitative prediction of the adoption of innovative practices. According to Rogers and Everett [56], diffusion is the procedure by which an innovation is communicated through networks over time among the members of a system. Sharma and Mishra [57] argue that technology adoption is a developed area of research in the information systems (IS) domain and cites Carr (1999) who defines technology adoption as the point of selecting technology for usage by a person, a network of people, or an organisation.

Dube and Gumbo [58] articulate the difference between innovation and technology which is often confused and cited Rogers (2003); Riesman (2006) who advance that technology is troubled with solving real-world societal problems to advance civilization. Innovation, on the other hand, entails the generation of new ideas and their development into new goods, methods, or services, resulting in economic development [59]. Innovation is not simply creativity, research and development, invention, bright thoughts, or expensive devices [60], but rather the advancement of new resources or new resource capacity that can generate wealth [61]. Lastly, it is a multifaceted, organisational-wide undertaking that requires a set of crosscutting practices and procedures to structure, establish, and encourage it [62].

Lawson and Samson [63] proposed a model of organisational innovation capability comprising seven fundamentals as depicted in Figure 8: (a) Vision and strategy (b) Harnessing the competence-base (c) Organisational intelligence (d) Creativity and idea management (e) Organisational structures and systems (f) Culture and climate, and (g) Management of technology.

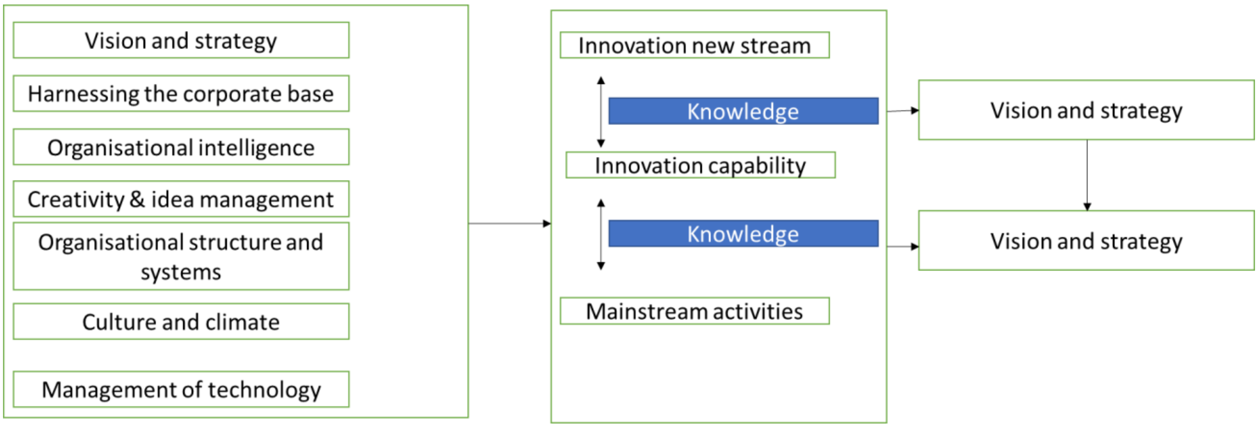


Figure 8: A model of innovation capability [62]

Lawson and Samson [63] further suggest that innovative organisations control the seven fundamentals to amalgamate and direct both their new stream and mainstream activities proficiently and efficiently. The innovation capability will affect the structure of new stream and mainstream activities resulting in an incessant artefact, method, and systems innovation. The sturdier the innovation capability established by an organisation, the more effectual will their innovation results be. Robinson [64] suggests that diffusion of innovation theory attempts to describe how people in a specific group adopt innovations and offers three insights into the process of change (a) Qualities and dynamics that ensure the successful spread of the innovation and (b) The significance of a peer-review mechanism (c) Comprehending needs of different user segments.

Rogers and Everett [56] investigate drivers that determine the rapidity of adoption of innovations and suggest the following four variables control the level of adoption. (a) Attributes of innovation are driven or inhibited by factors such as the relativity of the advantage of the innovation, compatibility of the innovation with current systems, the complexity of the innovation, trialability of the innovation, and observability of the outcomes. (b) Innovation decision is enabled or inhibited if the decision to adopt the innovation is voluntary, a shared decision or a compulsory decision through authority (c) the nature of social systems including a factor such as how connected the social systems are; and (d) Degree of change champions in advocating change.

Fonnesbeck [65] proposes that the efficacious commencement of innovation in an organisation involves two essential steps. First and foremost, the specific user must adopt the innovation, and secondly, the organisation must adopt the innovation through a diffusion process. Innovation is defined as a process by which an innovation is carried through networks over time among members of a particular social system [66]. Rogers and Everett [56] articulate stages that individuals use as they evaluate whether to adopt or reject the innovation. These stages are (a) Knowledge which is underpinned by characteristics of the decision by the individual which entails socio-economic, communication, personality, and behaviour as key drivers (b) Persuasion which is underpinned by characteristics of the innovation which comprises relative advantage, compatibility, complexity, trialability, and observability of the innovation (c) Decision which entail adoption or rejection (d) Implementation, and (e) Confirmation which entails continued adoption, later adoption, discontinuance, and continued rejection. This view is supported by Mahajan *et al.* [67], who propose that each innovation has exceptional features that enable or inhibit the diffusion process. These features are articulated below:

(a) Relative advantage is the extent to which an innovation is professed as being better than the idea it displaces, usually expressed as productivity, social stature, or other benefits. A high degree of relative advantage will result in a steeper S-curve. Prestige inspirations for adoption appear to be more imperative for those in the early stages of adoption and less significant for laggards. Relative advantage is one of the finest forecasters of an innovation's rate of adoption.

(b) Compatibility as viewed by memberships of society is directly related to the rate of adoption and influences the way clients behave towards innovations. If the behaviour correlates with the behaviour of potential adopters in the context of current products already in use, then acceptance is probable, and the shape of the S-curve is expected to be steeper. High adoption is expected with higher compatibility, whereas innovations that require bundling or other expensive purchases are sluggish to diffuse.

(c) Complexity is the level to which an innovation is viewed as comparatively hard to comprehend and use. In general, there is an inverse relationship between complexity and the rate of adoption; straightforward innovations diffuse quicker than difficult ones.

(d) Trialability is the extent to which an innovation may be piloted. The trialability of innovation is directly proportional to the rate of adoption. Trialability is more significant to early adopters as they have no pattern to witness the innovation in use. The outcomes of adoption for early adopters "witness" for adopters and laggards who adopt the "wait and see" approach.

(e) Observability is the extent to which outcomes are noticeable to the user and others. Sometimes it can be difficult to spot the effect or outcome of the innovation. Observability is directly proportional to the rate of adoption. Some effects or outcomes are lengthier to observe, and users may probably lose interest due to longer periods to observe outcomes.

Mahajan *et al.* [67] further posit that those prospective adopters of innovation will not adopt innovations simultaneously, but based on the extent to which the probable adopter is relatively early in adopting the innovation. Adopters can be characterised into different adopter categories as categorised by [66] and [68] with % distribution on the S-Curve distribution. Innovators are the first to adopt innovation with a distribution of 2.5%, followed by early adopters with a distribution of 13.5%. Thereafter, the early majority appears on the S-curve with a 34% distribution. The late majority with a distribution of 34% follows and lastly, the laggards with a distribution of 16% conclude the curve. The distribution curve, as depicted above, is detailed below in Figure 9:

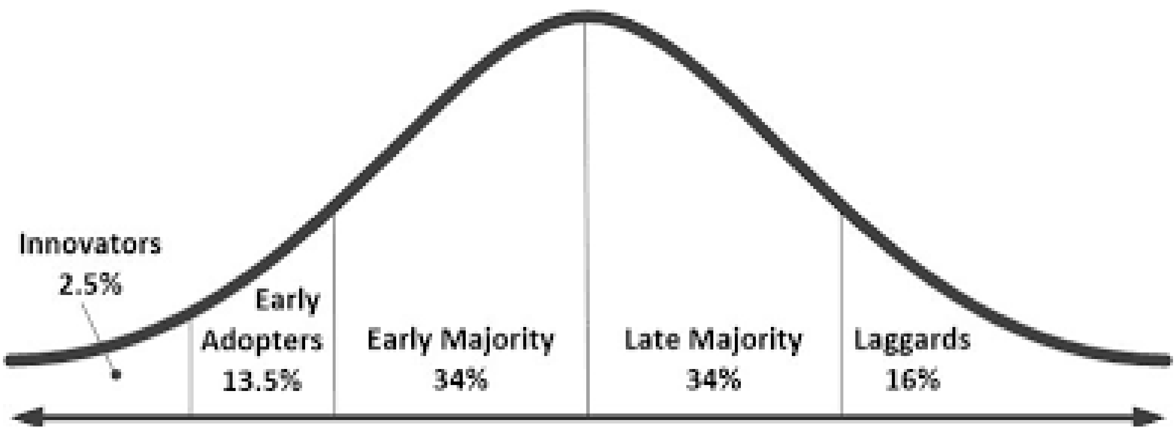


Figure 9: Innovation Adoption Curve [36]

This view is supported by Tornatzky, LG; Fleischer [4] citing Rogers (1962) who describes the behavioural characteristics of each adopter group as follows:

(a) Innovators are enthusiastic risk-takers and have the uppermost social standing, financial liquidity, proximity to scientific network communities, and members of the social community of innovators. Their risk tolerance permits them to adopt technologies that may eventually fail, but their financial resources aid to absorb these failures.
(b) Early adopters have the highest extent of thought leadership among the adopter categories. Early adopters have a higher social standing, financial liquidity, and cutting-edge education and are more socially advanced than late adopters. They are more judicious in adoption options than innovators.
(c) The early majority of adopters adopt new technology after a fluctuating degree of time which is pointedly lengthier than the innovators and early adopters. They possess above-average social standing, may have some form of contact with early adopters, and rarely hold positions of thought leadership in a system.
(d) The late majority of adopters adopt new technology after the average partaker. These personalities approach an innovation with a high level of scepticism and after most of the society has adopted the new technology. They typically have below-average social standing, have limited financial liquidity, and may be in contact with others in the late majority and early majority categories but have tiny thought leadership.
(e) Laggards adopt a new technology last. In contrast to some of the preceding categories, personalities in this category show little to no thought leadership. These personalities characteristically are change averse. They are inclined to be fixated on 'traditions and norms', have the lowest social standing and financial liquidity, are mostly the oldest among adopters and are inclined to interact with only immediate family and close-knit friends.

2.1.5 Technology Adoption Theory

Wentzel *et al.* [69] argue that the Theory of Reasoned Action (TRA) is the original concept that endeavoured to elucidate user adoption of technology. TRA describes user behaviour from a societal point of view, with the explicit goal of unearthing the roots of conscious behaviour. Mugo *et al.* [70] propose that the model (Technology Acceptance Model-TAM) was established from TRA as its basis but further polished.

Wentzel [71] argues that the foundation of TRA is that behaviour is projected by intention (I) and in addition, suggests that intentions are mutually enabled by two factors (a) Attitude (A) towards the behaviour which is a function of beliefs about the significances of this behaviour and (b) subjective norms (SN) defined as a person's view of whether stakeholders key to the person trust the behaviour, should be implemented. Attitude towards the behaviour is defined as the person's negative or positive viewpoint about implementing the behaviour. Ma and Liu [72] support the argument of Wentzel [71], by propositioning that TRA emphasizes that beliefs influence attitudes, which result in intentions and, therefore, provoke the behaviour. The TRA is graphically illustrated below in Figure 10:

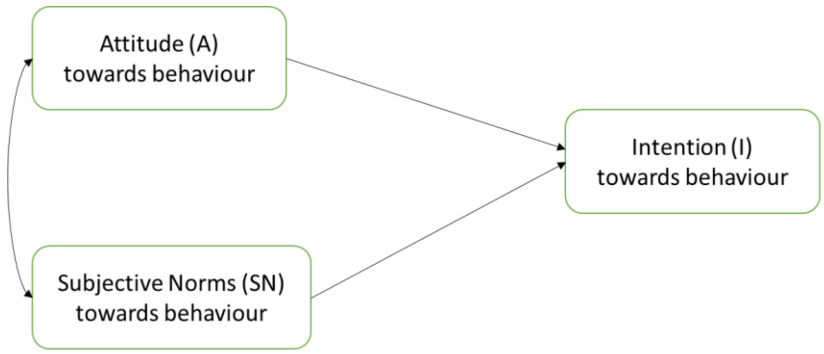


Figure 10: Theory of Reasonable Action [70]

Chuttur [73] states that Davids (1985) suggests that individual users of technology's motivation, to accept and adopt a technology could better be described by Perceived Usefulness (PU), Perceived Ease of Use (PEU), and attitude towards the system. The originator of TAM (Davids, 1985) proposes that the attitude of a user towards the system was the prime factor to determine if the individual user of technology will accept or reject the innovation, and that attitude is directly driven by (a) Perceived Usefulness (PU) and (b) Perceived Ease of Use (PEU); and concludes that apparent ease of use directly influences perceived usefulness. This is supported by Chuttur [72] who proposes that Davis (1989) presented the constructs in the original TAM (see Figure 11) as follows: Perceived usefulness (PU), perceived ease of use (PEOU), attitude, and behavioural intention to use (BIU). Among the constructs, PU and PEOU form end-users views on technology and consequently forecast users' attitudes towards the technology, which subsequently forecasts its acceptance.

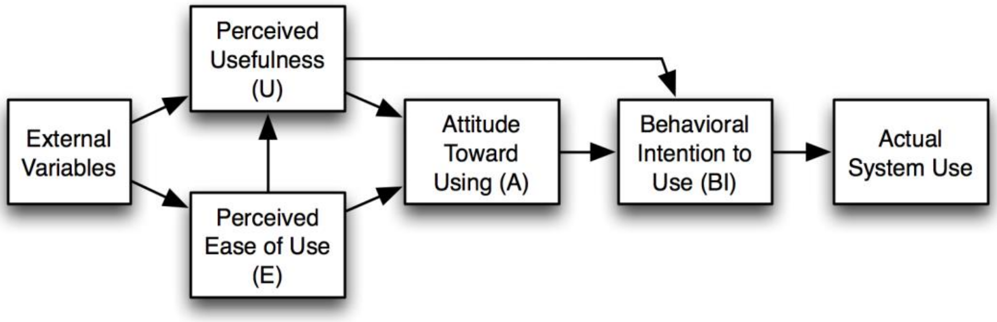


Figure 11: Technology Adoption Model [71]

Davids *et al.* [74] argue that although the TRA was designed to explain virtually any social behaviour, the TAM was intended to elucidate the causes of computer acceptance across a range of end-user computing applications and user populations. Wentzel [71] consequently argues that according to the TAM, actual system usage is directly influenced by behavioural intention (BI) to use. Consequently, BI is determined by the user's attitude toward using the system, while attitude is driven by the perceived usefulness (PU) and perceived ease of use (PEOU) of the system. Both PU and PEOU are influenced by external variables, such as user differences, situational limitations, organisational features, and system features. As the TAM grew past its original set, researchers recognised deficits in the model that demanded to be addressed. The consequence of the research that was steered was alterations to TAM. The modifications that ensued resulted in the introduction of novel variables and concepts [71]. Lai [75] proposes that Venkatesh and Davis (2000) projected TAM 2 as shown in Figure 12.

Wentzel [71] cites Venkatesh et al (2003) who advance that the foremost add-ons to the TAM that were introduced by TAM 2 were the addition of social influence processes (Subjective norm, voluntariness, and image) and cognitive instrument process (Job relevance, output quality and results in demonstrability).

This research work offered comprehensive insights into the reasons users found a given system useful at three points in time: (a) Pre-implementation, (b) 1-month post-implementation, and (3) 3-month post-implementation. TAM2 theorises that users' psychological assessment of the correlation between substantial goals at work and the after-effects of accomplishment of the task employing the system serves as a basis for forming perceptions regarding the usefulness of the system. The outcome of the research by Venkatesh and Davids (2000) discovered that TAM 2 performed well in both voluntary and mandatory environments.

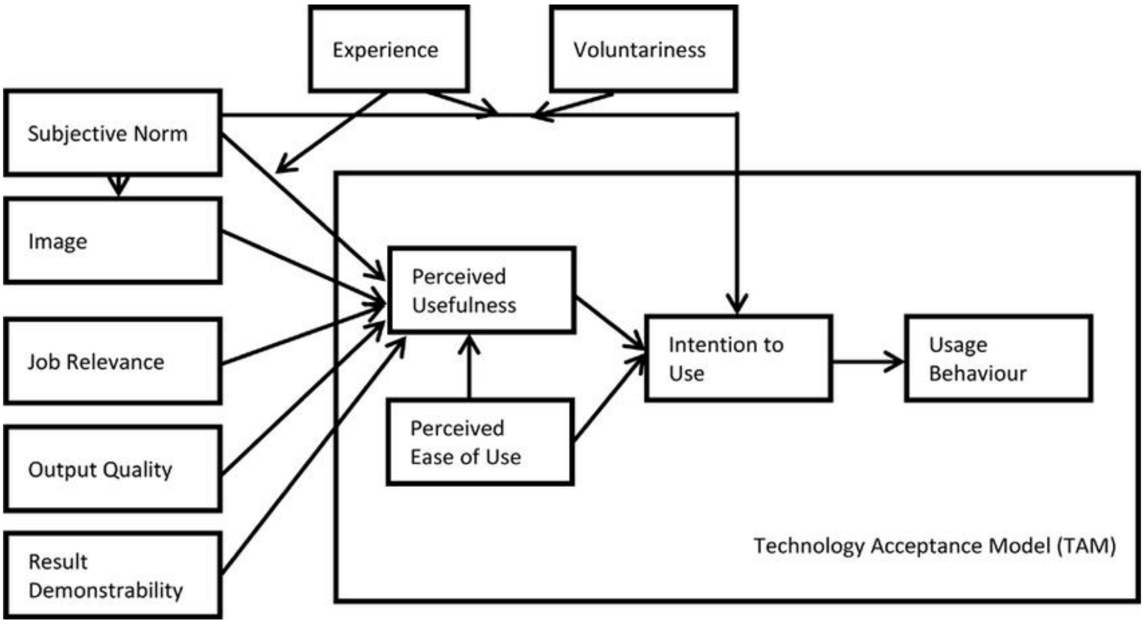


Figure 12: Technology Adoption Model 2 [75]

Wentzel [71] argues that the subsequent leading addition to TAM was the Unified Theory of Acceptance and Use of Technology (UTAUT). The author proposes that UTAUT was articulated, with four core determinants of intention and usage and up to four moderators of key relationships. The theory suggested that four key constructs play a significant part as direct determinants of user acceptance and usage behaviour: which are: (a) Performance expectancy (b) Effort expectancy (c) Social influence and (d) Facilitating conditions which encompass the gender, age, experience, and voluntariness were suggested to mediate the impact of the four key constructs on usage intention and behaviour. The UTAUT is presented in Figure 13.

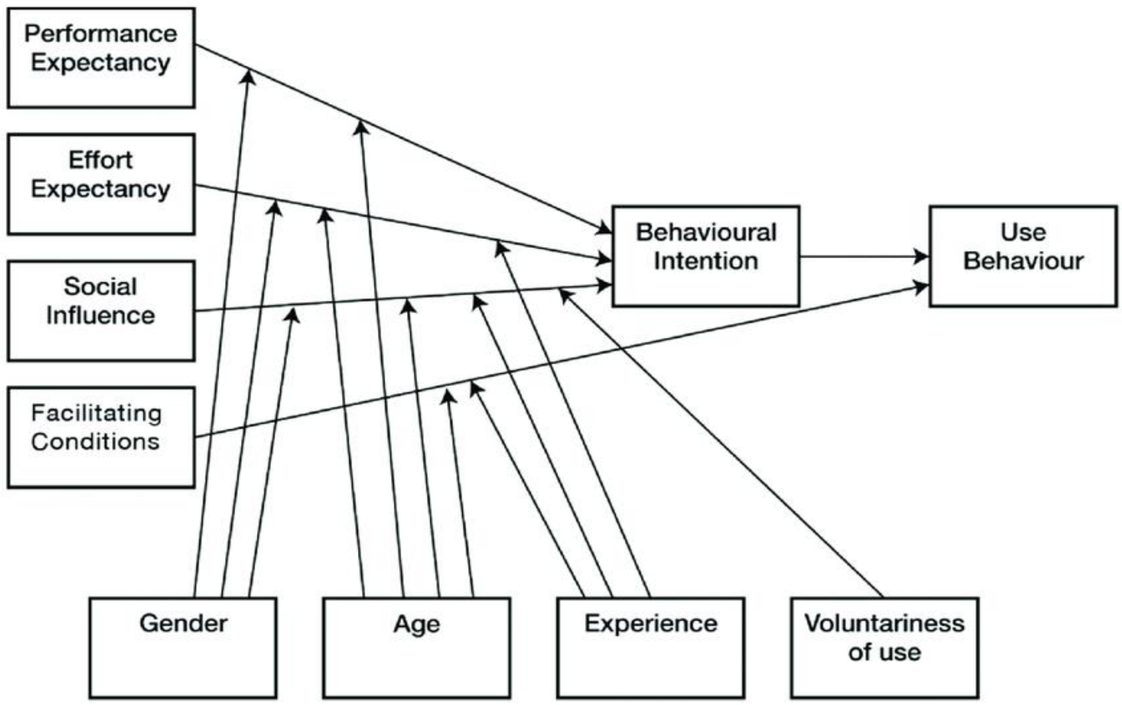


Figure 13: Unified Theory of Acceptance and Use of Technology [76]

Wentzel [71] hypothesises that UTAUT proposed that facilitating conditions with a high probability directly influence usage, while the other three constructs would directly influence Behavioural Intention (BI). The model defines facilitating conditions as the extent to which a person (user) trusts that organisational and technical infrastructure exists to support the proliferation of a system they are adopting [76]. The UTAUT further expanded the constructs in the original TAM through the comprehension of the crucial role that effort plays in implementing the new task.

Gangwar et al [77] argue that according to developers of the TOE (Technology-Organisation-Environment) framework, Tornatzky and Fleischer (1990) state that three types of sceneries may impact the technological innovation adoption and implementation process. TOE is grounded on three dimensions which are technological, organisational, and environmental. Oliveira and Martins [78] argue that the technological dimension defines the internal and external technologies suitable to the firm while the organisational dimension refers to expressive measures about the organisational scope, size, and structure. Lastly, the environmental dimension is the ground on which an organisation conducts its business. The three contexts/dimensions are depicted in Figure 14.

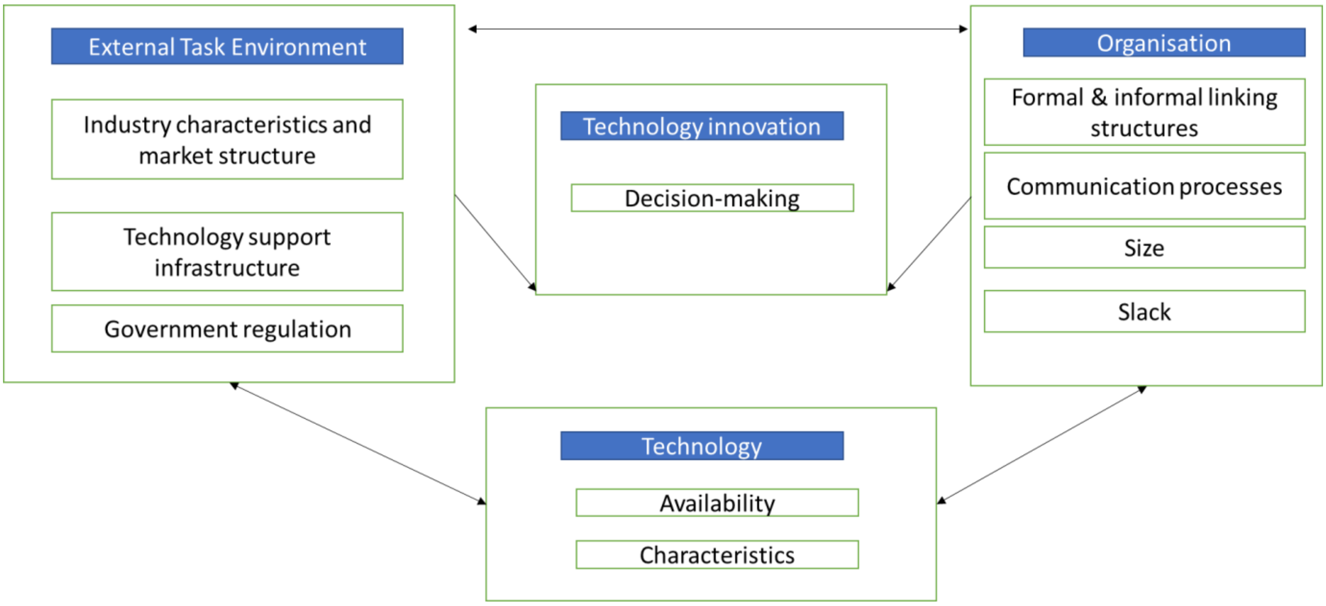


Figure 14: Technology, Organisation, and Environment Framework [80]

Dasgupta and Wendler [79] postulate that the TOE model outlines the drivers for technological adoption, concentrating on external pressures (e.g., market forces and governmental regulatory requirements), organisational structures, and technological availability. In addition, the BOE model was initially conceptualised to comprehend the adoption of EDI (Electronic Data Interchange) technology but has progressed to be applied as a general technology adoption model. The BOE model encompasses three factors: External pressure, organisational readiness, and perceived benefits. Dasgupta and Wendler [79] advance that BOE integrates the organisation and technology context of TOE into organisational readiness and enhances a perceived benefit dimension which provides an excellent logic to the adoption of the technology process. The BOE model is illustrated in Figure 15.

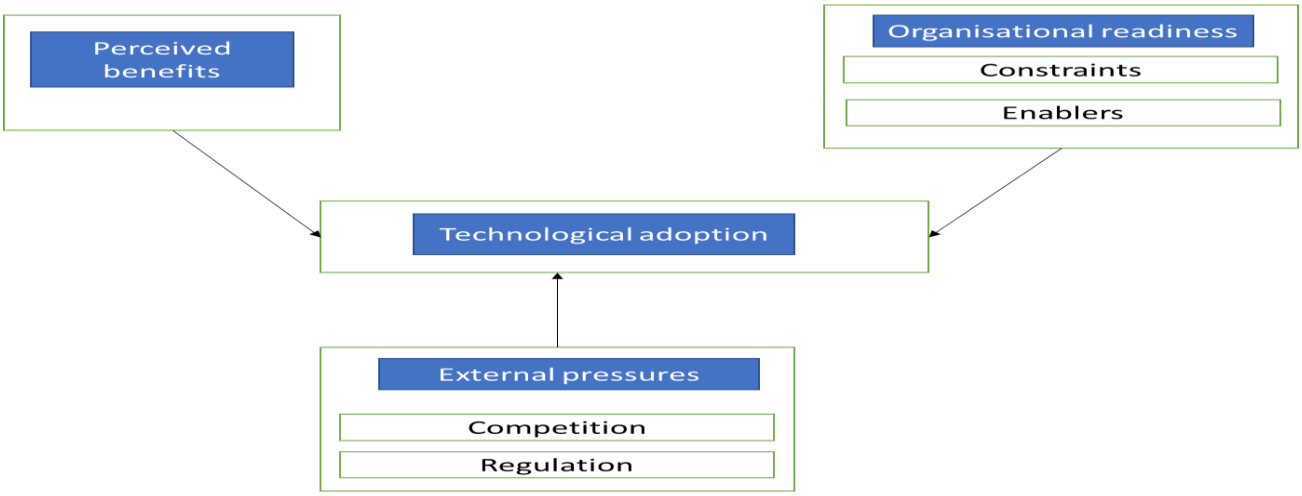


Figure 15: BOE Model [81]

Kuehne et al. [55] argue that the Adoption and Diffusion Outcome Prediction Tool (ADOPT) was conceptualised as a means to appreciate the socio-economic enablers and inhibitors that influence the adoption of agricultural innovations [55]. ADOPT focuses on factors that have been shown to influence the rate and/or peak level of adoption within a population. These are (a) the characteristics of the innovation, (b) the characteristics of the population, (c) the actual relative advantage of using the innovation, and (d) the learning of the actual relative advantage of the technology [80]. The variables of the conceptual framework can be separated into two categories: those that relate to the characteristics of the target population and those that relate to the characteristics of the practice [55]. These factors are presented in Figure 16.

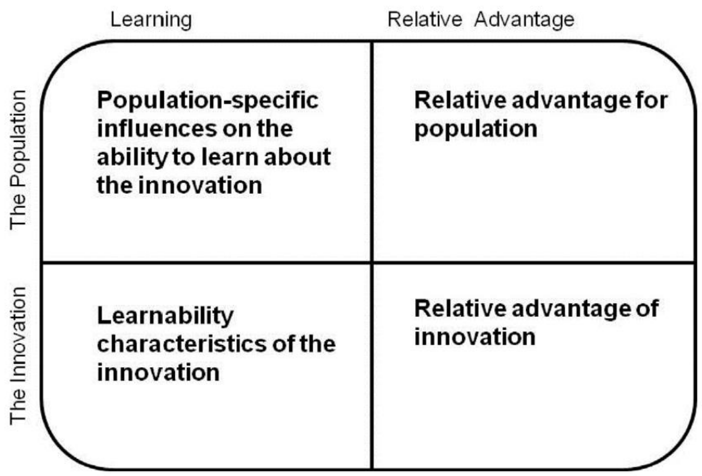


Figure 16: Conceptual characterisation of factors included in ADOPT model [54]

2.2 Technology Adoption and Innovation Diffusion Drivers and Barriers in Organisations

Caniels *et al.* [81] argue that the influencing factors listed in Table 2 are impediments to innovation which are monetary reasons, organisational support structures and motivations, human orientation, uncertainty and competition, consumer orientation, and government backing. These factors are fundamental in influencing innovation adoption by organisations.

Table 2: Influencing factors affecting innovation adoption [83]

Influencing factor	Explanation
Monetary reasons	The high capital investments required for research and development and the deficiency of financing sources are significant barriers to innovation.
Organisational support structures and motivation	Leadership motivation has a positive influence on innovation.
Human capital orientation	The mindset of human capital can inhibit or enable innovation.
Uncertainty and competition	Both uncertainty and competition are largely recognised to be significant drivers of innovation.

	The lack of uncertainty and competition can ease a company's impulse to innovate.
Consumer orientation	New consumer demands and pressures have a positive influence on organisations to innovate to remain customer-centric.
Government backing	Government backing through laws, policies and funding mechanisms can foster innovation.
Organisational culture	The dominant culture is difficult to overcome, it requires time, buy-in, and a shared vision to change a culture.
Operational excellence	Innovation and operational excellence are the main ingredients to build an organisation's competitive advantage.

The research report by UPU [82] identified numerous organisational and psychological factors that drive or hinder the adoption of technology and managerial approaches in the postal sector and are listed below:

(a) Innovation attitude: The extent to which an organisation is upbeat or impervious to change impacts implicitly on the probability of the members of the organisation prosperously adopting novel processes.

(b) Age and stage: The extent to which an organisation has a progressive mindset, and the period in business contribute to a decision pertinent role in whether the organisation is open to critique the effectiveness of their technology and management processes.

(c) Business focus: The extent to which the organisation is cognisant of outward competition, and whether they are concerned with profitability or other ideals, forms its candidness to integrate innovative processes to be up to date with industry advances.

(d) People: Organisations are inclined to be more open to increasing output and efficacy when the key decision-makers had been in their roles for shorter durations. It was observed that employees with opportunities for professional and personal development are inclined to be innovative.

(e) Processes and capabilities: The fundamental knowledge base and technical capabilities within an organisation are powerful ingredients of an innovative organisation.

On the one hand, these factors are pervasive in the postal sector and play a significant role in hindering or driving the adoption of technology in the sector. On the other hand, Toura *et al.* [83] identified barriers to Information and Communications Technologies (ICT) in their research and synthesized these barriers (depicted in Table 3), employing the non-hierarchical axial coding technique to characterise inhibitors into eight classes characterised as critical success factors and depicted in Table 3 below.

Table 3: ICT Barriers [85]

Common ICT Barriers		**Overlooked ICT Barriers**
Deficiency or insufficient fixed telephone lines	Inadequate use or non-existing universal	Deficiency of Internet exchange points (IXPs)
Malfeasance	Deficiency in research and development	Controlling managers
Poor investment	Instability in the political	Imperceptible hands
Uncertainty	Deficiency in language	
Poor income	Poor appropriate local content	
Deficiency of software and hardware	Intricate technology	
Poor political will	Poor access	
Domination of markets	Inadequate sustainable Networks	
Poor cultural knowledge or limitations in cultural	Poor Internet bandwidth	
Outdated technologies	Undependable	
high cost	Poor electricity supply	
Poor returns on investment	Perceived lack of	
high risk for investment	Poor maintenance	
Needless bureaucratic processes	Lack of upfront planning	
Change adverse	Absence of incentives	

Unsuitable technologies	Meagre network	
Insufficient regulation	Deficiency in ICT skills	
Inappropriate tax regimes	Fear of technological	
Poor regional initiatives	Unacceptable illiteracy	
Deficiencies in the legal framework	Shortage of technical workforce	

Toura *et al.* [83] further propose that for contextual clarity, a brief elucidation of the eight critical success factors is provided below and is further depicted in Table 4:

- Political and Leadership (PL): Many developing countries do not have ICT policies to direct the delivery and use of ICTs. The role of government and good inspirational leadership is imperative in this process.

- Socio-Cultural (SC): **T**his includes linguistic inhibitors, social attitudes towards ICTs, and the shortage of home-grown ICT content, predominantly in developing countries. These factors enormously limit access to ICT services in developing countries.

- Infrastructural (IF): The triumph of ICT significantly depends on respectable infrastructure that enables the availability and accessibility of ICTs. Accessibility denotes the existence of infrastructure that provides ICT services while accessibility denotes the liberty to use such services with the tiniest or without restrictions.

- Technical (TN): This denotes the types of barricades that obstruct the even conveyance or enactment of ICTs. It fundamentally denotes the technological confines related to ICTs which include substandard network reception, sluggish Internet connection, system integration glitches, etc. Technical limitations differ from infrastructural limitations because the latter does not involve the technological confines of ICTs. Instead, they concentrate on the availability and accessibility of ICTs. Technical barriers mostly encompass technology-related barriers.

- Educational and Skills (ES): This refers to the human capacity to grasp, apply and manage ICTs. It encompasses topics such as illiteracy, poor ICT skills, and meagre educational systems in developing countries.

- Economical (EC): This denotes the financial facets associated with ICTs. It entails the financial ability of ICT users, service providers, and stockholders to accommodate ICTs in terms of per capita income. It principally represents the cost factors of ICTs which can be summarised as the cost of ICT infrastructure.

- Security and Safety (SS): This denotes the ambiguity related to the use of ICTs. It includes the settings of safety, the ability to use ICT and the liberty from the perils that ICTs pose to society at large.

- Legal and Regulatory (LR): ICT, particularly in developing countries is frequently obstructed by legal and regulatory frameworks in place. The legal and regulatory framework governing ICT in these countries is mainly reactive. It principally deters persons from using ICTs and discourages possible ICT service providers. Regulators in some developing countries are mostly weak, reliant on, and frequently part of a system in which the bequest operator "captures" the regulatory and political process.

Horváth and Szabó [84], on one hand, propose several factors that could promote or inhibit the implementation of I4.0 in organisations. These factors with associated drivers and barriers are enlisted in Table 5. These factors are (a) Human capital (b) Economic resources and profitability (c) Market competition and competitors (d) Management expectations (e) Management reality (f) Productivity and efficiency (g) Organisational factors and lastly, and (h) Technological and process integration cooperation. Netheler *et al.* [85] on the other hand propose that (a) Process improvement (b) Workplace improvement (c) Vertical integration (d) Horizontal integration (e) Management support (f) Cost reduction (g) Client demands (h) Supply chain (i) Innovation push (j) Marketplace pressure (k) Government and laws, and lastly (l) Employee support are the main drivers of firms adopting industry

4.0 technologies. These drivers and their associated brief descriptions are alluded to in Table 6 and delve into ICT drivers in organisations.

Table 4: Barriers Grouped into Critical Success Factors [85]

Political & Leadership	Technical	Socio-Cultural	Economical	Security & Safety	Legal & Regulato	Infrastructural	Educational & Skills
Malfeasance	Outdated technologies	Lack of cultural knowledge or	Low income	Privacy concerns	Poor legal	Lack of fixed telephone lines	Insufficiency of technical workforce
Poor or no political will	Inappropriate technologies	Resistance to change	Poor investment	Insecurity	Poor regulatory framework	Poor software and hardware	Unacceptable illiteracy rates
Needless red-tape	Intricate technology	Fear of technology	Poor returns on investment			Poor access	Inadequate ICT skills
High taxes	Poor internet bandwidth	Lack of relevant local content	High expenditure			Electricity supply challenges	Inadequate Research and development outputs
Poor regional integration	Undependable Internet connection	Poor maintenance culture	Inadequate use of universal			Inadequate Internet exchange points	
Political volatility	Poor network reception	Poor language skills	Inadequate sustainability				
Lack of upfront planning			Poor incentives				

Market domination			Risky investments				
Imperceptible hands							
Micromanaging							

Table 5: Driving forces and barriers of Industry 4.0 [86]

Driving force	Factor	Barrier
• Growing workforce shortages • Dropping human labour • Redirecting labour to other areas (higher added value)	**Human capital**	• Lack of suitable capabilities and capable workforce • Lengthier learning times (Development of staff)
• Dropping costs e.g., human capital, and operational costs	**Economic resources and profitability**	• Deficiency of economic resources. • Yields and productivity. • Limitations in tendering processes. • Lengthier adjudication period for tenders.

• Marketplace competition • Marketplace trends • Competition pressure • Innovation of business models	**Marketplace competition and competitors**	**Management reality**	• Poor leadership • Lack of upfront planning
• Centralisation of power by management	**Management expectations**		
• Mistake proofing • Improving productivity • Ensuring dependable operation	**Productivity and efficiency**	**Organisational factors**	• Inflexible organisational structures • Silo mentality and lack of common vision in organisations • Resistance to change
		Technological and process integration, cooperation	• Poor common-purpose communication protocol • Lack of system integration • Poor cooperation in the supply chain • Poor standardisation • Divergent thinking • Insecure data storage systems • Requirement for big data storage

Table 6: ICT drivers [87]

Driver	Explanation
Process Improvement	Self-organising systems plan, control, and execute production. Professed rewards of self-organising systems are the augmentation of effectiveness as well as error reduction. Predictive maintenance remains a key innovation in this area.
Workplace Improvement	The goal is to improve the well-being, comfort design, and practicality of the workplace. Intricate or risky actions are performed by robots.
Vertical Integration	Data are gathered right at the operational level by sensors and managed for amalgamation at the managerial level. Feedback information is sent back through the operational structure to the manufacturing systems. The planning on the manufacturing level can be more precise with the prospect to manufacture various products in smaller batches.
Management Support	It entails the devising of visions and strategies. It is a significant feature of Management Support to formulate structures, allocate tasks, and hire employees.
Horizontal Integration	Denotes the amalgamation of the several IT systems employed in the various steps of the production processes that include an interaction of materials, energy, and information both within the organisation.
Cost Reduction	Digital transformation advances manufacturing processes and aids to reduce setup times and failures, leading to cost reductions.
Customer Demands	The tracing of goods through the business value chain is inherent in the quality assurance required by the client.
Supply Chain	The common scheduling of operations with stakeholders (suppliers, manufacturers, and clients) stresses the need for digital technologies to streamline and synchronise the supply chain processes.
Innovation Push	Innovative technologies lead to a push of these innovations into the marketplace. Innovations enable the digitalisation and competitiveness of an organisation.
Market Pressure	Digital technologies are the gold standard for organisations to maintain a competitive edge over their competitors, market pressure forces organisations to stay abreast with technology and leverage technology to

	provide value and remain competitive.
Laws/Government	Laws and regulations can drive or impede the use of digital technologies.
Employee Support	Digital systems aid personnel in the accomplishment of their work. Work is seen as interesting, safe, and streamlined. Consequently, digitisation advances with the support of the workforce, their familiarity, and their predisposition to use innovations.

Almeida *et al.* [86] propose that three drivers determine the adoption and diffusion of technology in organisations and identify these specific drivers as (a) Technical in which the crux is interoperability of new technology with existing technologies including business processes (b) Social in which the core is cultural dimensions including attitudes of both individuals and organisation at large (c) Organisational in which the crux is organisational leadership posture of the leaders. These determinants are depicted in Table 7.

Table 7: Factors that influence innovation diffusion or adoption [88]

Driver	**Descriptions and references**
Technical	Proof of concept, cost of the innovation, interoperability with existing technology; technology fits with current organisational processes and the extent to which the technology can be piloted.
Social	IT knowledge and general capabilities of users, the extent to which the technology enables inter-professional collaboration, and continuing participation of key participants from conceptual design to implementation.
Organisational	Organisational leadership; backing of boundary crossing and lessening of the gaps between technology, UPI operators, managers, and practitioners.

2.2.1 Technology Adoption and Digital Transformation Barriers and Drivers in the Postal Sector

UPU [4] argues that as society adopts the use of digital technologies at an exponential rate, clients are progressively expected to interrelate directly with the Post through digital channels. Subsequently, 73% of Posts have augmented their investment in digital postal services. Consequently, it is expected that the postal landscape will develop in several directions. UPU [4] further proposes that Posts are consequently at a crossroads; Posts are required to adjust to remain relevant and gear up to compete with digitally native organisations in various markets. To contest the market efficiently, Posts need to accelerate the digitalisation of their processes, products, and services. This means that DPOs that have not fully transformed their organisations from the perspective of digitalisation require to act with a sense of urgency or face the prospect of exclusion as providers of e-government, e-commerce, and e-financial services.

USPS [87] argues that the upsurge of digital technology over the past three decades has offered the DPOs a mixed bag of both threats and opportunities. Digital innovation by Posts in industrialised nations was prompted by the mail decline instigated by substitution, a requirement for cost efficiency, and a requirement to improve the quality of service. It has also offered prospects to streamline the postal business operating model to ensure sustainability and diversification to create new revenue sources. Figure 17 depicts the waves of digital innovation that the postal sector has undergone. Further, Table 8 defines the different waves (a) Postal automation (b) Revenue-generating services (c) Digital to enhance core, and lastly (d) Digital transformation.

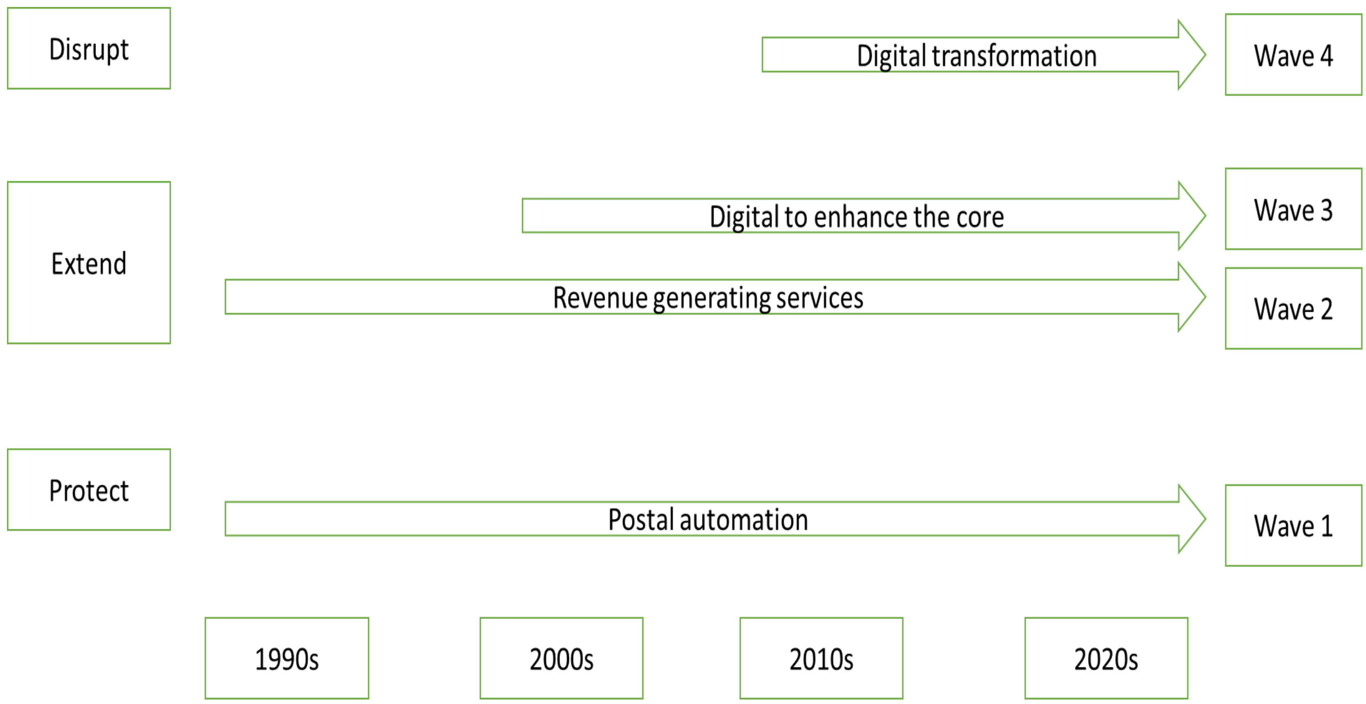


Figure 17: The Four Waves of Digital Innovation in the Global Postal Sector [89]

Table 8: Digital waves and associated explanations [90]

Wave	Explanation of digital wave
Wave 1: Postal automation	In the 1990s during the booming mail volumes, the digital efforts of Posts were largely fixated on streamlining and automating mail centres. Track and trace, then an innovative technology, was initially introduced for high-end express items and then extended through big initiatives such as the intelligent mail barcode. Additionally, machines that sort standard letters and non-standard letters together into "postman walks" sequences have been fitted in mail centres.
Wave 2: Revenue-generating services	Most DPOs expected to substitute lost mail revenue with an income stream from digital services. DPOs expected to manage electronic communications and transactions between governments, organisations, and citizens. DPOs expected to accomplish that role due to their physical proximity to citizens and government, as well as their reputation for confidence, dependability, and safety. A few Posts have attained that vision.
Wave 3 – Digital to enhance the core	As broadband penetration and Internet use amplified in the early 2000s, the efforts to digitalise the postal value chain intensified. The goal was to enable customer access to the DPOs and develop novel services at the juncture of physical and cyber mediums.
Wave 4 – Digital transformation	Digital transformation denotes updates in technology, progressions, culture, and operating models. For example, connectivity, cloud, and data analytics can permit rapid innovation, more informed data-driven decisions, and quicker execution.

UPU [2] proposes that integrated networks are crucial to providing digital services and addresses three foremost challenges (a) Accessibility (b) Affordability and (c) Eligibility; ITU [88] notes that only 55% of global households have internet access as depicted in Figure 18 while Africa as a continent stood at 22% which is the lowest as depicted in Figure 19. ITU [88] further suggests that only 15% of families in the least Developed Countries (LDCs) have access to the internet at home. UPU [4] contends that in many of these nations, many users access the Internet from the workplace, public schools, colleges and universities, or other communal public networks outside the home; and proposes that it is an area in that DPOs could play a significant role, due to its geographic reach in all touch-points of countries including the rural areas which are often neglected. This role by DPOS will enable the integration of citizens with services of e-government, e-commerce, and e-finance.

UPU [4] suggests that drivers of digital innovation and digital inclusivity are (a) The network (b) Employees (c) Laws and regulations (d) Financial capacity (e) Political commitment and public trust in the Post (f) National policy alignment. These six drivers are further elucidated in Table 9.

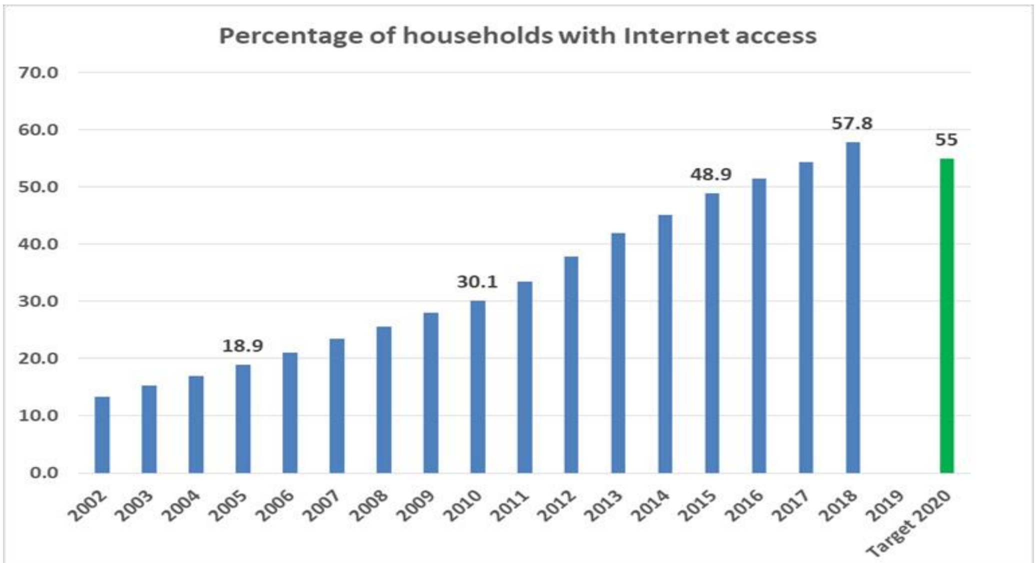


Figure 18: Percentage of households with internet access (globally) [91]

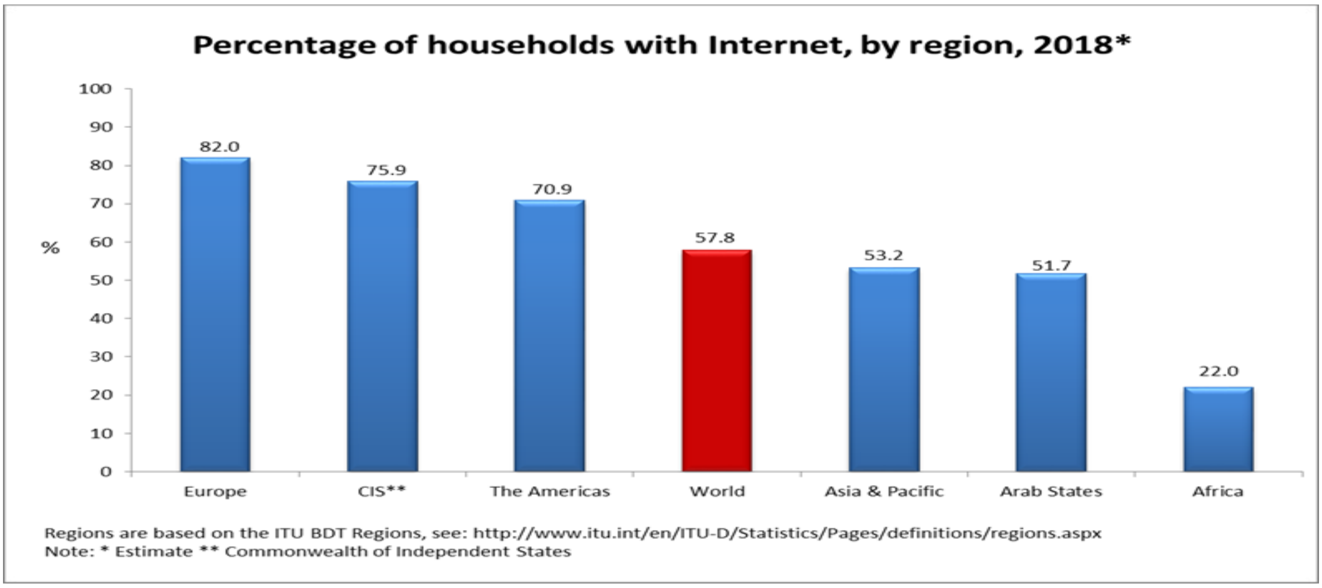


Figure 19: Percentage of households with internet access (By Region) [91]

Table 9: Drivers for digital adoption and diffusion in the postal sector [4]

Driver	**Components of driver**	**Explanation**
The network	Capillarity	• DPOs collectively hold one of the largest physical networks in the world with over six hundred and 50 thousand retail branches. The DPOs have the potential to offer a variety of products and services to communities and organisations.
	Connectivity	• To leverage its vast network, DPOs must be interconnected through the electronic network. Sustaining this kind of electronic network is most challenging in rural areas, where power and Internet connectivity are not reliable.
	Network	• DPOs are an appropriate service provider for

	flexibility	clients, due to DPOs' enormous network, including a geographic presence in rural areas. To be more attractive to clients, DPOs need to adjust to their client's requirements.
Staff		• DPOs are collectively employing an estimated workforce of 5.32 million. Employees are undisputedly the most valued assets for the prosperity of any organisation. • DPO employees need to be well-educated in digital services to engage with real-time data and information within themselves and with other DPOs because of the postal ecosystem.
Legal and regulatory framework		• Laws and regulations are important to DPOs as they determine if the DPOs can offer e-government, e-commerce, and e-finance services. Within the technological advancement of the last ten years, innovative technologies, new companies, and novel digital models are swiftly coming of age. • To support digital transformation in the postal sector, ICT policy and regulatory frameworks must be agile, market-driven, and incentive-based.
Financial capacity		• If a DPO is profitable, it can invest in the upgrading of its infrastructure to improve its network capabilities (size, density, and connectivity). Additionally, DPOs could attract trained personnel and are in a better position to retain them, as they have the resources of offering good working conditions.
Political commitment and public trust in the Post		• DPOs are currently double-bottom-line establishments, meaning that they must reach the corresponding objectives of profitability and social impact. DPOs cannot meet these objectives without the backing of the government.

	• DPOs can play a significant role in contributing towards sustainable development goals (SDGs) due to the socio-economic role DPOs have played in the last 100 years.
National policy alignment	• Governments leverage the potential of ICTs through clear policies meticulously allied with the wider national policies intended to deliver the SDGs. • Leveraging the full potential of ICTs similarly demands suitable infrastructure for interoperability and digital transactions across the public sector, reliant on mutual standards, data sharing, and a highly capable workforce, as well as comprehensive organisational capacity.

UPU [89] highlights the top five obstacles to movement into digital Posts by region and for purposes of this study, only the tier-1 DPOs (Industrialised countries) and Africa are considered.

Table 10: Barriers to digital adoption and diffusion in the postal sector [92]

Geographic area	**Barriers**
Globally	Resource limitations
	The shift toward a digital culture
	Restrictions on IT capabilities
	Deficiency of adequate inner proficiency required to develop e-services
	Customs clearance is a significant barrier
Industrialised countries	The time it takes to shift towards a digital culture
	Overall client adoption of digital postal services is sluggish
Africa	Limited financial resources
	Poor IT infrastructure

	Lack of digital culture
	Deficiency of the specialists required to develop e-services
	Overall client adoption of digital postal services is sluggish

Africa is confronted with an overabundance of trials as depicted in Table 10. Southern Africa as a microcosm of Africa is confronted by similar challenges. This view is supported by SADC [8] which suggests that inadequate internet connectivity and inadequate investment or recapitalization of the network infrastructure, poor service quality, inadequate interoperability and connectivity among business stakeholders' systems and vagueness in postal sector definition in Southern Africa, are recognised as foremost explanations for the little progress of the region in adopting new technologies of the 21st century.

UPU [89] advances that the best-ranked DPO in the context of digital readiness is the DPO that has attained a normalised score of 1, while the poor performer acquired a normalised minimum score of zero. All normalised scores can be understood as the distance of any given DPO regarding the best (score of 1), the intermediate (score above 0.5), or the worst (Score of zero scores). Table 11 embodies the postal digital readiness of the industrialised countries with Switzerland leading with a full score of one while Table 12 portrays Southern Africa as a region. South Africa leads with a score of 0.46 which is just below the intermediate score of 0.5 while the worst-performing countries are Madagascar and the Democratic Republic of Congo which are both at 0.05. The distance between the worst performer and the best performer stands at an enormous gap of 0.95. Southern Africa is faced with mammoth challenges to realising the transition from the physical to the digital provision of goods and services.

Table 11: Digital readiness score of Industrialised countries [92]

Country	**Normalised score 2020**
France	0.81
Germany	0.81
Japan	-
Netherlands	0.62

Switzerland	1.00

Table 12: Digital readiness score of Southern African countries [92]

Country	Normalised score 2020
Angola	-
Botswana	0.32
Comoros	0.14
Democratic Republic of Congo	0.05
Eswatini	-
Lesotho	0.19
Madagascar	0.05
Malawi	0.08
Mauritius	-
Mozambique	0.11
Namibia	0.27
Seychelles	-
South Africa	0.46
Tanzania (Republic)	0.22
Zambia	-
Zimbabwe	0.14

UPU [43] proposes that there are four fundamental critical success factors for Posts to advance digitalisation which are (a) Complementing the DPOs with innovative digital services to expand their competitive advantage in terms of network size and density, (b) Access to finance for digital initiatives, (c) Partnerships, and (d) Alignment with national government's digital strategies.

The literature points out that the adoption of technology by organisations and DPOs is an intricate non-linear phenomenon with a variety of enablers and inhibitors. Adoption and diffusion enablers and inhibitors reveal that dynamics interact in a complex and dynamic setting, which demands a holistic approach to managing the complex nature of adoption and diffusion enablers and inhibitors that encompasses an examination of interactions between adoption and diffusion barriers and drivers, as well as management of the causal relationship between the drivers and barriers of adoption and diffusion of technology/digitalisation.

2.3 From Reductionism to Systems Thinking

2.3.1 Reductionist Thinking Approach

Rafferty [90] proposes that reductionism is understood to be the orthodox way of handling problem-solving. Reductionism takes many names such as ‘step-wise refinement’, ‘disaggregation’ and simply ‘decomposition of the problem into parts. It should be noted that reductionism tends to denote comprehension or grasp rather than problem-solving but the latter appears more fitting in this case. Reductionism as the opposite of holism and systems thinking is consistent with the understanding that all objects or systems are reducible to lower levels in the order of their composition [91]. This view is supported by Mella [92] who contends that according to reductionist thinking “The total can be fragmented down into its parts and put back together from its parts. Parts are associated through a simple cause-effect relationship; Thus, its core characteristics exist in its parts.” However, there are confines to a reductionist thinking method because systems most often disobey the reductionist breakdown. After all, by focusing on the system’s parts, investigators cannot see the tree instead of the forest, which often took on a form that was not detectible from the reunited parts. This view assumes that for a system to perform efficiently and proficiently, its components (parts) should perform efficiently and proficiently.

Conversely, systems are intricate and as a result, the interface of the parts in a dynamic setting unvaryingly affects the performance of the whole system. Therefore, the adoption of digital technology and digital transformation must focus on the dynamic setting (interaction) of inhibitors and enablers instead of their distinct, individual actions. A system is an interrelated set of fundamental elements that are logically systematised in a way that achieves a purpose [93]. In another vein, [94] proposes that a system is an amalgamation of cooperating essential elements pre-arranged to attain one or more stated goals.

Strachan [95] proposes that there are key contrasts in the behaviours of reductionist thinkers and systems thinkers; these differences are captured in Table 13. Since organisations are multifaceted due to numerous interrelating dynamics and forces, it is plausible to propose that the postal sector in Southern Africa lags in its quest to be sustainable through the adoption of digital transformation and its associated digital technologies due to its reductionist thinking approach rather than a system's thinking approach.

Table 13: Habits of the Systems Thinker vs. Reductionist Thinker [98]

Reductionist thinker	**System thinker**
Decomposes the problem to its smallest elements to enable the deployment of vertical thinking analytical tools to solve the problem.	Pursues to comprehend the big picture
Reflects only the combination of elements in a system instead of their interconnections and patterns. Solutions at the event level tend to be temporary.	Perceives in what way essential elements within a system vary over time, engendering patterns and trends
Does not attach the behaviour of the system to the interrelation of the system.	Comprehends that a system's structure engenders behaviour
Inclines to accomplish the first one or two cause-and-effect connections.	Recognises the spherical nature of intricate cause-and-effect relationships
Inclines to base conclusions on mental models formed separately based on the separate belief system and earlier experiences.	Contemplates how mental models affect present reality and the future
Aims for speediness and rapid results at the expense of a maintainable solution.	Contemplates a topic completely and resists the impulse to conclude hurriedly
Does not fully understand that systemic interventions take a long time to yield results.	Comprehends the vital role of time delays when exploring the cause and effects of relationships
Contemplates mostly the short-term consequences of the action.	Contemplates both short and long-term consequences of actions

Infrequently considers the likely unintended consequences of their actions.	Discovers where unintended consequences emerge
Considers parts and partial features only.	The complete, overall picture
Independence.	Interdependency(s), Relation(s), Interconnectedness
No reciprocated influences.	Networking, relations, the interaction
A sole vantage point/ single perspective.	Multiple perspectives
No qualities arise from the interplay of parts and the relation between parts and the environment.	Emergence/Synergy

2.3.2 Event-Oriented Approach

Sterman [96] and Morecroft [97] propose that an event-oriented perspective is rational, action-oriented, appealingly simple, and often interconnected. Figure 20 depicts this mindset in an abstract. Morecroft [97] contends that this event-oriented mindset echoes a belief that problems are asymmetrical, stemming from many events in the outside world and that life is random. Morecroft [97] further reasons that this mindset has a belief that events "come from nowhere" or at least there is no time to agonise about their origins; what is imperative is to fix the problem as soon as possible. This form of thinking is linear, whereby problems are events and solutions are fixes.

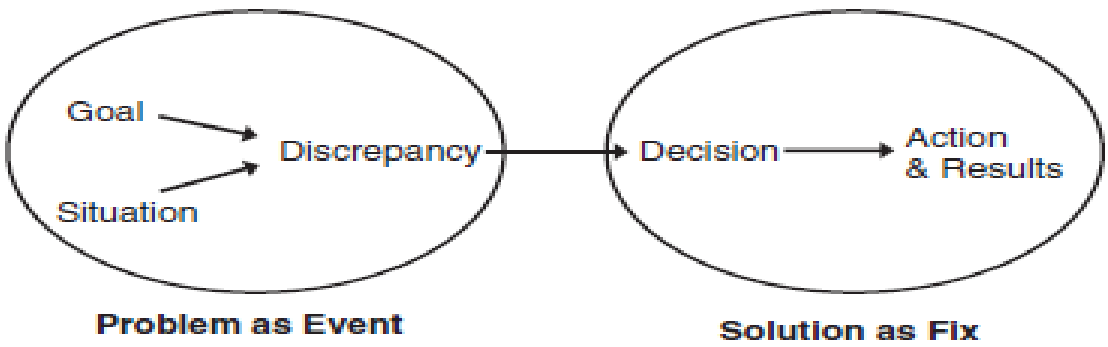


Figure 20: Event-oriented worldview [101]

2.3.3 System Thinking Approach

Morecroft [97] notes that in his persuasive book The Fifth Discipline, Senge (1990) suggests that feedback systems thinking is a "shift of mind', a novel mode of comprehending the business and social world, and a kind of remedy to silo mentality malady and narrow functional viewpoints often nurtured (unintentionally) by establishments and by our propensity to the decomposition of problems for analysis. He argues that problems and solutions are observed as intertwined, as depicted in Figure 21.

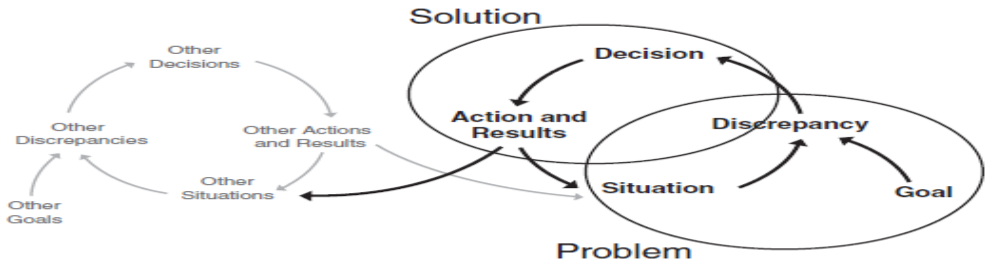


Figure 21: A shift of mind: A feedback perspective [101]

Sterman [96] argues that the highest constant of contemporary times is, change; and change confronts old-style institutions, norms, values, practices, and beliefs. Most significant is that most of the changes we struggle to realise, and grasp arise as consequences, intended and unintended. All too often, well-intentioned actions to resolve relentless problems frequently result in policy resistance, in which policies are deferred, weakened, or conquered by the startling rejoinders of other individuals or nature. This is a common encounter in the postal sector globally, in Africa, and for purposes of this study in Southern Africa where, for instance, the digital age has brought inadvertent consequences to the out-of-date postal business models that are choking the very survival of DPOs.

A system thinking approach is unlike a reductionist thinking approach. The reductionist approach concentrates on analysis which is grounded on the dissection of complexity into "controllable" parts and supported by the event-oriented approach conviction which is grounded on the illusion that problems "emanate from nowhere". The analysis in all fits into the mechanical and reductionist worldview in which the world is decomposed into parts.

Contrasting with a reductionist approach of “analysis” is the systems thinking approach which is grounded on synthesis instead of analysis. Synthesis is about grasping the full (whole) and the parts (elements) concurrently, along with the relations and networks that make up the dynamic setting of the whole [98]. Mella [92] supports this notion and argues that the whole emerges from the interplay amongst its fragments (parts) and proposes that parts are interrelated through intricate several impacts. Consequently, its defining features do not exist in its parts. Although Strachan [95] suggests that systems thinking can be defined as the skill to differentiate and analyse the interconnections within and between systems.

Iqbal [99] proposes that system thinking is a robust approach to dealing with the system of innovation. Senge [100] and Sterman [98] define systems thinking as a discipline for seeing wholes and a framework for seeing interrelations instead of things, for seeing patterns of change instead of inert snapshots. While Sterman and Sweeney [101] define system thinking as the aptitude to characterise and evaluate dynamic intricacy both in words and explicitly as illustrations.

Lastly, systems thinking is a set of harmonious systemic skills used to advance understanding through the capability of detecting and understanding systems, envisaging their behaviours, and formulating modifications for them to yield the desired effects. These skills work together as a system [102]. Schumacher [98] suggests that systems thinking is a process of probing and refining mental models and its core are four vital concepts (a) Connectedness (b) Synthesis (c) Feedback loops and (d) Causality.

Arnold and Wade [102] pronounce the definition of systems thinking through a systemigram depicted in Figure 22. These authors contend that the thick lines signify solid connections, while thin dotted lines signify frailer connections, but still important, connections. The system of Systems Thinking, as depicted in Figure 21, functions as a sequence of continuous feedback loops. Consequently, the system does not terminate to function at the final node. Rather, as each of the elements advances and in turn, advances the connected elements, Systems Thinking itself incessantly improves.

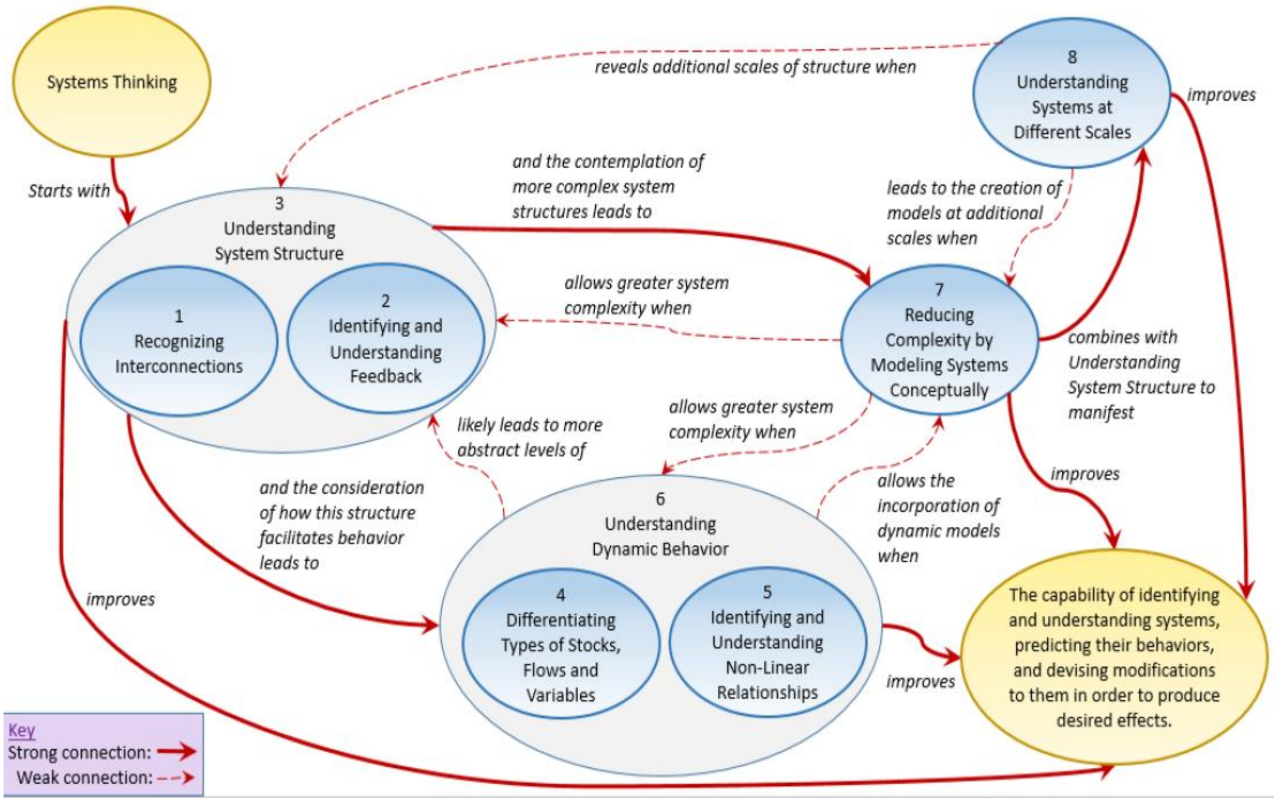


Figure 22: Systems Thinking Systemigram [106]

The elements of the systemigram are explained in Table 14 below.

Table 14: Systemigram elements and explanation adapted from [106]

Element	Explanation
Recognising Interconnections	This is the lowest level of systems thinking. This skill comprises the aptitude to recognise significant connections between parts of a system.
Identifying and Understanding Feedback	Some of the interconnections amalgamate to produce cause-effect feedback loops. Systems thinking entails finding those feedback loops and grasping how the connections impact system behaviour.
Understanding System Structure	The system structure contains essential parts and interconnectedness between these essential parts. Systems thinking requires comprehension of this structure and how it enables system behaviour. Spotting interconnectedness and

	grasping feedback are means to fully comprehend system structure.
Differentiating Types of Stocks, Flows, Variables	Stocks denote any pool of a resource in a system. This could be physical, or even emotional, such as the level of confidence in a brand. Flows are the deviations in these levels. Variables are the variable elements of the system that influence the stocks and flows, such as a flow rate or the maximum quantity of stock. The aptitude to distinguish these stock flows, and other variables and spot how they function is a vital system thinking dexterity.
Identifying and Understanding Non-Linear Relationships	This element denotes stocks and flows of a non-linear nature. It is theoretically conceivable to group this element under distinguishing types of stocks, flows, and variables. However, the latter seems to suggest a linear flow. To circumvent misunderstanding, non-linear flows are detached from this element.
Understanding Dynamic Behaviour	Interconnectedness is the way variables integrate into feedback loops, and the way these feedback loops affect each other; and consist of stocks, flows, and variables and generate dynamic behaviour within a system. This behaviour is hard to grasp or appreciate without systems training. Emergent behaviour, a term used to describe unforeseen system behaviour, is one example of dynamic behaviour. Distinguishing types of stock flow, and variables, as well as recognising and grasping non-linear relationships, are both vital in grasping dynamic behaviour.
Reducing Complexity by Modelling Systems Conceptually	This element is the aptitude to abstractly model diverse fragments of a system and view a system in different ways. Executing this action ranges beyond the scope of well-defined system models and enters the dominion of instinctive explanation through numerous methods, such as reduction, transformation, abstraction, and homogenization. This skill

	could also be observed as the aptitude to observe a system in different ways that cut out superfluous detail and lessen intricacy.
Understanding Systems at Different Scales	It involves the capability to distinguish diverse scales of systems and systems of systems.

Strachan [95] suggests that Systems Thinking requires an appreciation that in human-designed systems, recurrent events or patterns stem from systemic structures which, in turn, arise from mental models. Strachan [95] proposes that the Iceberg Model (Depicted in Figure 23), is a fundamental element of systems thinking. The Iceberg Model contends that events and patterns (which are noticeable) are driven by systemic structures and mental models, which are often unnoticeable. Strachan [95] proposes that systemic structures are the pyramid; social order; interrelations; directives and methods; institutions and approval levels; process flows and methods; encouragements, rewards, goals, and metrics; attitudes; reactions, and incentives and fears that cause them; organisational culture. As well as feedback loops and delays in the system dynamics; and fundamental forces are prevalent in the organisation. Behaviours grow from these structures, which are (in turn) established due to mental models or paradigms.

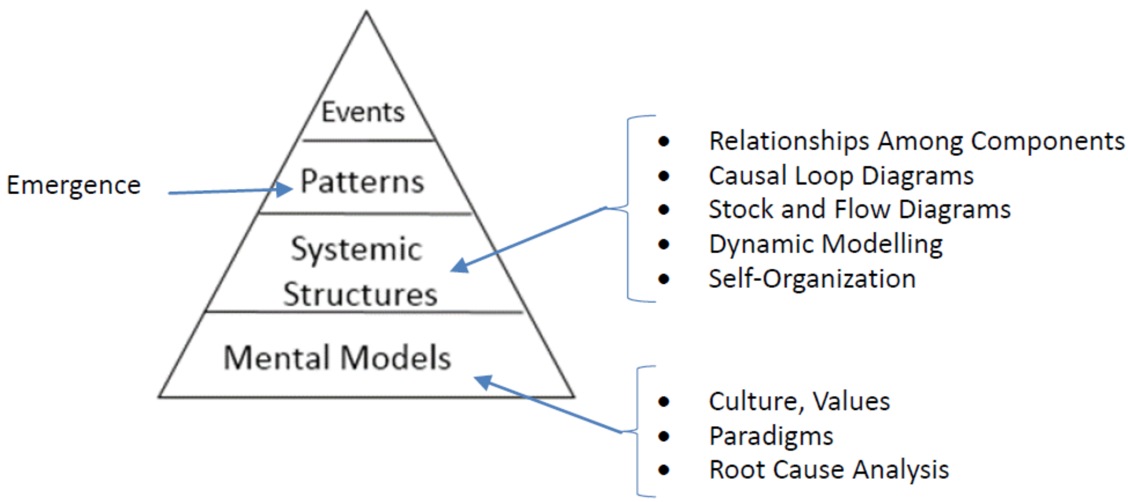


Figure 23: Integrated Model of Systems Thinking [98]

Sterman [96] and [103] propose that system dynamics modelling suggests deviations in a multifaceted, intricate system and is predominantly valuable for simulating the stock-flow-feedback processes that characteristically trigger the behaviour of intricate systems. Reinker and Gralla [104] argue that the modelling approach is grounded on three main types of variables; (i) “Stocks” represent the accumulation of something; (ii) “flows” represent the rate of flow into or out of a stock, and (iii) other variables may influence stocks, flows, and each other to govern the system.

The set of stock flows and variables characterises a system of connected non-linear differential equations, which can be modelled over time to determine how stocks vary. Fisher *et al.* [105] argue that one benefit of the application of the system dynamics approaches over more orthodox models, is the addition of feedback effects. Feedbacks guarantee that a model’s output is exact and divulges complexity that may be unnoticed in other modelling approaches. Thus, decision-makers can precisely differentiate the interrelations in the environment of the model.

Fisher *et al.* [105] assert that learning is a feedback process, while Sterman [103] contends that as decisions are made, these actions alter the real-world, and information feedback about the real-world is acknowledged and using the novel information, comprehension of the world is attuned and becomes closer to the goals. This observation is principally valuable in the context of the DPOs in SADC which are overwhelmed by the complexity related to multiple stakeholders with multiple interests including policy directions internationally (Universal

Postal Union), continentally (Pan African Postal Union), regionally (Southern African Postal Operators Association as implementing Agency of Southern Africa Development Community) and lastly nationally where the DPOs are located.

2.4 Chapter Summary

In summary, this chapter stresses the consequence of not only dealing with inhibitors and enablers to digital transformation in the DPO sector but stresses that these inhibitors and enablers are not linear but interact with each other in a dynamic setting. Literature reveals that the adoption of digital technologies and digital transformation agenda is an intricate process that involves numerous symbiotic enablers and inhibitors which are dynamic and involve numerous feedback processes that reveal non-linearity features.

The literature review paints the postal industry scene, echoes the digital outlook internationally, in the continent (Africa) and the region (Southern Africa), and points to deep-seated systemic challenges faced by developing and less developed countries from a digital transformation perspective. These challenges are echoed in numerous inhibitors that need to be conquered, and enablers that need to be nurtured and exploited to give impetus towards the quest for sustainable DPOs in the digital age.

The literature review revealed that TAM, TAM2, TRA, UTUAT, TOE, BOE, and ADOPT are among the most prevalent technology adoption models. However, there is a literature knowledge gap in these models as they are linear and do not appreciate the non-linearity that characterises multiple stakeholders with often competing interests augmented by inhibitors and enablers that interact in a dynamic setting, giving rise to a complexity that linear models will not be able to address.

The purpose of this research is to close the identified gap by applying a holistic or systems thinking approach to categorise systemic issues that relate to digital technology adoption and digital transformation in the region and consider the systemic issues that are prevalent in the system including the "system of stakeholders" and their respective factors that impede or enable digital transformation.

The literature reveals that this "system of stakeholders" and respective enablers and inhibitors can be modelled through the Systems Dynamics model. The literature points out that System Dynamics uses causal loop diagrams to represent the interaction of factors and demonstrates how these factors influence each other. It further uses computer simulation competence to excavate and grasp endogenic structures of system behaviour and has been applied in several studies of the contagion diffusion, technology adoption grounded on the Bass diffusion model. The System Dynamics approach in contrast to orthodox "linear" technology adoption models as reviewed earlier in the form of the Theory of Reasonable Action, the Technology Adoption Model, the Technology Adoption Model 2, the Unified Theory of Acceptance and Use of Technology, Technology-Organisation-Environment framework, Benefits Organisation and Readiness model. Additionally, the Adoption and Diffusion Outcome Prediction Tool was found to be the most suitable to capture and model the complex dynamics that characterise the DPOs environment in the region and beyond.

In this research, factors that positively or negatively affect the adoption and diffusion of technology in organisations were identified. As well as the systems thinking concepts which close the gap between linear approaches to technology adoption and non-linearity that characterise complex interaction of variables in the form of feedback loops.

The drivers and inhibitors identified in the in-depth literature review were subsequently used in Chapter 3 as input data into the grounded theory research process in which the variables emerged from the laborious grounded theory research strategy. The subsequent chapter discusses the research methodology, detailing the research philosophical worldview, research approach, research strategy, research methodological choice, data collection procedures, and data analysis tools adopted in this research.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter articulates the research methodology adopted in the study. Al Zefeiti and Mohamad [106] suggest that research methodology is a blueprint of a research strategy that outlines the manner a study is to be undertaken. It contains a system of principles and philosophical worldviews which inform the research questions and influence the research methods to be deployed.

Kothari [107] suggests that research is a systematic investigation of appropriate information on the topic under consideration. This definition is supported by Leedy and Ormrod [108] who contend that research is a methodical process of amassing, evaluating, and understanding information to grasp a phenomenon under investigation. Pandey and Pandey [109] affirm the notion that research is an essential and compelling instrument in leading humanity to advancement. "Without methodical research, society will progress at a snail-pace" [109].

Melnikovas [110] proposes that one of the approaches to research methodology development is premised on the theoretic idea of the "research onion" advanced by Saunders *et al.* (2016). Melnikovas [110] further refers to Raithatha (2017) who contends that the research onion offers a comprehensive illustration of the main steps which are to be followed to articulate a robust methodology. The research onion is shown in Figure 24. It defines explicitly the layers from an all-inclusive philosophical outlook to data collection procedures and data analysis tools.

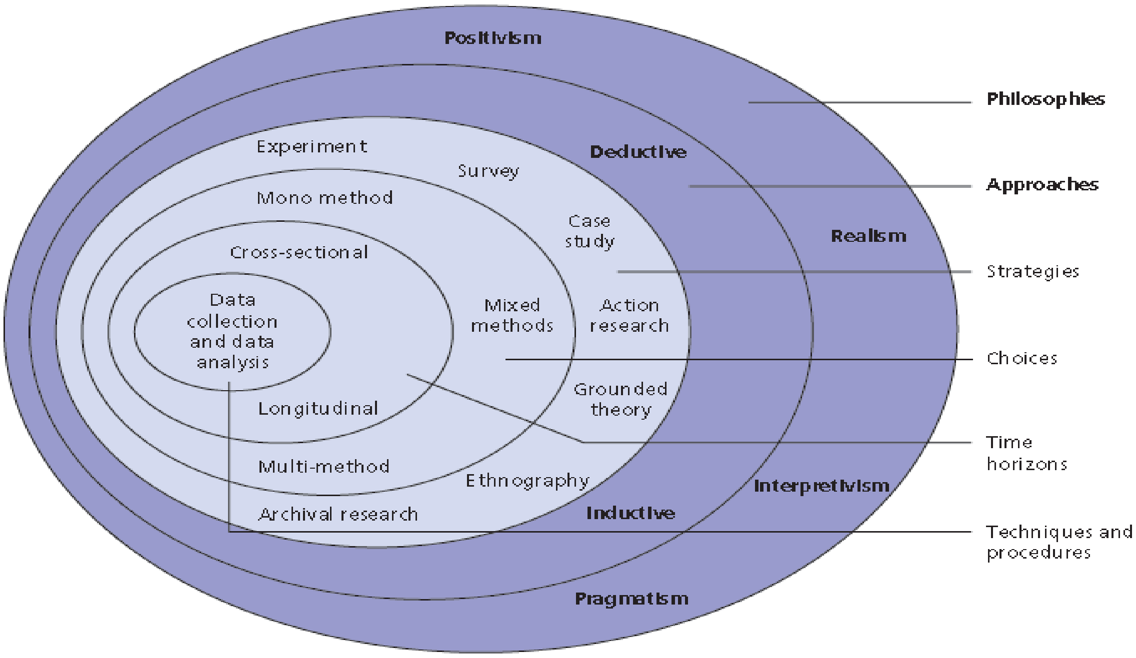


Figure 24: The Research Onion [115]

3.2 Philosophical Worldview or Paradigm

Creswell [111] proposes that the diversities of philosophical worldviews thought by specific researchers will frequently result in the researcher opting for a qualitative, quantitative, or mixed methods approach in their study. This proposition is supported by Khaldi [112] who proposes that the research design that the researcher adopts is grounded on the philosophical worldview the researcher holds in mind. The research design comprises a research approach, a research strategy, a research methodological choice, time horizons, and data collection procedures and analysis tools. These philosophical worldviews are positivism, constructivism, transformative, and pragmatism [111]. The foremost characteristics of the philosophical worldviews are articulated by Creswell [111] in Table 15 as shown below.

The philosophical worldview adopted in this study is grounded on how the researcher perceives the world. These assumptions underpin the research design adopted in this research.

Table 15: Major elements of the philosophical worldviews [116]

Positivism and Post-positivism	**Constructivism/Interpretivism**
• Deterministic • Reductionistic • Observation and measurement • Concept confirmation	• Comprehension • Several perspectives • Social and historical construction • Concept development
Transformative	**Pragmatism**
• Political • Power and justice-oriented • Cooperative • Change-focused	• Consequences of actions • Problem-focused • Multicultural • Real-world practice-focused

Saunder *et al.* [113] argue that pragmatism suggests that the core driver of the epistemological, ontological, and axiological approaches adopted by the researcher; is the research question. Ontology is focused on the nature of reality and the essence of its existence [107]; [113] and ontological perspective is divided into two categories which are objective and subjective [114]. Holden and Lynch [115] stress that objectivism and subjectivism can be defined as perpetuity's opposites with changeable philosophical positions associated between them. Objectivism, on the one hand, represents the position that social objects exist in reality outside of the social players engrossed with their existence [113]; [115]. Subjectivism, on the other hand, suggests that social occurrences are moulded by the intuitions and resultant actions of those social players engrossed with their existence [113].

Saunder *et al.* [113] propose that epistemology is the study of the nature of knowledge and how it is attained and offers an analogous two-fold deliberation between positivism and interpretivism. Post-positivism is grounded on a deterministic philosophy of cause and effect [111] while interpretivism advocates that the researcher should grasp variances between humans as social actors [113]. This is summarised in Table 16 below.

Table 16: Views of the two poles of the research paradigm spectrum [118]

Paradigm	Scientific	Humanistic
Ontology	Objectivism	Subjectivism
Epistemology	Positivism	Interpretivism (Phenomenology)
Views	• The biosphere is physical and precedes individuals. • One reality. • The researcher does not interact with the phenomena under study. • The research attempts to decompose the problem into manageable parts for problem-solving.	• The biosphere is constructed by the minds of people. • Numerous realities. • The researcher interacts with the phenomena under study. • The research attempts to provide a holistic comprehension of the phenomena.

3.3 Research Approaches

Ragab and Arisha [114] argue that the development of novel concepts could be addressed using two research approaches; deduction as depicted in Figure 25 which is characterised by its step-down method toward concepts (theory) testing, or induction depicted in Figure 26 which is characterised by its step-up process towards concepts (theory) building.

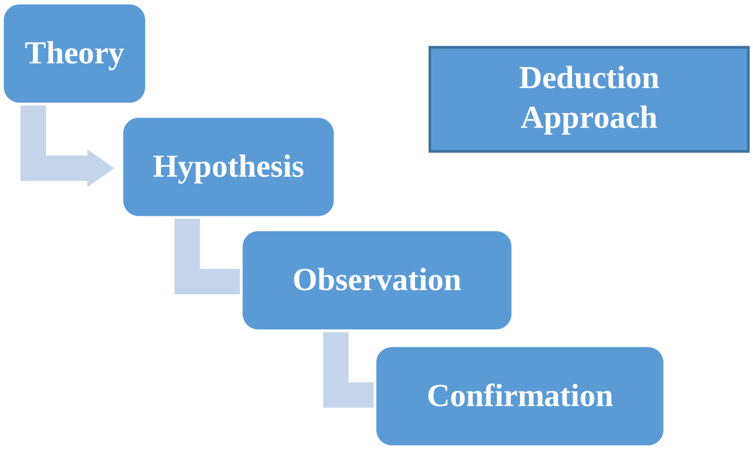


Figure 25: Deducting approach, adapted from [118]

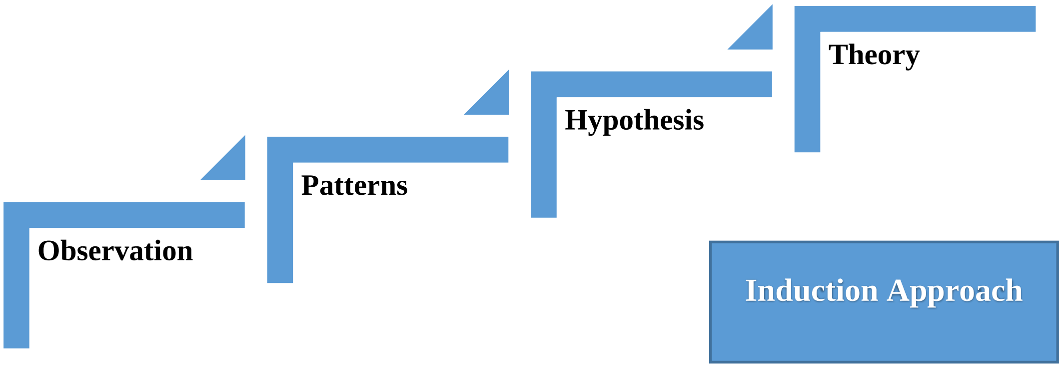


Figure 26: Inductive approach, adapted from [118]

Ragab and Arisha [114] cite Trochim and Donnelly (2008) who propose that the deduction method is grounded in an extremely ordered methodology and often examines casual relationships between variables to describe a certain phenomenon and produce a generalised conclusion. It is frequently denoted as the 'top-down' method; the inductive method commences with the explicit observations in which patterns and associations are recognised to form concepts (theory) about a specific phenomenon and is denoted as the 'bottom-up' method. The foremost differences between deductive and inductive methods are exemplified in Table 17 below and Table 18 below.

Table 17: Major differences between deductive and inductive approaches to research [118]

Deduction process	Induction process
Systematic science-based principles	Obtain insights into the meanings people attach to events.
The transition from theory to data.	Proximity to comprehending the research context.
The requirement to describe causal relations between variables.	The gathering of qualitative data.
The gathering of quantitative data.	A non-rigid approach allows the incorporation of changes in research emphasis as the research evolves.
The deployment of controls to certify the soundness of data.	A consciousness that the researcher is part and parcel of the research process.
The streamlining of concepts to guarantee clarity of definition.	No apprehension about the necessity to generalise.
An extremely controlled approach.	
Researcher's independence to phenomena under study.	
The obligation to select samples of adequate size to generalise findings.	

Table 18: Two main research approaches and corresponding attributes [118]

Research Approach	**Deduction**	**Induction**
Approach to investigation	Extremely organised	Non-rigid
Paradigm	Positivist	Interpretivist
Order of Inquiry	1. Concept 2. Proposition 3. Reflection 4. Validation	1. Reflection 2. Patterns 3. Proposition 4. Concept
Purpose Data	Descriptive; Describes cause and effects. between variables	Probing; Gaining insights into the phenomena under investigation
Data Collected	Quantitative	Qualitative
Generalisation	The requirement to generalise conclusions	Less emphasis on generalisation

Leedy and Ormrod [108] propose that theory is a methodical arrangement of concepts and philosophies envisioned to describe a specific phenomenon, and both deductive and inductive methods of theory testing and theory building correspondingly are similarly significant in engendering theoretic knowledge. They can be symbiotic [113]. This view is supported by Ragab and Arisha [114] who propose that ontology cannot be disconnected from epistemology and concludes that "to speak of the construction of meaning is to speak about the construction of meaningful reality", these two concepts are symbiotic.

This research adopted deductive and inductive logic methods. This research attempts to gain rich insights into inhibitors and enablers at play in a dynamic setting in the context of digital transformation dynamics for sustainable Posts in Southern Africa through the examination of academic literature and postal reports. The type of research approach adopted in this research extends to both theory testing and theory building as articulated previously. The theory building (inductive logic) was through Grounded Theory Research to solicit insights on the drivers and barriers of technology adoption in the postal sector in Southern Africa. The theory testing (deductive logic) was through a System Dynamics modelling approach.

3.4 Grounded Theory

Corbin *et al.* [116] argue that although the grounded theory has not altered in form since its introduction in 1967, the features of its methods have been elucidated explicitly as the methodology progressed in practice. The processes of grounded theory are envisioned to nurture a set of concepts that offer an in-depth theoretical explanation of social phenomena under investigation. Grounded theory (GT) represents exploratory scrutiny in which the researcher interrogates the evidence provided by participants or extracted from archives [117]. The grounded theory process assumes a qualitative methodological choice where investigators formulate a theory from data [118].

Creswell [111] proposes that qualitative approaches display a different method of scholarly review than approaches of quantitative study. Though the procedures are alike, qualitative approaches rely on textual and image data, have distinguishing phases in data analysis, and draw on diverse designs [111]. This view is supported by Adolph *et al.* [118] who propose that grounded theory is dissimilar to the dominant logico-deductive approaches of inquiry because, instead of beginning with a theory and systematically searching for evidence to confirm the theory; grounded theory investigators gather data and meticulously develop a mid-range purposeful theory grounded on the data collected.

Consequently, Charmaz and Bryant [119] argue that the grounded theory technique entails agile, yet discrete, stratagems that differentiate it from other qualitative methods. Zikmund *et al.* [117] argue that Grounded Theory (GT) is essentially appropriate in significantly dynamic situations that are influenced by the rapid and considerable change. The vital characteristic of grounded theory is that it does not begin with a theory but instead extracts one from whatever arises from an area under consideration [117]. Corbin *et al.* [116] propose that grounded theory has meticulous procedures for data gathering and examination, and grounded theory scholars must have in-depth knowledge and understanding of these processes and related doctrines to carry out an investigation. The GT doctrines are as follows:

(a) **Data collection and analysis are symbiotic processes**: In grounded theory, the scrutiny begins as soon as the opening set of data is gathered.

(b) **Concepts are the basic units of analysis**: A scholar works with the abstraction of data, not the actual data. Concepts cannot be formulated with real incidents or activities as detected or conveyed; that is, from "fresh data".

(c) **Categories must be developed and related**: Concepts that relate to the same phenomenon may be grouped to form categories. Not all concepts develop into categories. Categories are more advanced in level and abstract than the concepts they express.

(d) **Sampling in grounded theory proceeds on theoretical grounds**: Sampling in grounded theory proceeds not with the intent to extract samples of explicit clusters of individuals or units of time but in terms of concepts, their properties, degrees, and distinctions.

(e) **The analysis makes use of constant comparisons**: As an occurrence is noted, it should be compared against other occurrences for resemblances and variances.

(f) **Patterns and variations must be accounted for**: Data must be examined for regularity and for comprehension of where that regularity is not apparent.

(g) **The process must be built into the theory**: In grounded theory, the process has abundant implications. Process analysis may mean the decomposition of a phenomenon into phases.

(h) **Writing theoretical memos is an essential part of undertaking grounded theory**: Since the scholar cannot track all the groupings, features, hypotheses, and propagative interrogations that evolve from the systematic process, there must be a structure for doing so. The use of memos institutes such a structure. Memos are not exclusively about "thoughts." They are tangled in the building and modification of theory during the research process.

(i) **Hypotheses about relationships among categories should be established and confirmed during the research process**: As propositions about the interplay among categories are formulated, feedback mechanism to the field is a significant prerequisite to guarantee the dynamics are checked against material conditions in a dynamic setting and reviewed as necessary. A vital characteristic of grounded theory is not that propositions remain unproven, but that propositions (whether involving qualitative or quantitative data) are unceasingly revised during the research process until they hold for all of the evidence regarding the phenomena under study, as collected in recurrent interviews, observations, or documents.

(j) **A grounded scholar must not work alone**: A substantial part of grounded theory research is testing concepts and their relations with peers who are knowledgeable in the same functional area.

(k) **Broader structural conditions must be analysed, however microscopic the research**: The analysis of a dynamic setting must not be inhibited by the conditions that directly influence the phenomenon under study. Wider drivers affecting the phenomenon may include political, social, economic, cultural, technological, environmental, and other associated factors.

Saunder *et al.* [113] argue that in grounded theory, data gathering commences without the formulation of a preliminary theoretical framework. The theory is formulated from data formed by a series of observations. The insights gained from the data extracted from the interplay of inhibitors and enablers in a dynamic setting are the foundation for the formulation of predictions which are then confirmed in additional observations that may confirm, or otherwise, reject the predictions. "Grounded theorists share a conviction with many other qualitative researchers that the orthodox principles of "good science" should be retained, but require redefinition to correlate to the realities of qualitative research and the intricacies of social phenomena" [116].

Adolph *et al.* [118] suggest that grounded theory is conceptually simple, yet painstaking and logical in practice. Figure 27 depicts the process of the grounded theory which can be summarised as:

(a) A researcher begins data gathering on a phenomenon of interest and explores the data by examining patterns of occurrences to specify concepts. Concepts are the foundation of grounded theory research, and abstraction is one of its characteristics.

(b) The theoretic features of a category are developed by likening instances in current data with preceding incidences in the same category. During the analysis, the "core category" is developed. The process of engendering categories and their properties proceeds until the categories become "saturated"; that is when the additional gathering of data does not add new value to the prevailing categories.

(c) After saturation, the substantive theory is compared to theories pronounced in the literature.

(d) Throughout the process, the scholar writes memos capturing their views and critical processes; the memos ground the emerging concepts, categories, and relationships.

Fernández [120] cites Lehmann (2001) who initially theorised that the grounded theory process is exemplified as a spiral shape that starts with gathering data in a substantial part of the investigation which is subsequently coded and classified in a continual method that advances towards saturation and completes in the theoretical concretion of concepts personified by a substantive theory. Figure 27 illustrates the grounded theory process as abstracted by Lehmann (2001). Fernández [120] argues that while Figure 28 provides an overview of the process tangled in grounded theory, it misses vital events which include (a) Entering the field which encompasses (i) Defining the research problem, and (ii) Ensuring theoretical elasticity and significance through an attentive selection of cases; (b) The role of theoretical memos and extant literature in a grounded theory study. The expanded Lehmann's research model proposed by [120] is depicted in Figure 29.

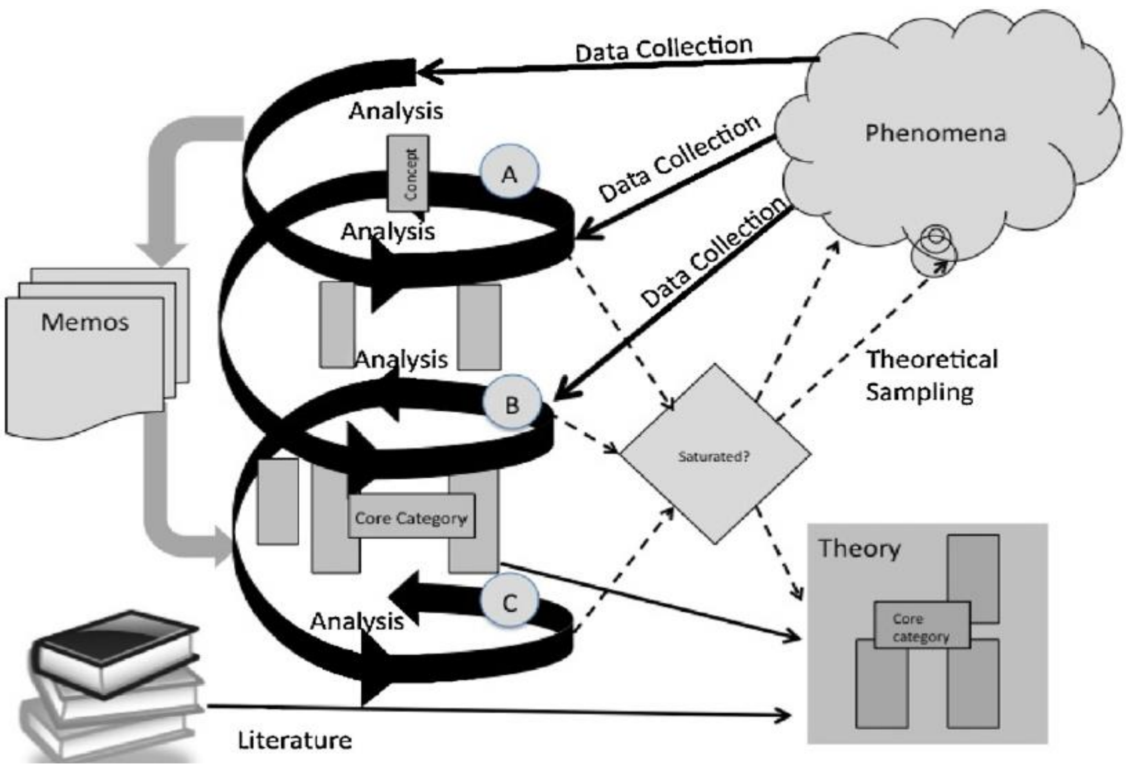


Figure 27: The Grounded Theory Method [122]

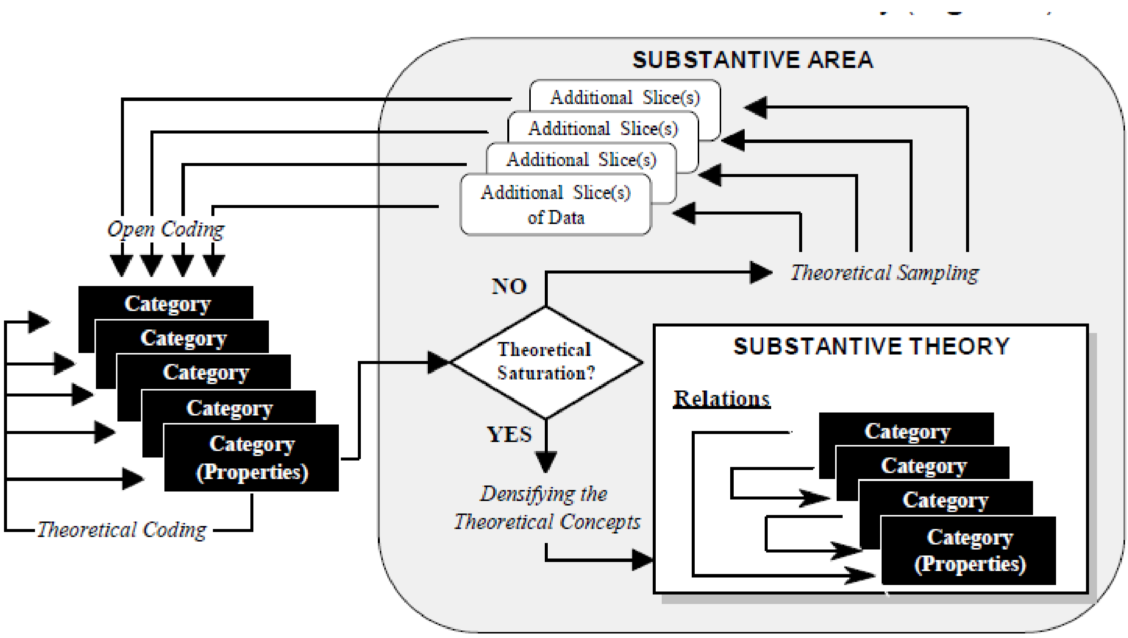


Figure 28: Lehmann's grounded theory process [124]

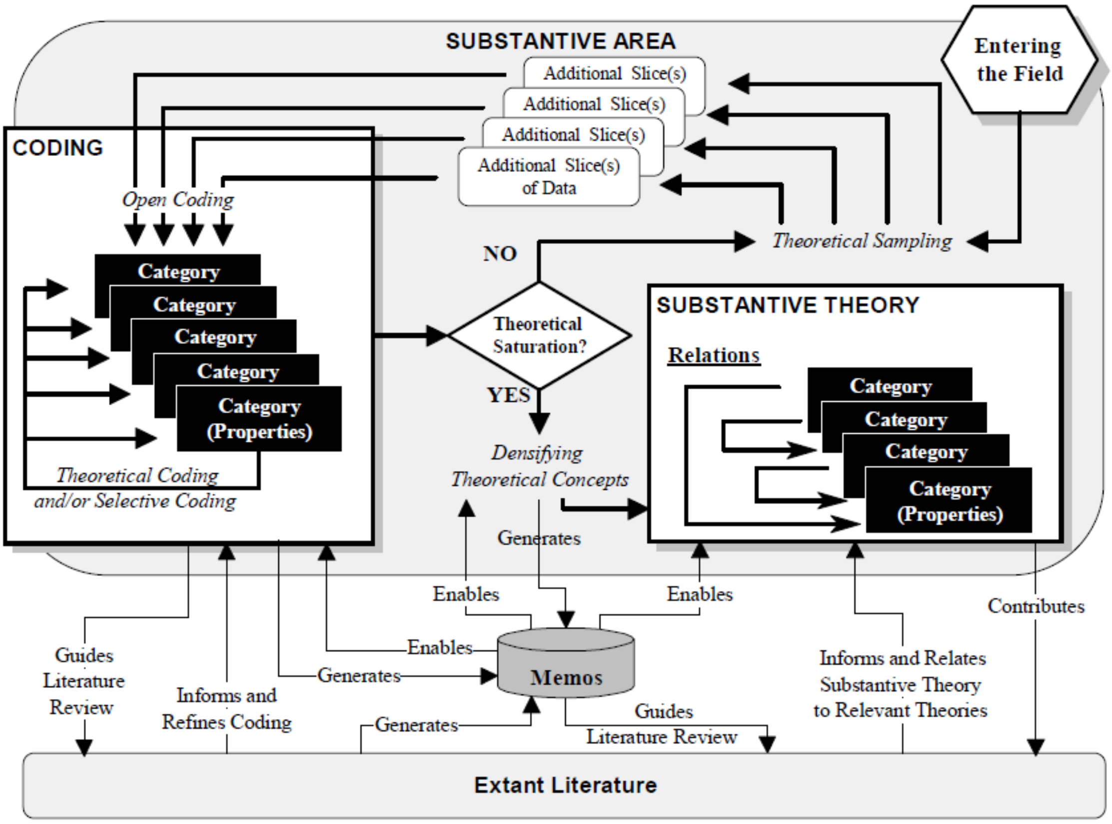


Figure 29: Expanded Lehmann's (2001) research model [124]

This inquiry adopted the grounded theory method in the probing phase of the research through the interface of the scholar with secondary data on digital technology adoption and digital transformation organisations. Additionally, the insights gained were framed to the DPOs in the international context and regional (SADC) context.

3.5 Research Design

UPU [89] suggests that the United Nations (UN) Sustainable Development Goals (SDGs) are determined universal agenda set to accomplish a sustainable future for all. The report argues that these SDGs are aimed at addressing urgent global trials that the planet is facing and relating to hunger, disparity, climate alteration, ecological ruin, success, harmony, and fairness. These goals are interweaved and, to have everyone on board, they are aimed to realise the SDGs and their respective targets by 2030. This view is supported by UPU [2] which argues that with a widespread web of over 677,000 retail offices around the globe, over five million employees, and physical infrastructure that is spread out in 192 nations, DPOs contribute to the vital role of the socio-economic role and argues that it is for this significant reason why postal development matters.

SAPOA [7] suggests that the Southern African Postal Operators Association is SADC's alliance of leading DPOs devoted to interconnecting people through the propagation of information, mail products, and financial services in SADC. While the core business remains mail delivery, interests extend to retail, freight and courier, direct mail, e-commerce, and financial services. With 16,064,394 delivery points and a network of 5,441 branches and outlets, the postal network is larger than that of the member countries' banks, reaching the most remote populations. The postal sector globally, continentally, regionally, and nationally is a significant player in social and economic development and a partner of choice for governments to provide inclusive services to citizens.

Kumar [121] proposes that research design is a path, structure, and stratagem of inquiry, envisioned to unearth answers to study questions or phenomena under study. Zikmund *et al.* [117] suggest that a research design is a blueprint which outlines the approaches for gathering and examining the required information and offers a context of an action for the research. This definition is supported by Kothari [107] who suggests that a research design is the scheduling of settings for the gathering and examination of information in a way that purposes to amalgamate significance to the study purpose with efficiency in the method; it is the theoretical arrangement within which study is guided. Research design entails the outline for the gathering, quantification, and examination of data. Lastly, Pandey and Pandey [109] note that research design is basically the agenda for a study that is used to guide the collection, and examining of the data and proposes that the objective of research design is:

(a) To curtail costs: Research design brings a vital impact on the consistency of the results attained. It consequently offers a strong foundation for the whole research process. This makes the research as effective as possible by providing maximum information with minimum spending of effort, money, and time by preparing the advance plan of all about the research.
(b) To assure streamlining of the research: Research design is appropriate and crucial as it helps to streamline a series of research processes, thus guaranteeing an effectual

research process that produces optimum information within the constraints of resources.

(c) To amass the applicable data and procedure: Research design is grounded on upfront planning of the procedures to be used in the gathering of the applicable data and the methods to be implemented in examining the data.

(d) To provide an outline for plans: Research design is essential as it assures the streamlining of several research operations. It is an outline required to arrange the procedures to be implemented for gathering the applicable data and methods to be used in its examination to answer the research questions.

(e) To afford perspectives of other experts: A research design offers an outline of the research process and with the aid of the design process, helps scholars to have a view and take note of the body of knowledge documented by research methodology specialists.

(f) To give a clear path: A research design offers a proper path to the other scholars supporting the primary researcher in the study journey.

Leedy *et al.* [122] contend that research design can be categorised into (a) Research design in the context of an exploratory study; (b) Research design in the context of an explanatory study, and (c) Research design in the context of the deductive study. Table 19 illustrates the tenets of these three research design approaches.

Table 19: Three research design approaches adapted from [126]

Research Design Approach	**Characters**
Research design in the context of an exploratory study	• An exploratory study aims to formulate a problem for detailed inquiry. • The aim of the exploratory study is the discovery of ideas and insights. • Multidimensional.
Research design in the context of a descriptive study	• A descriptive study is engrossed with describing the features of an individual, or a group. • Dimensional.

Research design in the context of a deductive study	• Deductive studies test the propositions of causal relationships between variables. • Dimensional.

Creswell [111], on the one hand, notes that research designs are forms of examination within qualitative, quantitative, and mixed methods approaches that provide a set of procedures in a research design. On the other hand, Leedy and Ormrod [108] note that while quantitative research inclines to pursue elucidations and forecasts that will generalise to other settings, qualitative research inclines to pursue an improved comprehension of complex circumstances. Table 20 illustrates the qualitative, quantitative, and mixed-method research design approaches with their characteristics, while Table 21 illustrates the distinctive characteristics of quantitative versus qualitative approaches.

Table 20: Quantitative, Qualitative, and Mixed Methods [116]

Quantitative Methods	**Mixed Methods**	**Qualitative Methods**
Pre-planned instrument	Both pre-arranged and emergent methods	Emergent approaches
Tools grounded on questions	Unrestricted and restricted questions	Flexible inquiry
Historical data	Numerous arrangements of data collection	Primary and secondary data
Statistical scrutiny	Statistical and text examination	Textual and image examination
Statistical explanation	Across databases explanations	Themes, constructs, and explanations

Table 21: Characteristics of Quantitative and Qualitative Methods [112]

Question	Quantitative	Qualitative
What is the aim of the research?	• Explanatory and predictive • Confirmatory • Deductive	• Exploratory and interpretive • Inductive
What is the character of the research method?	• Fixated. • Identified variables. • Conventional rules. • Pre-arranged methods. • Context-free to some degree. • The researcher is detached from the environment under study.	• All-inclusive • Unfamiliar variables • Agile rules • Developing methods • Context-bound • The researcher interacts with the environment under study
Type of data, and how it is gathered?	• Mathematical data • Representative, big sample • Uniform instruments	• Written and/or graphic-based data • Revealing, a small sample • Lightly controlled
How was data examined to determine their meaning?	• Statistical examination • Emphasis on objectivity • Primarily deductive reasoning	• Exploration of themes and categories. • Recognition that examination is subjective and hypothetically biased. • Primarily inductive reasoning.
How are the results communicated?	• Statistics • Official voice, scientific style	• Words • Accounts, individual quotes • Individual voice, literary style (in some disciplines)

This research in 3.3 adopted the induction logic (theory building) and deduction logic (theory testing) and, therefore, embraced the mixed method research design approach in the form of

(a) Grounded Theory as a qualitative research design approach and, (b) System Dynamic Modelling approach as a quantitative research design approach.

3.6 Data Collection and Analysis

Kothari [107] suggests that data gathering begins instantly as soon as a research problem has been well-defined and the research design outlined. This view is supported by Saunders *et al.* [113] who argue that data gathering, data examination, and the formulation and confirmation of hypothesis are very much an interconnected and collaborative set of procedures. These authors contend that the collaborative nature of data gathering, and examination permits qualitative scholars to spot important themes, patterns, and associations during data gathering. In other words, to permit these themes, patterns, and relationships to arise from the process of data collection and analysis.

Kumar [121] proposes that there are two foremost methods of collecting information about a phenomenon, and can be considered primary and secondary data; Figure 30 depicts the methods of data gathering. Kothari [107] supports this view and suggests that two types of data exist, primary data, and secondary data; (a) Primary data are data that are gathered afresh, and as a result, are considered to be original in form. (b) The secondary data, on the other hand, are gathered by another researcher and such information has previously been evaluated or documented. Saunder *et al.* [113] contend that secondary data encompass both fresh data and published materials.

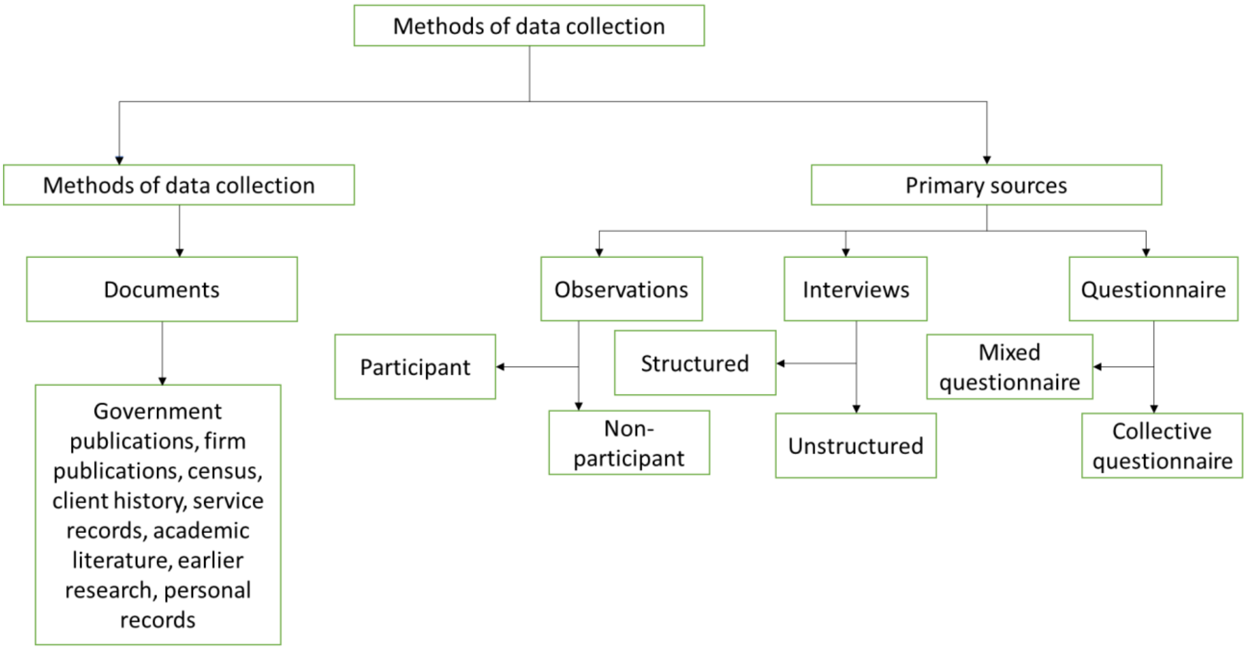


Figure 30: Methods of data collection [125]

Quantitative scholars typically identify a selection of variables to study and then gather data explicitly relating to the variables that were identified. Procedures for quantifying each variable are identified, established, and normalised, with great consideration given to the validity and reliability of the measurement instruments. Leedy and Ormrod [108] propose that data are often gathered from a bigger sample that is presumed to describe a specific population to aid generalisations about the population.

On the other hand, qualitative investigators operate under the hypothesis that reality is not simply detached into disconnected, quantifiable variables. Instead of sampling numerous partakers with the determination of generalising, qualitative researchers are inclined to identify a few partakers who can provide meticulous insight into the phenomenon under study. Both verbal data (interview responses, and documents) and nonverbal data (sketches, pictures, videos, and artefacts) are gathered as part of the data [108].

The data collected for the exploratory (inductive logic) study and, therefore, the qualitative research design approach was secondary and comprised of in-depth literature on technology adoption-digital transformation (Industry 4.0) adoption and, ICT adoption. Secondly, industry reports from a postal perspective including strategic plans on digitalisation, annual reports from various postal operators, Universal Postal Union reports on the digital panorama, digital infrastructure, postal development reports, reports from International Telecommunications Union, South African Development Community, and related literature.

3.6.1 Data Collection Methods and Instruments – Exploratory Study

Creswell [111] suggests that the idea behind qualitative research is to purposefully hand-pick participants or sites (or documents or visual material) that enable the researchers to comprehend the problem and the research question. This fundamental feature of qualitative research design resulted in the collection of specific secondary data that provides insight to the researcher to comprehend the phenomenon under study.

The data were collected from archival data from literature and industry reports. This data focused on a variety of factors (drivers and barriers) common in the adoption of technology and digital transformation in organisations broadly, as well as in the postal sector. These characteristics, drivers, and barriers are delved deeply into in the literature review in Chapter 2.

This exploratory aspect of the research was aimed at answering at great length the first research question which is, "what are the technology and digital transformation adoption dynamics in organisations broadly and in the postal sector globally and in Southern Africa?"

The research adopted the expanded Lehmann's grounded theory research model method as proposed by [120] and as depicted in Figure 27. The study was further guided by the methodological steps depicted in Figure 29 to sift through data collected in the literature review to develop core categories. The grounded theory research commenced by "entering" the field by posing a broad research question to ensure a divergent collection of information with no prior assumptions and constructs in the broad sphere of technology and digital transformation adoption.

The initial phase of "entering the field" in grounded theory research is meant to comprehend and utilise constant comparison [120]. This view is endorsed by [123] who proposes that it is only through rigorous evaluations (constant comparison) that a robust theory with one or more fundamental categories emerges as depicted in Figure 29.

The constant comparative method between events and settings is the essence of grounded theory since, through the four stages of the constant comparative method [(1) "comparing occurrences applicable to each category", (2) "integrating categories and their features", (3) "delineating the theory", and (4) "writing the theory"], the researcher incessantly groups through the data gathering, analyses and codes the information. In addition, reinforces theory generation through the process of theoretical sampling [124]. This view is reinforced by Shiau and George [123] who suggest that theoretical sampling is deployed to decide what to observe and it essentially concentrates on data gathering.

Figure 31 depicts this phenomenon of the relationships amid the constant comparison method, theoretical sampling, and theoretically sensitive coding which are the crux of grounded theory.

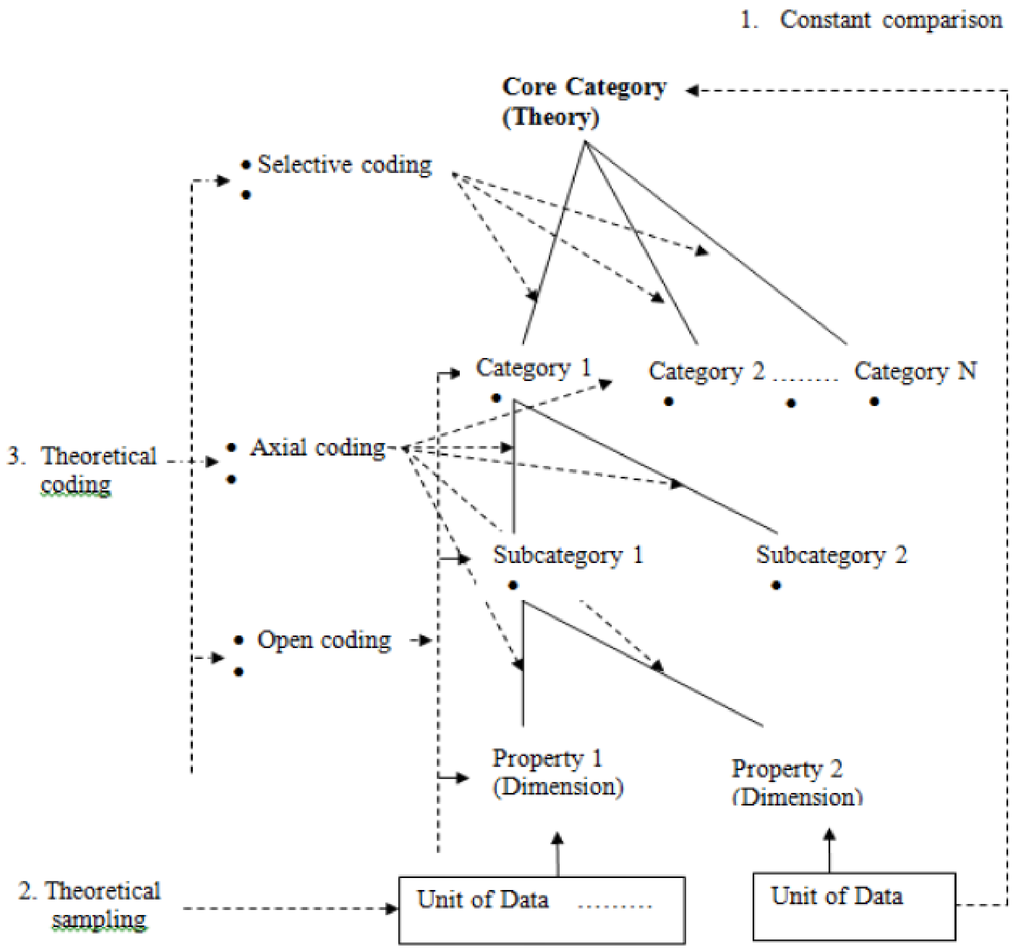


Figure 31: Grounded Theory method [127]

Table 22 describes the categories and concepts that emerged from the grounded theory research. Each category signifies one of the main phenomena of the study.

Table 22: Emergent dimensions, concepts, codes, and data sources

Emergent Dimension	**Concepts/Constructs And Codes**	**Sample Data Source**
Individual drivers	Relative advantage (A), Compatibility (B), Complexity (C) Trialability (D)	Innovation Diffusion Theory
	Attitude towards the behaviour (E), Subjective Norms (F) Intention towards behaviour (G)	Theory of Reasonable Action
	Perceived Usefulness (H), Perceived Ease of Use (I), Attitude Towards Uses (J), Behavioural Intention (K), Actual System Use (L)	Technology Acceptance Model
	Subjective Norms (M), Voluntariness (N), Image (O), Output Quality (P), Job Relevance (Q), Results from Demonstrability (R), Perceived Usefulness (H), Perceived Ease of Use (I), Intention to Use (S), Usage Behaviour (T)	Technology Acceptance Model 2
	Performance Expectancy (U), Effort Expectancy (V) Social influence (W), Facilitating Conditions (X), Gender (Y), Age (Z), Experience (AA), Voluntariness of Use (AB), Intention to Use (AC), Use Behaviour (T)	Unified Theory of Acceptance and Use of Technology
	The characteristics of the innovation (AD), The characteristics of the population (AE), The actual relative advantage of using the innovation (AF), Learning of the actual relative advantage (AG)	ADOPT Framework

Organisational drivers	Perceived Benefits (AH), Organisational readiness (Enablers) (AI), Organisational readiness (Inhibitors) (AJ), External pressure (Regulations) (AK), External pressure (Competition) (AL)	Benefits, Organisation, and Technology (BOE)
	Industry characteristics and market structure (AM) Technology support infrastructure (AN) Government regulation (AK) Formal and informal structures (AO) Communication processes (AP), Organisational size (AQ)	Technology Organisation and Environment (TOE)
Emergent Dimension	**Concepts/Constructs and codes**	**Sample data source**
Organisational drivers	Harnessing the competence-base (AS), Organisational intelligence (AT), Creativity and idea management (AU), Organisational structures (AO) and systems (AV), Culture and climate (AW), Management of technology (AX), Innovation stream (AY), Innovation mainstream (AZ), Innovation capability (BA), Innovation performance (BB),	Innovation Capability Model
	Strategies (AR), Customer relationships (BE), Business models (BF), Corporate structures (AO), inter-organisational processes (BG) Customer and product knowledge (BH), Defined responsibilities (BI), Collaborative organisation with a flat hierarchy (BK), Empowering leadership (BL)	Digital Framework (Digital leadership)
	Market competition (AL), Following market trends (AL), Increasing pressure from the competition (AL), Business model innovation (BM)	Digital Capability Framework

	Value creation (BN), Business Processes (BO), Training (BP), Change Management (BQ), Culture-Leadership-Values (AW), Innovation Capability (AU-AY-AZ-BB), Transformation Capability (BR), Customer Centricity (BS), Operational Excellence (BT)	
	Reducing the error rate (BU), Improving lead times (compliance with market conditions) (BV), Improving efficiency (BW), Ensuring reliable operation (e.g., less downtime) (BX)	Driving forces of Industry 4.0
	Vertical integration (ET), Horizontal integration (EU), Innovation push (BB)	Industry 4.0 objectives
	Deviant logic (FB), Discovery (FC), Development (FD), Diffusion (FE), Impact (FD), Adoption (FE)	Digital disruption dynamics
	Digital maturity (FF), Digital readiness (FG), 2IPD (FH), Firm performance (BC)	Digital capability maturity model, Universal Postal Union (2IDP), Drivers of Industry 4.0
Organisational barriers	Inadequate organisational structure and process organisation (AO), Contradictory interests in different organisational units (BY), Resistance by employees and middle management (BZ), Lack of conscious planning: Defining goals, steps, and needed resources (CA), Lack of vision and strategy (AR), Poor digital-savvy culture and vision (BJ),	Barriers to Industry 4.0
Technological drivers	Technology Availability (CB), Technology Characteristics (CC)	Technology Organisation and Environment (TOE)

	IT Excellence (CJ)	Digital Capability Framework
	Interoperability (CD), Virtualization (CE), Decentralization (CF), Real-time capability (CG), Service Orientation (CH), Modularity (CI)	Industry 4.0 design principles

Emergent Dimension	**Concepts/Constructs And Codes**	**Sample Data Source**
Technological barriers	Lack of a unified communication protocol (CK), Lack of back-end systems for integration (CL), Lack of willingness to cooperate (at the supply chain level) (CM), Lack of standards including technology, and processes (CN), Lack of proper common thinking (CP), Unsafe data storage systems (CQ), The need for large amounts of storage capacity (CR)	Barriers to Industry 4.0
	Obsolete technologies (CS), Inappropriate technologies (CT), Complex technologies (CU), Low internet bandwidth (CV), Unreliable internet connection (CW), Poor network reception (CX)	Technical ICT Barriers
Institutional drivers	Network (CY), Staff (CZ), Legal and regulatory framework (AK), Financial capacity (DA), Political commitment (DB), Public trust (DC), National policy alignment (DD), Process improvement (ER), Workplace improvement (ES), Management support (EV), Cost reduction (EW), Customer demands (EX), Supply chain transformation (EY), Market pressure (AL), Laws & regulatory framework (AK), Employee support (EZ), Digital innovation (FA)	Drivers of digital adoption and diffusion in the postal sector

Institutional barriers	Resource constraints (DE), Poor transition towards digital culture (DF), Limitations of IT infrastructure (DG), Lack of sufficient internal expertise required to develop e-services (DH), Custom clearance (DI), Poor digital culture (DJ), Slow customer adoption of digital services (DK)	Barriers to digital adoption and diffusion in the postal sector

Emergent Dimension	**Concepts/Constructs And Codes**	**Sample Data Source**
Institutional barriers: Political and leadership	Corruption (DL), Lack of political will (DM), Unnecessary red-tape (DN), High taxes (DO), Lack of regional initiatives (DP), Political instability (DQ), Lack of proper planning or coordination (CA), Monopoly (DR), Invisible hand (DS), Micromanaging (DT)	ICT barriers
Institutional barriers: Socio-cultural	Lack of cultural knowledge (DU), Resistance to change (DV), Fear of technology (DW), Lack of relevant local content (DX), Lack of maintenance culture (DY), Lack of language skills (DZ)	ICT barriers
Institutional barriers: Economic	Low income (EA), Lack of investment (EB), Low return on investment (EC), High initial costs (ED), High risk on investments (EE)	ICT barriers
Institutional barriers: Security & Safety	Perceived lack of privacy (EF), Insecurity (EG)	ICT barriers
Institutional barriers: Legal & Regulatory	Lack of proper legal framework (AK), Poor regulation (AK)	ICT barriers
Institutional barriers: Infrastructural	Lack of software and hardware (EH), Inadequate electricity supply (EI), Lack of internet exchange points (EJ)	ICT barriers

Institutional barriers: Skills	Scarcity of technical personnel (DH), High illiteracy rates (EK), Lack of ICT skills (DH), Lack of Research & Development outputs (EL)	ICT barriers
	Increasing labour shortages (EM), Reducing human work (EN), Allocating workforce to other areas (higher added value) (EO)	Drivers of Industry 4.0
	Lack of appropriate competencies and skilled workforce (EP), Longer learning time (training of staff) (EQ)	Barriers to Industry 4.0

3.6.2 Data Analysis, Coding, and Results – Exploratory Study

Grounded Theory (GT) was adopted as a tool of analysis for the exploratory phase because it is deemed an approach that explicitly incorporates the elements of process and context under study and, therefore, was particularly appropriate as an analysis tool. [125] proposes that the three attributes of the grounded theory which are inductive, contextual, and processual fit with the interpretive orientation of qualitative research.

Lawrence and Tar [125] further propose that the process of analysis in grounded theory comprises theoretical sampling, theoretical coding (comprising of open, axial, and selective); memo writing, and theoretical coding. This proposition is reinforced by Glaser [126] who advances that theoretical coding entails open coding, axial coding, and theoretically sensitive coding. Fernández [120] suggests that theoretical saturation ensues when further sampling yields no further significant value to the study and the theory becomes dense with concepts, augmented by extant literature, and could then be considered as substantive theory. The activities involved in grounded theory methodology as they relate to techniques and procedures of handling data are briefly explained below.

3.6.2.1 Theoretical Sampling

Breckenridge and Jones [127] propose that theoretical sampling is a fundamental tenet of classic grounded theory and is crucial to the advancement and enhancement of a theory that is 'grounded' in data, this view is supported by Draucker *et al.* [128] who contend that "Theoretical sampling is a hallmark of grounded theory methodology". Theoretical sampling refers to additional data collection directed by the outcomes from previous data analysis. It aims to gather, systematically, more data to explore emergent patterns. Significantly, at this stage, fresh data are used to authenticate, add to or question the emerging patterns as well as recognise gaps in the data analysis necessitating additional examination or exploration [129].

Conlon *et al.* [130] allude that theoretical sampling develops out of the rationality of discovery, underpinning the method which requires the researcher to take part in inductive as well as deductive reasoning. Inductive reasoning entails moving from observing instances or cases to developing a general abstract depiction with allusion to the specific characteristics observed.

Theoretical sampling can be viewed as a data triangulation technique. It is applied to produce additional data to confirm and refute original categories until theoretical saturation is achieved [123]. Further, it serves as a thread that connects all dimensions of the grounded theory research process.

3.6.2.2 Theoretical Memos

Kumar [120] proposes that the writing of theoretical memos begins simultaneously with open coding due to memos representing “the theorising write-up of concepts about codes and their relations as they form in the mind of the researcher while coding”. This view is captured by [116] who argues that memos progress in complexity, density, and accuracy during the unremitting process of data collection to theorising, thereby boosting the theoretical richness through an ongoing process of comparison and conceptualisation. [123] suggests that theoretical memos are an essential element of grounded theory research that is incessantly performed during the data collection and analysis processes.

Kumar [120] argues that as the richness and quality of codes and memos accumulate, relationships between them are perceived giving rise to a process called theoretical coding that gives rise to the emergence of patterns and the beginning of selective coding. [131] proposes that selective coding aims to assimilate the different categories developed, elaborated, and mutually related during axial coding into one cohesive theory. Developing the emerging theory entails coalescing the classified memos and emerging theoretical outlines into a solid and comprehensible working theory.

3.6.2.3 Theoretically Sensitive Coding

Elliott [132] suggests that coding is a prevalent process in qualitative research; it is a vital characteristic of the systematic process and articulates the decomposition of data to create something novel. Coding is a way of charting data, to offer an overview of contrasting data that allows the scholar to make sense of the data concerning the research questions [132].

Lawrence and Tar [125] argue that open coding is the analytic process through which concepts are pinpointed and their properties and dimensions are uncovered in the data. Axial coding on the other hand encompasses re-building the data (fractured through open coding) in new-found ways by determining interactions between categories and their subcategories. Axial codes normally signify categories that describe the open codes [125], and [116] points out that axial coding is required to probe the relations between concepts and categories that have been developed in the open coding process, which according to [120] entails probing data to unearth a set of classifications and their attributes. Shiau and George [123] propose that axial coding is a set of procedures to create connections among categories and subcategories by synthesizing data and crystalizing it in a new way after the open coding process.

Finally, Lawrence and Tar [125] cite Darke *et al.* (1998) who argue that selective coding is aimed at integrating and refining the categories into a theory, which accounts for the phenomenon being explored and confirms the statements of relations among concepts and fills in any categories in need of additional enhancement.

In this analysis, data analysis immediately trailed data collection. The constant comparison process (data collection and data analysis) concluded when no further data that are substantial could be found, suggesting that theoretical saturation was reached. The data from Table 22 were analysed through a grounded theory research process that culminated with 14 dimensions that emerged with associated 180 concepts/variables. The emerging dimensions were further refined and culminated with seven dimensions resulting from amalgamating similar dimensions which are depicted in Table 23. The dimensions in Table 23 were synthesized and ensued with 11 themes that characterise the seven dimensions. The themes which ensued are; (a) Adoption, (b) Digital ecosystem, (c) Digital culture, (d) Digital investment, (e) Operational efficiency, (f) Digital capabilities, (g) Shared vision, (h) Digital competitiveness, (i) Customer insights, and (j) Diverging interests. The synthesis and emerging themes are depicted in Table 24.

Table 23: Emergent categories, integrated concepts; and codes

Emergent Categories	Variables And Codes
Individual factors	Relative advantage (A), Compatibility (B), Complexity (C), Trialability (D),
	Attitude toward the behaviour (E), Subjective Norms (F), Intention towards behaviour (G)
	Perceived Usefulness (H), Perceived Ease of Use (I), Attitude Towards Uses (J), Behavioural Intention (K), Actual System Use (L)
	Subjective Norms (M), Voluntariness (N), Image (O), Output Quality (P), Job Relevance (Q), Results Demonstrability (R), Perceived Usefulness (H), Perceived Ease of Use (I), Intention to Use (S), Usage Behaviour (T)
	Performance Expectancy (U), Effort Expectancy (V) Social influence (W), Facilitating Conditions (X), Gender (Y), Age (Z), Experience (AA), Voluntariness of Use (AB), Intention to Use (AC), Use Behaviour (T)
	The characteristics of the innovation (AD), The characteristics of the population (AE), The actual relative advantage of using the innovation (AF), Learning of the actual relative advantage (AG)
Organisational factors (Enabling)	Perceived Benefits (AH), Organisational readiness (Enablers) (AI), External pressure (Regulations) (AK), External pressure (Competition) (AL)
	Industry characteristics and market structure (AM), Technology support infrastructure (AN), Government regulation (AK), Formal and informal structures (AO), Communication processes (AP), Organisational size (AQ)
	Harnessing the competence-base (AS), Organisational intelligence (AT), Creativity and idea management (AU), Organisational structures (AO) and systems (AV), Culture and climate (AW), Management of technology (AX), Innovation new stream (AY), Innovation mainstream (AZ), Innovation capability (BA), Innovation performance (BB),

	Strategies (AR), Customer relationships (BE), Business models (BF), Corporate structures (AO), and inter-organisational processes (BG) Customer & product knowledge (BH), Defined responsibilities (BI), Collaborative organisation with a flat hierarchy (BK), Empowering leadership (BL)
	Market competition (AL), Following market trends (AL), Increasing pressure from the competition (AL), Business model innovation (BM)
	Value creation (BN), Business Processes (BO), Training (BP), Change Management (BQ), Culture-Leadership-Values (AW), Innovation Capability (AU-AY-AZ-BB), Transformation Capability (BR), Customer Centricity (BS), Operational Excellence (BT)
	Reducing the error rate (BU), Improving lead times (compliance with market conditions) (BV), Improving efficiency (BW), Ensuring reliable operation (e.g., less downtime) (BX)
	Vertical integration (ET), Horizontal integration (EU), Innovation push (BB)
	Deviant logic (FB), Discovery (FC), Development (FD), Diffusion (FE), Impact (FD), Adoption (FE)
	Digital maturity (FF), Digital readiness (FG), 2IPD (FH), Firm performance (BC)

Emergent Categories	Variables (concepts) and codes
Organisational factors (Inhibiting)	Inadequate organisational structure and process organisation (AO), Contradictory interests in different organisational units (BY), Resistance by employees and middle management (BZ), Lack of conscious planning: Defining goals, steps, and needed resources (CA), Lack of vision and strategy (AR), Poor digital-savvy culture and vision (BJ), Organisational readiness (Inhibitors) (AJ)

Technological factors (Enabling)	Technology Availability (CB), Technology Characteristics (CC), IT excellence (CJ), Interoperability (CD), Virtualization (CE), Decentralization (CF), Real-time capability (CG), Service Orientation (CH), Modularity (CI)
Technological factors (Inhibiting)	Lack of a unified communication protocol (CK), Lack of back-end systems for integration (CL), Lack of willingness to cooperate (at the supply chain level) (CM), Lack of standards (including technology and processes) (CN), Lack of proper common thinking (CP), Unsafe data storage systems (CQ), The need for large amounts of storage capacity (CR)
Environmental factors (Internal)	Staff (CZ), Financial capacity (DA) Process improvement (ER), Workplace improvement (ES), Cost reduction (EW) Employee support (EZ) Digital innovation (FA) Management support (EV), Customer demands (EX), Resource constraints (DE), Poor transition towards digital culture (DF), Limitations of IT infrastructure (DG) Lack of sufficient internal expertise required to develop e-services (DH), Custom clearance (DI), Poor digital culture (DJ), Corruption (DL), Unnecessary red-tape (DN), Micromanaging (DT), Lack of cultural knowledge (DU), Resistance to change (DV), Fear of technology (DW), Lack of relevant local content (DX), Lack of maintenance culture (DY), Lack of language skills (DZ), Low income (EA), Lack of investment (EB), Low return on investment (EC), High initial costs (ED), High risk on investments (EE)
Environmental factors (External)	Legal and regulatory framework (AK) Public trust (DC), National policy alignment (DD), Political commitment (DB) Network (Spectrum) (CY), Supply chain transformation (EY) Market pressure (AL), Laws and regulatory framework (AK) Slow customer adoption of digital services (DK) Corruption (DL), Lack of political will (DM), High taxes (DO) Lack of regional initiatives (DP), Political instability (DQ), Lack of proper planning or coordination (CA), Monopoly (DR), Invisible hand (DS), Perceived lack of privacy (EF), Insecurity (EG), Lack of proper legal framework (AK), Poor regulation (AK), Lack of software and hardware (EH), Inadequate electricity supply (EI), Lack of internet exchange points (EJ), Scarcity of technical personnel (DH), High illiteracy rates (EK), Lack of ICT skills (DH), Lack of Research and Development outputs (EL), Increasing labour shortages (EM), Reducing human work (EN), Allocating

	work force to other areas (higher added value) (EO), Lack of appropriate competences and skilled workforce (EP), Longer learning time (training of staff) (EQ)

Table 24: Emerging final themes and associated categories

Emergent Themes	Coded variables (concepts)
Adoption	A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, S, S, T, U, V, W, X, Y, Z, AA, AB, AC, AD, AE, AF, AG.
Shared Vision	AR, BI, BK, AH, AO, AP, BF, AO, BL, BQ, BR, CA, AR, CK, CN, EZ, EV, DH, DX, DC, DD, DB.
Diverging Interests	BY, BZ, CM, CP, DL, DN, DT, DV, DQ, DS.
Digital Competitiveness	AT, BN, BO, FD, FH, BC, CG, FA.
Customer Insights	BE, BH, BS, EX.
Digital Ecosystem (UPU standards and systems)	AM, AI, AL, AK, DK, DP, DR.
Digital Capabilities	AN, BA, BM, AU, AY, AZ, BB, ET, BB, FE, FF, CB, CC, CD, CE, CF, CG, CQ, DG, DI, CY, EF, EG, EH, EJ, DH, EL, EN.

Digital Investment	AI, DA, DE, EA, EB, EC, ED, EE, DK, EM.
Operational efficiency	AX, AY, AZ. AQ, AS, BG, BP, BT, BU, BV, BW, BX, CJ, CG, CL, CQ, CZ, ER, ES, EW, CA, EH, DH, EO, EP.
Digital Culture	AW, FD, FB, FC, FE, FG, BJ, AJ, DF, DJ, DU, DW, DY, DZ, EQ.

3.7 System Dynamics Research Paradigm

Guller [133] proposes that high-level models are modest models intended at strengthening insights, and analysis of complex phenomena, communication, and decision-making. Fisher [105] argues that system dynamics models have limitless opportunities to act as “flight simulators” that decision-makers may use as a training environment to conduct research and comprehend the complexity of the environments they model. Management of digital transformations and, more specifically, the effects of digital business transformations are becoming progressively complicated in the current business environment where competition and technological revolutions are dynamic and change happens at a faster pace than before [54]. A system dynamic approach offers a holistic view of the postal digital dynamics that are at play in this complex environment and will provide regulators, governments, and posts with a novel tool to manage interventions (policies) that will improve the postal system performance in Southern Africa and lead towards a sustainable future.

3.8 System Dynamics Principles and Fundamentals

Sterman [103] contends that more often, well-intentioned energies to resolve persistent difficulties create unforeseen side effects. Actions taken from decisions taken provoked unforeseen reactions. The result is policy resistance which can be defined as the propensity for interventions to be conquered by the response of the system to the intervention itself. System dynamics is better positioned to counter this blind spot that characterises human mental models that completely miss the mark due to the inability to see the whole.

Yearworth [134] notes that System Dynamics modelling arose from ground-breaking work at MIT in the 1950s by Jay Forrester. Richardson [135] notes Forrester in his ground-breaking article in the Harvard Business Review (Forrester, 1958) put forward an initial statement of the approach that would, in time, become known as system dynamics. Richardson [135] argues that Forrester (1958) fashioned the method on what were then four interesting advances: (a) Progress in computing technology (b) Growth and skill with computer simulation (c) Enhanced comprehension of strategic decision making, and (d) Advances in the comprehension of the role of feedback in complex systems. Richardson [135] notes that Forrester (1958) devised the four fundamentals of industrial dynamics:

- The concept of feedback systems.
- A familiarity with decision-making processes.
- The investigational model approach to complex systems.
- The digital computer simulates a plausible mathematical model.

Maldonado *et al.* [136] concur with [135] and suggest that system dynamics modelling has been advanced as an approach and technique to (a) Provoke such feedback loops to determine the main growth, balancing, and decay (stagnation) dynamics that drive the behaviour of socio-economic systems, (b) To inspire the system's dynamic behaviour through the application of differential equations and (c) To examine and design improved policies that will result in enhanced system performance. Maldonado *et al.* [136] further propose that the modelling process in system dynamics is grounded on iteration between all five stages: (a) Problem articulation (b) Dynamic hypothesis (c) Model formulation (d) Model testing and validation, and (e) Policy analysis and design.

Sterman [96] contends that modelling is a feedback process and not a series of linear steps and that models undergo constantly iterative, persistent questioning, testing, and enhancement. Figure 32 depicts the modelling process. And depicted in Table 25, more precisely as a reiterative cycle. The initial purpose defines the limits and scope of the modelling application, and frames what could be learned from the process of modelling through feedback to streamline a basic comprehension of the problem and the aim of the modelling effort. Iteration can occur from any step to any other step (indicated by the interconnections in the centre of the diagram). In any modelling project, one will iterate through these steps many times.

Table 25: Steps of the modelling process [100]

Element	Process
Problem Articulation (Boundary Selection)	**Theme selection:** What are the problems? Why are they a problem? **Key variables:** What significant variables and concepts must we contemplate? **Time horizon:** How far in the future should we contemplate? How far back in the past lie the origins of the problem? **Dynamic problem definition (reference modes):** What is the historical behaviour of the significant concepts and variables? What might their behaviour be in the future?
Formulation of Dynamic Hypothesis	**Initial hypothesis generation:** What are existing theories of challenging behaviour? **Endogenous focus:** Formulate a dynamic proposition that clarifies the dynamics as endogenous consequences of the feedback structure. **Mapping:** Develop maps of causal structure based on initial propositions, significant variables, reference modes, and other available data, using tools such as model boundary diagrams, Sub-system diagrams, Causal loop diagrams, Stock-and-flow maps, Policy structure diagrams, and other facilitation tools.
Formulation of a Simulation Model	**Specification** of structure, and decision rules. **Estimation** of parameters, behavioural relationships, and initial conditions. **Tests** for consistency with the purpose and boundary
Testing	**Comparison to reference modes:** Does the model replicate the problem sufficiently for your purpose? **Robustness under extreme conditions:** Does the model perform persuasively when stressed by extreme conditions?

	Sensitivity: How does the model perform given the ambiguity in parameters, initial conditions, model boundary, and aggregation?
Policy design and evaluation	**Scenario specification:** What conditions might arise? **Policy design:** What new decision guidelines, stratagems, and structures might be tried in the real-world? How can they be represented in the model? **'What if...'** analysis. What are the effects of the policies? **Sensitivity analysis:** How vigorous are the policy endorsements under different scenarios and given uncertainties? **Interactions of policies:** Do the policies intermingle? Are there synergies or compensatory responses?

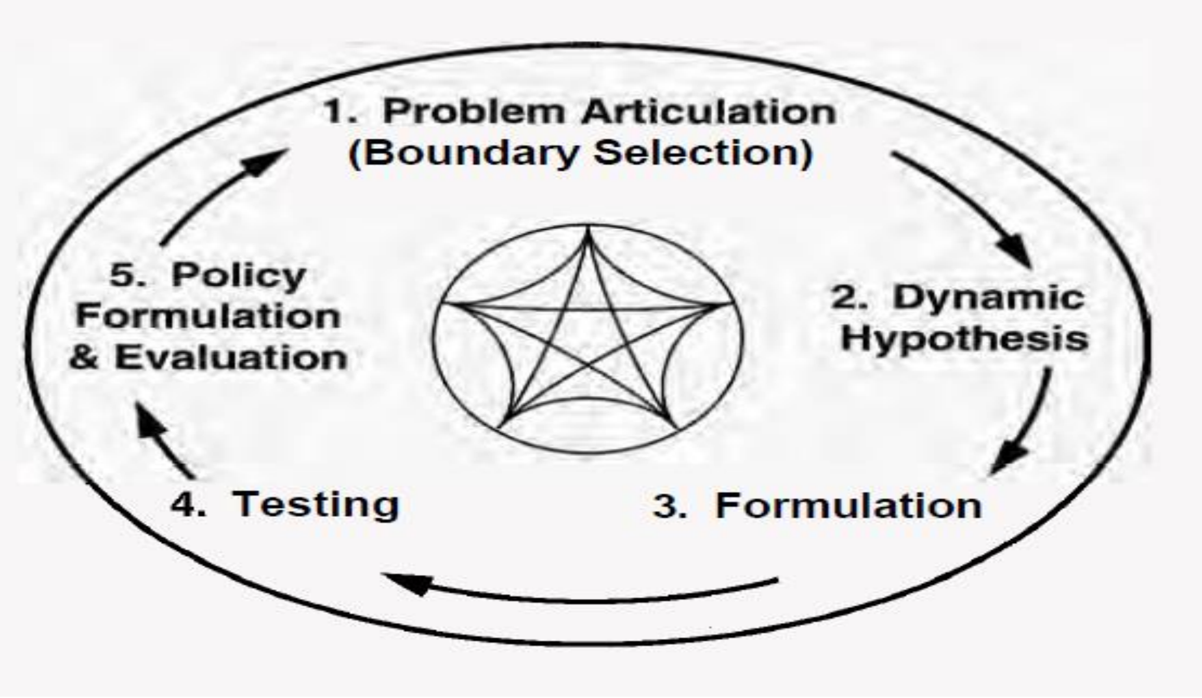


Figure 32: Modelling process [100]

Sterman [96] hypothesises that the model is grounded by mental models and by information gathered from the real-world. Stratagems, plans, structures, and decision guidelines in the real-world can be considered and tested in the simulated world of the model. The experimentations conducted in the model feedback alter our mental models and lead to the design of novel stratagems, novel plans, novel structures, and novel decision rules. These novel policies are then implemented in the real-world, and feedback about their effects leads to new insights in both our formal and mental models as depicted in Figure 33. Forrester [137] and Sterman [96] suggest that modelling is not a lone action that produces answers, but an enduring technique of incessant cycling between the virtual world of the model and the real-world of action.

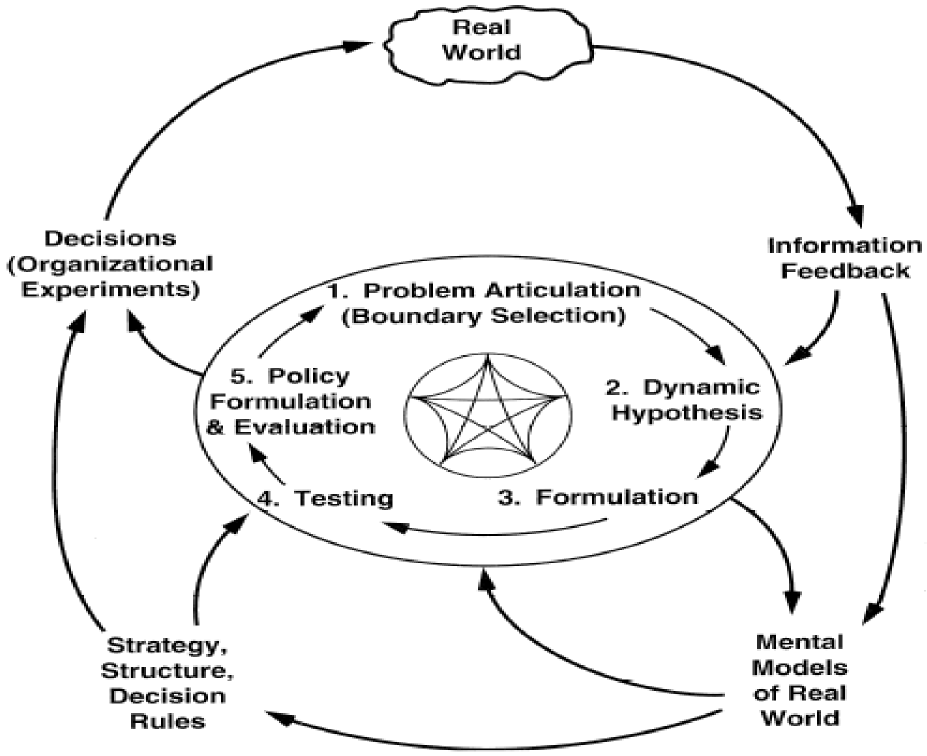


Figure 33: Modelling process embedded in dynamics of a system [100]

3.8.1 Endogeneity and Feedback

Richardson [135] suggests that the utmost prominent characteristics of the system dynamics method are indisputably stocks and flows, and feedback loops. These perceptible fundamentals stick out and grasp our attention. But it is important to note that feedback loops are a result of the endogenous point of view [135]. According to Richardson [135], Figure

34 demonstrates the idea. On the left is a depiction of a modest causal system, with causal elements extending outside the system boundary. The dynamics of variables A–E are engendered partially by the interplay among the elements within the system boundary but originate principally from variables P, Q, R, and S outside the boundary. The dynamics of this system are engendered exogenously by forces outside the system boundary.

Richardson [135] on the right is an endogenous view, in which the dynamics of variables A–E are engendered exclusively from the interplay among the variables, inside the system boundary. Considering an endogenous point of view triggers causal influences to form loops, without loops, all causal influences would point to dynamic forces external to the system boundary. Feedback loops thus enable the endogenous point of view and give it structure [135]. Sterman [96] proposes that system dynamics attempts to discover endogenous explanations for phenomena. The word "endogenous" implies "emerging from within." An endogenous theory engenders the dynamics of a system through the interplay of the variables denoted in the model.

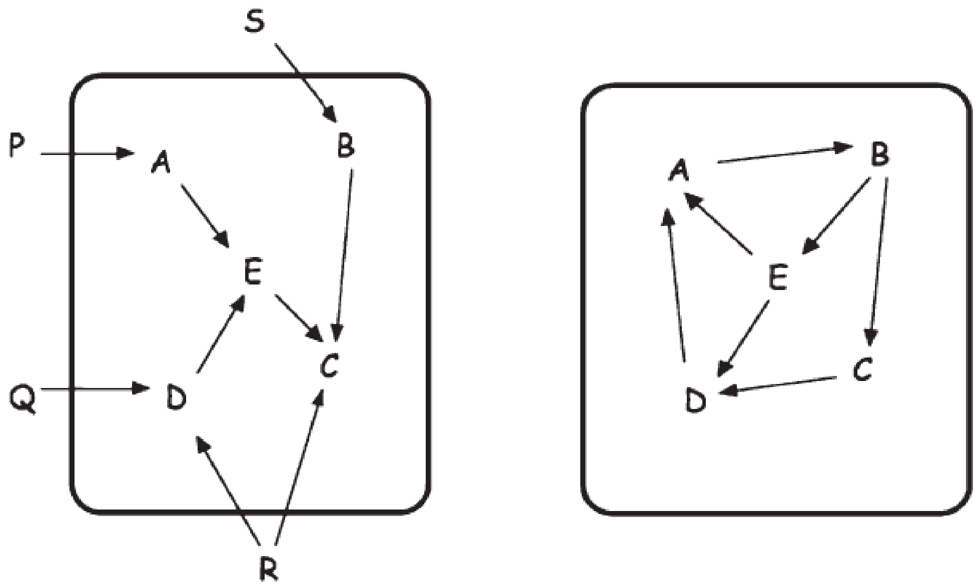


Figure 34: Left: Exogenous view of system structure; causality traces to external influences outside the system boundary. Right: Endogenous view; causality remains within the system boundary; causal loops (feedback) [139]

3.8.2 Casual Loop Diagrams

Morecroft [97] postulates that a causal loop diagram is a schematic tool for systems thinking researchers, such diagrams illustrate the cause-and-effect relations and feedback processes. Haraldsson [138] suggests that CLDs (Causal Loop Diagrams) pronounce reality through interconnections amongst variables and how they produce a dynamic circular effect. According to Haraldsson *et al.* [139], CLDs are a means for methodically detecting, examining and communicating feedback loop structures. It is systematic thinking and enables the communication of complex information into a simplified circular loop feedback structure. CLD is a tool that promotes continuous thinking [139].

Sterman [96] proposes that Causal Loop Diagrams (CLDs) are agile and valuable tools for schematising the feedback structure of systems in any realm. Causal diagrams are sketches that illustrate the causal interconnectedness between variables with arrows from a cause to an effect. Figure 35 abridges the explanations of interconnectedness polarity. Purwanto *et al.* [140] state that the ability to distinguish the arrangement of systems and to detect main feedback loops in a descriptive CLD can offer qualitative evidence about their typical dynamic behaviour. Therefore, when systems are not excessively intricate, it may be possible by observing at the CLD level to determine the behaviour of some of the variables before quantitative modelling.

Sterman [96] suggests that variables are interrelated by causal interconnectedness, shown by arrows. In Figure 37, the birth rate is influenced by the population and the fractional birth rate. Each causal interconnectedness is allocated a polarity, a positive (+) or a negative (-) to show how the dependent variable varies when the independent variable changes. The significant loops are indicated by a loop identifier which displays whether the loop is positive or negative feedback. It is noteworthy that the loop identifier correlates in the same direction as the loop to which it corresponds. In Figure 36, the positive feedback concerning births and population is clockwise corresponding with its loop identifier; the negative death rate loop is anticlockwise along with its identifier.

This view is supported by Purwanto *et al.* [140] who propose that in intricate systems, amalgamations of positive and negative causal relations may form feedback loops. There are two fundamental feedback loops, balancing (negative) and reinforcing (positive) loops. Characteristically, a balancing feedback loop contains causal relationships which cooperatively try to diminish the incongruity between the present state and the desired state. Consequently, reinforcing feedback loops frequently illustrate enduring trends of growth or decline.

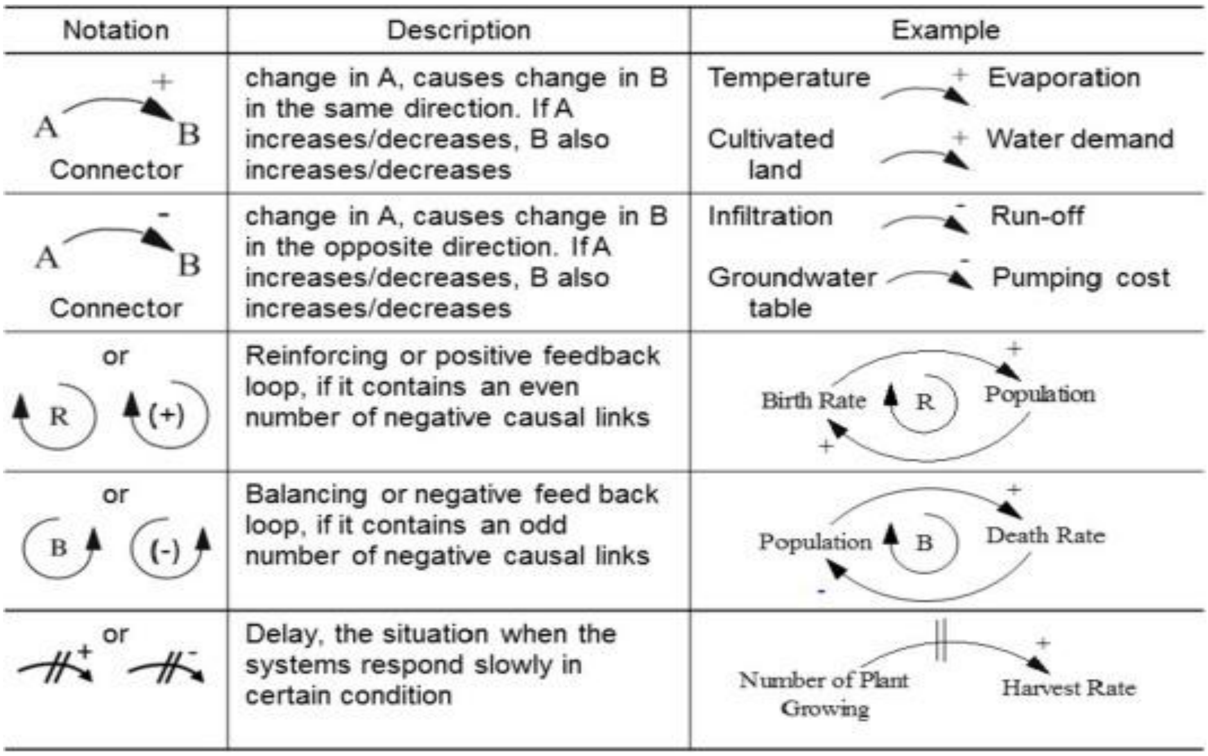


Figure 35: Graphical notation and polarity of causal relationships [144]

Sterman [96] notes that a causal diagram entails variables' interconnectedness through arrows representing the causal influences amongst the variable with the significant feedback loops identified in the diagram. Delgado-Maciel *et al.* [141] suggest that CLD uses diagrams to classify feedback loops. In this diagram, an arrow signifies the causal interconnectedness between some variables. The graph, in addition, has a polarity which signifies the kind of influence, positive or negative. Figure 36 depicts the relations between two variables and their polarity. Figure 36 depicts a simple representation of a CLD and in this instance, it reveals that the population increase is strengthened by the number of births while the number of deaths diminishes the population and impedes the effect of the reinforcing loop.

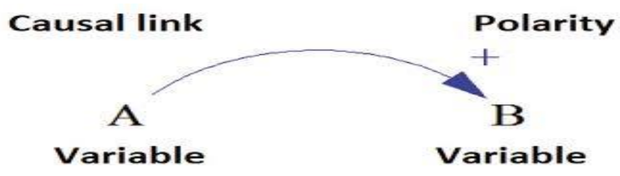


Figure 36: Polarity between two variables [145]

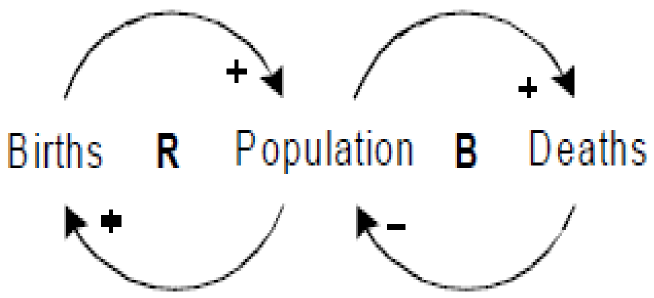


Figure 37: A simple casual loop [143]

3.8.3 Stocks and Flows

Iandolo [142] argues that System Dynamics (SD) models can be evaluated through simulation, which is conceivable after the creation of a Stock and Flows Diagram (SFD). An SFD is a quantitative valuation of the system. The Dynamics of the system are evoked in the SFD, and the model construction is arranged through the elaboration of equations that pronounces how the variables are interconnected with others, and how the build-up process is determined by the change in the flows fluctuating the state of the system levels. Ogano [143] proposes that one of the chief confines of CLDs is the failure of CLDs to comprehend the stock-and-flow structure of a system. A stock is the building block of any system. Stocks are the essentials of the system that can be perceived, sensed, calculated, or measured at any given time. A system stock is an accretion of material or information that has built up over time, a reminiscence of the antiquity of fluctuating flows within the system [93]. Ogano [143] further argues that stocks change over time through the actions of a flow. Flows are filling and draining, births and deaths, procurements and sales, growth and decay, payments and withdrawals, triumphs, and disappointments. A stock, then, is the current reminiscence of the antiquity of changing flows within the system.

Meadows [93] proposes that Figure 38 depicts stocks depicted as boxes and flows depicted as arrow-headed “pipes” flowing into or out of the stocks. The small T on each flow indicates a “faucet;” it can be turned higher or lower, ON or OFF. The “clouds” stand for wherever the flows emanate from and disappear.

A source or sink either has an infinite, unchangeable concentration or a basin that is outside the boundaries of the system under investigation.

Figure 38: Simple stock-and-flow diagram [96]

As depicted in Figure 39, the volume of wood in the living trees in a forest is stock. Its influx is the growth of the trees. Its depletions are the normal deaths of trees and their harvest by loggers. The logging harvest flows into another stock, conceivably an inventory of lumber at a mill. Wood flows out of the inventory stock as lumber that is sold to customers.

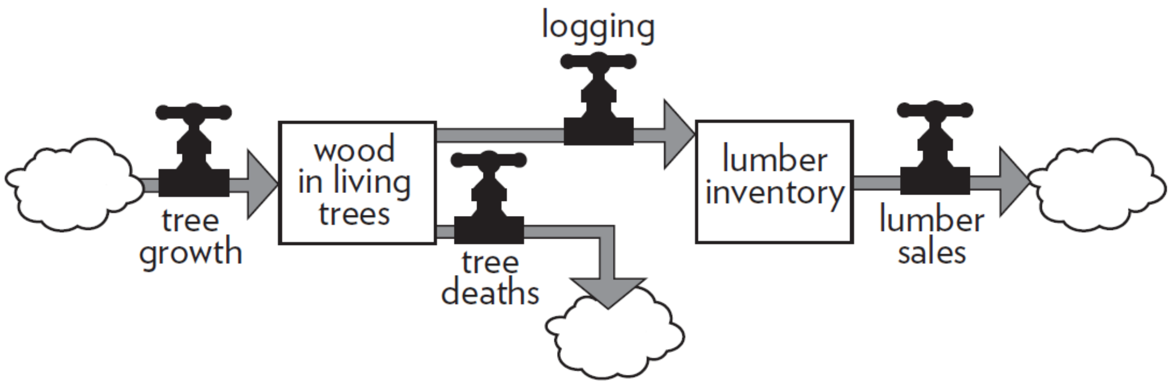


Figure 39: A stock of lumber links to a stock of trees in a forest [96]

Sliwa [144] proposes that stocks are essential in producing the dynamics of systems, and suggests that stocks illustrate the state of the system and provide the source for their actions.

The evaluation of a problem resolution is principally grounded on the stocks' values. Stocks do not have to be perceptible; stocks can be defined as representing the accretion of information, experience, invention, contagions, impetus, or professed quality of a product. Sliwa [144] further proposes that stocks are important for the following reasons:

- Stocks offer systems with inertia and memory; they accumulate historical events and can vary because of the net value of influx and depletion.
- Stocks are the source of delays.
- Stocks detach rates of flow and create an imbalance in a problem.

3.8.4 Mathematical Approach to Stocks and Flows

Sliwa [144] argues that stock-and-flow structures have an exact scientific meaning. Stocks accrue or integrate their flows with the equivalent integral equation, as denoted in Equation 1 below:

$$Stock(t) = \int (Inflow - Outflow)\,(dt) + Stock\,(t-1) \qquad \text{Equation 1}$$

Where (t)=final time, (dt)=time interval, (t-1) = Preceding time moment

Sliwa [144] proposes that the expression Stock (t -1) offers variables with a “recollection” assuring that the stock variable does not overlook its preceding state. Stock variables transform relative to the net flow into it; consequently, the net proportion of change of any stock is its inflow minus its outflow, defining the differential equation:

$$d(Stock)/dt = (Inflow - Outflow)\,(t) \qquad \text{Equation 2}$$

Consequently, Sliwa [144] argues; an equivalent stock-and-flow can be effortlessly constructed from any system of integral or differential equations and in addition, a stock-and-flow map of the equivalent integral or differential equation system can be engendered.

3.9 System Dynamics Approach in Technology Adoption

Maldonado *et al.* [136] note that dynamics of innovation and technology adoption have been modelled employing system dynamics, and propose that according to these SD models, diffusion processes are characterised by non-linearity as innovations are communicated through certain channels over time. The initial category to adopt a novel innovation is innovators in the context of research undertaken by Rogers (1962) and they are followed by imitators at different levels of the product life cycle ranging from early majority to laggards.

Sterman [96] notes that the rate of probability of adopting an innovation trail a contagion process, analogous to epidemics [96], and that the demand by innovators, intensifies sales and diminishes the potential market (or potential adopters) as they have become "infected"; as the proportion of "adopters" surges, demand by imitators increases as well, boosting total demand and sales and reducing the potential market [136]. The adoption process depends on numerous aspects, beyond "social imitation", including the supply side, the demand side, and the institutional side [136].

Figure 40 depicts a CLD together with the significant feedback loops of innovation diffusion and technology adoption.

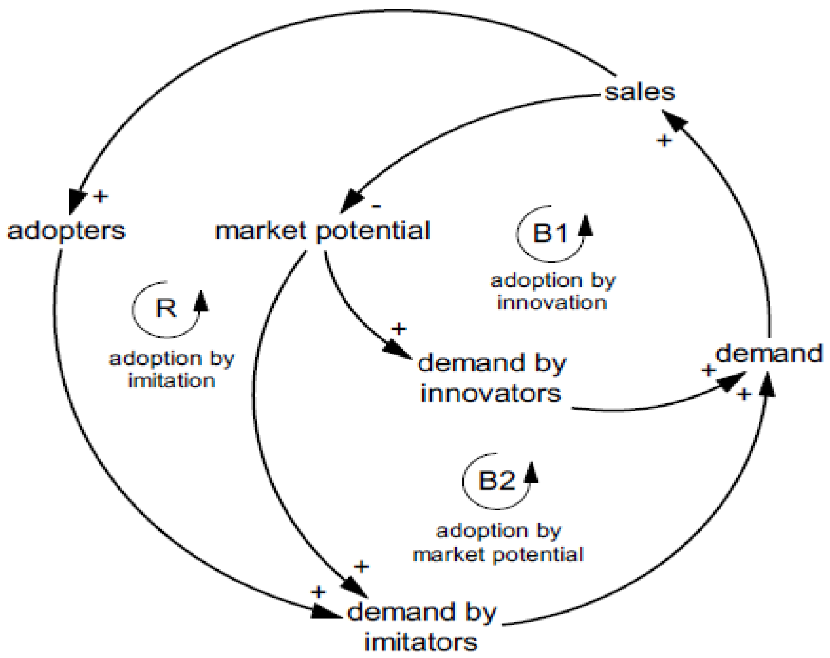


Figure 40: Key feedback loops in the dynamics of innovation diffusion [140]

Sterman [96] contends that the behaviour of a system ascends from its structure. That structure consists of the feedback loops, stocks, flows, and non-linearities formed by the interplay of the physical and institutional structure of the system with the decision-making processes of the players acting within the system. This phenomenon of the behaviour of a system in a dynamic setting is depicted in Figure 41, below.

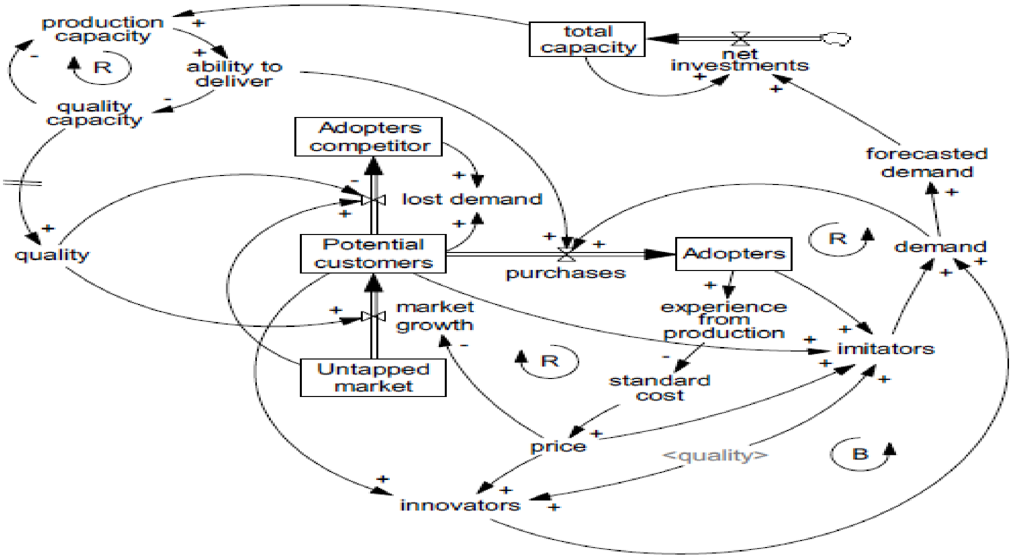


Figure 41: Stock-and-Flow diagram for the dynamics of innovation diffusion [140]

Mokgohloa *et al.* [145] argue that in contrast to a dynamic environment characterised by "causality," which is the core idea of a system thinking approach, traditional technology adoption models are characterised by "linearity," which is the antithesis of that. A linear approach to digital transformation and technology adoption is ineffective in the postal industry due to the several players and their frequently conflicting interests. A systemic approach is therefore necessary. Chen [146] proposes that the adoption of new technologies is the consequence of intricate interactions and feedback taking place in a dynamic context. Adoption is a widespread practice that spans many organisations. It involves intricate exchanges and feedback between businesses, IT companies, decision-makers and policymakers.

The postal industry in Southern Africa is a good candidate for a system-dynamic approach to technology adoption due to mandate, policies at international, continental, regional and national levels; interests from various stakeholders such as government, regulators, unions, management, and society at large with opposing interests in a dynamic setting. Therefore, System Dynamics modelling is relevant for modelling the technology adoption and digital transformation drivers and barriers in the postal sector in Southern Africa and the postal sector in developing countries at large.

System Dynamics was preferred as the apt modelling approach in this research mainly from insights gained from the literature review. The adoption and diffusion processes can be compared to the complex contagion process [103] in nature because the adoption and diffusion process especially, in the highly regulated postal sector in Southern Africa, can be viewed as a complex phenomenon buttressed by multiple stakeholders with competing interests, operating in an environment with respective inhibitors and enablers that interplay in a dynamic setting.

3.10 Problem Articulation

Sterman [96] proposes that problem articulation is the main phase in the modelling process. At the problem articulation phase, the problem under study should undoubtedly be expressed together with the aim or goal of the model. It is at this point that the variables that will be used in the modelling effort are distinctly identified, and which variables are endogenous, exogenous, and those that are excluded. System dynamics pursue endogenous elucidations for phenomena. The word "endogenous" means "arising from within." An endogenous theory engenders the dynamics of a system as a result of the interplay of variables and agents represented in the model [96].

As articulated in the problem statement in Chapter 1, the calamities that have befallen DPOs in Southern Africa have triggered the near collapse of the sector owing to poor performance on the 2IPD. This is supported by the score of each Post in Southern Africa obtained on the 2IPD.

The deficit in performance by SADC DPOs is fueled by an overabundance of factors which includes rigid or rather out-of-date business models that are not adjusting to the digital age and associated technologies that are disrupting present business models enormously. The outdated business models cannot contend in the 21st century and this results in the majority of DPOs in Southern Africa posting losses year in and year out. The lack of financial sustainability of the DPOs leaves the respective governments in their respective countries with no option but to bail out these institutions, which becomes a burden to taxpayers.

3.11 Dynamics Hypothesis

Hassan [147] argues that the dynamic hypothesis is an abstract model archetypally comprising a CLD and sub-system diagram that examines the system qualitatively. A dynamic hypothesis is a theory relating to a structure that is in existence that creates the reference modes [143]; [148], it is a functioning theory of the manner a particular problem developed [96] which can be stated vocally, as a CLD, or finally as an SFD [143]. The dynamic hypothesis developed is beneficial as it can be utilised to establish the system boundary (what can be included and what can be excluded in the model).

The poor performance of the postal sector in Southern Africa on the Integrated Index on Postal Development (2IDP) and Digital Readiness Index can be ascribed to different dynamic factors that are at play. These factors were elucidated and the resultant emergence of themes through a rigorous process of grounded theory research. This research creates a sub-system diagram and conceptual model to explicate the big picture of the postal sector in Southern Africa. Moreover, the qualitative model will be transformed into a quantitative system dynamics model with respective stocks and flows. The dynamic hypothesis is further restated in Chapter 5; a process of eliminating duplications and streamlining the emergent dimensions.

The initial dynamic hypothesis is that the adoption of industry 4.0 technologies will improve the financial sustainability of the postal sector. This hypothesis is further refined in Chapter 4 to take into cognisance the insights gained from the conceptual model that was developed and was a precursor to the development of the stock-and-flow system dynamics model.

3.12 Model Development and Design

The model structure may be constructed to embody the interaction of both barriers and drivers that are at play in the adoption of technology and digital transformation in a dynamic setting. These variables (drivers and barriers) are causally and mathematically connected as presented in the Causal Loop Diagram (CLD) and System Architecture Map (SAM). The Anylogic software is employed in developing the system dynamic model and permits for a rigorous engagement with the practitioners in the postal sector to interact with the model and simulate scenarios. This rigorous engagement allows for the refinement of the model to closely represent reality.

3.13 Model Testing and Validation

Roy and Mohapatra [149] suggest that model validation is a vital feature of any model-based approach, in particular, with a system dynamics approach, and validation of models is one of the most important phases in the process of system dynamics [150]. Model validation is a "set of procedures envisioned to validate that models are performing as anticipated, in line with their design objectives and business uses" [151]. The purpose of model validation is to assure that there are no inconsistencies between the model and the dynamic hypothesis [152].

Fonnesbeck [65] proposes that testing permits the user and modeller to cultivate confidence in the model as a useful and appropriate decision-making tool. Validation of the system dynamic model is relative to the degree the user utilises the model for decision-making in the context of the area under study. As the model undergoes numerous rigorous tests, the user and modeller earn trust in the model, and where the model underperforms, it can be refined and adjusted accordingly until the user trusts the model as a close reflection (mirror) of the real-world.

Sterman [96] proposes seven key tests for evaluating dynamic models which are the boundary adequacy test, structure assessment test, dimensional consistency test, parameter assessment test, extreme conditions test, behaviour anomaly test, and sensitivity analysis test. Table 26 articulates the seven key tests for evaluating dynamic models.

Table 26: Tests for the assessment of dynamic models [100]

Test	**Purpose of test**
Boundary adequacy test	Are the significant notions for addressing the problem endogenous to the model captured?
	Does the behaviour of the model vary significantly when boundary assumptions are relaxed?
	Do the policy recommendations vary when the model boundary is extended?
Structure Assessment	Is the model structure in line with the relevant descriptive acquaintance of the system?
	Is the level of aggregation appropriate?

	Does the model obey basic physical laws such as conservation laws?
	Do the decision guidelines capture the behaviour of the actors in the system?
Dimensional Consistency	Is each equation dimensionally reliable without the use of parameters having no real-world meaning?
Parameter Assessment	Are the parameter values consistent with relevant descriptive and mathematical knowledge of the system?
	Do all parameters have real-world equals?
Extreme Conditions	Is each equation sensible even when its inputs take on extreme values?
	Does the model reply conceivably when exposed to extreme policies, shocks, and parameters?
Behaviour anomaly test	Do uncharacteristic behaviours result when assumptions of the model are changed or deleted?
Sensitivity analysis test	Numerical sensitivity: Do the mathematical values alter significantly when assumptions about parameters, boundary, and aggregation are varied over the conceivable range of uncertainty?
	Behavioural sensitivity: Do the modes of behaviour generated by the model change meaningfully when assumptions about parameters, boundary, and aggregation are varied over the probable range of uncertainty?
	Policy sensitivity: Do the policy implications vary meaningfully when assumptions about parameters, boundaries, and aggregation are varied over the plausible range of uncertainty?

The data collected and analysed in the previous chapter through a grounded theory approach resulted in ten key variables that will be used in the subsequent chapter to develop the reference modes which depict the problem and inform the dynamic hypothesis. Sterman [96] describes a reference mode as a set of graphs that generates the behaviour of variables over a period. These reference modes could be oscillating, s-shaped growth, exponential growth, growth with overshoot, and overshoot and collapse, and are depicted in Figure 42.

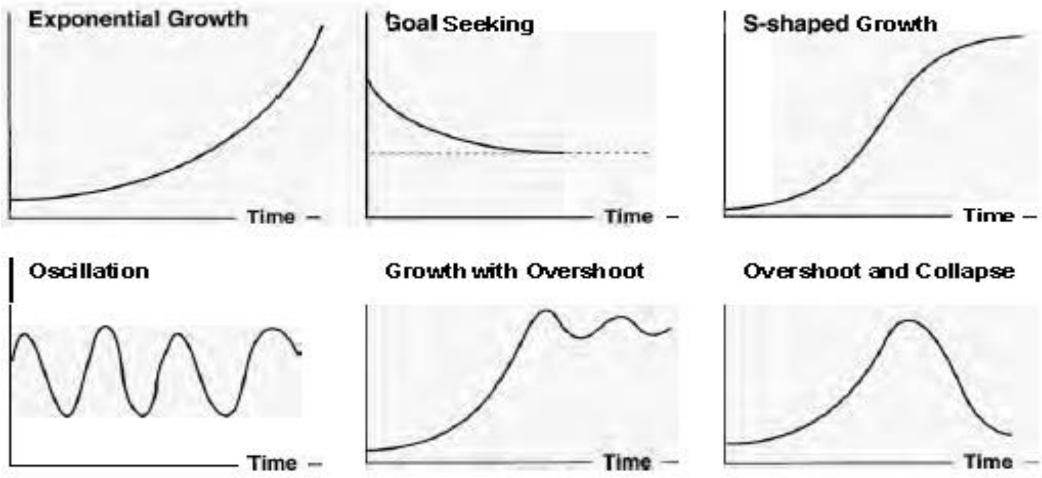


Figure 42: Common modes of behaviour in dynamic systems [100]

After the model has been verified, using applicable assessments and procedures as outlined in Table 26, all stakeholders in the modelling process are convinced that the model meets specifications and is a mirror of reality. The modeller can then augment the model with leadership interventions that can lead to the implementation of policies within the system. Fonnesbeck [65] suggests that the intricacies related to dynamic systems make it challenging for managers to comprehend what effects their interventions will have in the system, and as a result, the modeller should explore management interventions under divergent conditions and contexts.

Good managers and leaders could formulate policies that seem beneficial in the short-term, but over the medium to long term; unintended consequences take hold giving rise to other problems within the system boundary. On the other hand, decisions that appear bad in the short-term could turn out to be good in the medium to long term. System dynamic modelling is geared to solve this type of challenge. The value of a system-dynamic approach to digital transformation and technology adoption is a reduction in uncertainty for various policy actions and management actions.

This research was aimed at assisting policymakers and administrators to optimise policy design and management actions in a dynamic setting driven by volatility, uncertainty, complexity, and ambiguity (VUCA) to make informed decisions that will improve the performance of the postal sector in the context of the integrated index on postal development (2IPD) and digital readiness index for long term sustainability of the postal sector in Southern Africa.

3.14 Chapter Summary

This chapter articulated the research methodology adopted in the study which discussed the philosophical worldview, the research approach, the research strategy, the research methodological choice, and as well as the data collection procedures and data collection tools. A qualitative research design was utilised in this study guided by the deployment of a Grounded Theory research strategy which was used to engage with secondary data from both academic literature and industry reports that were reviewed in Chapter 2. The philosophical worldview adopted is interpretivism/constructivism of a qualitative grounded theory inductive (theory building) approach where secondary data were sourced from industry reports and related academic peer-reviewed literature. The grounded theory method was used to develop emergent dimensions that underpin digital transformation dynamics in the postal sector in Southern Africa.

The grounded theory fundamentals, data gathering, data analysis, and emergent theory (the ten dimensions/variables) were tailed by a thorough articulation of systems dynamics modelling as the methodology adopted to quantitatively model the interaction of the variables in a dynamic setting and comprehend feedback, resulting from the interaction of the ten variables. The fundamental concepts and underlying principles of system dynamics were articulated in-depth including stages to be followed in model development such as problem articulation, dynamic hypothesis, model development, and design, and lastly, model testing and validation.

The emergent dimensions were used to develop a dynamic model archetypical of the digital transformation and technology adoption dynamics in the postal sector in Southern Africa employing the System Dynamics modelling approach. In this study, data were initially gathered through an exploratory study utilising grounded theory and then deployed to develop a conceptual system dynamics model which, through rigorous testing by practitioners in the postal sector in Southern Africa, is refined into a system dynamics simulation model.

The next chapter presents and discusses the conceptual model, the causal loop diagrams, the emergent stocks, the emergent causal loop diagram, and the restated hypothesis, as well as the quantification of variables and the mathematical expressions that define the model.

CHAPTER 4: MODEL CONCEPTUALISATION

4.1 Introduction

This chapter commences with a summary of the data gathering and data examination that were articulated in the preceding chapter. This chapter elucidates the variables (categories) that emerged from the grounded theory research process, the variables will be employed to construct both the qualitative and quantitative models which are the subject of discussion in this chapter. This chapter provides a generic conceptual model overview that describes the interaction of the variables in a dynamic setting in the form of a sub-system diagram. Ten main subsystems complete the whole system and are adoption, digital ecosystem, digital culture, shared vision, digital investment, operational excellence, digital capabilities, customer insights, diverging interests, and digital competitiveness.

The system dynamics approach necessitates the researcher to unearth the substantial, collected system elements that impact the problem under investigation. As deliberated in the previous chapter, there are ten categories (variables) that arose from the grounded theory research which are: adoption, digital ecosystem, shared vision, customer insights, digital culture, diverging interests, digital investment, operational excellence, digital capabilities, and digital competitiveness. Diverging interests, digital culture, and customer insights endogenously affect (positively or negatively) each of these key processes.

The factors, as depicted in Figure 43, are entwined in a loop. The development of the loops, on the one hand, affords an endogenous elucidation for behaviour and permits the system structure to determine behaviour instead of exogenous variables that externally determine behaviour. As explained above, endogenous variables (inside the boundary) are digital culture, shared vision, adoption, digital investment, operational excellence, digital capabilities, and digital competitiveness.

Exogenous variables, on the other hand, entail a digital ecosystem, diverging interests, and customer insights. The exogenous variables are not engendered by endogenous variables, but they influence the endogenous variables. The exogenous variables describe the setting within which the postal sector operates, but over which the DPOs have no direct control, depending on the context some of the variables can be endogenous but, in another dimension, could be exogenous. The endogenous and exogenous variables are depicted in Table 27.

Table 27: Endogenous and exogenous variables

Endogenous variables	Exogenous variables
Adoption	Diverging interests
Shared vision	Customer insights
Digital investment	Digital ecosystem
Operational excellence	
Digital capability	
Digital competitiveness	
Digital culture	

This chapter further articulates the stocks and flows construction of the simulation model of digital transformation dynamics and complex policy analysis and design in the postal sector in Southern Africa. Quantitative facets of system dynamics are explained on the mathematical approach through the application of differential equations to stock-and-flow variables in a system simulation depiction. Herein, the thorough model is classified into eight sub-models: shared vision, digital culture, digital investment, operational excellence, digital capability, digital competitiveness, digital ecosystem, and adoption of digital technologies among postal stakeholders. Diverging interests and customer insights are exogenous variables but are inputted into the system and interact in a dynamic setting with endogenous variables.

These sub-models incorporate stocks, flows, and influence interconnectedness that flows into flow variables as articulated in Chapter 3 and Chapter 4. The formation of block models is based on the “influence” diagrams articulated in Chapter 4. Since the dynamic hypothesis has been articulated in detail, an SD model in the simulated world can be developed where recreation, testing, and investigation can ensue. In the development method, there is a requirement that every variable is quantified (including equations) and the structure that emerged from the dynamic hypothesis is encompassed in the framed model. The empirical data from the system will be used to harmonize the model with actual data from the DPOs.

4.2 Conceptual Model as a Sub-system Diagram

The conceptual model is the initial step in modelling digital technology adoption dynamics in the postal sector in Southern Africa with system dynamics. The vital system components are all exhibited and articulated as espoused in the variables. These include both endogenous and exogenous variables and some of the variables could be classified as both endogenous and exogenous depending on the context and perspectives. System dynamics modelling is utilised as the core tool of analysis from a strategic perspective in this research in the context of the postal sector in Southern Africa.

The conceptual model is depicted in Figure 43. The sub-system diagram emanates from the grounded theory research process in which the ten dimensions (variables) emerged.

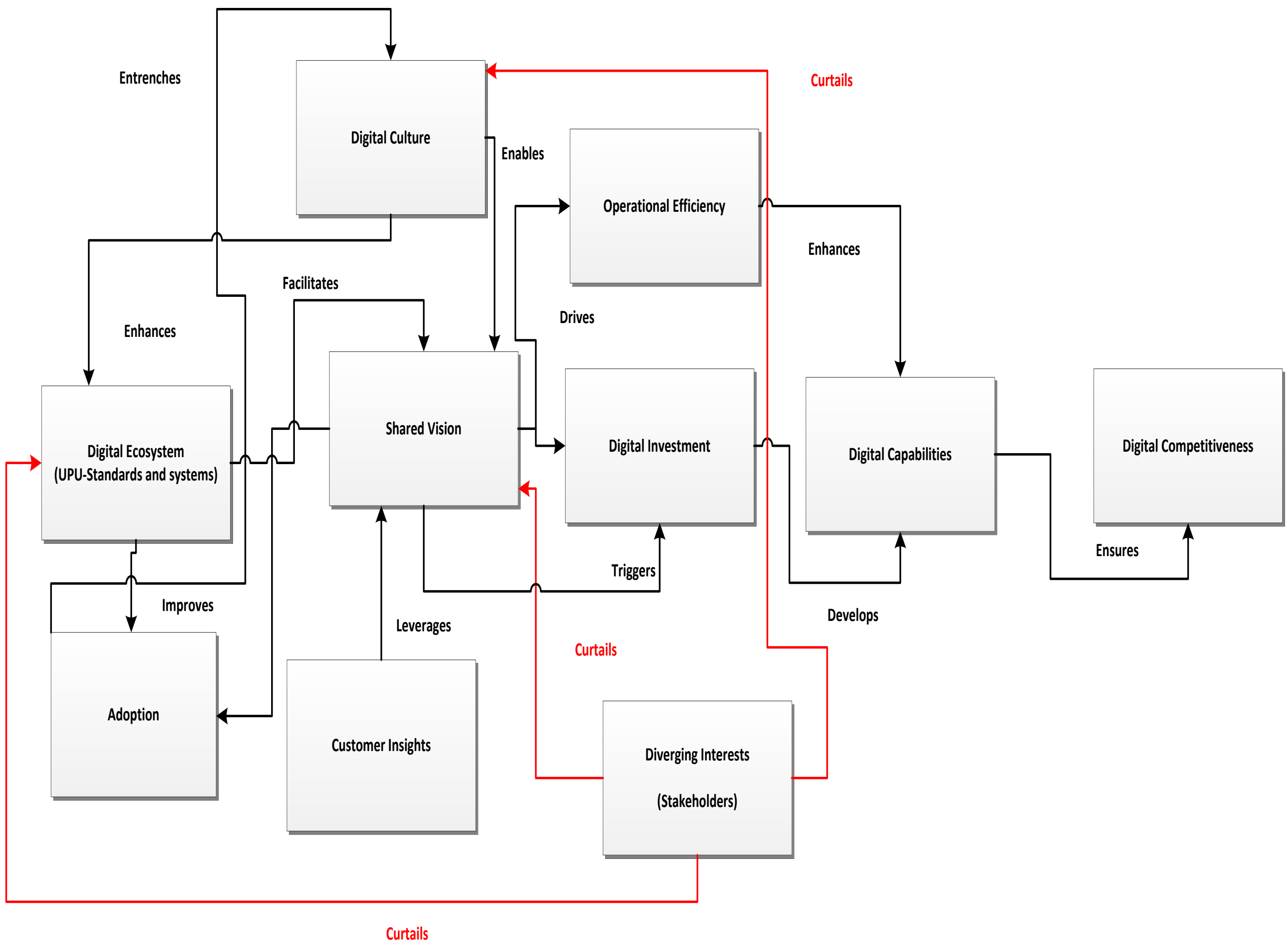


Figure 43: A conceptual model overview of digital transformation dynamics for the postal sector in Southern Africa

The proposed conceptual framework presented in Figure 43 denotes the illumination of the insights and subsequent synthesis of the grounded theory research which was elaborated upon in the preceding chapter. The Universal Postal Union (UPU) endeavours to create a digital ecosystem through its business processes, standards, and systems in which the postal sector transacts. The digital ecosystem entrenches a deep digital culture that enables shared vision. A shared vision is leveraged through customer insights. Adoption of the systems, standards, and protocols of the UPU which epitomizes the digital ecosystem, entrenches a deep and robust digital culture. A robust digital culture, on the other hand, enhances the digital ecosystem and enables a shared vision.

An unambiguous shared vision amongst stakeholders drives operational efficiencies and triggers digital investment. Digital investment develops digital capabilities and on the other hand, operational excellence enhances digital capabilities. Digital capabilities ensure digital competitiveness which incorporates factors such as digital innovation and digital disruption. Diverging interests are illuminated in red solid lines and they denote inhibitors ranging from institutional to organisational, inhibit or rather curtail a shared vision, digital culture, and digital ecosystem and ultimately negatively affect the path towards digital competitiveness. Customer insights, digital ecosystem, and digital culture are inputs to a shared vision that ensures the development of digital capability through operational excellence and digital investment which results in digital competitiveness. It is crucial to mitigate diverging interests to achieve competitiveness that embodies the financial sustainability of the postal sector.

At this stage, the dynamic conceptual model is employed as a framework to obtain comprehension of the interaction of the ten variables in a dynamic setting in the context of the postal sector in Southern Africa. The conceptual model elucidates the logical relationship between variables and is a critical step towards the construction of a system dynamic model to simulate the interaction and resultant dynamics at play between diverse variables in a dynamic setting. It is the study that intends to develop the system dynamics model and validate the appropriateness of the variables and the rationality of the interconnectedness between variables.

The postal sector has been connecting people and society at large for more than a century and has been a pillar of society for the longest time. The digital age has disrupted business models in all sectors of society and the postal sector is not insusceptible to these strong currents of change. It is, therefore, critical that the postal sector in Southern Africa as a casing point adopt digital technologies and embrace digital transformation with the necessary urgency to ensure its long-term sustainability. It is often wrongly assumed that the postal sector is on the decline because of pipeline efficiencies within its business processes. However, the facts point to a completely different direction; the postal sector is facing a momentous crisis because of "tectonic shifts" in the marketplace, a shift steered by I4.0, a shift from the industrial age to the digital age.

4.3 Causal Loop Diagrams

Hassan [147] suggests that as defined in system dynamics, a causal loop diagram also branded as an "influence diagram" is a potent technique to explicitly illustrate the dynamic feedback relationship between variables within each sub-system. This view is reinforced by Duggan [153] who advances that a feedback loop is a chain of spherical causal interconnectedness, in which the level of a stock affects a flow, which in turn alters the stock. In contrast to model conceptualisation or sub-system diagram, the causal loop diagram permitted the researcher to distinguish the variables and respective interconnectedness between variables that were employed in the simulation model. The model will then be constructed through the established logical interconnectedness through stocks and flows as contended by [153].

The variables and parameters will be estimated based on data gathering and examination articulated in the preceding chapter. Entirely, the model comprises ten sub-system diagrams interacting with each other in a dynamic setting. The ten variables (categories) articulated in the preceding section 4.2 are adoption, digital ecosystem, digital culture, shared vision, customer insights, digital investment, digital capability, operational excellence, competitiveness (financial sustainability), and diverging interests.

The model overview, as depicted in Figure 43, was further developed into a CLD conceptual model which depicts the dynamic hypothesis of the digital transformation dynamics in the postal sector in Southern Africa depicted in Figure 44. Each interconnectedness and loop will be elaborated upon in Tables 28 and 29 respectively.

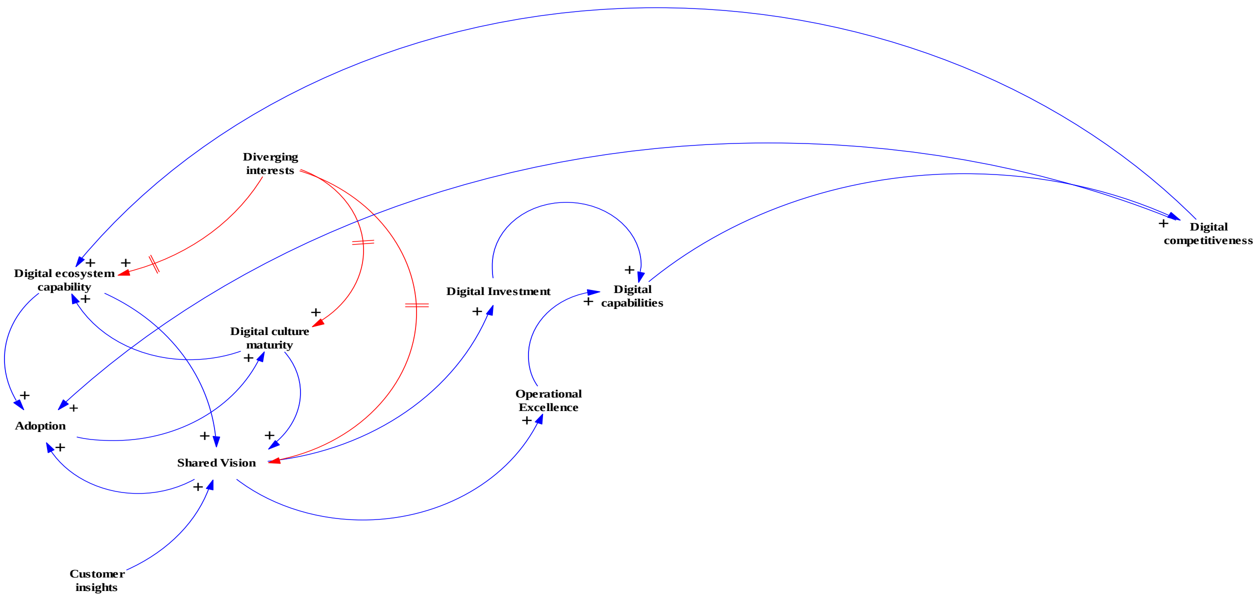


Figure 44: CLD of postal digital transformation dynamics for the postal sector in Southern Africa

Table 28: Description of digital dynamics interconnectedness

Interconnectedness	**Explanation**
Diverging interests relating to digital culture maturity interconnectedness.	This interconnectedness suggests that diverging interests in the postal sector in the region will likely negatively affect the maturity of digital culture. The delay mark on the loop signifies time delays concerning diverging interests impacting digital culture maturity.
Diverging interests relating to digital ecosystem capability interconnectedness.	This interconnectedness suggests that diverging interests in the postal sector in the region will most likely affect effective and efficient participation in the digital ecosystem. The delay sign signifies time delays for the behaviour to take hold.
Diverging interests relating to shared vision interconnectedness.	This interconnectedness suggests that diverging interests in the postal sector in the Region impede convergence and buy-in into a shared vision or shared purpose.

Digital ecosystem influence on digital adoption interconnectedness.	This interconnectedness suggests that the digital ecosystem of the postal sector in the region will positively influence digital adoption.
Digital adoption influences digital culture interconnectedness.	This interconnectedness suggests that digital adoption will positively influence digital culture, as more stakeholders adopt digital transformation pathways; the digital culture of stakeholders will heighten.
Digital culture influences digital ecosystem interconnectedness.	This interconnectedness suggests that as the digital culture matures within the postal sector in the region, the postal digital ecosystem will improve significantly as more users, suppliers, and aggregators become part of the digital ecosystem.
Digital ecosystem influence on shared vision interconnectedness.	This interconnectedness suggests that a sound and mature digital ecosystem will positively influence shared vision amongst stakeholders.
Shared vision influence on digital adoption interconnectedness.	This interconnectedness suggests that a convergence of purpose in the form of a shared vision in the postal sector in the region positively impacts digital adoption by stakeholders of the postal sector in the region.
Digital culture influences shared vision interconnectedness.	This interconnectedness asserts that a maturing digital culture will augment buy-in and unity of purpose through a shared vision amongst stakeholder participants in the postal sector in the region.
Shared vision influences operational excellence interconnectedness.	This interconnectedness asserts that a shared vision amongst stakeholders and decision-makers in the postal sector in the region will heighten operational excellence within the business processes of the postal sector in the region,
Shared vision influences digital investment interconnectedness.	This interconnectedness asserts that a shared vision amongst stakeholders and decision-makers in the postal sector in the region will trigger investment in digital technologies.
Digital investment influences digital capabilities interconnectedness.	This interconnectedness reveals that investment in digital technologies in the postal sector in the region will ensue in increased digital capabilities within the region.

Operational excellence influences digital capabilities interconnectedness.	This loop reveals operational excellence in the postal sector in the region will boost digital capabilities within the region.
Digital capabilities influence digital competitiveness and interconnectedness.	This interconnectedness asserts that the more the postal service is digitally capable, the more digitally competitive is the postal service.
Digital competitiveness influences digital ecosystem capability interconnectedness.	This loop reveals that digital competitiveness will positively influence a robust digital ecosystem.
Customer insights influence shared vision interconnectedness.	This interconnectedness reveals that the incorporation of customer insights as in the voice of the customer will push the postal industry in the region to find a unity of purpose espoused as a shared vision amongst stakeholders in meeting and exceeding customers' requirements.
Digital competitiveness capability influences adoption interconnectedness.	This interconnectedness reveals that digital competitiveness capability will positively reinforce adoption.

Table 29: Description of digital transformation dynamics loops

Loop	**Explanation**
R1: Diverging interests-decreasing digital ecosystem capability-digital ecosystem capability-new revenue streams-digital competitiveness.	This loop suggests that increasing diverging interests amongst stakeholders will reinforce a decreasing digital ecosystem capability which will curtail new revenue-generating streams and negatively impact digital competitiveness.
R2: Diverging interests-decreasing digital ecosystem capability-digital ecosystem capability-cost-streamlining- digital competitiveness.	This loop suggests that increasing diverging interests amongst stakeholders will reinforce a decreasing digital ecosystem capability which will curtail cost-streamlining and negatively impact digital competitiveness.

R3: Diverging interests-increasing digital ecosystem capability-digital ecosystem capability-catalysis of adoption speed -digital competitiveness.	This loop suggests that increasing diverging interests amongst stakeholders will curtail an increasingly digital ecosystem capability which will slow down or bring to a grinding halt adoption speed and negatively impact digital competitiveness.
R4: Diverging interests-adoption-digital investment-digital talent-digital capabilities-increasing digital ecosystem capability-digital ecosystem capability-new revenue streams-digital competitiveness.	This loop suggests that increasing diverging interests amongst stakeholders will curtail digital investments which will reduce digital talent. A lack of digital talent will reduce digital capabilities which in turn will result in a decline in the capability of the digital ecosystem. A decline in the capability of the ecosystem will curtail new revenue streams and negatively impact digital competitiveness.
R5: Diverging interests-adoption-digital investment- digital talent-digital capabilities-increasing digital ecosystem capability-digital ecosystem capability- cost-streamlining-digital competitiveness.	This loop suggests that increasing diverging interests amongst stakeholders will curtail digital investments which will reduce digital talent. A lack of digital talent will reduce digital capabilities which in turn will result in a decline in the capability of the digital ecosystem. A decline in the capability of the ecosystem will curtail cost-streamlining measures and will negatively impact digital competitiveness.
R6: Diverging interest-adoption-digital investment-digital talent-digital capabilities-increasing digital ecosystem capability-digital ecosystem capability-catalysis of adoption speeds-digital competitiveness.	This loop suggests that increasing diverging interests amongst stakeholders will curtail adoption by stakeholders which will trigger a reduction in digital investments which will reduce digital talent. A lack of digital talent will reduce digital capabilities which in turn will result in a decline in the capability of the digital ecosystem. A decline in the capability of the ecosystem will slow down the catalysis of adoption speed and will negatively impact digital competitiveness.
R7: Diverging interests-adoption-digital investment-digital	This loop suggests that increasing diverging interests amongst stakeholders will curtail adoption by

infrastructure-digital capabilities-increasing digital ecosystem capability-digital ecosystem capability-new revenue stream-digital competitiveness.	stakeholders which will curtail digital investments. A lack of digital investments will reduce digital capabilities which in turn will result in a decline in the capability of the digital ecosystem. A decline in the capability of the ecosystem will curtail diversification into new revenue streams and will negatively impact digital competitiveness.
R8: Diverging interests-adoption-digital investment-digital infrastructure-digital capability-increasing digital ecosystem capability-digital ecosystem capability-cost-streamlining-digital competitiveness.	This loop suggests that increasing diverging interests amongst stakeholders will curtail adoption by stakeholders which will curtail digital investments. A lack of digital investments will reduce digital capabilities which in turn will result in a decline in the capability of the digital ecosystem. A decline in the capability of the ecosystem will curtail cost-streamlining measures and will negatively impact digital competitiveness.
R9: Diverging interests-adoption-digital investments-digital infrastructure-digital capabilities-increasing digital ecosystem capability-digital ecosystem capability-catalysis of adoption speeds-digital competitiveness.	This loop suggests that increasing diverging interests amongst stakeholders will curtail adoption by stakeholders which will curtail digital investments which will lead to poor digital infrastructure. A lack of digital infrastructure will reduce digital capabilities which in turn will result in a decline in the capability of the digital ecosystem. A decline in the capability of the ecosystem will slow down the catalysis of adoption speeds which will negatively impact digital competitiveness.

4.3.1 Digital Ecosystem

DPOs have been confronted by widespread changes over the past few years. It has become indispensable for DPOs to deploy emerging technology to respond efficiently to the evolution of customer needs which are shifting rapidly as the digital age takes the grip of every sector in society. Consequently, the Postal Technology Centre (PTC) connects technology and the shifting requirements of DPOs by taking the pole position as the provider of choice for IT solutions, applications, and services that facilitate the distribution of international and national postal services [154]. The PTC has over a decade developed:

(a) The sustainability system comprises the OSCAR Online Solution for Carbon Analysis and Reporting (OSCAR) tool which is made available by the UPU to measure and scrutinise the carbon footprint of DPOs.
(b) Postal Payments System (PPS) is a complex platform that comprises (i) POST*Net designed in an adaptable manner to ensure efficiency and ensures availability and speedy processing. (ii) UPU Interconnection Platform (UPU IP) web services interconnectedness to other payment databases instantaneously. (iii) Secured Transfer of Electronic Financial Information (STEFI) which is a safe platform to transfer postal payments. (iv) Financial Electronic Inquiry System (FEIS) is a web application for generating, conveying, receiving, tracking and resolving international postal payment inquiries. (v) PPS*Clearing is a computerised and safe settlement solution between DPOs.
(c) The mail system comprises (i) Domestic Postal System (DPS), DPS manages mail events (tracking) at the national level and is also equipped with a point-of-sale module. (ii) International Postal System (IPS) which comprises of IPS Line of products that are comprehensive international mail management applications that integrate postal value chain operational processes with Electronic Data Interchange messaging into a single application. The IPS Line of products provides a means for DPOs to have a precise and complete view of product movement through the postal value chain and finally to customs.

The Universal Postal Union postal digital ecosystem integrates the postal sector and interconnectedness of the postal sector to collaborate and conduct business across the postal value chain, it further allows the postal sector to integrate key clients and stakeholders such as customs authorities into the ecosystem to facilitate transactions. Designated postal operators and key customers are integrated into the ecosystem through Application Programming Interfaces (APIs) to ensure interoperability between designated postal operators and customer systems with the UPU digital ecosystem. Several apps are available for different products to facilitate web and mobile interfaces with the UPU ecosystem.

The postal digital ecosystem facilitates the digital economy as well as digital postal development. The digital ecosystem encompasses companies, persons, information, procedures, and machines and devices (IoT) which can be collectively characterised as stakeholders or actors that are connected by mutual utilisation of the digital platform [155]. [156] argues that digital ecosystems are loosely connected networks of the interacting organisation that are digitally interconnected and aided by modularity, and that influence and are influenced by each other's service offerings. The digital ecosystem drives value along three paths: creating new revenue-generating sources, streamlining cost, and catalyzing the speed of technology adoption [157]. [49] argues that digital ecosystems are intricate and dynamic networks of symbiotic digital technologies, consumers, providers, aggregators, government, and regulators, extending industry boundaries to comprise assorted players and innovative digital technologies from several sectors.

Dynamics and learning experiences within the ecosystem space and in the postal industry dictate that the desired behaviour pattern for digital ecosystem capability is a goal-seeking approach to steady state as depicted in 45 where the X axis is time, and the Y axis is digital ecosystem capability. At first, the level of digital ecosystem capability swiftly rises and starts decreasing as it moves towards the digital ecosystem capability goal value (to the point that postal organisations endeavour to participate in the digital ecosystem). The undesired, and frequently observed, behaviour pattern is a goal-seeking behaviour pattern that declines after a solid head start.

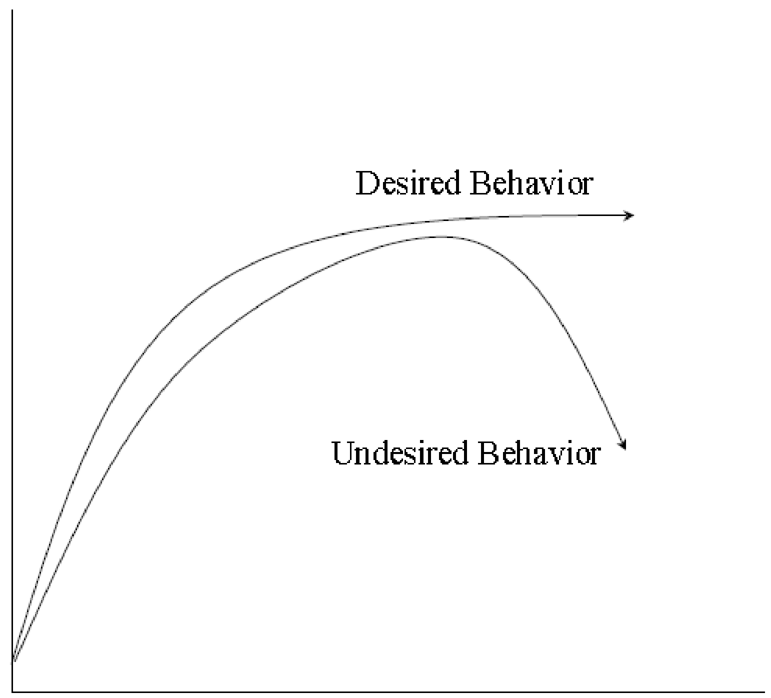


Figure 45: Desired and undesired reference mode behaviour patterns for digital ecosystem capability

A CLD that describes the required structure that will conceivably engender the reference mode behaviour over a period is proposed after the reference mode behaviour pattern is described for a variable in the system. The CLD for ecosystem capability is depicted in Figure 46 which details the structure expected to engender the envisioned behaviour pattern as depicted in Figure 45. In the context of a goal-seeking reference mode behaviour pattern, four variables are core in driving the desired behaviour in the context of digital ecosystem capability. These variables are digital ecosystem capability goal, digital ecosystem capability, management interventions, digital ecosystem capability management efforts, digital ecosystem capability UPU efforts, increasing digital ecosystem capability, decreasing digital ecosystem capability, digital investment, adoption, and diverging interests.

Table 30 elucidates the descriptions and explanations of causal interconnectedness between the elements or rather factors associated with the digital ecosystem capability, and its casual loop diagram is depicted in Figure 46. Table 31 articulates the description of the loops that emerge from the interaction of the interconnectedness.

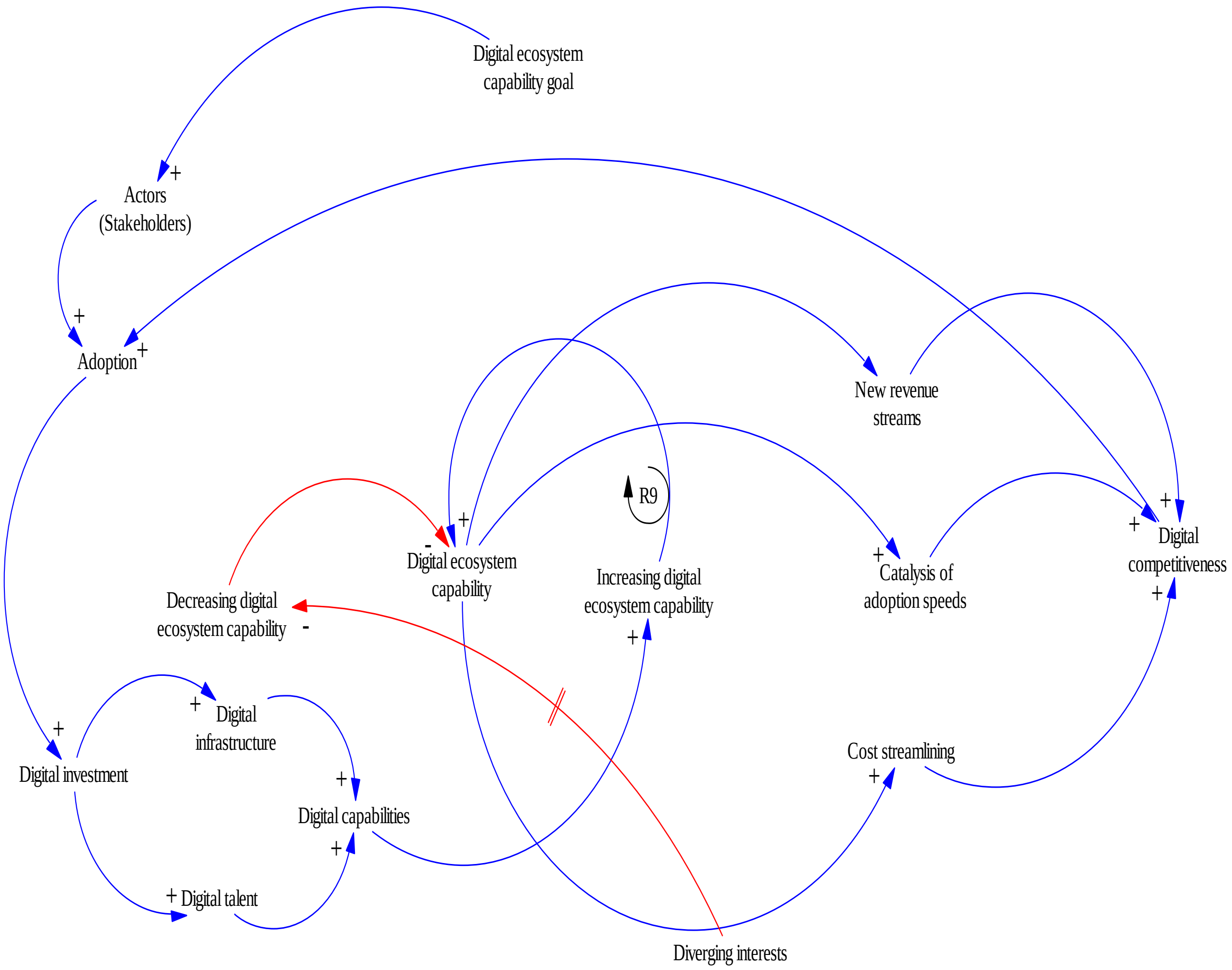


Figure 46: CLD of digital ecosystem capability dynamics

Table 30: Description of digital ecosystem dynamics

Interconnectedness	**Explanation**
Digital ecosystem capability goals influence actors' efforts interconnectedness.	This interconnectedness reveals that the digital ecosystem capability goal will likely prompt actors to take positive steps to attain the digital ecosystem capability goal. Actors include all stakeholders in the digital ecosystem, it encompasses postal operators (both management and employees), policymakers, regulators, aggregators, technology providers, government (shareholders), and consumers.

Actors (stakeholders) influence adoption interconnectedness.	This interconnectedness reveals that the actions of actors in pursuit of the digital ecosystem capability goal will likely result in the adoption of various digital technologies that are pervasive in the digital economy.
Adoption influence on digital investment interconnectedness.	This interconnectedness reveals that as the adoption of digital technologies grows, digital investments are triggered to sustain the movement towards the digital capability goal.
Digital investment influences digital talent interconnectedness.	This interconnectedness reveals that an upsurge in digital investment will yield a creased investment in digital talent.
Digital investment influences digital infrastructure interconnectedness.	This interconnectedness reveals that an upsurge in digital investment will increase investment in digital infrastructure.
Digital infrastructure influences digital capabilities' interconnectedness.	This interconnectedness reveals that as digital infrastructure is deployed, it will increase digital capabilities.
Digital talent influences digital capabilities interconnectedness.	This interconnectedness reveals that as digital talent rises, it will contribute to an improvement in digital capabilities.
Digital capabilities influence an increasingly digital ecosystem capability interconnectedness.	This interconnectedness reveals that an upsurge in digital capabilities will contribute to an increasingly digital ecosystem capability.
An increasing digital ecosystem capability influences digital ecosystem capability interconnectedness.	This interconnectedness reveals that an increasingly digital ecosystem capability will plausibly lead to an enhanced digital ecosystem capability.
Digital ecosystem capability influences new revenue-generating streams' interconnectedness.	This interconnectedness reveals that digital ecosystem capability will positively contribute to diversification into new revenue-generating streams to enhance competitiveness.

Digital ecosystem capability influence on catalysis of adoption interconnectedness.	This interconnectedness reveals that digital ecosystem capability will positively contribute to the acceleration of adoption efforts by stakeholders to enhance competitiveness.
Digital ecosystem capability influence on streamlining of cost interconnectedness.	This interconnectedness reveals that digital ecosystem capability will positively contribute to streamlining costs to enhance competitiveness.
Catalysis of adoption speeds influences digital competitiveness interconnectedness.	This interconnectedness reveals that catalysis or rather an acceleration of adoption speed by actors will positively contribute to digital competitiveness.
Costs streamlining influence on digital competitiveness interconnectedness.	This interconnectedness reveals that streamlining costs will positively contribute to digital competitiveness.
New revenue-generating streams influence digital competitiveness interconnectedness.	This interconnectedness reveals that diversification into new revenue-generating streams will positively contribute to digital competitiveness.
Digital competitiveness capability influences adoption interconnectedness.	This interconnectedness reveals that a heightened digital competitiveness capability will plausibly influence adoption by actors.
Diverging interest influences the adoption.	This interconnectedness suggests that an increase in diverging interests amongst stakeholders will negatively impact adoption by stakeholders (Actors).
Diverging interest influence digital ecosystem capability.	This interconnectedness suggests that an increase in diverging interest amongst stakeholders will negatively impact the capability of the digital ecosystem.
Digital competitiveness influences diverging interests.	This interconnectedness suggests that increasing digital competitiveness will reduce diverging interests among stakeholders.

Table 31: Description of digital ecosystem dynamics

Loop	Explanation
R1: Digital ecosystem capability goal-Stakeholders-Adoption-Digital Investment-Digital Infrastructure-Digital Capabilities-Increasing digital ecosystem capability-Digital ecosystem capability-Catalysis of adoption speeds-Digital competitiveness	This loop reveals that when an organisation has a clear digital ecosystem capability goal, it triggers action from stakeholders which triggers digital investment that builds a digital infrastructure for the ecosystem. The digital infrastructure develops the digital capabilities of the organisation which result in an increasingly digital ecosystem capability that supports the capability of the digital ecosystem. The more capable the digital ecosystem becomes, the more adoption speeds by actors are catalyzed and that results in the competitiveness of the ecosystem.
R2: Digital ecosystem capability goal-Stakeholders-Adoption-Digital Investment-Digital Talent-Digital Capabilities-Increasing digital ecosystem capability-Digital ecosystem capability-Catalysis of adoption speeds-Digital competitiveness	This loop reveals that when an organisation has a clear digital ecosystem capability goal, it triggers action from stakeholders which triggers digital investment which builds and attracts digital talent for the ecosystem. The digital talent harnesses the digital capabilities of the organisation which result in an increasingly digital ecosystem capability that supports the capability of the digital ecosystem. The more capable the digital ecosystem becomes with a wealth of digital talent, the more adoption speeds by actors are catalyzed and that results in the competitiveness of the ecosystem.
R3: Digital Ecosystem capability goal-Stakeholders-Adoption-Digital Investment-Digital Infrastructure-Digital Talent-Digital Capabilities-Increasing digital ecosystem capability-Digital	This loop reveals that when an organisation has a clear digital ecosystem capability goal, it triggers action from stakeholders which triggers digital investment which builds digital infrastructure and attracts digital talent for the ecosystem. The digital talent harnesses the digital capabilities of the

ecosystem capability-new revenue streams-Digital competitiveness	organisation which result in an increasingly digital ecosystem capability that supports the capability of the digital ecosystem. The more capable the digital ecosystem becomes with a wealth of digital talent and digital infrastructure, the new revenue stream opportunities are identified, harnessed, and seized resulting in the competitiveness of the ecosystem.
R4: Ecosystem capability goal-Stakeholders-Adoption-Digital Investment-Digital Infrastructure-Digital Talent-Digital Capabilities-Increasing digital ecosystem capability-Digital ecosystem capability-Cost-streamlining revenue -Digital competitiveness	This loop reveals that when an organisation has a clear digital ecosystem capability goal, it triggers action from stakeholders which triggers digital investment which builds digital infrastructure and attracts digital talent for the ecosystem. The digital talent harnesses the digital capabilities of the organisation which result in an increasingly digital ecosystem capability that supports the capability of the digital ecosystem. The more capable the digital ecosystem becomes with a wealth of digital talent and digital infrastructure, the more the costs are streamlined and optimised resulting in the competitiveness of the ecosystem.

4.3.2 Adoption

Digital ecosystem capability directly affects adoption and as a result, this variable (adoption) will be delved into first. The literature reviewed in Chapter 2 points to the adoption process following an S-curved growth over time and ultimately reaching a steady state. This is exemplified by the phenomenon of potential adopters transitioning into adopters. This indicates a phenomenon whereby one variable cannibalizes another variable until there is nothing left, this phenomenon fits with an S-curved-shaped growth to a steady state. The Universal Postal Union digital ecosystem was discussed in detail in 4.3.2. The adoption process specifically relates to key customers of the postal sector who adopt E-commerce APIs (Application Programming Interfaces) in the form of systems and tools that the UPU digital ecosystem offers. These APIs provide benefits to the postal sector and its key customers and some of the benefits of these APIs as articulated in [154] are listed below.

- The UPU Interconnection Platform (Hub) is a platform that allows close to instantaneous transfer and receipt of postal payment-related messages between DPOs and their partners;
- Android application for safe and dependable international and domestic postal payment operations through IFS (International Financial System);
- IPS Web Tracking which allows postal value chain visibility as customers can track their products across the value chain; and
- Electronic Advance Data (EAD) mobile application is the simplest way for DPOs to handle customs declarations. The EAD mobile app replaces CN22/CN23 paper forms and transmits data to offices of exchange in respective DPOs and respective customs to streamline clearance and assure compliance with respective customs laws and regulations in the respective countries of the destination.

Figure 47 depicts a reference mode for potential adopters, and Figure 48 depicts the desired and undesired reference mode behaviour pattern for adopters. The potential adopter's mode illustrates an inverse S-curve shape because this variable reduces over a period while the adopters' mode is an S-shaped growth behaviour due to this variable increasing over a period. The undesired adoption adopter reference mode is at first S-curve-shaped growth trailed by an incremental decline.

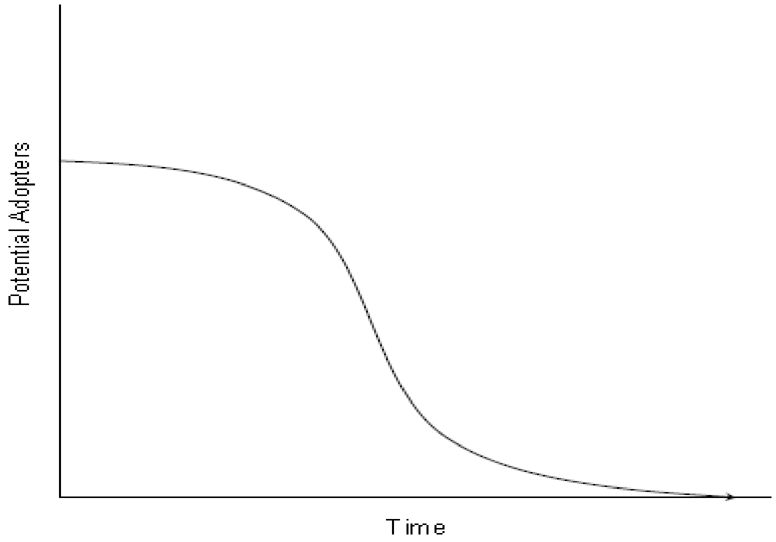


Figure 47: Reference Mode for Potential Adopters: Inverse S-Shaped Behaviour

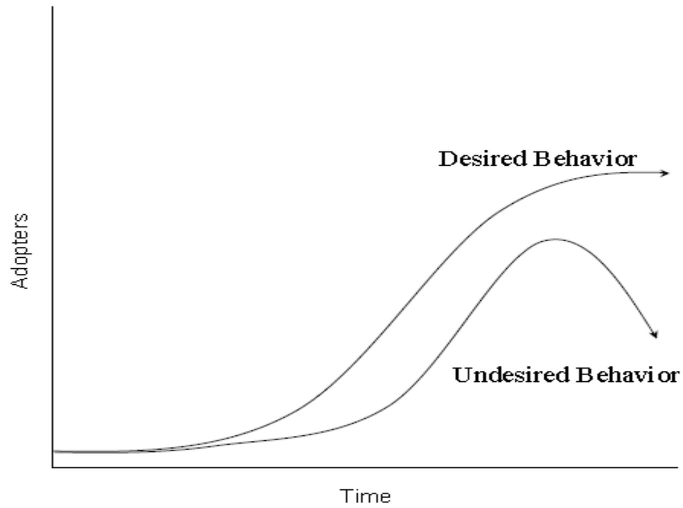


Figure 48: Desired and undesired reference mode behaviour patterns for adopters: S-curve-shaped behaviour pattern

The structure that interconnectedness' potential adopters and adopters into an S-curve-shaped behaviour pattern are depicted in Figure 47. This interconnectedness is characterised by a balancing loop on the potential adopters, connecting the potential adopters to the adoption rate. In essence, it implies that as the rate of adoption increases, the result will be a rapid decline of the potential adopter's variable. In contrast, a reinforcing loop is applied to the adopter's variable which implies that as the magnitude of adoption rises, the adoption rate increases. The structure has a balancing loop that connects to the adoption due to leadership efforts. It implies that leadership plays a decisive part in motivating the transitioning of potential adopters to adopters.

As soon as the adopter variable picks up in growth, a reinforcing loop that runs through adoption from facilitating conditions such as strategic communications will carry through the transitioning of remaining potential adopters into adopters.

Kuehne *et al.* [55] propose that the adoption rate is further driven by the relative advantage (RA) which incorporates the relative advantage of the innovation and the relative advantage for the population as sub-factors. The other factor that drives adoption is the ease of use (EoU) which incorporates the complexity of the innovation, trialability of the innovation, and perceived ease of use as sub-factors. The last factor that drives adoption is the compatibility of the innovation with existing systems.

As soon as an entity or specific person becomes an adopter (transitioning from potential adopter to adopter), such an entity or an individual may remain as an adopter or may cease to be an adopter based on diverting interests which may drain adopters' group as an entity or individuals drop out. A shared vision will retain the adopters in the group.

Two distinct processes characterise adoption, on one front it is the adoption from marketing efforts. Marketing can influence clients to transition from potential adopters to adopters. Marketing efforts are driven by marketing effectiveness. On another front, adoption is driven by diffusion through formal and informal communication channels which are driven by contact rate which means the rate at which the adopter group reaches out and influences non-adopters. The adoption process is further moderated by perceived factors typified by aspects such as Relative Advantage (RA), Ease of Use (EoU), and Compatibility. It is argued that the higher the composite of the perceived factors, the swifter the shift from the potential adopter group to the adopter group. These two distinct processes that drive adoption emanate from a shared vision, it can be hypothesised that the higher the shared vision amongst stakeholders: the higher the rate of adoption amongst potential adopters and adopter variables.

The rate of adoption is influenced by digital ecosystem capability and shared vision, as depicted by the arrow from digital ecosystem capability to adoption rate. The extra balancing loop was included in the adopter variable to illustrate how undesirable diverging interests can influence the group of adopters. This structure accepts when an entity or individual becomes an adopter, they can remain as an adopter or drop out as an adopter and exit the system should diverging interests take a grip of the system.

Table 32 elucidates the descriptions and explanations of causal interconnectedness associated with adoption, and its casual loop diagram is depicted in Figure 49. Table 33 articulates the description of the loops that emerge from the interaction of the interconnectedness.

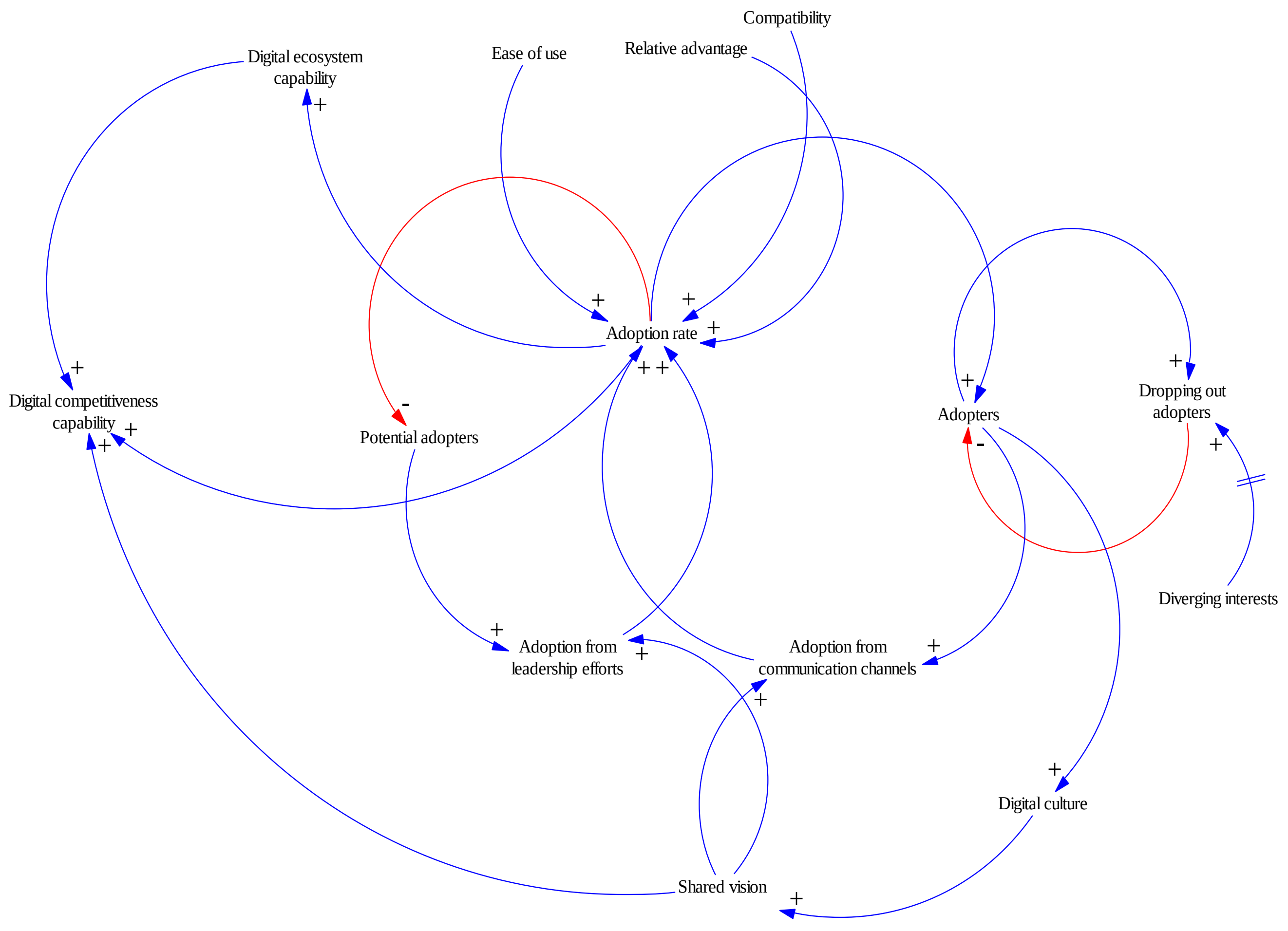


Figure 49: CLD of adoption dynamics for the postal sector in Southern Africa

Table 32: Description of adoption dynamics

Interconnectedness	Explanation

Adopters' rates influence the potential adopters’ pool.	The interconnectedness suggests that as the adoption rate rises, the pool that comprises potential adopters decreases until the pool is left with no potential adopters.
Dropping out adopters' influence on adopters.	This interconnectedness suggests that as dropping-out adopters increase; the adopter's pool decreases proportionally.
Ease of use influences the adoption rate.	This interconnectedness suggests that ease of use of the new technology or innovation will plausibly improve the adoption rate.
Compatibility with existing systems influences the adoption rate.	This interconnectedness suggests that the compatibility of the innovation with existing systems will likely positively influence the adoption rate.
Relative advantage influence on the adoption rate.	This interconnectedness suggests that the relative advantage of the innovation and the population of the innovation will plausibly positively influence the adoption rate.
Adoption rate influence on adopter’s pool.	This interconnectedness suggests that as the adoption rate increases it reinforces and increases the adopter's pool.
Adopters influence dropping-out adopters.	This interconnectedness suggests that an increasing adopter pool underpinned by “converging” interests will plausibly influence adopters to not drop out of the ecosystem.
Adopters influence adoption from communications channels.	This interconnectedness suggests that the adopters' pool increases, adoption from communication channels (formal and informal) rise and positively reinforces the adoption rate.
Adoption from communication channels influences the adoption rate.	This interconnectedness suggests that adoption from communication channels (formal and informal) will likely improve the adoption rate.
Adoption from leadership efforts influences adoption rates.	This interconnectedness suggests that leadership efforts will plausibly improve the adoption rate.

Potential adopters influence adoption from leadership efforts.	This interconnectedness suggests that potential adopters reinforce leadership efforts and are likely to become adopters due to leadership efforts.
Diverging interests influence adopters dropping out.	This interconnectedness suggests that diverging interests will likely influence the dropping out of adopters from the ecosystem.
Shared vision influences adoption from marketing efforts.	This interconnectedness suggests that a shared vision positively will likely influence adoption due to leadership efforts.
Adopters influence digital culture.	This interconnectedness suggests that adopters will likely positively influence a digital culture which is the glue that holds it all together. Digital culture is an integrator.
Digital culture influences shared vision.	This interconnectedness suggests that digital culture maturity will likely influence a maturing shared vision.
Shared vision maturity influences digital competitiveness capability.	This interconnectedness suggests that an upsurge in shared vision maturity will likely lead to an improvement in digital competitiveness capability.
Digital ecosystem capability influences digital competitiveness capability.	This interconnectedness suggests that an improvement in digital ecosystem capability will plausibly positively influence the digital ecosystem capability of the system.
Adoption rate influences digital competitiveness capability.	This interconnectedness suggests that an upsurge in the adoption rate will likely positively influence the competitiveness of the ecosystem.

Table 33: Description of digital ecosystem dynamics

Loop	**Explanation**
R1: Digital ecosystem capability-Digital Competitiveness-Adoption rate	This loop reveals that a capable digital ecosystem reinforces the competitiveness of the digital ecosystem which heightens the adoption rates of stakeholders/actors.

R2: Potential Adopters-Adoption from leadership efforts-Adoption rates	This loop reveals that the potential adopter's pool will gradually reduce with concerted efforts from leadership efforts to persuade potential adopters to adopt and join the digital ecosystem and that will heighten the adoption rates of actors/stakeholders.
R3: Adopters-Adoption from communication channels-Adoption rates	This loop reveals that the adopter's pool will persuade those who have already adopted through communication channels (including informal communication) to remain in the pool. This will at the same time persuade potential adopters to join the adopters' pool through communication channels including word of mouth.
R4: Adopters-Digital Culture-Shared vision	This loop reveals that adopters will be "assimilated" into the digital ecosystem through the adoption of a digital culture which will heighten shared vision due to "buy-in" and "assimilation".
R5: Diverging Interests-Dropping out adopters-Adopters	This loop reveals that diverging interests have the peril of triggering adopters to drop out which will reduce the adopters' pool.

4.3.3 Digital Culture Maturity (Integrator)

Digital Transformation Institute [158] proposes that culture is the adhesive that keeps organisations and people doing the right things or keeps organisations and people doing the wrong things. A culture which supports digital transformation is a characteristic of growing companies, and these organisations have a strong predisposition to promote risk-taking, nurture innovation, and cultivate collaborative work environments [159]. Siriram [160] proposes that organisational culture and climate are important factors in driving an organisation towards growth while [161] takes this concept of culture in the context of digital transformation further by arguing that a digital culture could be defined as the application of unified cultural and teaching methodologies, procedures, methods, and practices intended to co-invent an ecosystem awakened with digital knowledge. Sadiku [162] adds that digital cultures denote habits and beliefs evolving from digital technologies, and further argues that digital technologies do not just mean human connection, but are an essential element of human interchange and communication means. For an organisation to adopt digital culture requires the organisation to have a culture of transformation already; and argues that without an existing transformative culture embedded in the organisation, no amount of strategy will help as culture eats strategy for lunch [163].

According to the conceptual framework depicted in Figure 43, digital culture enables shared vision and enhances the digital ecosystem which both directly influence adoption. Adoption naturally follows an S-Curve with potential adopters who with time will transition to adopters. There is a strong interconnectedness between adoption as a concept and innovation which is one of the key attributes of digital culture. Ghinea and Bratianu [164] argue that culture in organisations is an intricate non-linear integrator of any organisation's intellectual capital. It, therefore, follows that digital culture is a complex integrator that exhibits non-linearity characteristics of the digital ecosystem. It is the glue that holds the system together. Cultures mature with time and as a result, digital culture follows an S-curve reference behaviour mode as depicted in Figure 50. The undesired behaviour pattern for culture would entail an initial S-shaped growth behaviour pattern followed by a trailed decline.

Table 34 elucidates the descriptions and explanations of causal interconnectedness between the elements associated with digital culture, and its casual loop diagram is depicted in Figure 51. Table 35 articulates the description of the loops that emerge from the interaction of the interconnectedness.

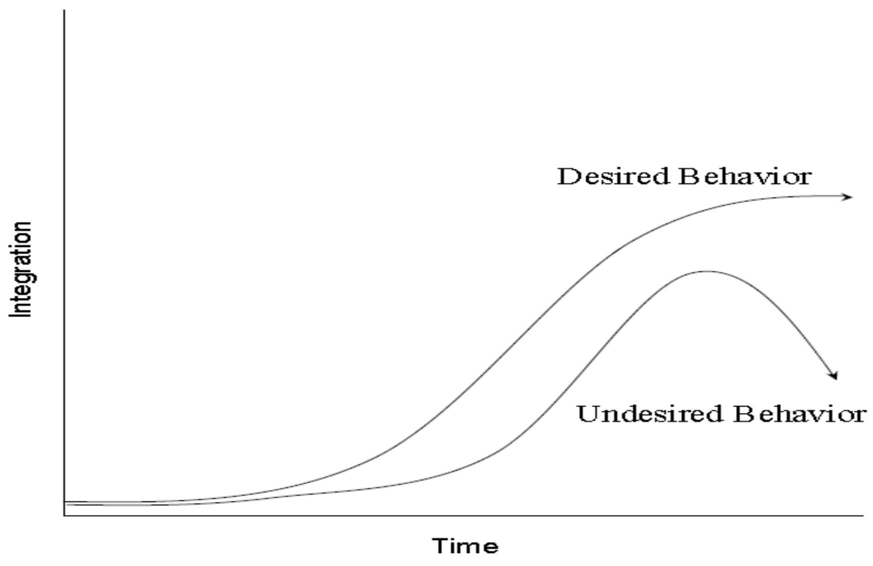


Figure 50: Desired and undesired reference mode behaviour patterns for digital culture maturity [100]

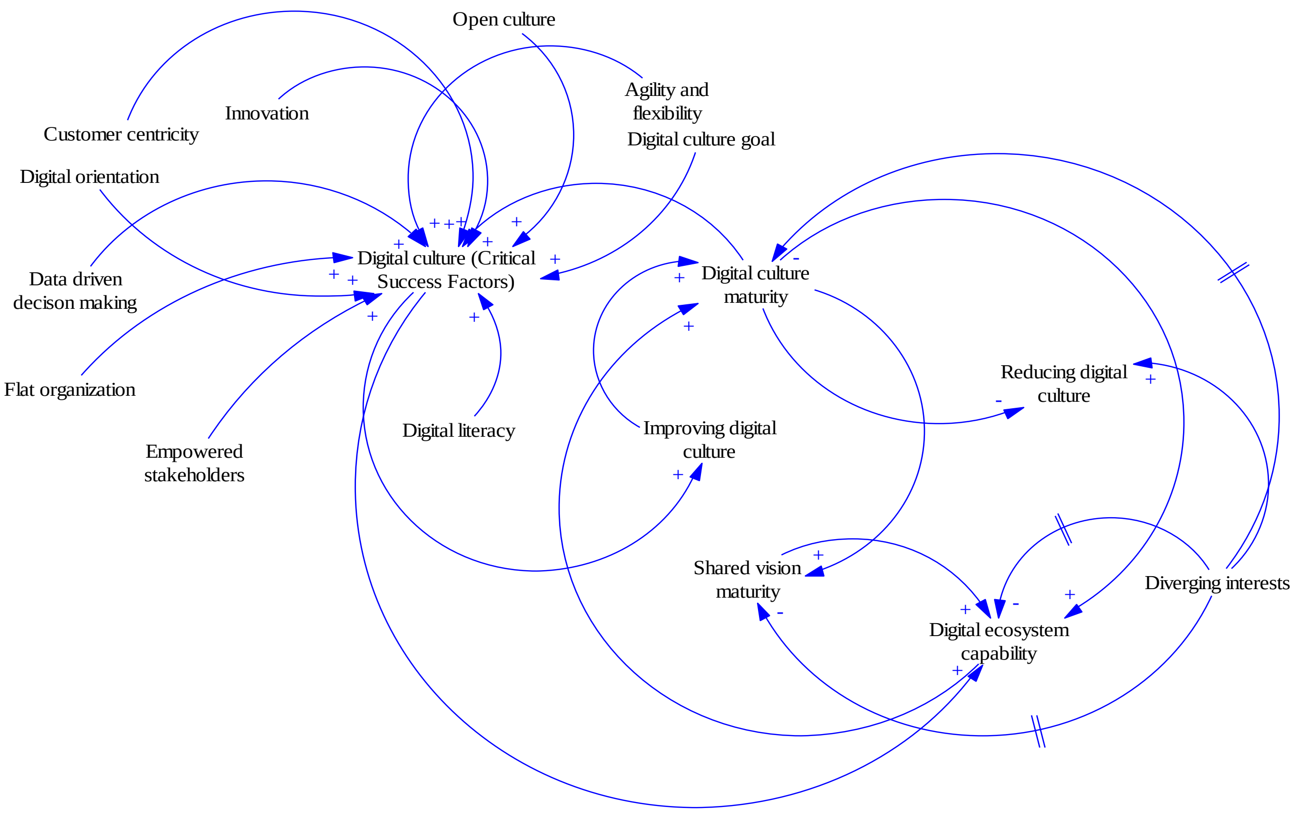


Figure 51: CLD of digital culture dynamics

Table 34: Interconnectedness description of digital culture dynamics

Interconnectedness	Explanation
Digital culture goal influence on digital culture success factor	This interconnectedness suggests that a digital culture goal that is driven by the postal organisation will likely positively influence the digital culture success factor.
Digital literacy influence on digital culture critical success factors	This interconnectedness suggests that digital literacy is likely to positively influence the composite of the digital culture's critical success factors.
Empowered stakeholder's influence on digital culture critical success factors	This interconnectedness suggests that empowered stakeholders are likely to positively influence the composite of the digital culture's critical success factors.
Flat organisation influence on digital culture critical success factors	This interconnectedness suggests that a flat organisation is likely to positively influence the composite of the digital culture's critical success factors.
Data-driven decision-making an influence on digital culture critical success factors	This interconnectedness suggests that a data-driven decision-making organisation is likely to positively influence the composite of the digital culture's critical success factors.
Digital orientation influence on digital culture critical success factors	This interconnectedness suggests that digital orientation is likely to positively influence the composite of the digital culture's critical success factors.
Customer centricity influence on digital culture critical success factors	This interconnectedness suggests that customer centricity is likely to positively influence the composite of the digital culture critical success factors.
Open culture influence on digital culture critical success factors	This interconnectedness suggests that open culture is likely to positively influence the composite of the digital culture's critical success factors.

Agility and flexibility influence digital culture critical success factors	This interconnectedness suggests that agility and flexibility are likely to positively influence the composite of the digital culture's critical success factors.
Digital Culture Critical Success Factors influence improving digital culture	This interconnectedness suggests that digital culture critical success factors are likely to positively reinforce an improving digital culture.
Improving digital culture influence on digital culture maturity	This interconnectedness suggests that an improving digital culture is likely to reinforce digital culture maturity.
Digital culture maturity influences digital ecosystem capability	This interconnectedness suggests that a matured digital culture will likely reinforce and enable digital ecosystem capability.
Digital ecosystem capability influences digital culture maturity	This interconnectedness suggests that a capable digital ecosystem will likely reinforce a maturing digital culture.
Digital culture maturity influence on reducing digital culture	This interconnectedness suggests that an increasingly digital culture maturity counters a reduced digital culture.
Diverging interests influence digital culture maturity	This interconnectedness suggests that diverging interests over time erode digital culture maturity.
Diverging interests influence shared vision maturity	This interconnectedness suggests that diverging interests over time erode shared vision maturity among stakeholders.
Diverging interests influence reducing digital culture maturity	This interconnectedness suggests that diverging interests will reinforce a declining or reduced digital culture.

Table 35: Loop description of digital ecosystem dynamics

Loops	**Explanation**
R1: Digital culture Critical Success Factors (CSF)-	This loop reveals that critical success factors (Digital orientation, Data-driven decision-making, Customer

Improving digital culture-Digital culture maturity-Shared vision maturity-Digital ecosystem maturity	centricity, Open culture, Flat organisation, Agility & flexibility, Empowered stakeholders, and Digital literacy) improve digital culture maturity which results in a maturing shared vision that triggers a capable and matured digital ecosystem.
B1: Diverging Interests-Digital culture maturity	This loop reveals that when diverging interests multiply, digital culture maturity plummets over time.
B2: Diverging Interests-Shared vision maturity	This loop reveals that when diverging interests multiply, shared vision maturity plummets over time.

4.3.4 Shared Vision

Hoe [165] suggests that shared vision refers to a clear and common picture of a desired future state that participants of an ecosystem identify themselves with, and is understood as a crucial part of the success of a Learning Organisation [166]. A learning Organisation is an organisation that learns through its adherents independently and mutually to develop a competitive edge by efficiently managing internal and external change [167]. Farrukh and Waheed [167] further suggest that a learning organisation is characterised by facilitative leadership, innovation, information sharing (communication), self-development, and empowerment which are the tenets of a learning organisation. This view is reinforced by [166] who proposes that antecedents to a shared vision include a strong personal vision, learning organisational principles, leadership, and communication. A shared vision embraces the collective and cooperative goals, values, and missions that illustrate an organisation; and the essential ingredient to effectively shared visions is communication [168].

Feldman [168] proposes that personal mastery and the common mental models are the foundation of developing a shared vision, a shared vision integrates the shared and combined goals, ideals, and undertakings that depict an organisation. The generalities we make and the images or metaphors we create in our minds are our mental models [168] and they influence not only how we perceive the world but how we take action [100]. Personal mastery entails a superior level of aptitude which is engrossed in our energies and the skill to see in an unbiased manner, our sense of commitment, and the expanding of our vision. It can be concluded that shared vision is an integrator and in the same league as digital culture [168].

The shared vision is an intricate non-linear integrator, an integrator suggests that the variable matures over time and therefore this complex integrator also follows an S-curve reference behaviour mode as depicted in Figure 52. The undesired and very so often observed behaviour pattern for an integrator is an initial S-shaped growth behaviour pattern followed by a lagged decrease. The causal loop diagram is depicted in Figure 53 while the elucidation of the interconnectedness in the causal loop diagram is explained in Tables 36 and 37 respectively.

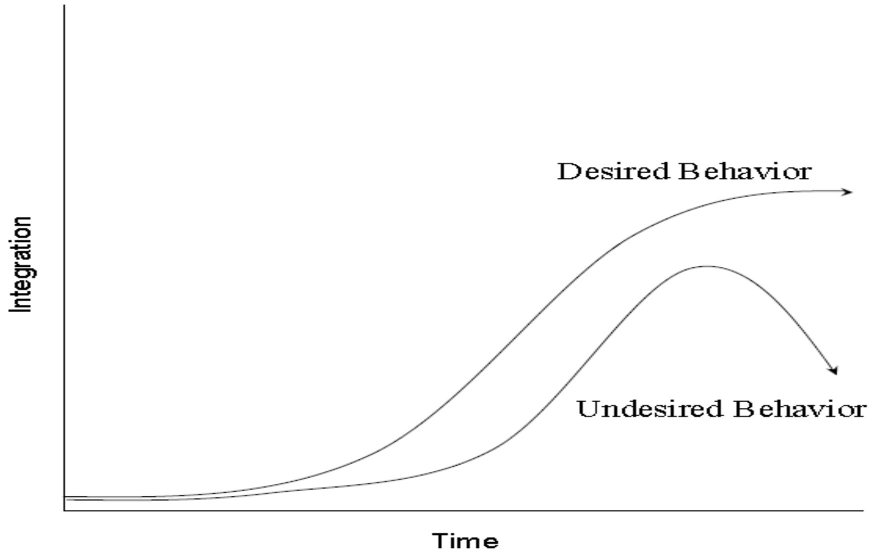


Figure 52: Desired and undesired reference mode behaviour patterns for a shared vision

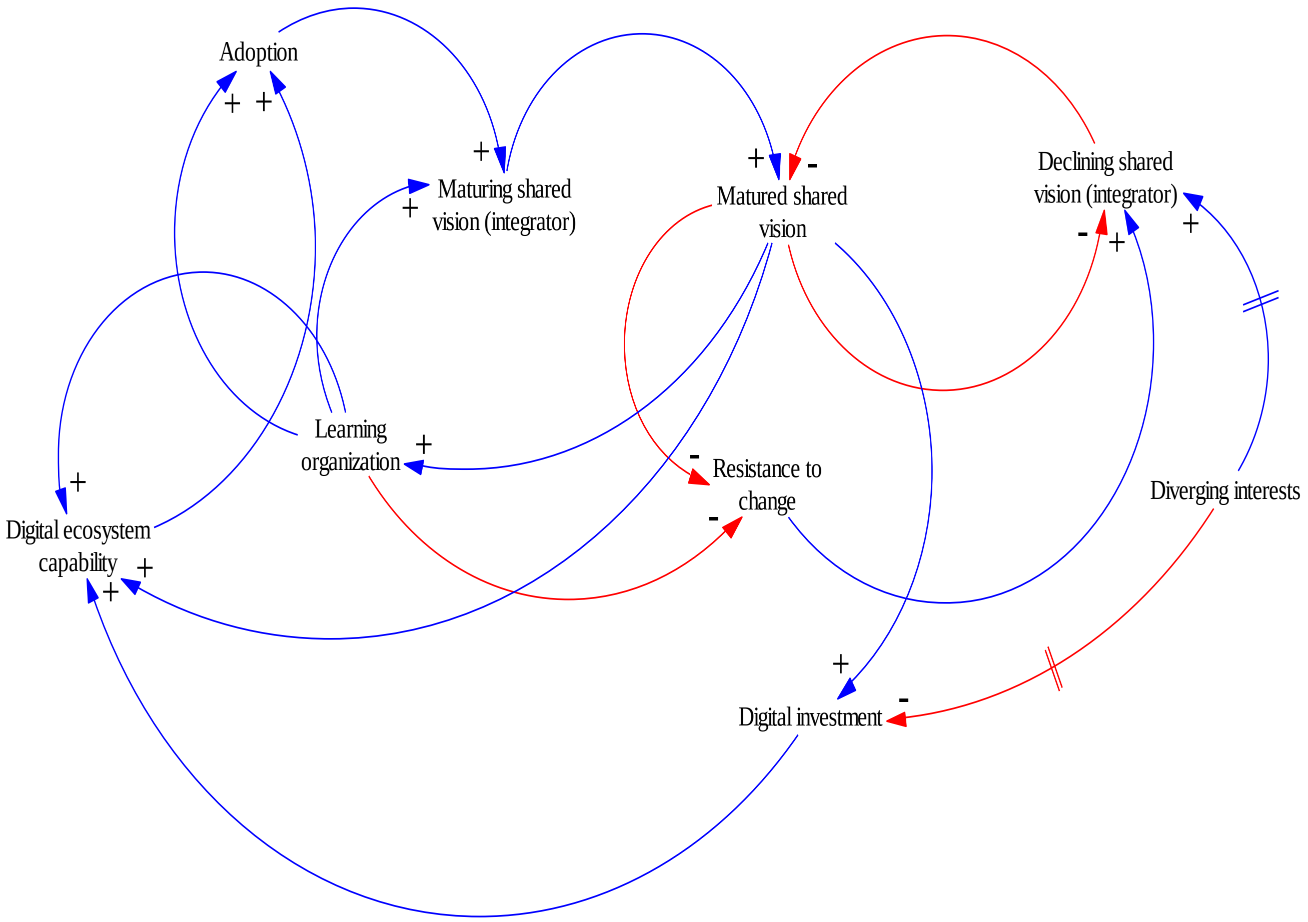


Figure 53: CLD of shared vision dynamics

Table 36: Description of shared vision dynamics interconnectedness

Interconnectedness	Explanation
Declining shared vision (integrator) influence on digital culture maturity.	This interconnectedness suggests that a declining shared vision (integrator) reduces a muted shared vision.
Matured shared vision influences declining shared vision.	This interconnectedness suggests that a matured shared vision that is on decline reinforces a declining shared vision.
Diverging interests influence digital investment.	This interconnectedness suggests that diverging interests over time inhibit digital investment.
Matured shared vision influences resistance to change.	This interconnectedness suggests that a rise in matured shared vision reduces resistance to change.
Learning organisation influences resistance to change.	This interconnectedness suggests that a learning organisation mindset lessens resistance to change.
Diverging interests influence declining shared vision (integrator).	This interconnectedness suggests that diverging interests reinforce a declining shared vision.
Resistance to change influences declining shared vision (integrator).	This interconnectedness suggests that resistance to change reinforces a declining shared vision.
Matured shared vision influence on digital investment.	This interconnectedness suggests that a matured shared vision reinforces digital investment.
Digital investment influence digital ecosystem capability.	This interconnectedness suggests that digital investment reinforces the digital ecosystem's capability.
Matured shared vision influence on digital ecosystem capability.	This interconnectedness suggests that matured shared vision reinforces the digital ecosystem capability.
Matured shared vision influence on digital ecosystem capability.	This interconnectedness suggests that a learning organisation mindset reinforces the digital ecosystem capability.

Maturing shared vision influences matured shared vision.	This interconnectedness suggests that a maturing shared vision reinforces a matured shared vision of the ecosystem.
Learning organisation influences on maturing shared vision.	This interconnectedness suggests that a learning organisation mindset reinforces a maturing shared vision of the ecosystem.
Adoption influence on maturing shared vision.	This interconnectedness suggests that adoption reinforces a maturing shared vision of the ecosystem.
Learning organisations influence adoption.	This interconnectedness suggests that a learning organisation mindset reinforces adoption.
Digital ecosystem capability influences adoption.	This interconnectedness suggests that digital ecosystem capability reinforces adoption.
Learning organisation influence on digital ecosystem capability.	This interconnectedness suggests that a learning organisation mindset reinforces digital ecosystem capability.

Table 37: Loop description of digital ecosystem dynamics

Loops	**Explanation**
R1: Digital ecosystem capability-Adoption-Maturing shared vision-Matured shared vision-Learning organisation	This loop reveals that a capable digital ecosystem triggers adoption by actors which results in a maturing shared vision that propels a matured shared vision over time. A mature shared vision builds the foundation of a learning organisation.
R2: Digital ecosystem capability-Adoption-Maturing shared vision-Matured shared vision-Digital investment	This loop reveals that a capable digital ecosystem triggers adoption by actors which results in a maturing shared vision that propels a matured shared vision over time. A matured shared vision triggers digital investments.
R3: Diverging Interests-Declining shared vision maturity	This loop reveals that when diverging interests upsurge, it proliferates the decline of shared vision maturity.

B1: Matured shared vision-Resistance to change	This loop reveals that the propagation of a matured shared vision diminishes resistance to change.
B2: Learning Organisation-Resistance to change	This loop reveals that maturity in a learning organisation moderates resistance to change.
B3: Diverging Interests-Digital investment	This loop reveals that as diverging interests rise, digital investments will likely plummet.

4.3.5 Digital Investment

Nwankpa and Datta [169] argue that due to a bombardment of innovative digital technology, organisations must invest based on the influence of IT capabilities on the business' performance. Digital investment is a gauge of an organisation's strategic technology investments for exploring how developing digital technologies could distinguish business transactions and operations [169]. World Economic Forum [170] asserts that it is broadly recognised that digital technologies assist in increasing cost effectiveness, enhancing existing revenue streams, and opening new revenue streams. Conversely, with the accelerating speed of change in the digital era, organisations are confronted with the apparent option of adopting digital technologies while upholding agility, speed, open culture of experimenting, and innovation [171].

World Economic Forum [170] argues that maximizing value from digital investments is centred on five key enablers which are (a) Agile and digital-savvy leadership which maintains a strategic vision, aim, aptitude, desire, and orientation across management levels to ensure a quick decision-making process and innovation (b) Forward-looking skills agenda which infuses a digital paradigm within employees by ensuring that innovation is the emphasis of training and employment programme (c) Ecosystem thinking which embeds collaboration of stakeholders within the value chain (d) Data access and management which propels competitiveness through a solid data infrastructure and warehouse capability united with the right data analytics and communication tools, and lastly, (e) Technology infrastructure readiness which is concerned with developing the vital technological infrastructure to establish robust competencies on the cloud technologies, cybersecurity and interoperability.

Digital investment suggests that a “goal” must be set and worked towards until the desired digital investment goal is achieved. Therefore, digital investment follows a goal-seeking reference behaviour mode as depicted in Figure 54. Initially, the level of digital investment swiftly rises and begins falling as it moves towards the digital investment goal. The undesired, and often observed, behaviour pattern in a goal-seeking behaviour pattern declines after a robust beginning. The causal loop diagram is depicted in Figure 55 while elucidation of the causal interconnectedness is in Table 38 and articulation of the associated causal loop diagram is explained in Table 39.

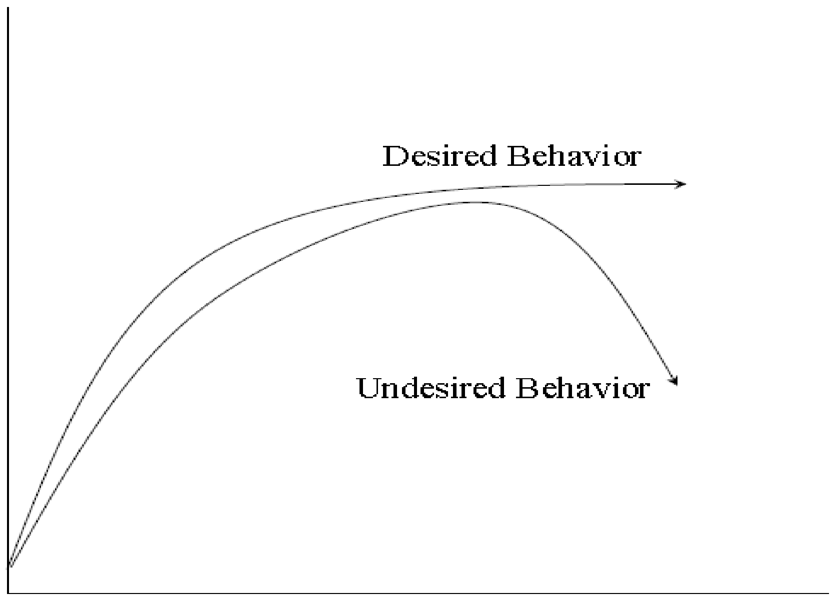


Figure 54: Desired and undesired reference mode behaviour patterns for digital investment

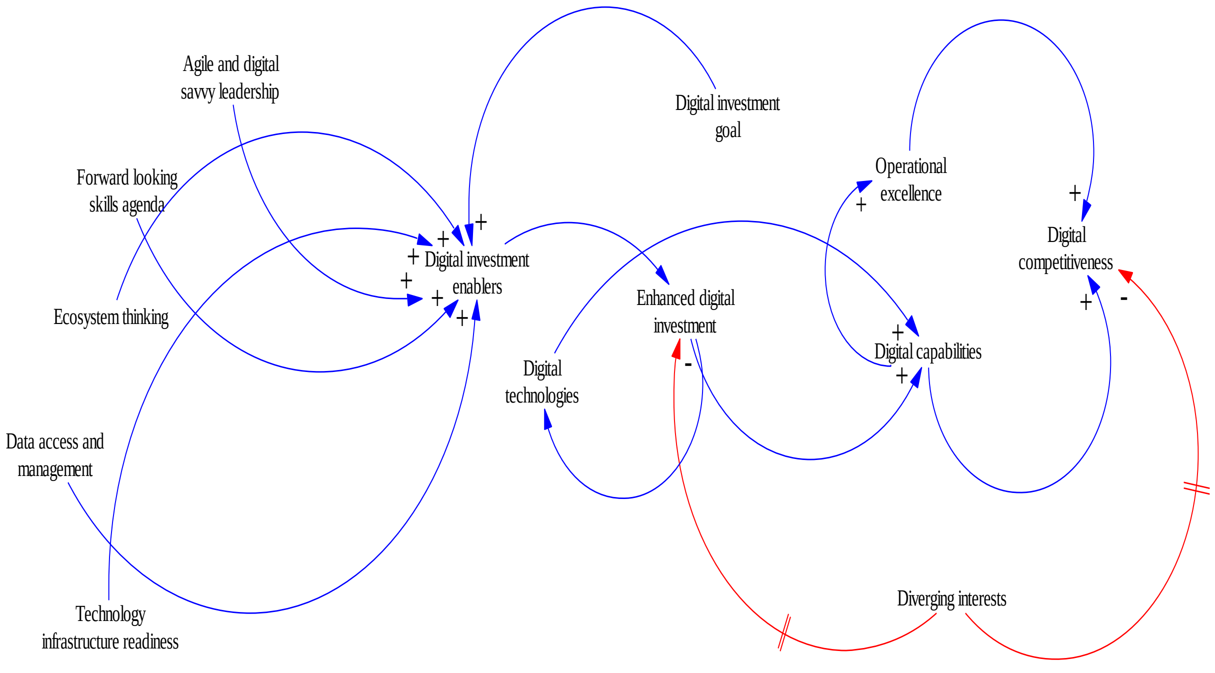


Figure 55: CLD of digital investment dynamics

Table 38: Description of digital investment dynamics interconnectedness

Interconnectedness	Explanation
Diverging interests influence enhanced digital investment.	This interconnectedness reveals that diverging interests negatively impact enhanced digital investment, as diverging interests increase, the enhanced digital environment plummets.
Diverging interests influence digital competitiveness.	This interconnectedness reveals that diverging interests negatively impact digital competitiveness. As diverging interests rise, digital competitiveness declines.
Digital investment goals influence digital investment enablers.	This interconnectedness reveals that a set of digital investment goals positively reinforce digital investment enablers.
Agile and digital-savvy leadership influence digital investment enablers.	This interconnectedness reveals that agile and digital-savvy leadership positively reinforces digital investment enablers.
Ecosystem thinking influences digital investment enablers.	This interconnectedness reveals that an ecosystem thinking mindset positively reinforces digital investment enablers.
Forward-looking skills agenda influences digital investment enablers.	This interconnectedness reveals that a forward-thinking skills agenda positively reinforces digital investment enablers.
Data access and management capability influence digital investment enablers.	This interconnectedness reveals that data access and data management capability positively reinforce digital investment enablers.
Technology infrastructure readiness influences digital investment enablers.	This interconnectedness reveals that technology infrastructure readiness positively reinforces digital investment enablers.
Digital investment enablers influence digital technologies.	This interconnectedness reveals that digital investment enablers positively reinforce the adoption of digital technologies.

Digital technologies influence digital capabilities.	This interconnectedness reveals that digital technologies positively reinforce digital capabilities. As the deployment of digital technologies multiplies, the digital capability of the ecosystem increases.
Enhanced digital investment influences digital capabilities.	This interconnectedness reveals that enhanced digital investment positively reinforces digital capabilities. As the enhanced digital investment rises, digital capabilities rise too.
Enhanced digital investment influences operational excellence.	This interconnectedness reveals that enhanced digital investment positively reinforces operational excellence. As the enhanced digital investment rises, digital capabilities rise too.
Operational excellence influences digital competitiveness.	This interconnectedness reveals that optimal operational excellence positively reinforces digital competitiveness.
Digital capabilities influence digital competitiveness.	This interconnectedness reveals that optimal digital capabilities positively reinforce digital competitiveness.
Diverging interests influence digital competitiveness.	This interconnectedness suggests that diverging interests will likely hinder digital competitiveness.
Diverging interests influence enhanced digital investments.	This interconnectedness suggests that diverging interests will likely obstruct enhanced digital investment.

Table 39: Description of digital investment dynamics loops

Loops	**Explanation**
R1: Digital investment goal-Digital investment enablers-Enhanced Digital Investment-Digital Technologies-Digital	This loop reveals that the digital investment goal will likely reinforce digital investment drivers (Agile and digital-savvy leadership, Ecosystem thinking; Forward-looking skills agenda, Data access, and management capability, and Technology infrastructure readiness) which will trigger an

Capabilities-Digital competitiveness.	enhanced digital investment. An enhanced digital investment will trigger the proliferation of digital technologies which will enhance the digital capabilities of the ecosystem resulting in the digital competitiveness of the ecosystem.
R1: Digital investment goal-Digital investment enablers-Enhanced Digital Investment-Digital Technologies-Operational Excellence-Digital competitiveness.	This loop reveals that the digital investment goal will likely reinforce digital investment drivers (Agile and digital-savvy leadership, Ecosystem thinking; Forward-looking skills agenda, Data access, and management capability, and Technology infrastructure readiness) which will trigger an enhanced digital investment. An enhanced digital investment will trigger the proliferation of digital technologies which will enhance the operational excellence of the ecosystem resulting in digital competitiveness of the ecosystem.
B1: Diverging interests influence digital competitiveness.	This loop reveals that diverging interests will likely hinder digital competitiveness.
B2: Diverging interests influence enhanced digital investments.	This interconnectedness suggests that diverging interests will likely impede enhanced digital investments.

4.3.6 Digital Capabilities

Siriram [160] proposes that organisations function in a world that is progressively pervaded by digital technologies [172] and digital technologies are restructuring conventional business models and further transmuting the structure of societal relationships for both the customer and the organisation [173]. These digital technologies are one of the facets that determine digital capabilities. [174] argues that digital capability could be considered as an organisation's aptitude to establish novel digital artefacts and react to a flux of dynamics in the digital economy. Digital capabilities are the amalgamation of proficiencies and developments of digital business to build, rally, and use organisational resources backed by digital technologies' platforms to react to a fluid environment and add value to the organisation to participate effectively in the digital economy [175].

Junior [175] suggests that sensing capability, ecosystem capability, process digitisation, and responsiveness are important digital capabilities that organisations aim for in their quest to remain competitive and sustainable in the digital age. This view is reinforced by [173] who postulate that the aptitudes and capabilities required to build digital capabilities are quickness and responsibility, multi-channel ecosystem connectivity, visualizations, and governance. Lastly, [176] suggests that Information Technology (IT) capability, data and data analytics capability, customer engagement capability, collaboration and connectivity capability, business process excellence capability, knowledge work support capability, and digitisation of business models are foundational capabilities organisations require to navigate the digital age.

The phenomenon of digital capabilities suggests that a “goal” must be set and worked towards until the desired digital capability’s goal is achieved, therefore digital capabilities follow a goal-seeking reference behaviour mode as depicted in Figure 56. Initially, the level of digital capability rapidly climbs and begins declining as it moves towards the digital capability goal. The undesired, and every-so-often seen behaviour pattern in a goal-seeking behaviour pattern declines after a relatively strong start. The causal loop diagram is depicted in Figure 57 while an explanation of the causal interconnectedness and causal loop diagram is explained in Tables 40 and 41 respectively.

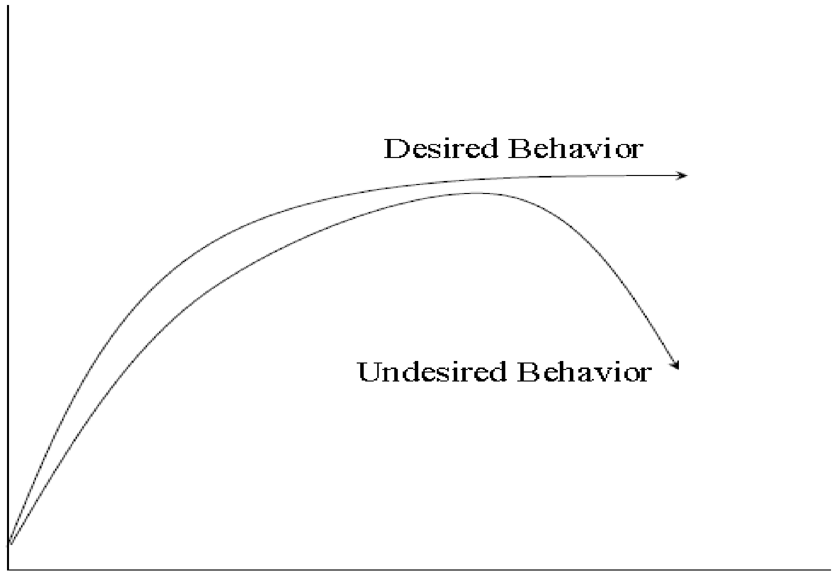


Figure 56: Desired and undesired reference mode behaviour patterns for digital capability

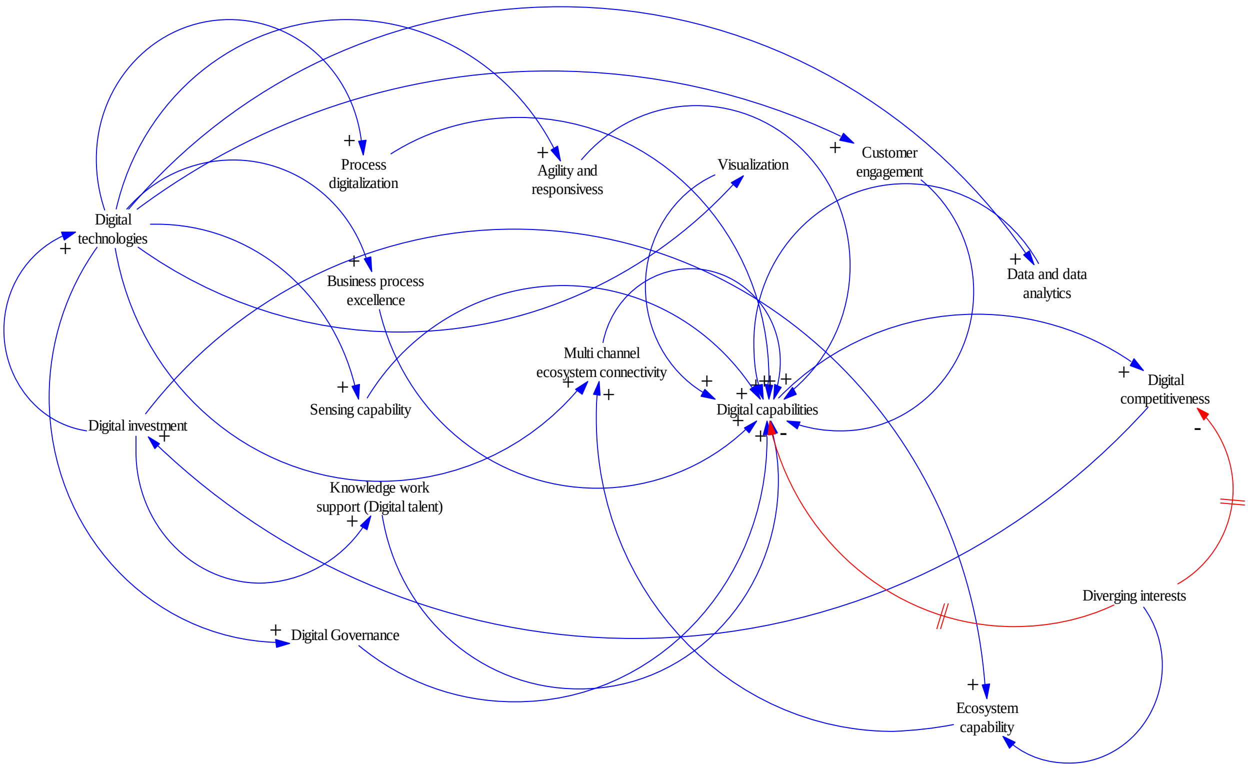


Figure 57: CLD of digital capabilities dynamics

Table 40: Interconnectedness description of digital capabilities dynamics

Interconnectedness	Explanation
Diverging interests influence digital capabilities.	This interconnectedness reveals that diverging interests negatively impact digital capabilities, as diverging interests increase; digital capability reduces.
Diverging interests influence ecosystem capability.	This interconnectedness reveals that diverging interests negatively impact digital ecosystem capability, as diverging interests increase; digital ecosystem capability reduces.
Diverging interests influence digital competitiveness.	This interconnectedness reveals that diverging interests negatively impact digital competitiveness, as diverging interests increase; digital competitiveness reduces.

Digital investment influence digital technologies.	This interconnectedness reveals that digital investment positively reinforces the digital technologies' capability of the system.
Digital technologies influence process digitalisation.	This interconnectedness reveals that digital technologies positively reinforce the process of digitalisation of the value chain in the system.
Digital technologies influence agility and responsiveness.	This interconnectedness reveals that digital technologies positively reinforce the agility and responsiveness capability of the system.
Digital technologies influence data and data analytics.	This interconnectedness reveals that digital technologies positively reinforce the data and data analytics capability of the system.
Digital technologies influence customer engagement.	This interconnectedness reveals that digital technologies positively reinforce the customer engagement capability of the system.
Digital technologies influence multi-channel ecosystem connectivity.	This interconnectedness reveals that digital technologies positively reinforce the multi-channel ecosystem connectivity capability of the system.
Digital technologies influence sensing capability.	This interconnectedness reveals that digital technologies positively reinforce the sensing capability of the system.
Digital technologies influence business process excellence.	This interconnectedness reveals that digital technologies positively reinforce the business process excellence of the system.
Digital technologies influence visualization.	This interconnectedness reveals that digital technologies positively reinforce the visualization capability of the system.
Digital technologies influence digital governance.	This interconnectedness reveals that digital technologies positively reinforce the digital governance of the system.
Digital technologies influence knowledge work (digital talent) support.	This interconnectedness reveals that digital technologies positively reinforce knowledge work (digital talent) and support the capability of the system.

Process digitalisation influences digital capabilities.	This interconnectedness reveals that the process of digitalisation positively reinforces the digital capabilities of the system.
Multi-channel ecosystem connectivity influences digital capabilities.	This interconnectedness reveals that the multi-channel connectivity ecosystem positively reinforces the digital capabilities of the system.
Agility and responsiveness influence digital capabilities.	This interconnectedness reveals that the agility and responsiveness of the system positively reinforce its digital capabilities.
Visualization influences digital capabilities.	This interconnectedness reveals that visualization positively reinforces the digital capabilities of the system.
Customer engagement influences digital capabilities.	This loop reveals that the customer engagement capability of the system positively reinforces its digital capabilities.
Data and data analytics influence digital capabilities.	This interconnectedness reveals that the data and data analytics capability of the system positively reinforces its digital capabilities.
Business process excellence influences digital capabilities.	This interconnectedness reveals that the business process excellence capability of the system positively reinforces its digital capabilities.
Sensing capability influences on digital capabilities loop.	This interconnectedness reveals that the sensing capability of the system positively reinforces its digital capabilities.
Knowledge work support (Digital talent) influences on digital capabilities loop.	This interconnectedness reveals that knowledge work (digital talent) supports the capability of the system and positively reinforces its digital capabilities.
Digital governance influence on digital capabilities loop.	This interconnectedness reveals that the digital governance capability (digital security) of the system positively reinforces its digital capabilities.
Digital capabilities influence on digital competitiveness loop.	This interconnectedness reveals that digital capabilities positively reinforce the system's digital competitiveness.

Digital competitiveness influences digital investment.	This interconnectedness reveals that digital competitiveness positively reinforces digital investments. As the ecosystem becomes more competitive, its ability to make further digital investments increases.
Digital investment influences ecosystem capability.	This interconnectedness reveals that digital investment positively reinforces ecosystem capability. As digital investments are made, the ecosystem becomes more capable.
Ecosystem capability influences multi-channel ecosystem connectivity.	This interconnectedness reveals that ecosystem capability positively reinforces multi-channel ecosystem connectivity.

Table 41: Description of digital investment dynamics loops

Loops	**Explanation**
R1: Digital investment-digital technologies-process digitalisation-digital capabilities-digital competitiveness	This loop reveals that digital investment triggers the propagation of digital technologies which results in digitalisation ecosystem processes that proliferate the digital capabilities of the ecosystem and ultimately lead to digital competitiveness.
R2: Digital investment-digital technologies-agility and responsiveness-digital competitiveness	This loop reveals that digital investment triggers the propagation of digital technologies which results in agility and responsiveness which proliferates the digital capability of the digital ecosystem and leads to digital competitiveness.
R3: Digital investment-digital technologies-agility and responsiveness-digital capability-digital competitiveness	This loop reveals that digital investment triggers the propagation of digital technologies which results in agility and responsiveness which proliferates the digital capability of the digital ecosystem and leads to digital competitiveness.

R4: Digital investment-digital technologies-agility customer engagement-digital capability-digital competitiveness	This loop reveals that digital investment triggers the propagation of digital technologies which results in customer engagement which proliferates the digital capability of the digital ecosystem and leads to digital competitiveness.
R5: Digital investment-digital technologies-data and data analytics-digital capability-digital competitiveness	This loop reveals that digital investment triggers the propagation of digital technologies which results in the ability to engage with data and obtain insights from data analytics which proliferates the digital capability of the digital ecosystem and leads to digital competitiveness.
R6: Digital investment-digital technologies-visualization-digital capability-digital competitiveness	This loop reveals that digital investment triggers the propagation of digital technologies which results in visualization of the ecosystem which proliferates the digital capability of the digital ecosystem and leads to digital competitiveness.
R7: Digital investment-digital technologies-sensing capabilities-digital capability-digital competitiveness	This loop reveals that digital investment triggers the propagation of digital technologies which results in the capability of the ecosystem to increase sensing technologies which proliferate the digital capability of the digital ecosystem and leads to digital competitiveness.
R8: Digital investment-digital technologies-sensing capabilities-digital capability-digital competitiveness	This loop reveals that digital investment triggers the propagation of digital technologies which results in the capability of the ecosystem to increase sensing technologies which proliferate the digital capability of the digital ecosystem and leads to digital competitiveness.

4.3.7 Operational Excellence

Martin and de Souza [177] propose that Operational Excellence (OE) implies that customers receive the products and services they demand within time, cost, quality, safety, and performance, it is considered a corporate business strategy [178] and a competitive weapon for service and manufacturing organisations [179]. Shehadeh *et al.* [180] propose that Operational

Excellence (OE) is a result of organisation-wide practices based on appropriate tenets that can be characterised under four elements; (i) Cultural enablers which entail leading with humbleness and reverence for every individual; (ii) Continuous Process Improvement which entails flow and pulls value, quality at the source, process-orientation, adoption of a scientific thinking approach, and seek continuous improvement; (iii) Enterprise Alignment which entails thinking systemically and creates constancy of purpose; and (iv) Results which entail creating value for the customer.

Jaeger *et al.* [181] propose that foundational perspectives of operational excellence are underpinned by six tenets that encompass leadership which entails breakthrough and change management, management systems, and key performance indicators (KPIs); a business culture that encompasses a culture of excellence, and sustainability and long term success; a business strategy which comprise vision, mission, success model and solution provider approach; an organisation which comprises agile systems and structures, and cooperation, networks, and alliances. In addition, people comprising of life cycle management, smart work environment, and internal cooperation; and lastly results which entail business growth, exceptional customer value, and stakeholder orientation. Carvalho *et al.* [182] suggest that the tenets of operational excellence are process efficiency and effectiveness, systems thinking approach, stakeholder requirements and expectations, learning organisation, and lastly Total Quality Management (TQM).

Operational excellence as a concept suggests a goal-seeking behaviour reference model.
The phenomenon of operational excellence (OPEX) suggests that a “goal” must be set and worked towards until the desired operational excellence goal is achieved. Therefore, operational excellence follows a goal-seeking reference behaviour mode as depicted in Figure 58. Initially, the level of operational excellence rapidly climbs and begins declining as it moves towards the operational excellence goal. The undesired, and every-so-often seen behaviour pattern in a goal-seeking behaviour pattern declines after a relatively strong start. The CLD is depicted in Figure 59 while an explanation of the causal interconnectedness and causal loops is described in Tables 42 and Table 43 respectively.

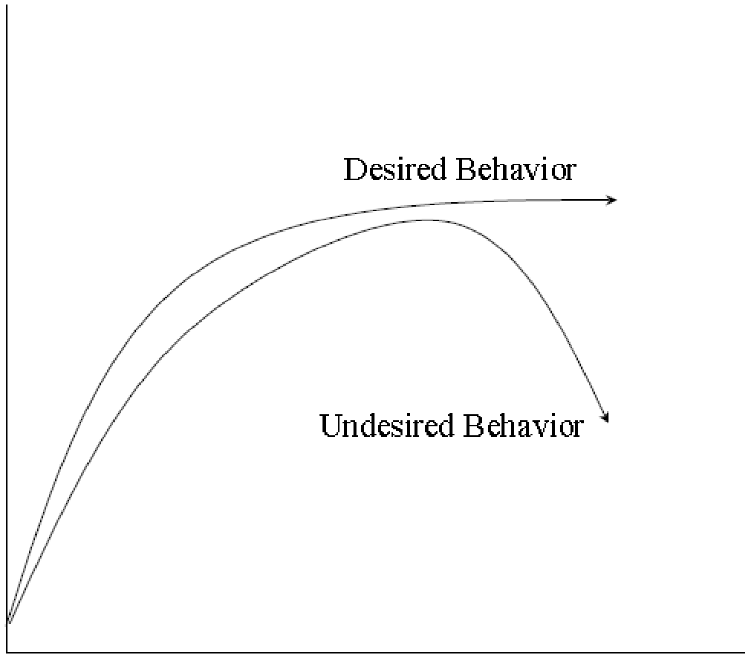


Figure 58: Desired and undesired reference mode behaviour patterns for operational excellence

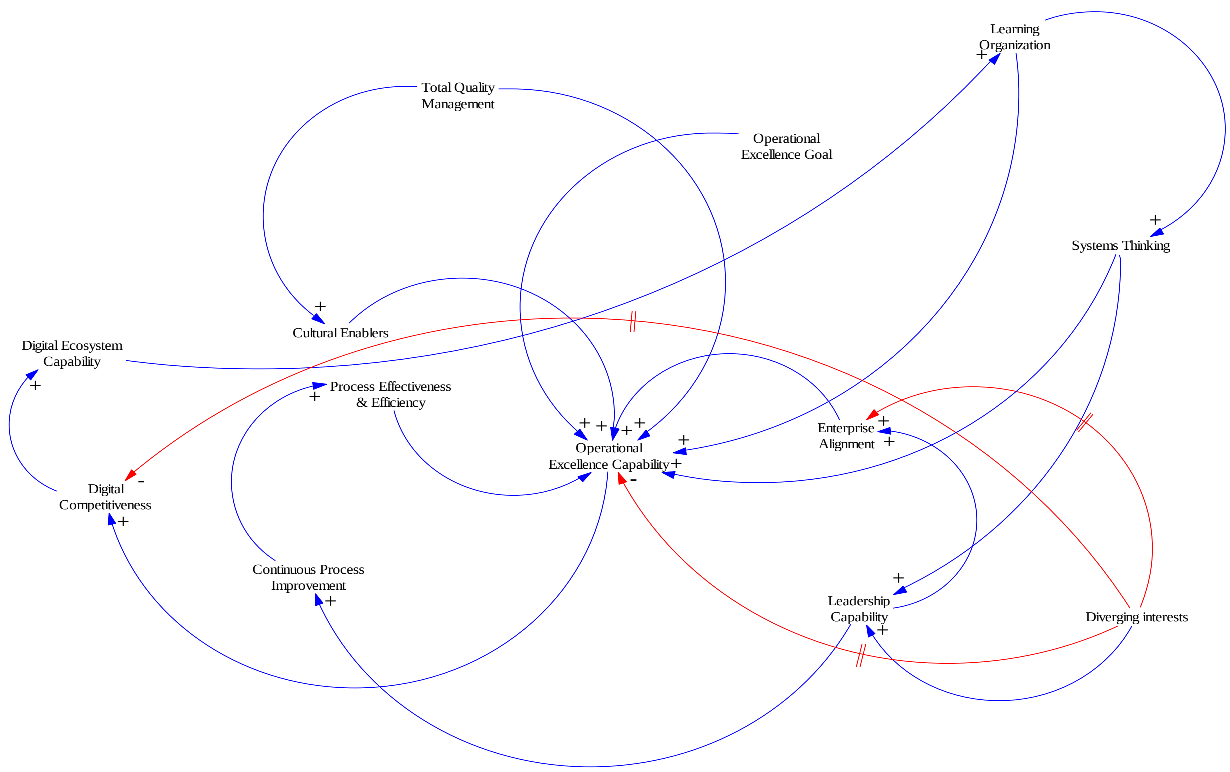


Figure 59: CLD of operational excellence (OPEX) dynamics

Table 42: Interconnectedness description of operational excellence dynamics

Interconnectedness	Explanation
Diverging interests influence leadership capability.	This interconnectedness reveals that diverging interests negatively impact leadership, as diverging interests increase, leadership capability reduces.
Diverging interests influence enterprise alignment.	This interconnectedness reveals that diverging interests negatively impact enterprise alignment, as diverging interests rise; enterprise alignment reduces.
Diverging interests influence digital competitiveness.	This interconnectedness reveals that diverging interests negatively impact digital competitiveness, as diverging interests increase; digital competitiveness reduces.
Diverging interests influence operational excellence capability.	This interconnectedness reveals that diverging interests negatively impact operational excellence capability, as

	diverging interests rise; operational excellence capability reduces.
Operational excellence goals influence operational excellence capability.	This interconnectedness reveals that an operational excellence goal positively reinforces the operational excellence capability of the system.
Leadership capability influences continuous process improvement.	This interconnectedness reveals that digital technologies positively reinforce continuous process improvement in the ecosystem.
Continuous process improvement influences process effectiveness and process efficiency.	This interconnectedness reveals that continuous process improvement reinforces process effectiveness and process efficiency of the ecosystem.
Process effectiveness and process efficiency influence operational excellence capability.	This interconnectedness reveals that process effectiveness and process efficiency reinforce the operational excellence capability of the system.
Leadership influence on enterprise alignment.	This interconnectedness reveals that leadership capability reinforces enterprise alignment.
Enterprise alignment influences operational excellence capability.	This interconnectedness reveals that enterprise alignment reinforces operational excellence capability.
Cultural enablers influence operational excellence capability.	This interconnectedness reveals that cultural enablers reinforce operational excellence capability.
Total Quality Management (TQM) influences operational excellence capability.	This loop reveals that Total Quality Management reinforces operational excellence capability.
Total Quality Management (TQM) influences cultural enablers.	This interconnectedness reveals that Total Quality Management reinforces cultural enablers.
Operational excellence capability influences digital competitiveness.	This interconnectedness reveals that operational excellence capability reinforces digital competitiveness.

Digital competitiveness influences digital ecosystem capability.	This interconnectedness reveals that digital competitiveness reinforces digital ecosystem capability.
Digital ecosystem capability influences learning organisation.	This interconnectedness reveals that digital ecosystem capability reinforces a learning organisation's capability.
Learning organisation capability influence on systems thinking mindset.	This interconnectedness reveals that a learning organisation's capability reinforces a system-thinking mindset.
Learning organisation capability influences operational excellence capability.	This interconnectedness reveals that a learning organisation's capability reinforces operational excellence capability.
Systems thinking mindset influences operational excellence capability.	This interconnectedness reveals that a systems thinking mindset reinforces operational excellence capability.
Systems thinking mindset influences leadership capability.	This interconnectedness reveals that a systems thinking mindset reinforces leadership capability.

Table 43: Description of digital investment dynamics loops

Loops	**Explanation**
R1: Digital ecosystem capability-learning organisation-systems thinking-leadership capability-continuous process improvement-process effectiveness & efficiency-operational excellence capability-digital competitiveness	This loop reveals that digital ecosystem capability reinforces a learning organisation culture which improves the system thinking outlook. The system thinking outlook reinforces leadership capability which strengthens a culture of continuous improvement, which reinforces process effectiveness and efficiency. Heightened process effectiveness and efficiency lead to an intensification of operational excellence which improves the digital competitiveness of the ecosystem.

R2: Digital ecosystem capability-learning organisation-operational excellence capability-digital competitiveness	This loop reveals that digital ecosystem capability reinforces a learning organisation culture that rallies operational excellence which then heightens the digital competitiveness of the ecosystem.

4.3.8 Digital Competitiveness

Istomina *et al.* [183] propose that competitiveness is the competence of a nation to restructure the value created in the economy in its favour, this is reinforced by Weresa [184] who suggests that the concept of competitiveness can be broken down into three levels which the macro level is the competitiveness of nations and cascades to the meso level which can be ascribed to the competitiveness of nations, segments; and lastly, the micro level which can be ascribed to the competitiveness of companies. Weresa [184] further suggests that novelty and talent are vital drivers of the competitiveness of organisations and nations.

According to the report by the UN [185], e-government can guarantee that services and opportunities are brought straight to people in rural and disadvantaged communities, providing them with access at their place of residence or through digital kiosks in the villages. e-Government is not just about providing services but also plays a role in the solidification of the digital literacy sustainable development goals' outcomes [185]. These goals are vital for the competitiveness of a country by elevating the skills of citizens and ensuring an inclusive society where citizens could partake in the digital economy. This view is supported by Chakravorti and Chaturvedi [186] who suggests that highly advanced countries usually have robust State/policy interests in shaping their digital economies, and as a result, the use of public policy to shape the digital economy and improve digital competitiveness is a key success factor.

Digital competitiveness as a concept suggests a goal-seeking behaviour reference model.
The phenomenon of digital competitiveness suggests that a "goal" must be worked towards until the desired digital competitiveness goal is achieved, as digital competitiveness follows a goal-seeking reference behaviour mode as depicted in Figure 60. At first, the level of digital competitiveness promptly increases and begins declining as it moves towards the digital competitiveness goal. The undesired, and frequently seen behaviour pattern in a goal-seeking behaviour pattern declines after a relatively sturdy start. The causal loop diagram is depicted

in Figure 61 while an explanation of the causal interconnectedness and causal loops are described in Tables 44 and Table 45 respectively.

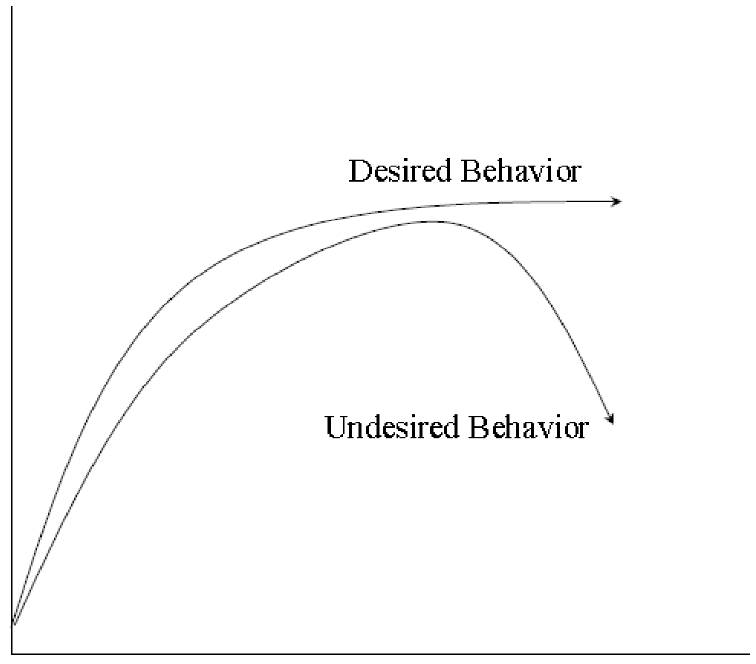


Figure 60: Desired and undesired reference mode behaviour patterns for competitiveness

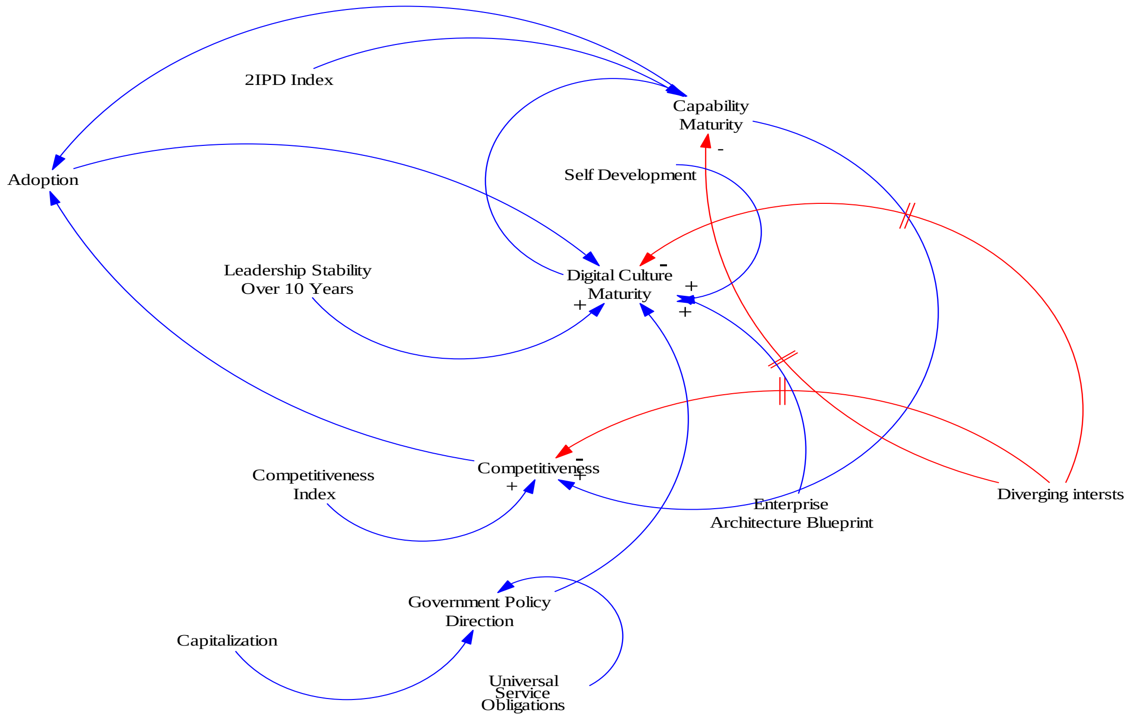


Figure 61: CLD of digital competitiveness dynamics

Table 44: Description of digital competitiveness dynamics interconnectedness

Interconnectedness	**Explanation**
Diverging interests influence digital culture maturity.	This interconnectedness reveals that diverging interests with time hamper the maturity of the digital culture.
Diverging interests influence capability maturity.	This interconnectedness reveals that diverging interests over time impede capability maturity.
Diverging interests influence competitiveness.	This interconnectedness reveals that diverging interests over time obstruct the competitiveness of the ecosystem.
2IPD index score influences capability maturity.	This interconnectedness reveals that an increasing 2IPD score will cultivate the capability maturity of the ecosystem.
Digital culture influences capability maturity.	This interconnectedness suggests that increasing digital culture will improve capability maturity.
Adoption influence on digital culture.	This interconnectedness suggests that an increase in adopters will improve the digital culture.

Capability maturity influences the adoption.	This interconnectedness suggests that as the capability matures, it will influence adopters to remain in the ecosystem and not exit.
Leadership stability influences digital culture.	This interconnectedness suggests that stable leadership enhances digital culture.
Enterprise architecture blueprint influence on digital culture.	This interconnectedness suggests that an enterprise architecture blueprint enhances digital culture.
Capability maturity influences competitiveness.	This interconnectedness suggests that an increasing capability maturity will enhance competitiveness.
Competitiveness influences adoption.	This interconnectedness suggests that the competition will influence adopters to remain in the ecosystem and not exit and encourage other potential adopters to adopt and be part of the competitive ecosystem.
Government policy direction influences competitiveness.	This interconnectedness suggests that positive government policy will enhance the competitiveness of the postal sector.
Competitiveness index influence on digital culture.	This interconnectedness suggests that the aggregate competitiveness index of the country will positively influence digital culture when it increases.

Table 45: Description of digital competitiveness dynamics loops

Loops	**Explanation**
R1: Adoption-digital culture maturity-capability maturity	This loop reveals that adoption reinforces digital culture maturity which further reinforces capability maturity.
R2: Adoption-digital culture maturity-capability maturity-competitiveness	This loop reveals that adoption reinforces digital culture maturity which further reinforces capability maturity. Capability maturity reinforces competitiveness.

4.4 Framed Structures and Quantification of Aggregate Variables

4.4.1 Synthesizing Postal Stocks and Flows from the Ten Dimensions

The ten dimensions discussed in the preceding chapter were further synthesized to develop postal-specific stocks and flows that are grounded on the work undertaken thus far. A recap of the ten dimensions provides the foundation of the work that emerged in this chapter. The ten dimensions are (1) Digital culture, (2) Digital investments, (3) Operational excellence, (4) Ecosystem capability, (5) Adoption, (6) Competitiveness, (7) Digital capabilities, (8) Shared vision, (9) Customer insights, and (10) Diverging interests.

The Integrated Index for Postal Development (2IPD) is defined by the UPU [4] as a relative global measure of postal development. 2IPD is a complex index that describes the performance of DPOs in 168 countries. As such, the 2IPD is an exceptional means for examining the performance of the postal sector. The 2IPD according to UPU [6] is grounded on four pillars which are (1) Relevance which appraises the vigour of demand for the full offerings of postal services compared to the finest DPOs in each category of postal activity, (2) Reliability echoes performance in terms of swiftness and certainty of delivery, across all the key segments of physical postal services, (3) Reach implies global connectedness by appraising the extensiveness and deepness of the DPOs international network. Lastly, (4) Resilience shows the degree of the diverseness of revenue streams, along with the aptness to invent and bring about a postal service which serves the broader society.

UPU [6] advances that; (1) The reliability pillar aims to appraise the operational effectiveness of postal service, displaying the level to which operations are executed aptly and expectedly. (2) The reach pillar captures the level of internationalization of these operations, demonstrating whether postal services in the country in question have a high level of cross-border exchanges. (3) The relevance pillar aims to appraise the competitiveness of the DPOs in all significant segments and in particular the potential to generate higher volumes. Lastly, (4) The resilience pillar intends to evaluate the aptitude of DPOs to endure external tremors through flexible business models. The four pillars are designed at ensuring a sensible perspective of postal development, without exclusively concentrating on operational, strategic, or socio-economic matters. This allows the final 2IPD score to expansively echo (while concisely articulating) the condition of postal services in any given geography [6].

Warren [187] argues that capability is the aptitude to accomplish an activity that comprises multifaceted patterns of synchronisation between human capital and other resources. Capabilities are, therefore, composite asset stocks integrating people, skills, processes, and information systems and accumulating or depleting over time. The 2IPD as articulated in [4] is a composite index that integrates four dimensions (Reliability, Reach, Relevance, and Resilience) of postal development. The capability maturity articulated by [188] argues that the finest postal development performer attains a standardised maximum score of 100 points, while the worst performer obtains a minimum score of zero points. Consequently, the standardised scores can be best understood as the performance of any given DPO relative to the best (100 points) or worst (0 points) global performer. They classify the performers relative to their composite scores as follows:

(1) Postal champions: A score over 55 displays that a nation's postal development is amongst the top 20% in the world, this score can be understood as very good to outstanding. This group of nations imply a sound performance across all pillars of postal development.

(2) Good performers: A score that ranges between 30 and 55 demonstrates an upper-intermediate level of performance. These nations are steady performers and belong to the top 50%

(3) Potential performers: A score that ranges between 15 and 30 expresses a performance that is lower than the average, with nations typically performing only moderately well, notwithstanding the developmental potential that they possess. The majority of nations in this group display evident weaknesses in one or more areas of postal development.

(4) Least developed operators: A score below 15 illustrates that a nation's postal development is at its lowest. These nations are faced with big trials in numerous pillars of postal development.

Figure 62 depicts the operations' capability maturity in the context of the 2IPD score and it illustrates the performance of least developed operators, potential performers, good performers and postal champions.

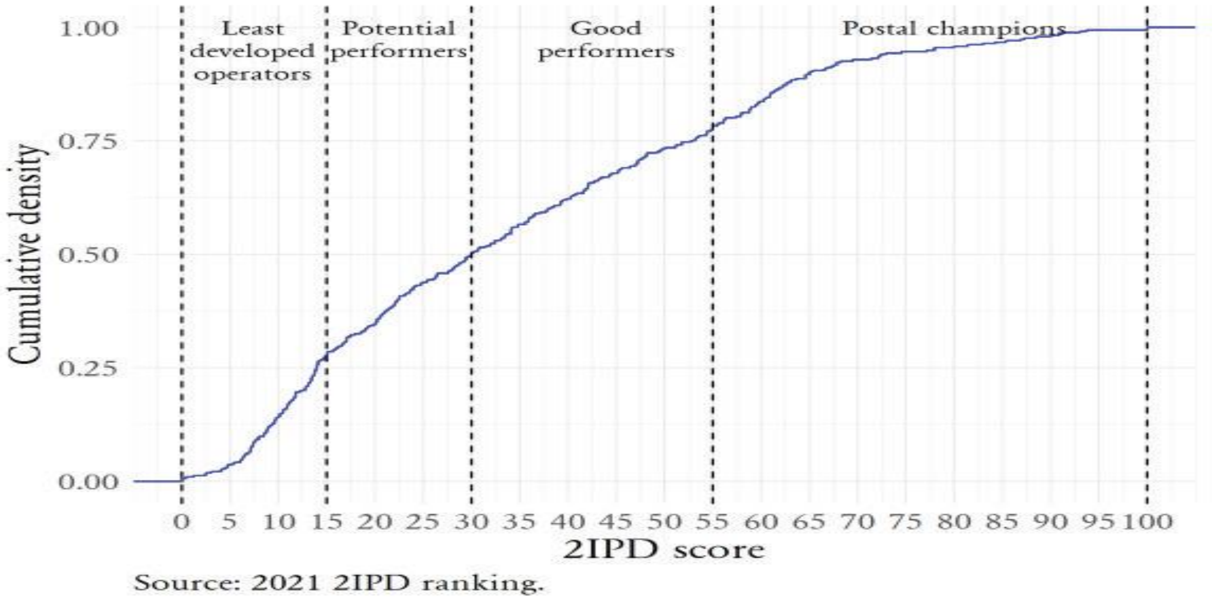


Figure 62: Operations Capability Maturity (2IPD score)

The 2IPD as a composite stock that accumulates or depletes over time and integrates some of the seven dimensions under the stock "capability maturity". Table 46 illustrates the synthesis and integration of the ten dimensions into composite stocks that emerged. The table represents the fusion of some of the ten dimensions to the stocks that deplete or accumulate over time, other dimensions emerged as stocks; with adoption and digital culture vital to improving capability and ultimately competitiveness. Two of the dimensions are exogenous to the system and therefore are outside the boundary of the model, the two are a digital ecosystem and customer insights. Diverging interests are represented by inhibiting factors that will be articulated in the stocks and flow.

Table 46: Emergence of stocks from the seven dimensions

Dimension	**Operations Capability Maturity**	**Digital Culture**	**Financial Performance**
Digital culture		X	
Digital investments	X		
Operational excellence	X		
Adoption			
Competitiveness			X
Digital capabilities	X		
Shared vision		X	

The synthesis depicted in Table 46 resulted in the emergence of the four key stocks that will be utilised to develop the stock and flows. The four stocks are (1) Capability Maturity (CM), Digital Culture (DC), Competitiveness (C), and Adoption (A).

Figure 63 captures the CLD of the synthesis as discussed in 5.2.1 and culminated in the four stocks that will be articulated in 5.2.2. Figure 63 characterises the restated hypothesis and theorises that the adoption of the UPU digital ecosystem by major clients of the postal sector will improve the digital culture of the respective postal operator which will improve the capability maturity of the respective postal operator. The hypothesis further theorises that improvement in capability maturity will improve the adoption rate which is further influenced by leadership efforts in the form of adoption from marketing efforts and adoption from communication channels. The potential adopters will likely convert into adopters based on the leadership efforts articulated above. This will increase until all potential adopters have converted into adopters. The increase in adopters, increase in digital culture, and increase in operations capability maturity stocks are likely to positively reinforce the financial performance (competitiveness) of the designated postal organisation. The financial performance will likely directly influence adopters' stock, digital culture stock, and capability maturity.

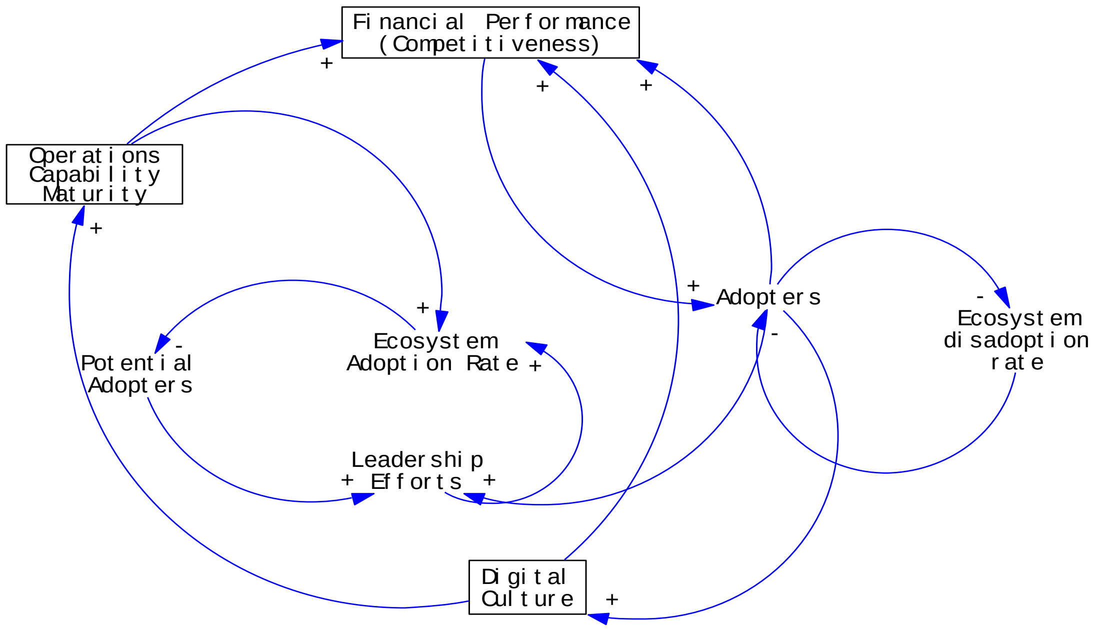


Figure 63: Postal development dynamics CLD as a restated hypothesis

4.4.2 Stocks and Flows for Emergent Dimensions

The four stocks that emerged in the 4.4.1 synthesis which are depicted in Table 46 and Figure 63 are formulated and discussed from 4.4.2.1 to 4.4.2.4. Anylogic software was used to develop the structure of the model and formulate the mathematical expressions that govern the model behaviour to mimic real-life situations. The stocks: capability maturity, digital culture, adoption, and financial performance (competitiveness) are discussed below.

The South African Post Office was selected to test and validate the model and as a result, the data that are used to quantify the variables were sourced from the South African Post Office. Figure 64 is the overall model that captures the stock and flows as depicted in Figure 63. Figures 65 to 68 depict the individual stock and flows formulated with the Anylogic PLE software.

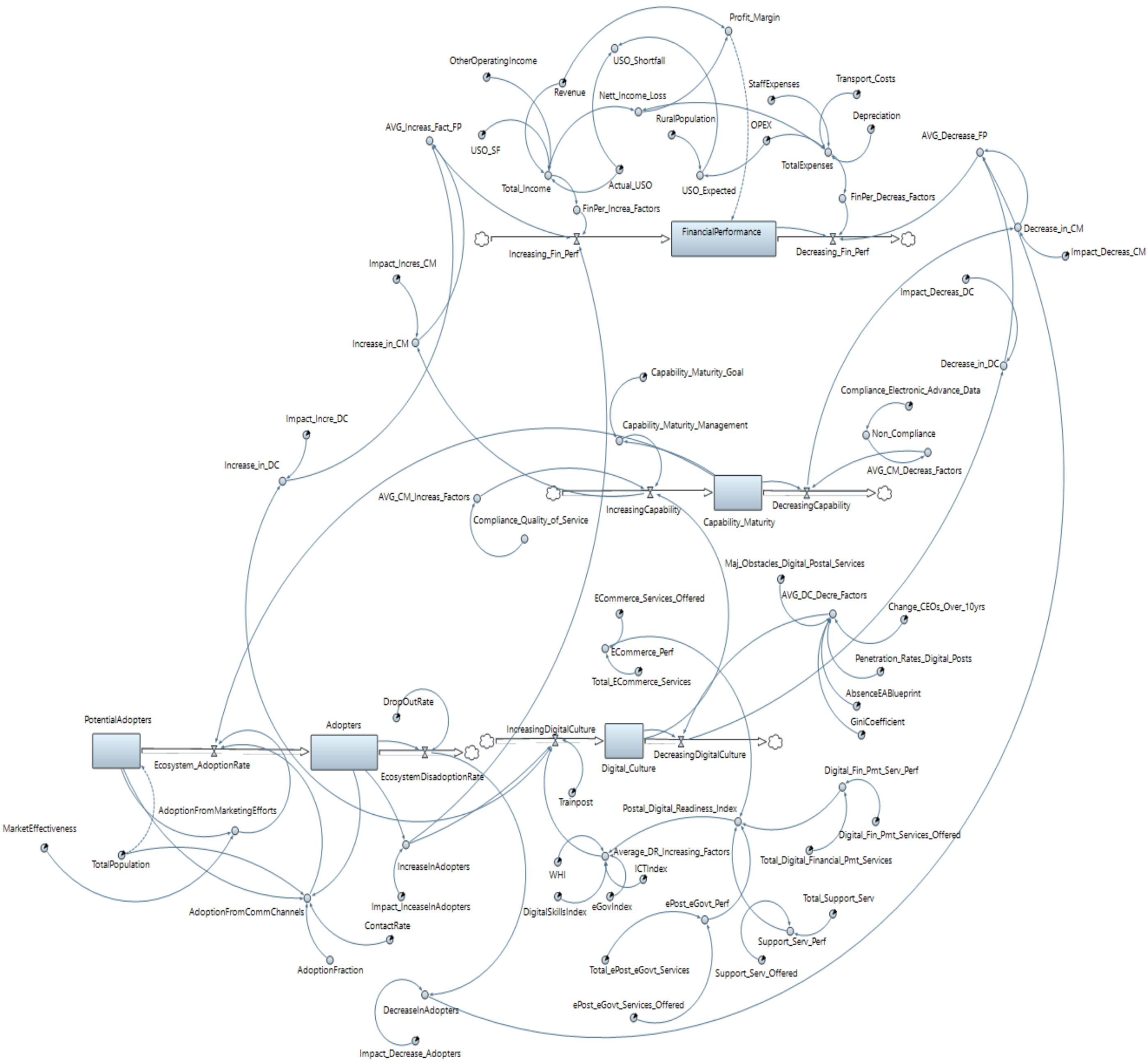


Figure 64: Postal development model with stocks and flows formulated in Anylogic PLE software

4.4.2.1 Operations Capability Maturity

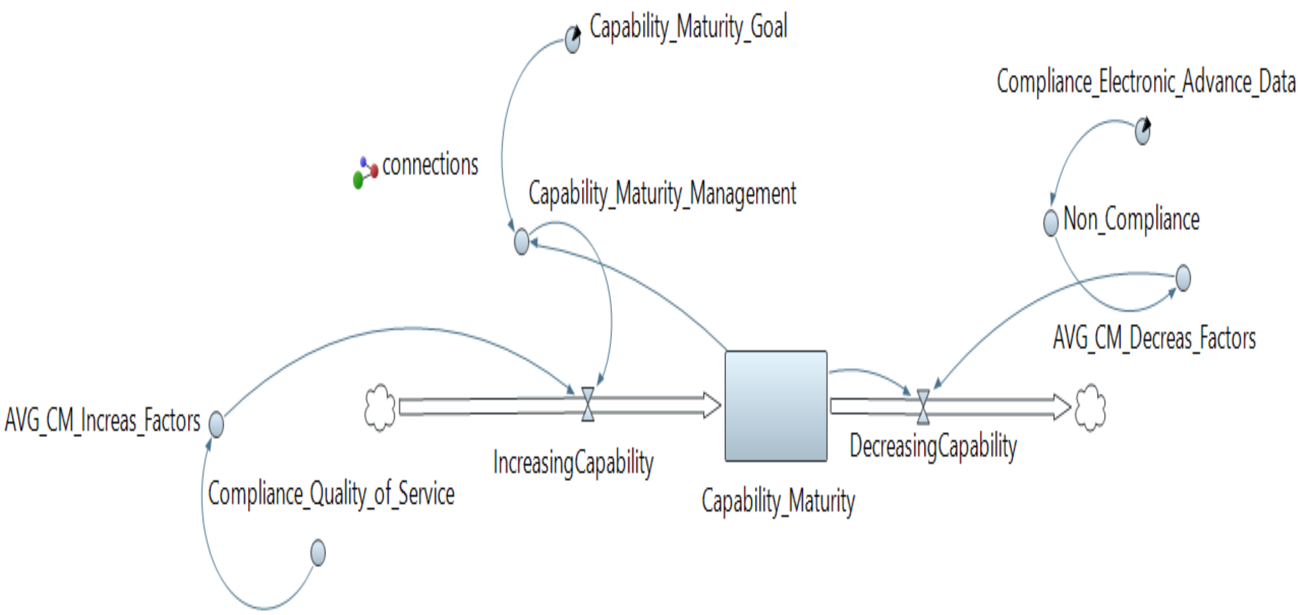


Figure 65: Operations Capability maturity dynamics formulated in Anylogic

Figure 65 articulates the construction of the goal-seeking structure in Anylogic simulation software as well as the balancing influence loop from diverging interests (Non-compliance to Electronic Advance Data). The discussions on what each of the elements represents are articulated in the preceding chapter. The structure depicted in Figure 65 comprises a single stock which is the operations capability maturity which accumulates capability components over time, based on its flows, increasing capability, and decreasing capability. It is conceptually correct to quality assure that the model is rationally accurate which means that each flow should surge or deplete the capability maturity "stock" with "units" or components over time.

Operations Capability Maturity (CM) is defined as the difference between increasing capability maturity (ICM) and decreasing capability maturity (DCM) which can be described mathematically as in equation 3.

$d(DC)/dt = ICM - DCM$ *Equation 3*

Equation 1 explains that capability maturity over time is the difference between increasing capability maturity and decreasing capability maturity. The capability maturity goal is envisaged to be 0.6 and the current capability based on the 2IPD is 0.33. The gap that exists requires to be managed and as a result, capability maturity management (CMM) emerges as a concept and is defined as the difference between capability maturity goal (CMG) and Capability Maturity (CM) stock resulting in the formulation of the equation:

$$CM\ Goal - CM \qquad \text{Equation 4}$$

Equation 4 explains that operations Capability Maturity Management (CMM) is a function of both the operations Capability Maturity Goal (CMG) and the current level of Operations Capability Maturity (CM).

Decomposition of equation 3 yields (i) Increasing capability maturity which is on the left side of the capability maturity stock as depicted in Figure 65 and (ii) Decreasing capability maturity which is on the right side of the capability maturity stock as depicted in Figure 65. Equation 3 represents the two flows that interact to result in the level of capability maturity. Increasing Capability Maturity (ICM) is the sum of Capability Maturity Management (CMM) and average capability management increasing factors ($AvgCMI_f$) which comprise compliance to quality of service (CQoS) multiplied by digital culture (DC) as an increase in digital culture will affect operations capability maturity. The relationship is described mathematically in Equation 5.

$$ICM = (AvgCMI_f + CMM) * DC \qquad \text{Equation 5}$$

The impact of an increase in capability management (ImpiiCM) is calculated as the total increase impact factor (Tiif) minus the sum of the Impact of an increase in adoption (IiiA) and the Impact of an increase in digital culture (IiiDC). Therefore, the mathematical expression is written as:

$$ImpiiCM = Tiif - (IiiA + IiiDC) \qquad \text{Equation 6}$$

Decreasing Capability Maturity (DCM) on the other hand is the difference between capability maturity and a diverging variable in the form of average capability maturity decreasing factors ($AvgCMD_f$) which comprise the overall level of non-compliance to UPU's EAD (Electronic

Advance Data) with notation (NCEAD). Therefore, decreasing capability maturity is defined as:

$$DCM = CM - AvgCMI_f \qquad \text{Equation 7}$$

Warren [189] argues that X (t +1) = X(t) ∓ ΔX is the core theory that lies at the heart of how firms and organisations perform and argues that the rate of loss or gain of a resource (stock) over a period explains the quantity of the stock at any given time, and it does so by depleting or accumulating. It is against this theory articulated by [189] that Equation 4 and other subsequent expressions of other stocks involved in this model are conceptually and mathematically correct.

The variables articulated in equations 1, 2, 3, and 4 were computed to harmonize replication output with representative behaviour patterns and mathematical completeness. For sensible model simulation performance, the baseline values for variables are articulated in Table 47. Table 47 depicts the baseline, minimum, and maximum values that the computed variables take in the articulated model.

Table 47: Operations Capability maturity factor values

Variable	**Minimum**	**Maximum**	**Baseline**	**Source**
Capability Maturity (CM)	0	1	0.3414	[5]
Capability Maturity Goal (CMG)	0	1	0.6	[189]
Compliance with Quality of Service (CQoS)	0	1	0.42	[190]
Overall Compliance with EAD	0	1	0.8859	[191]
Non-compliance to EAD	0	1	0,1141	Calculated (1-0.8859)

Impact of increase in capability maturity (ImpiiCM)	0	1	0.08	Calculated 1-(0.42+0.5) [4]

4.4.2.2 Digital Culture

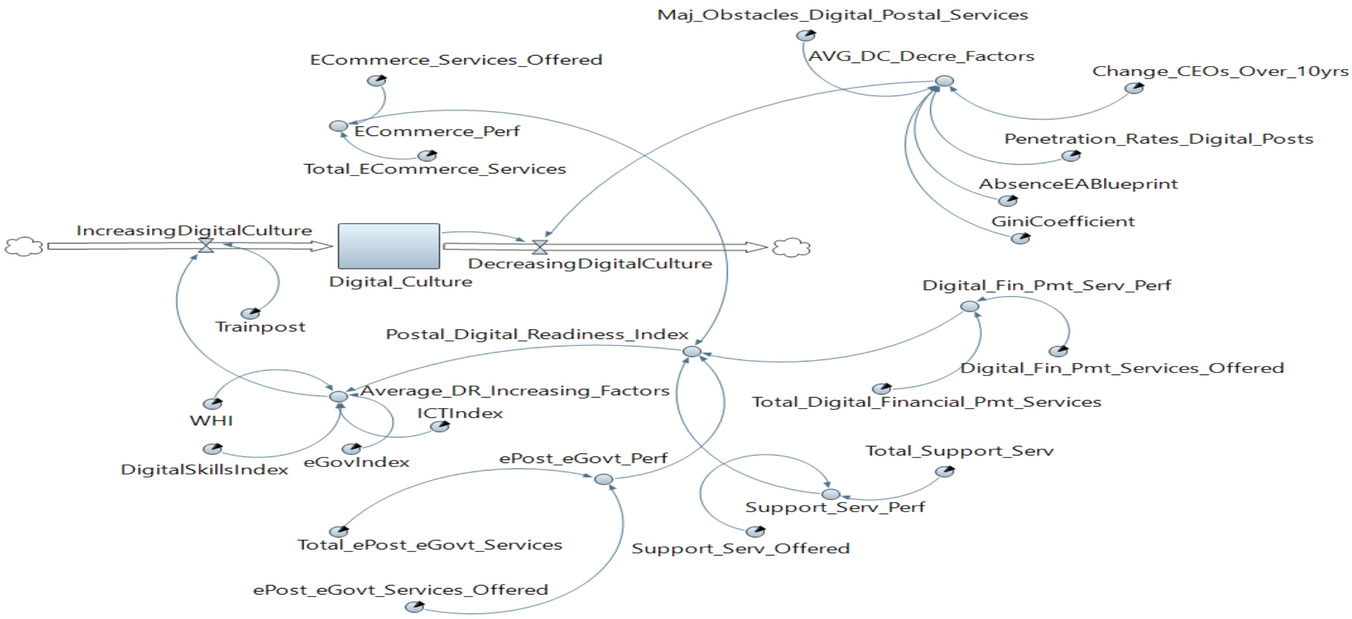


Figure 66: Digital culture dynamics formulated in Anylogic

Figure 66 depicts the construction of the s-shaped growth structure for digital culture in Anylogic as well as the unsought balancing influence from diverging interests. The structure comprises one stock which is digital culture. The digital culture stock has two flows connected to it which are an influx (Increasing digital culture) and a discharge (Decreasing digital culture). The digital culture stock accrues units of digital culture and the two flows move units of digital culture/units of time into and out of the stock.

Digital Culture (DC) is defined as the difference between increasing digital culture and decreasing digital culture which can be described mathematically as in Equation 8.

$$d(DC)/dt = IDC - DDC \quad \text{Equation 8}$$

This construction in the virtual world follows an s-shaped structure in the causal diagram for digital culture, which was derived from the reference mode behaviour pattern for digital culture. Increasing digital culture is the sum of average digital culture factors (Avg_DCI_f) and the percentage of staff who attended train-post courses (SATPC) divided by two and multiplied by the increase in adopters (IiA). Average digital culture factors comprise (a) Postal readiness index (PRi) which is a composite of (i) Support Service Performance (SSP), E-commerce performance (ECSP), ePost and e-Government services performance (ePeGSP), and digital financial and payment services performance (DFPSP). (b) Global Index Factors (GI_f) that drive a digital culture which is a composite of (i) Word Happiness Index (WHi), (ii) Digital Skills Index (DSi), (iii) e-Government Index (eGi), and (iv) ICT Index (ICTi). Therefore, increasing digital culture (IDC) can be expressed mathematically as:

$$IDC = ((Avg\_DCI_f + SATPC)/2) * IiA \qquad \text{Equation 9}$$

Where:

$$Avg\_DCI_f = (SSP + ECSP + ePeGP + DFPSP + WHi + DSi + eGi + ICTi)/8 \qquad \text{Equation 10}$$

Where:

(i) Support Services Performance (SSP) equals the support services offered (SSO) by the designated postal operator divided by the total support services (TSS) that are available in the ecosystem. Therefore, support services performance is calculated as:

$$SSP = SSO / TSS \qquad \text{Equation 11}$$

(ii) E-commerce services performance (ECSP) equals the e-commerce services offered (ECSO) by the designated postal operator divided by total e-commerce services (TECS) that are available in the ecosystem. Therefore, E-commerce services performance is calculated as:

$$ECSP = ECSO / TECS \qquad \text{Equation 12}$$

(iii) ePost and e-Government services performance (ePeGSP) equals the ePost and e-Government services offered (ePeGSO) by the designated postal operator divided by the total ePost and e-Government services (TePeGS) that are available in the ecosystem. Therefore, ePost and e-Government services performance (ePeGSP) is calculated as:

$$ePeGSP = ePeGSO / TePeGS \quad \text{Equation 13}$$

Increase in adopters (IiA) = Adopters (A) * Impact of increase in Adopters (ImpiiA) and it can be mathematically expressed as:

$$IiA = A * ImpiiA \quad \text{Equation 14}$$

Decreasing digital culture (DDC) on the other hand is the difference between digital culture and a diverging variable in the form of average digital culture decreasing factors (($AvgDCD_f$) which comprise the absence of EA blueprint (AEABP), penetration of digital postal services (PRDPS), Gini coefficient (GCO_{eff}) which measures the level of inequality in society, major obstacles to digital postal services (MODPS), and percentage change in Chief Executive Officers over 10 years (CoCEO_10Yrs). O'Reilly III *et al.* [192] propose that the mainstream studies of organisational culture are grounded on two assumptions: (a) Leaders lead the cause of culture, and (b) Culture is interrelated to ensuing organisational outcomes. O'Reilly III *et al.* [192], demonstrated through the experimental results constructed on data from respondents in 32 high-technology firms, that the character of the Chief Executive Officer (CEO) influences, to a high degree, organisational culture which is thereafter connected to a comprehensive set of organisational results including an organisation's economic performance.

Therefore, decreasing capability maturity is defined as:

$$DDC = DC - AvgDCDf \quad \textit{Equation 15}$$

Where:

$$AvgDCDf = (AEABP + GCOeff + PRDPS + MODPS + CoCEO\_10Yrs)/5 \quad \textit{Equation 16}$$

The major obstacle to digital postal services is a composite of factors that hinder fully digital postal services in Africa. These factors are poor investments (PI), lack of digital culture (LDC), lack of expertise (LE), poor integration of merchants (PIM), poor customer adoption (PCA), inadequate training (IT), poor rate of change (PRC), difficulty in finding right external partners (DFREP), custom clearance challenges (CCC), stiff competition (SC), inadequate legal framework (ILF), and limited best practices (LBP). The equation for the major obstacle to digital postal services (MODPS) is:

$$MODPS = AVG\ (PI + LDC + LE + PIM + PCA + IT + PRC + DFREP + CCC + SC + ILF + LBP) \quad \text{Equation 17}$$

Table 48 depicts the minimum, maximum, and baseline values that the quantified variables take in the formulated model.

Variable	Minimum	Maximum	Baseline	Source
Digital culture	0	1	0.46	[4]
Support Services Offered (SSO)	0	13	3	[4]
Total Support Services (TSS)	0	13	13	[4]
Support Services Performance (SSP)	0	1	0.23	Calculated (3/13)
E-commerce Services Offered (ECSO)	0	8	5	[4]
Total E-commerce Services (TECSS)	0	8	8	[4]
E-commerce Services	0	1	0.625	Calculated (5/8)

Performance (SSP)				
ePost & e-Government Services Offered (ePeGSO)	0	16	6	[4]
Total ePost & e-Government Services (TePeGS)	0	16	16	[4]
ePost & e-Government Services Performance (ePeGSP)	0	1	0.375	Calculated (6/16)
Digital Financial and Payment Services Offered (DFPSO)	0	6	5	[4]
Total Digital Financial and Payment Services (TDFPS)	0	6	6	[4]
Digital Financial and Payment Services Performance (DFPSP)	0	1	0.83	Calculated (5/6)

Train-Post statistics	0	140000 (Total employees)	140 (Actual employees who attended Train-post courses)	[193]
Staff Attendance of Train-Post Courses (SATPC)	0	1	0.001	Calculated 140/140000
Change of CEOs over 10 years (CoCEO_10Yrs)	1	0	7/10 (0.7)	Analysis of annual reports since 2012
Absence of Enterprise Blueprint	1	0	0.5	[194]
Poor investment (PI)	0	1	0.72	[4]
Lack of digital culture (LDC)	0	1	0.58	[4]
Lack of expertise (LE)	0	1	0.53	[4]
Poor integration of merchants (PIM)	0	1	0.5	[4]

Poor customer adoption (PCA)	0	1	0.5	[4]
Inadequate training (IT),	0	1	0.44	[4]
Poor rate of change (PRC),	0	1	0.42	[4]
Difficulty in finding the right external partners (DFREP),	0	1	0.33	[4]
Custom clearance challenges (CCC)	0	1	0.28	[4]
Stiff competition (SC)	0	1	0.26	[4]
Inadequate legal framework (ILF)	0	1	0.26	[4]
Limited best practices (LBP)	0	1	0.17	[4]
Major obstacle to digital postal services (MODPS)	0	1	0.416	Calculated AVG (0.5+0.72+0.58+0.53+0.5+0.5+0.44+0.42 +0.33+0.28+0.26+0.26)

World Happiness Index (WHi)	0	1	0.5197	[195]
e-Government Index (eGi)	0	1	0.66	[196]
ICT Index (ICTi)	0	1	0.496	[197]
Digital Skills Index (DSi)	0	1	0.583	[198]
Gini Coefficient	1	0	0.63	[199]
Impact of increase in adopters (ImpiiA)	0	1	0.5	[4]

4.4.2.3 Adoption

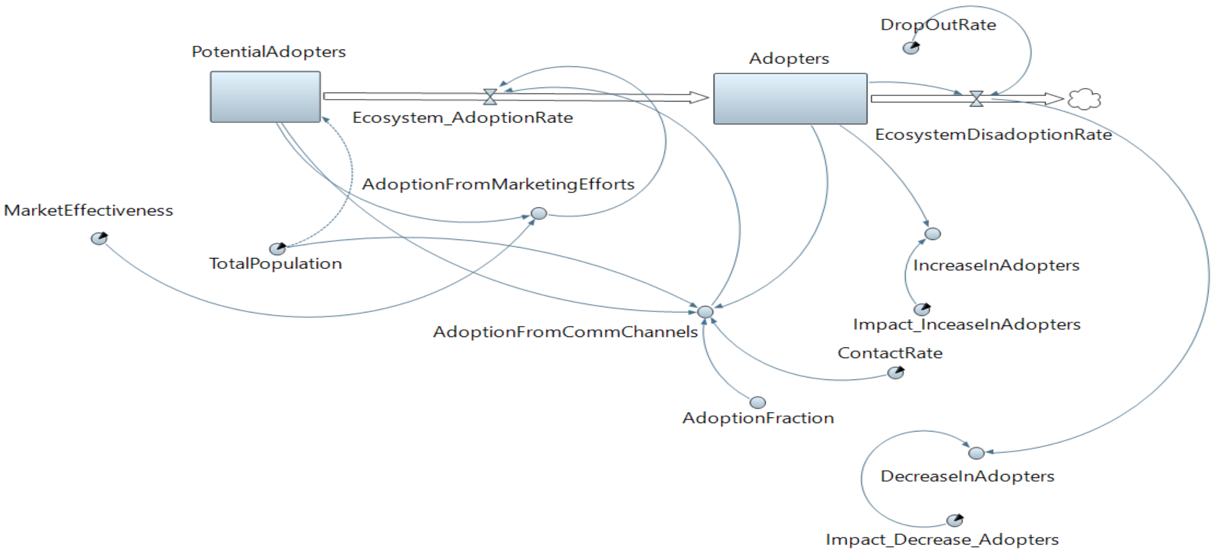


Figure 67: Adoption dynamics formulated in Anylogic

To provide context before the articulation of mathematical expressions, potential adopters are the 174 key customers of the organisation who contribute more than R10 million a month towards revenue at the South African Post Office which is used to validate the postal development system dynamics model. There are currently five key customers who have adopted and had been integrated into the UPU digital ecosystem platform. The UPU digital ecosystem platform is a complex ecosystem offering designated postal operators an opportunity to collaborate and integrate into the postal industry's industry 4.0 platform (ecosystem) which is grounded on the (i) Six industry 4.0 design principles of interoperability, virtualization, decentralization, real-time capability, service orientation, and modularity. (ii) The four Industry 4.0 dimensions of cyber-physical systems, Internet of Things (IoT), Internet of Services (IoS), and smart factories. Table 48 depicts the four dimensions of Industry 4.0 and the UPU systems matched against the four dimensions. Table 49 depicts the six design principles of Industry 4.0 matched against the four major UPU systems.

Table 48: Industry 4.0 design principles vs UPU systems

Industry 4.0 design principles → **UPU systems ↓**	**International Postal System**	**Postal Payment System**	**Custom Declaration System**	**Domestic Postal System**
Interoperability	X	X	X	X
Virtualization	X	-	X	X
Decentralization	-	X	-	X
Real-Time Capability	X	X	X	X
Service Orientation	X	X	X	X
Modularity	X	X	X	X

Table 49: Industry 4.0 dimensions vs UPU systems

Industry 4.0 dimensions → UPU systems ↓	**Cyber-Physical Systems**	**Internet of Things**	**Internet of Services**	**Smart Factory**
International Postal System	X	X	X	X
Domestic Postal System	X	X	X	X
International Financial System	X	X	X	X
Custom Declaration System	X	X	X	X
. Post	X	X	X	-
. Cloud	X	X	X	X
UPU IP	-	X	X	-
STEFI	-	X	X	-
www.wnsstamps.post	-	-	X	-
FEIS	-	-	X	-
PPS*Clearing	-	-	X	-

The adoption rate is articulated in detail in Chapter 4 and is driven by leadership efforts that are in the form of (i) Adoption from marketing efforts which represent leadership efforts to market the digital ecosystem to the 174 key customers, to convince the key customers to adopt the UPU digital ecosystem API (Application Programming Interfaces) and participate in the global postal economy. (ii) Adoption from communication channels which is driven by both formal and informal communication among adopters.

Figure 67 depicts the construction of the s-shaped growth structure for adoption in Anylogic as well as the unsought balancing influence from dis-adoption due to adopters dropping out and ceasing to use the ecosystem. The structure comprises two stocks which are (i) Potential adopters and (ii) Adopters. The digital culture stock has two flows connected to it which are an influx (Increasing digital culture) and a discharge (Decreasing digital culture). The digital culture stock accrues units of digital culture and the two flows move units of digital culture/units of time into and out of the stock.

Adoption from marketing efforts (AME) is calculated by multiplying marketing effectiveness (MI) multiplied by potential adopters (PA). Therefore, the mathematical expression can be written as:

$$AME = MI * PA \qquad \text{Equation 18}$$

Adoption from communication channels (ACC) is the product of adopters' stock (A), adoption fraction (AF), and contact rate (CR) multiplied by the quotient of potential adopters' stock (PA) and total population (TP).

$$ACC = A * AF * CR * (PA)/TP \qquad \textit{Equation 19}$$

The ecosystem adoption rate (ESAR) is calculated by multiplying the sum of Adoption from Marketing Efforts (AME) and Adoption from Communication Channels (ACC) by Capability Maturity (CM) stock because as the capability maturity increases, it will persuade other potential adopters to adopt the UPU API's and integrate to the ecosystem to benefit from the benefits other adopters reap from UPU digital ecosystem.
The mathematical expression for ecosystem adoption rate is written as:

$$ESAR = (AME + ACC) * CM \qquad \textit{Equation 20}$$

The ecosystem dis-adoption rate (ESDR) represents the number of adopters (A) who discontinue the use of the ecosystem. The calculation of the dis-adoption rate is arrived at by multiplying the dropout rate (DoR) and adopter stock (A). The mathematical expression for ecosystem dis-adoption rate is written as:

$$ESDR = DoR * A \qquad \text{Equation 21}$$

The effect of an increase in adopters was articulated in Equation 14 in the preceding paragraphs and further stated below:

$$\mathrm{IiA} = \mathrm{A} * \mathrm{ImpiiA} \qquad \text{Equation 22}$$

Table 51 depicts the minimum, maximum, and baseline values that the quantified variables take in the formulated model.

Table 50: Adoption factor values

Variable	Minimum	Maximum	Baseline	Source
Marketing effectiveness (ME)	0	1	0.2	[200]
Contact Rate (CR)	-	-	20	[200]
Adoption Fraction	0	1	0.1	[200]
Total population (TP)	0	174	174	[200]
Total population (TP)	0	1	1	Calculated (174/174)
Potential adopters	0	169	169	Calculated (174-5)
Potential adopters	0	1	0.9716	Calculated (1-0.0287)
Adopters	0	169	5	[200]
Adopters	0	1	0.0287	Calculated (5/174)
Impact of increase in adoption (ImpiiA)	0	1	0.5	[4]

4.4.2.4 Financial Performance (Competitiveness)

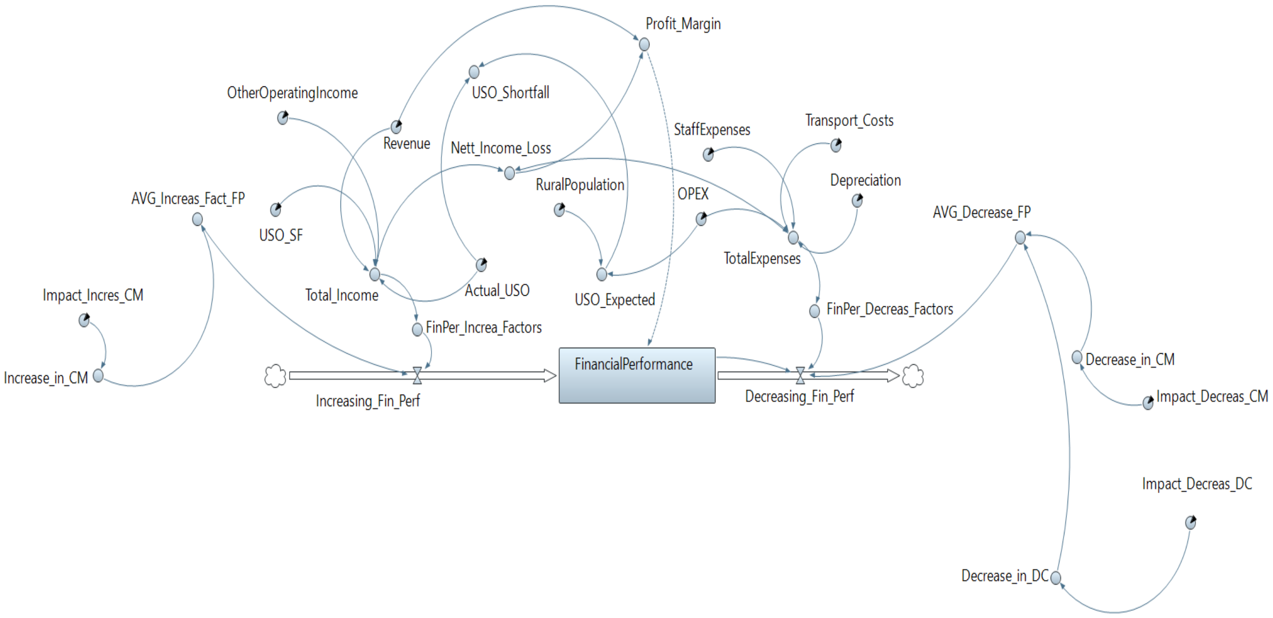


Figure 68: Financial performance (competitiveness) dynamics formulated in Anylogic

Figure 68 depicts the construction of the s-shaped growth structure for financial performance in Anylogic as well as the undesired compensating influence from discontinued use inertia. The structure comprises one stock which is digital culture. The financial performance (competitiveness) stock has two flows connected to it which are an influx (Increasing financial performance) and a discharge (Decreasing financial performance). The financial performance (competitiveness) stock accrues or drains units of financial performance, and the two flows move units of financial performance/units of time into and out of the stock.

Financial Performance (FP) is defined as the difference between Increasing Financial Performance (IFP) and Decreasing Financial Performance (DFP) which can be described mathematically as in Equation 20.

$$d(FP)/dt = IFP - DFP \quad \text{Equation 23}$$

Where:

Increasing Financial Performance (IFP) is the average of the sum of an increase in adopters (IiA), financial performance increase factors, and average increase factors for financial performance which can be mathematically expressed as:

$$IFP = AVG\ (FinPer\_Increa\_Factors + AVG\_Increas\_Fact\_FP + IncreaseInAdopters)$$ Equation 24

Where:

Average Increase Factors in Financial Performance (AIFFP) are the average increase in capability management (IiCM), increase in digital culture (IiDC), and increase in adopters (IiA). Therefore, the Financial Performance Increase Factors (FPIF) can be mathematically expressed as:

$$AIFFP = AVG\ (IiCM + IiDC + IiA)$$ Equation 25

An increase in digital culture (IiDC) is expressed as the product of the impact of an increase in digital culture (ImpiiDC) and Increasing Digital Culture (IDC). The mathematical expression that follows is:

$$IiDC = ImpiiDC * IDC$$ Equation 26

The Financial Performance Increase Factors (FPIF) are attributed to total income (TI) which is made up of the sum of revenue (RV), other operating income (OOI), actual universal obligation paid (AUSOPD), and universal service obligation shortfall (USOSF). The mathematical expression that follows is:

$$FPIF = TI = RV + OOI + AUSOPD + USOSF$$ *Equation 27*

Decreasing Financial Performance (DFP) is attributed to (i) Financial performance decrease factors (FPDF) which are attributed to total expenses (TE) which are made up of the sum of transport costs (TC), staff expenses (SE), operational expenses (OPEX), and depreciation

(DEP). (ii) Average decrease in financial performance (ADFP) which is attributed to the average decrease in capability maturity (DiCM), decrease in digital culture (DiDC) and decrease in adopters (DiA). (iii) Financial performance stock

The mathematical expression that follows is:

$$DFP = FP - (ADFP - FPDF) \quad \text{Equation 28}$$

$$FPDF = TE = TC + SE + OPEX + DEP \quad \text{Equation 29}$$

Table 52 depicts the minimum, maximum, and baseline values that the quantified variables take in the formulated model.

Table 51: Financial performance (competitiveness) factor values

Variable	**Minimum**	**Maximum**	**Baseline**	**Source**
Revenue (RV)	0	1	0.75	[201]
Other operating income (OOI)	0	1	0.13	[201]
Actual USO Paid (AUSOP)	0	1	0.086	[201]
Total Revenue (TR)	0	1	0.966	Calculated (0.75+0.13+0.0860)
USO Shortfall (USOSF)	0	1	0.046	Calculated (0.132 - 0.086)
USO Expected (USOEXPECT)	0	1	0.132	Calculated (OPEX * Rural Population) = (0.4 * 0.33)
Rural population	0	1	0.33	[199]
Operational Expenses (OPEX)	0	1	0.42	[201]

Staff Expenses (SE)	0	1	0.8	[201]
Transport costs (TC)	0	1	0.0551	[201]
Depreciation (DEP)	0	1	0.06	[201]
Total Expenses (TE)	0	-	1.335	Calculated (0.8+0.42+0.0551+0.06)
Nett Income or Loss (NIoL)	-	-	-0.369	Calculated (0.966 – 1.335)
Profit Margin (PM)	-	-	-0.492	Calculated (NIoL/RV) = -0.369/0.75

4.5 Chapter Summary

This chapter articulates the model conceptualisation which is grounded on the research undertaken in Chapter 3 from where ten dimensions (variables) emerged. A sub-system diagram was developed and presented in Figure 43. The dimensions (variables) of the sub-system diagram were further developed into causal loop diagrams or rather "influence diagrams" which unambiguously demonstrate the dynamic feedback relationship between variables within each sub-system. In the process of developing the "influence" diagrams, both exogenous variables (outside the boundary) and endogenous variables (within the boundary) were identified. The endogenous variables excluding the digital ecosystem, which is exogenous but the subject of the study, were synthesized into causal loop diagrams or "influence" diagrams to describe their interaction in a dynamic setting. The influence diagrams were supplemented by a detailed explanation of the interconnectedness and the loop dynamics for each of the variables presented as causal loop diagrams or CLDs.

This chapter further articulates the stocks and flows that emerged from the preceding chapter which dealt with CLDs. The ten dimensions that were discussed in the preceding chapter are further refined and streamlined and described in Table 50. The resultant dimensions are consolidated, and a new causal loop diagram emerges which comprises capability maturity, adoption, digital culture, and financial performance (competitiveness). The emergent CLD is depicted in Figure 63 and grounds the hypothesis in the context of the realities and material conditions that are at play in the postal sector.

The restated hypothesis theorises that the adoption of the UPU (Universal Postal Union) APIs (Application Programming Interfaces) by key customers of the postal sector will reinforce a robust digital culture. This culture will thereafter strengthen the capability maturity of the postal sector and the three stocks will reinforce financial performance (competitiveness) of the postal sector which will ensure the sustainability of the postal sector.

This chapter further quantifies the variables and develops the mathematical expressions for respective stocks and flows. The next chapter delves into the simulation results and discussions of these key findings.

CHAPTER 5: RESULTS AND DISCUSSIONS

5.1 Chapter overview

Before the discussion of the simulation results, this chapter first delves into model verification and validation which lay the foundation of the simulation process and its subsequent results. The simulation results immediately follow the results and discussion of the model verification and validation. The delta T that was used in the simulation traces was 0.001 which is the fraction of the model time unit and used to set how often differential and complex equations are recalculated during the model run.

5.2 Model Verification and Model Validation

Numerous authors have researched model validation in system dynamics and this study has cited Sterman [100] who published 12 tests for the assessment of dynamic models. Barlas [202] posits that model validation is a vital, yet contentious facet of model-oriented methods, and system dynamics specifically. The validity of the outcomes in model-based research is significantly reliant on the soundness of the model. Barlas [202] proposes that the general rational direction of validation is to primarily assess the validity of the structure and thereafter test the behaviour accuracy after these two vital tests of the structure of the model are perceived as sound.

Pruyt [203] argues that model verification comprises assessing the correctness of the numeric values, scrutiny of mathematical expressions, assessing the subsystems and model structures, and assessing the dimensional consistency. The validation process confirms if a model replicates historical actual data. In System Dynamics, the replication of past patterns is merely one of several assessments relative to the modelling purpose. Comparison of the model behaviour with historical data is seldom a goal, particularly not for SD modelling that is futuristic due to the complexity of systems and challenges studied in a world driven by volatility, uncertainty, complexity, and ambiguity; SD validation transcends this orthodox concept of validation [203].

Pruyt [203] further suggests that the two accustomed applications of SD modelling are (i) To delve into plausible futures, and (ii) To examine the repercussions of diverse policies. Juxtaposing model outcomes with historical data does not assure a perfect fit with future progress. Orthodox validation in the context of "impartial demonstration of the truth of a model" is impossible. Another habitual or frequent application of SD modelling is to comprehend a system and the interconnectedness between system structure and behaviour. For that endeavour, insights can be extracted from reflective modelling which relates to unconstrained inquiry through models to discover and comprehend, without coercing the model to replicate historical system behaviour. A model that does not replicate a perfect fit with historical data may be more valuable than a model that does. This proportion is supported by Sterman [100] who posits that SD validation is about inspiring confidence and utility of models for the purpose at hand and therefore, valid models are models that are thought to be beneficial for their envisioned purpose. The below section discusses the direct structure tests.

5.2.1 Direct Structure Tests

Pruyt [203] argues that direct structure tests could comprise a combination of:

(1) Direct boundary adequacy test: This evaluates if boundaries are suitable;
(2) Direct structure assessment test: This evaluates if the structure obeys the physical system and associated laws of nature;
(3) Parameter confirmation test: This evaluates if the structures and parameters have real-life complements and correlate with knowledge;
(4) Direct extreme conditions test: This evaluates without replication (i) If structures and equations are plausible even under extreme conditions, or (ii) What the perimeter is for the model to be conceivable/beneficial;
(5) Face validation: This evaluates if experts in the field discover the model structure and equations apt for the envisioned purpose.

5.2.1.1 Structure Confirmation Tests

Ogano [143] suggests that verifying the structure of the model entails the comparison of the structure of a model with the structure of the physical world that the model denotes. Barlas

[202] proposes that when structural confirmation tests are applied as empirical tests entail associating the nature of the equations of the model with the relations that occur in the physical system. It may also be executed as a theoretical structure test, by associating the model equations with comprehensive knowledge in the literature. Consequently, for the model to be considered as having “passed the test”, the model structure may not contradict the erudition about the structure in the literature. The verification process could be tackled through an appraisal of model assumptions by an extremely capable, and skilled expert with a grasp and comprehension of the interconnectedness of the physical system [202].

The model was shared with digital transformation experts and policymakers in the postal industry, this iterative verification process resulted in several versions (version 1 to version 47) from which a purposeful model emerged (version 47). The model structure that emerged in version 47 was agreed upon and considered as representing the reality of digital transformation in the postal sector. A select group of progressive versions of the model is depicted in Figures 69 to Figure 73.

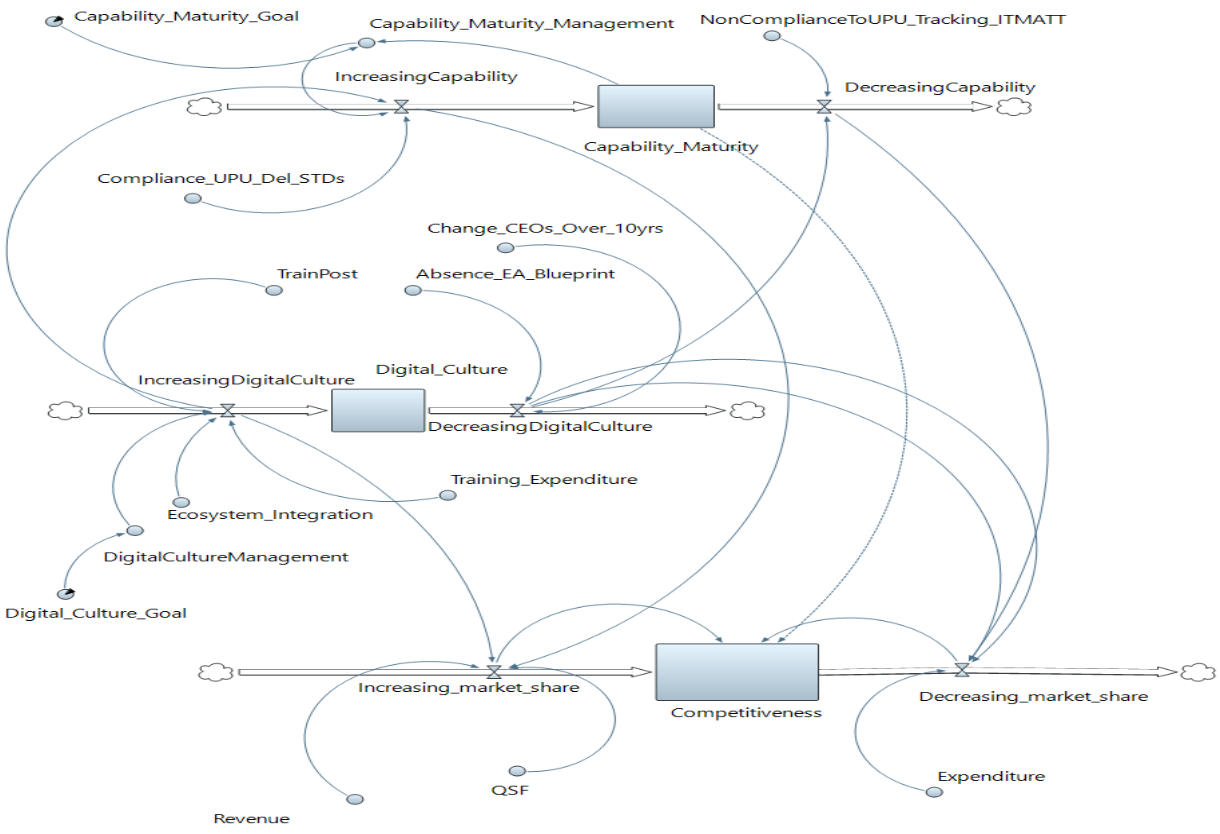
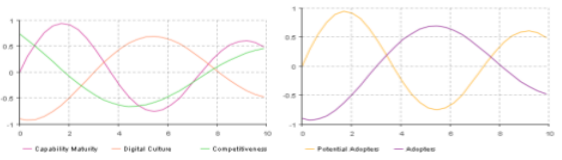


Figure 69: Version 1 of the model



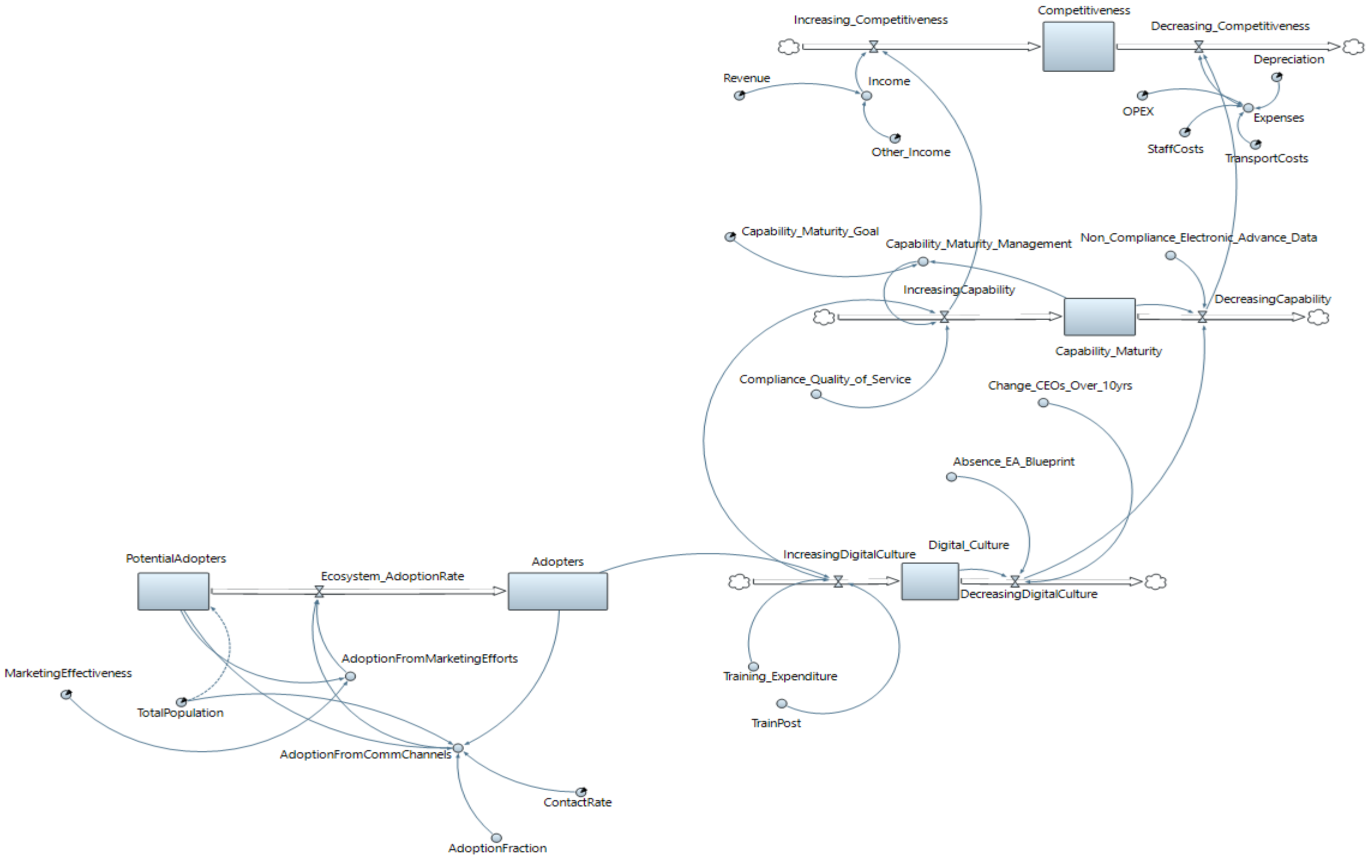


Figure 70: Version 4 of the model

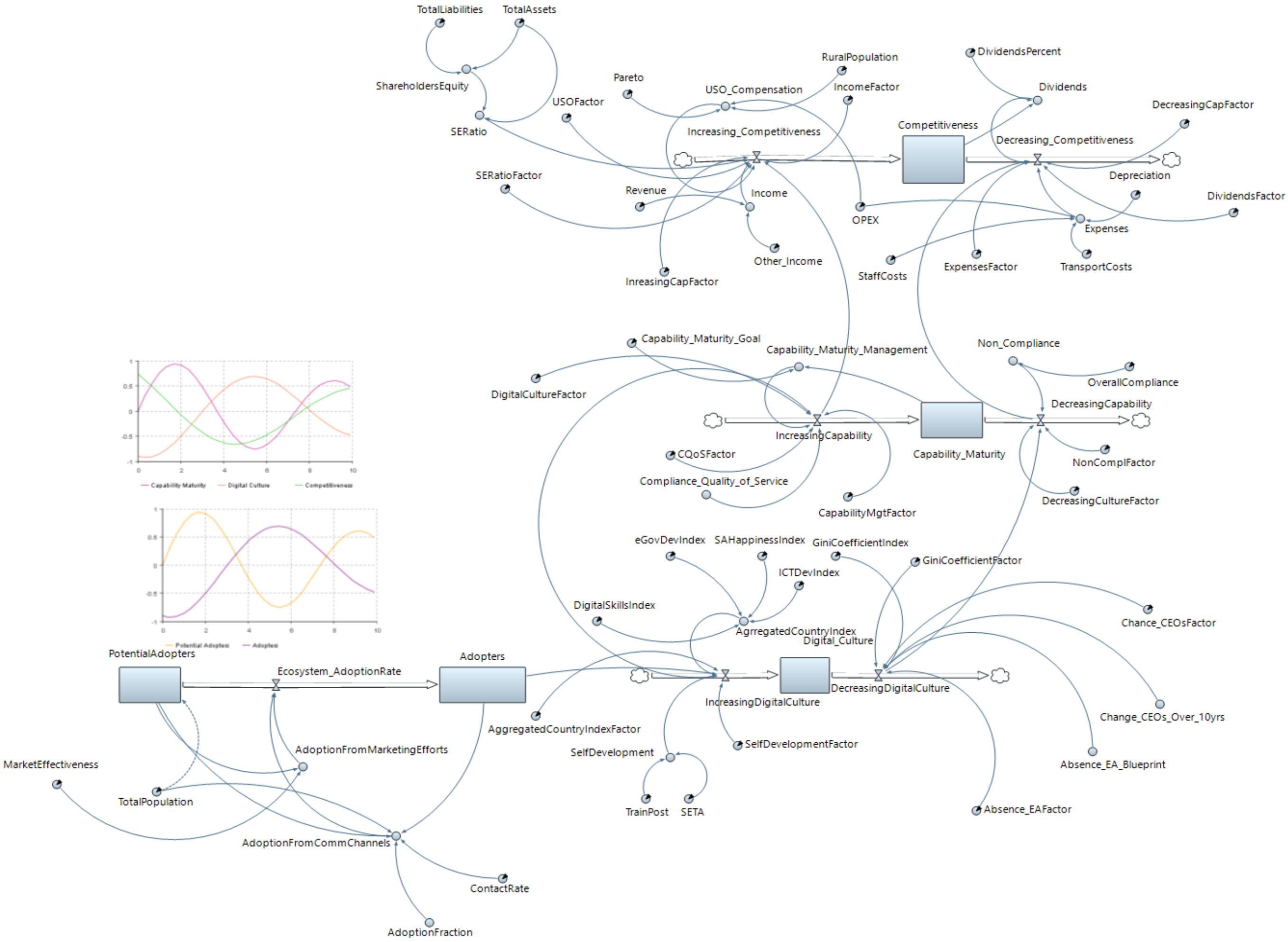


Figure 71: Version 10 of the model

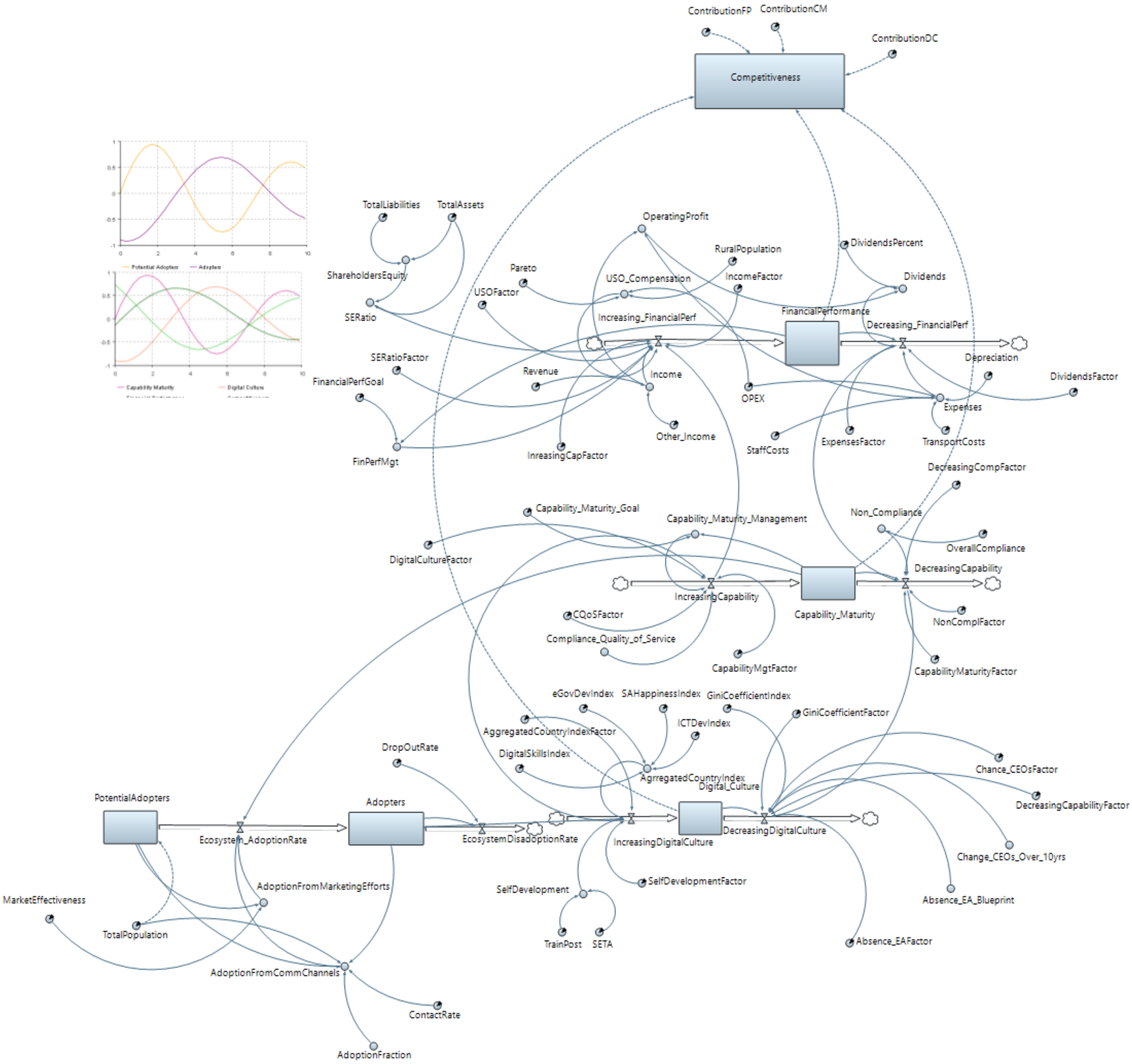


Figure 72: Version 15 of the model

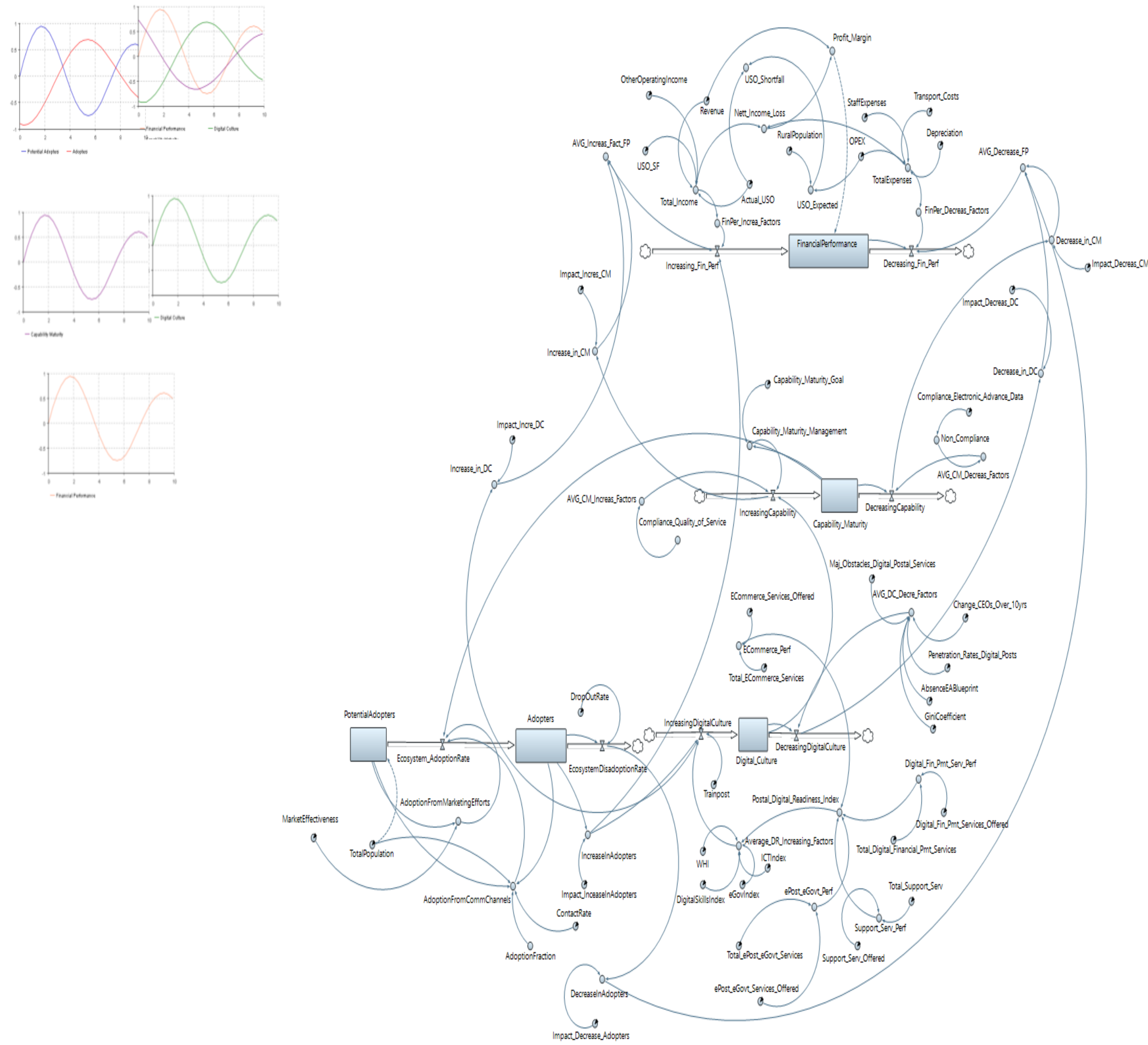


Figure 73: Version 47 of the model (Final)

5.2.1.2 Parameter Confirmation Tests

Sterman [100] suggests that before determining how a parameter is to be appraised or if its numerical value is rational, it is vital to ensure that every constant (and variable) has a vivid, concrete meaning. Barlas [202] proposes that the second direct structure test, parameter confirmation entails evaluating the constant parameters and variables compared to the knowledge of the physical system, both conceptually and mathematically. Conceptual confirmation entails the aptitude to detect essentials (elements) in the physical system that resemble the parameters of the model. Mathematical or numeric confirmation entails the approximation of the numerical value of the parameter with suitable correctness [202]. In this research parameter, confirmation tests were dealt with simultaneously with structure confirmation tests as they are related and were dealt with by the same experts as articulated in 5.2.1.3.

5.2.1.3 Dimensional Consistency Tests

Forrester and Senge [204] propose that the dimension consistency test is mundane yet insightful and revealing, and involves the dimensional analysis of the model's rate equations. Sterman [100] proposes that each mathematical expression must be dimensionally consistent without the insertion of random factors that do not correlate with real life. Figure 74 depicts the output result of the unit scrutiny test produced by Anylogic PLE software. The vertical axes in system dynamics results are dimensionless except for financial performance that relates to monetary value in Rand.

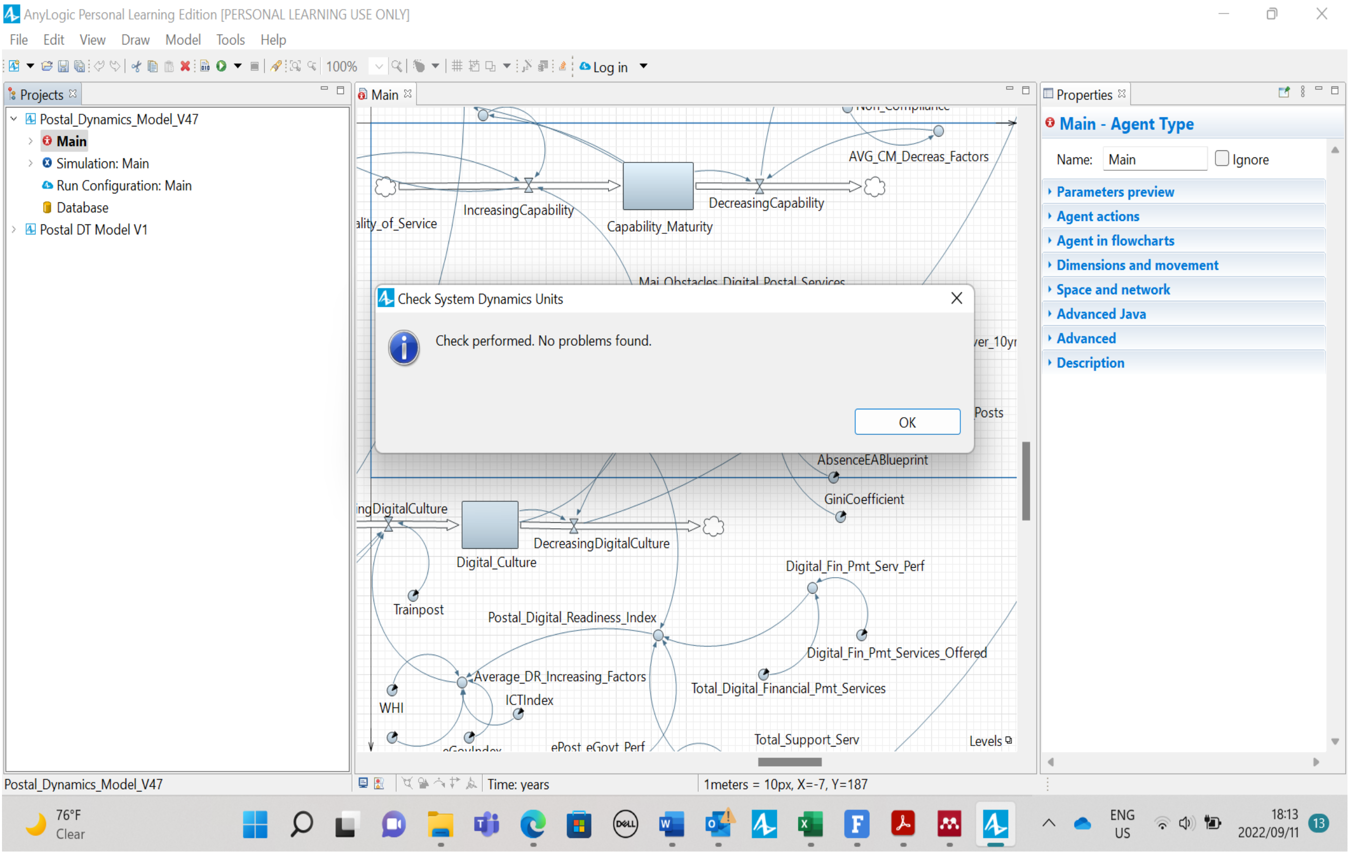


Figure 74: Dimension consistency check produced by Anylogic PLE software

The section below discusses the structure-oriented behaviour tests.

5.2.2 Structure-oriented Behaviour Tests

Barlas [202] proposes that structure-oriented behaviour tests evaluate the soundness of the structure indirectly, through the application of certain behaviour tests to model behaviour patterns. The research considered two vital structure-oriented tests (i) the Boundary adequacy test, and (ii) the extreme conditions test to further assess the validity of the structure of the model which is presented in 5.2.2.1 to 5.2.2.2.

5.2.2.1 Boundary Adequacy Test

Sterman [100] advances that the boundary adequacy test evaluates the aptness of the model boundary for its designed goal and proposes that the initial step is to check what the boundary is with the assistance of tools such as boundary charts and sub-system diagrams. Sterman [100] further proposes that model equations must be assessed for exogenous inputs to substantiate that the list of exogenous variables is comprehensive and cautions that all constants are exogenous but may be inconstant over the time horizon under consideration. Lastly, Sterman [100] argues that model boundary should be shared with the "client" and outside experts in addition to a review of relevant literature and direct experience with the system to solicit feedback and new insights that could suggest some of the processes that perhaps could be made endogenous; and such insights should be incorporated in the model and scrutinise its effects on the model behaviour as the primary objective is to build client's confidence in the model.

This research aimed to determine prevalent inhibitors and drivers of digital transformation in organisations and construct an SD model of intermingling digital transformation variables based on insights from both academic and industry literature to design appropriate policies that would benefit the postal sector. During this assessment, the model was adapted to comprise a conceivable added structure in which the following constants were made endogenous (i) Impact increase in adopters (ii) Impact decrease in adopters (iii) Impact increase in capability maturity (iv) Impact decrease in capability maturity (v) Impact increase in digital culture (vi) Impact decrease in digital culture (vii) Postal readiness index, (viii) Compliance to Electronic Advance Data (EAD), and (ix) Major obstacles to digital postal services.

These insights were gained from sharing the model with stakeholders and comprehending and incorporating these insights into the model to build the client's confidence in the model.

5.2.2.2 Extreme Conditions Test

Sterman [100] argues that models ought to be solid even in extreme conditions and proposes that solidness under extreme conditions equates to the model behaving realistically regardless of the extremities of inputs or policies subjected to it. The extreme condition test comprises allocating extreme values to particular parameters and contrasting the model-generated behaviour to the observed or expected behaviour of the physical system under similar extreme conditions [202]. The model is accepted as having "passed the test" if it engenders similar transformed behaviour when replicated with structural adjustments that reflect the structure of the "altered" physical system [204].

During this assessment, inputs to respective mathematical expressions were allocated extreme values such as 0, 1, 25%, 50%, and 100%, and the SD model was simulated to evaluate if the mathematical expressions still hold. The model was further put through extreme disturbances that related to policies and parameters, the outputs were assessed to ascertain if they are reasonable and useful. The extreme conditions tests are very important as they can potentially assist the modeller to uncover structural flaws and take appropriate action to correct such underlying structural flaws. When extreme values were assigned to the mathematical expressions of adopters' stock, digital culture stock, and capability maturity stock, the model was run to produce the results, as divided as follows:

(a) Extreme condition test of zero value (0%)

The extreme conditions tests of a zero value are depicted below in Figures 75 to 79.

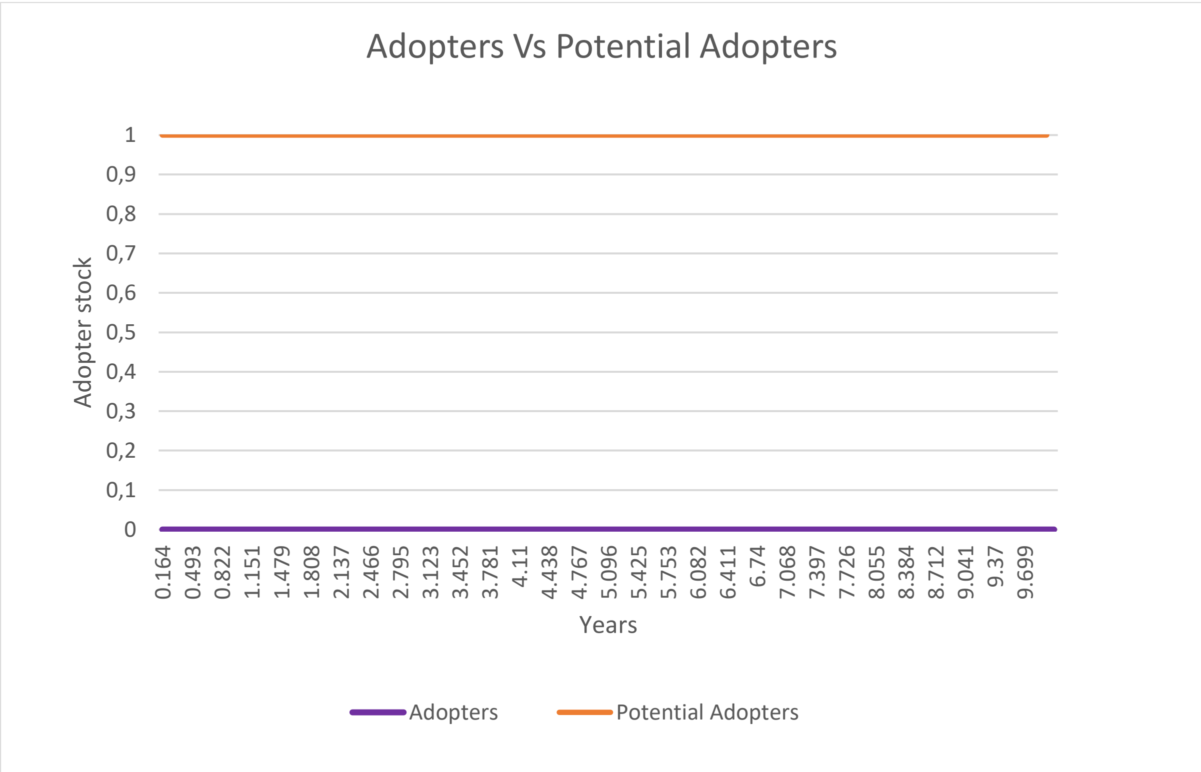


Figure 75: Extreme conditions test of zero value for adopters and potential adopters

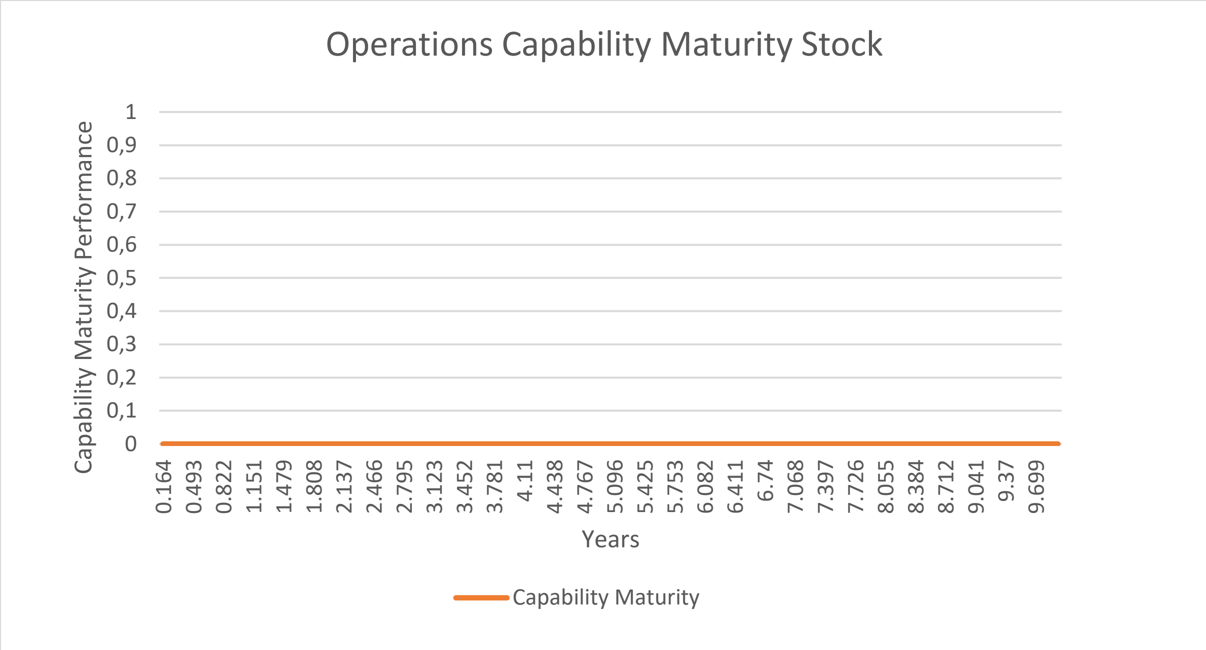


Figure 76: Extreme conditions test of zero value for operations capability maturity

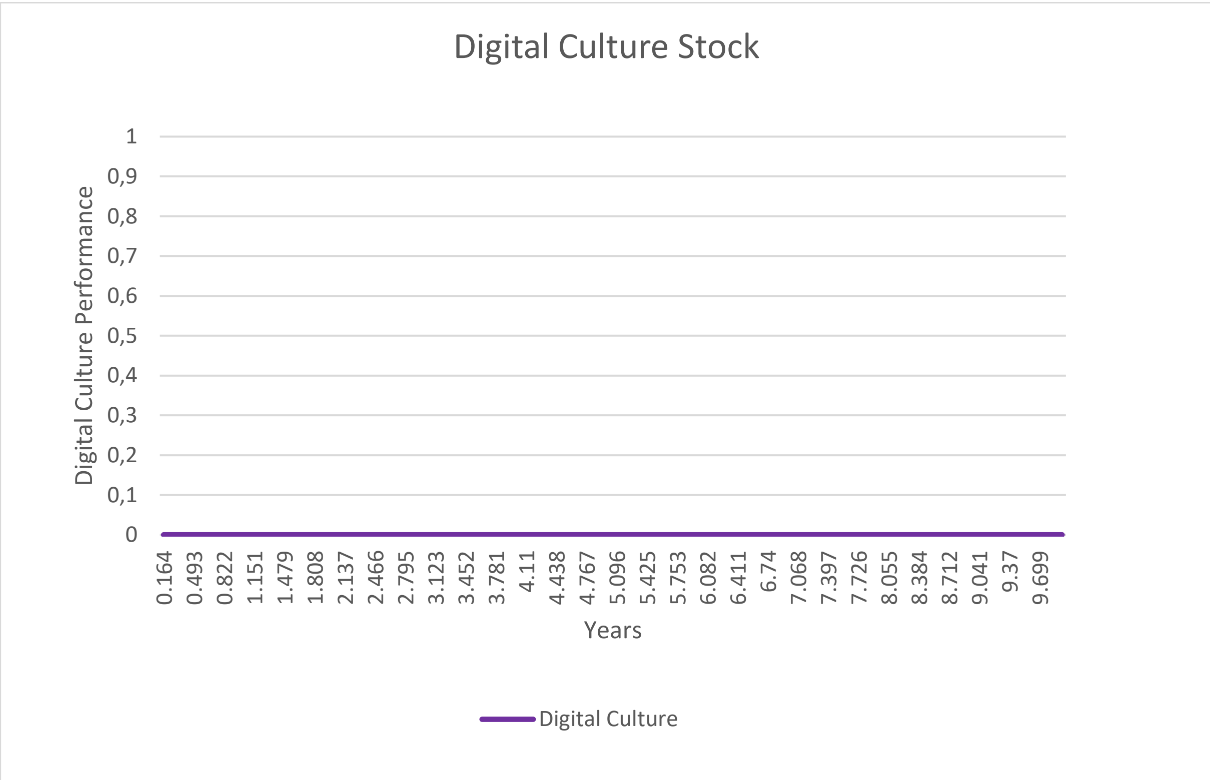


Figure 77: Extreme conditions test of zero value for digital culture

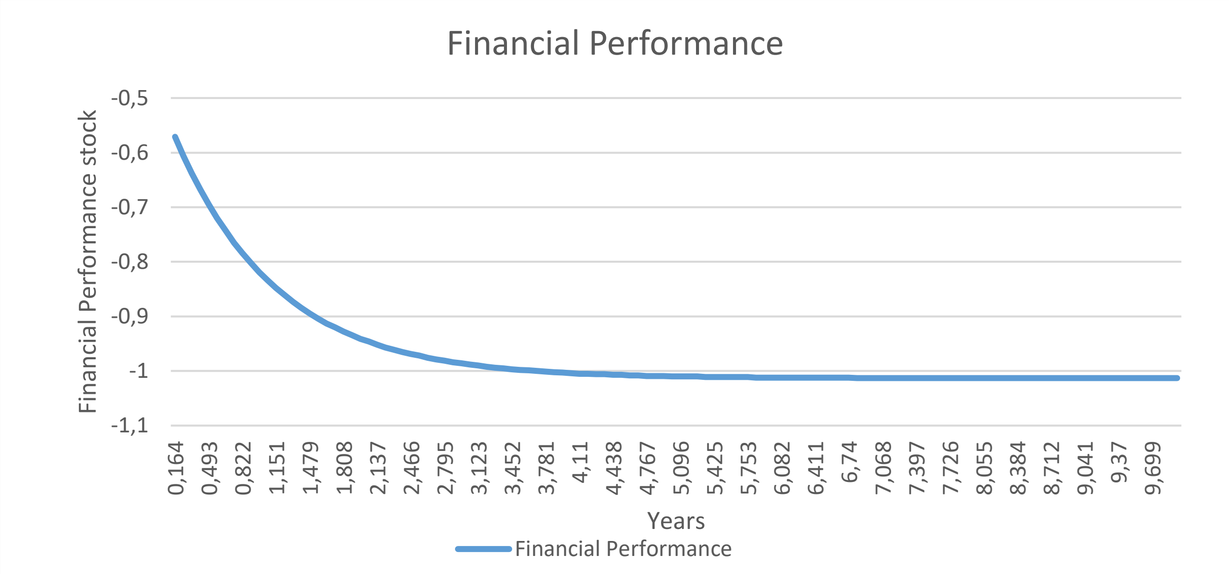


Figure 78: Extreme conditions test effects of zero value (Adoption, Capability Maturity, Digital Culture) on financial performance stock

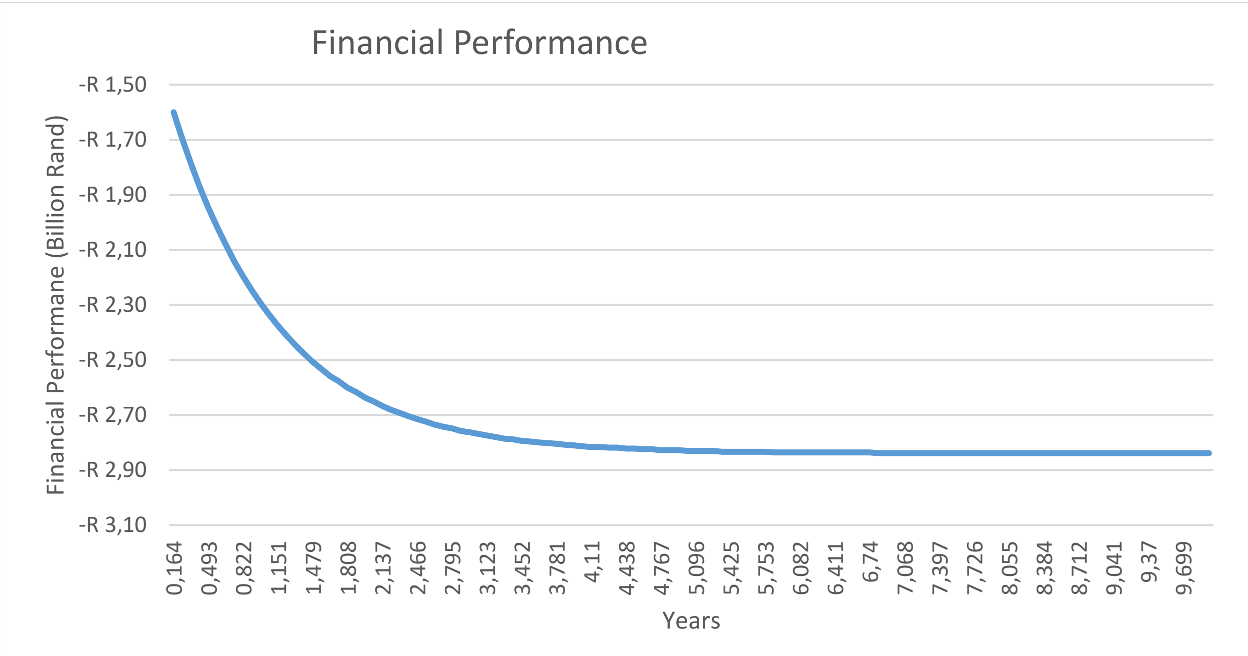


Figure 79: Extreme conditions test effects of zero value (Adoption, Capability Maturity, Digital Culture) on financial performance stock (Rand)

Figure 75 depicts the effect of a zero-value allocation on the mathematical expressions that describe the adoption process. When marketing effectiveness, contact rate, and adoption fraction are set to zero; adoption remains at zero while potential adopters remain at 1 (Total population) which represents 174 potential adopters as calculated and depicted in Table 50.

Figure 75, therefore, makes logical sense and the behaviour is expected even under extreme conditions.

Figure 76 depicts the effect of a zero-value allocation on the mathematical expressions that describe the operations capability maturity performance in the context of the postal sector. When average increasing factors, average decreasing factors, and the capability maturity stock are set to zero; the capability maturity remains at zero for the duration of the simulation period. Therefore Figure 74 makes logical sense and the behaviour is expected even under extreme conditions.

Figure 77 depicts the effect of a zero-value allocation on the mathematical expressions that describe the digital culture performance in the context of the postal sector. When average increasing factors, average decreasing factors, and the digital culture stock are set to zero; the digital culture remains at zero for the duration of the simulation period. Therefore Figure 77 makes logical sense and the behaviour is expected even under extreme conditions.

Figures 78 and 79 depict the effect of the zero-value allocations articulated in Figures 75 to 77 on the output of the model, the financial performance stock. When capability maturity, digital culture, and adoption stocks remain at zero as articulated in Figures 75 to 77. The financial performance (competitiveness) stock stands at -0,58 which translates to -R1.6 billion in year 0.164 and declines to just below -1 which translates to -R2.9 billion in year 9.945. Therefore, Figures 78 and 79 are plausible and the behaviour is expected even under extreme conditions. The results of the extreme conditions test with zero allocation are consistent with the propositions of Barlas [202] and Sterman [100].

(a) Extreme condition test of 1 (100%)

The extreme conditions tests of a 1 (100%) value are depicted below in Figures 80 to 84.

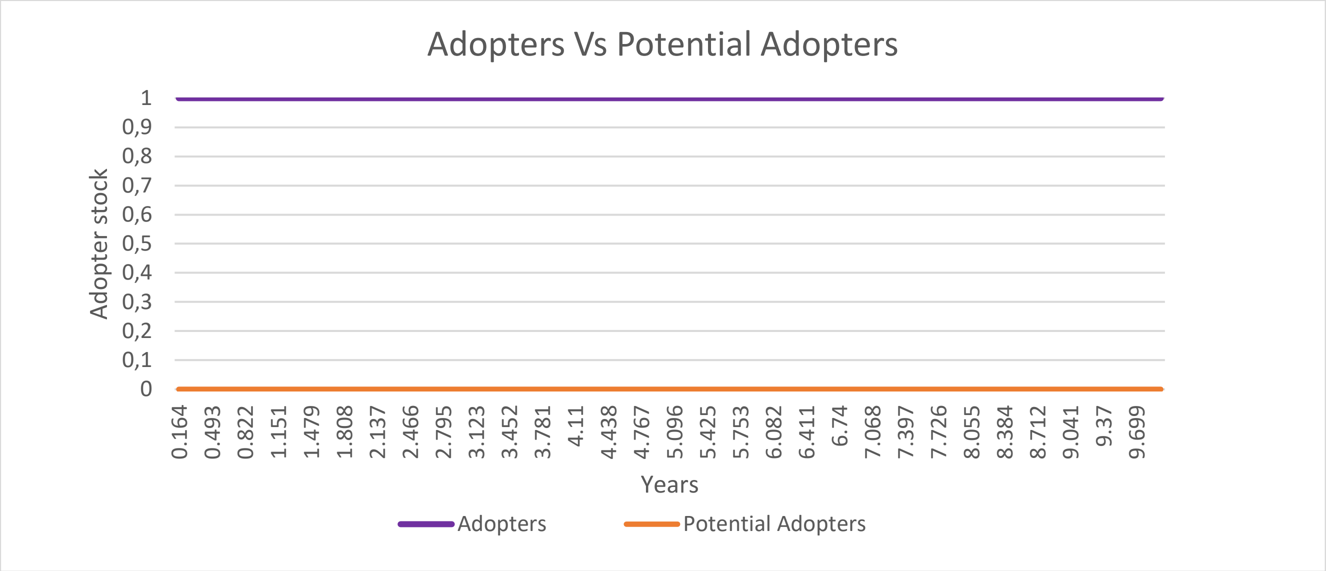


Figure 80: Extreme conditions test of zero value for adopters and potential adopters

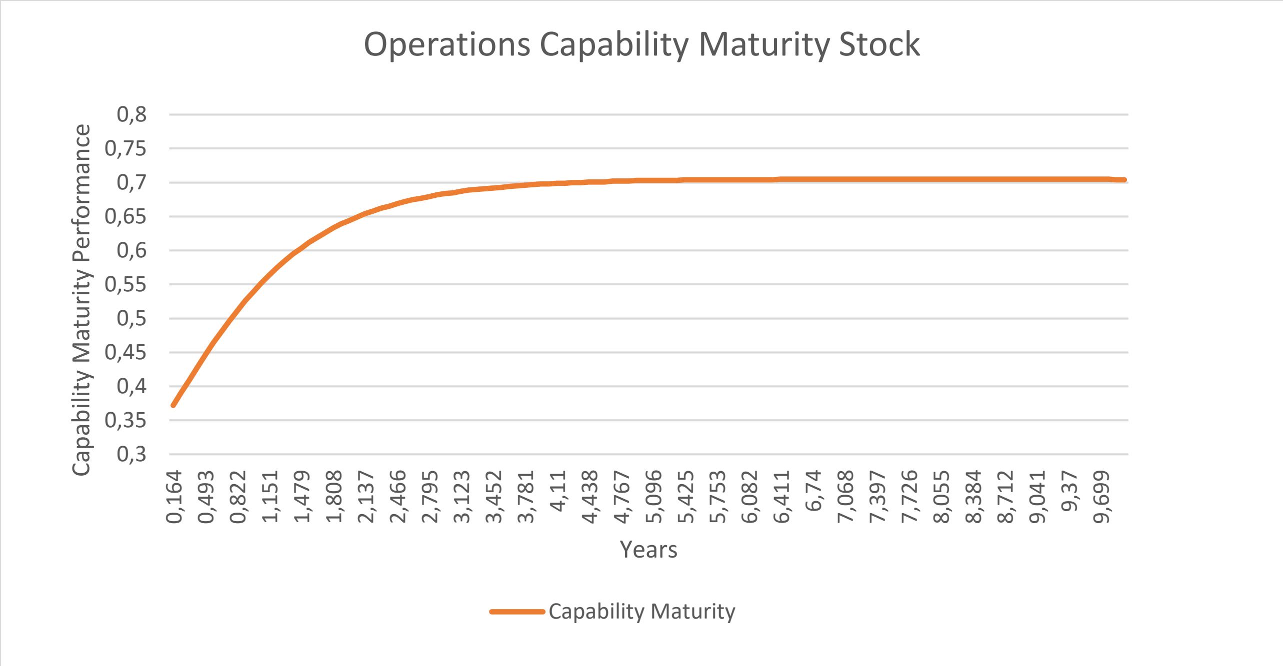


Figure 81: Extreme conditions test of one (100%) value for operations capability maturity

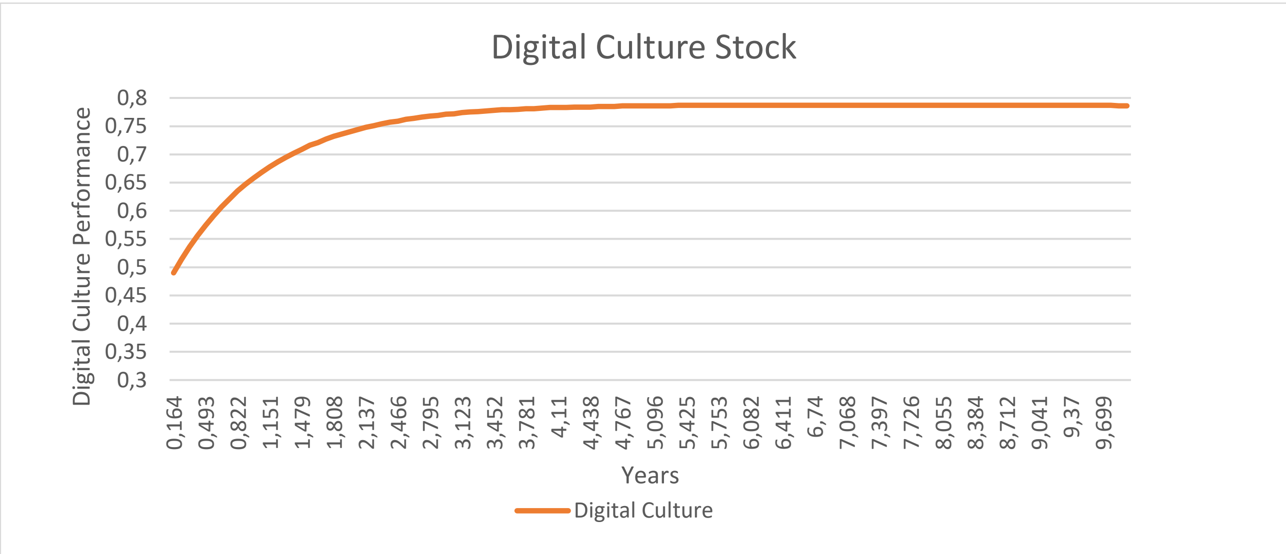


Figure 82: Extreme conditions test of one (100%) value for digital culture

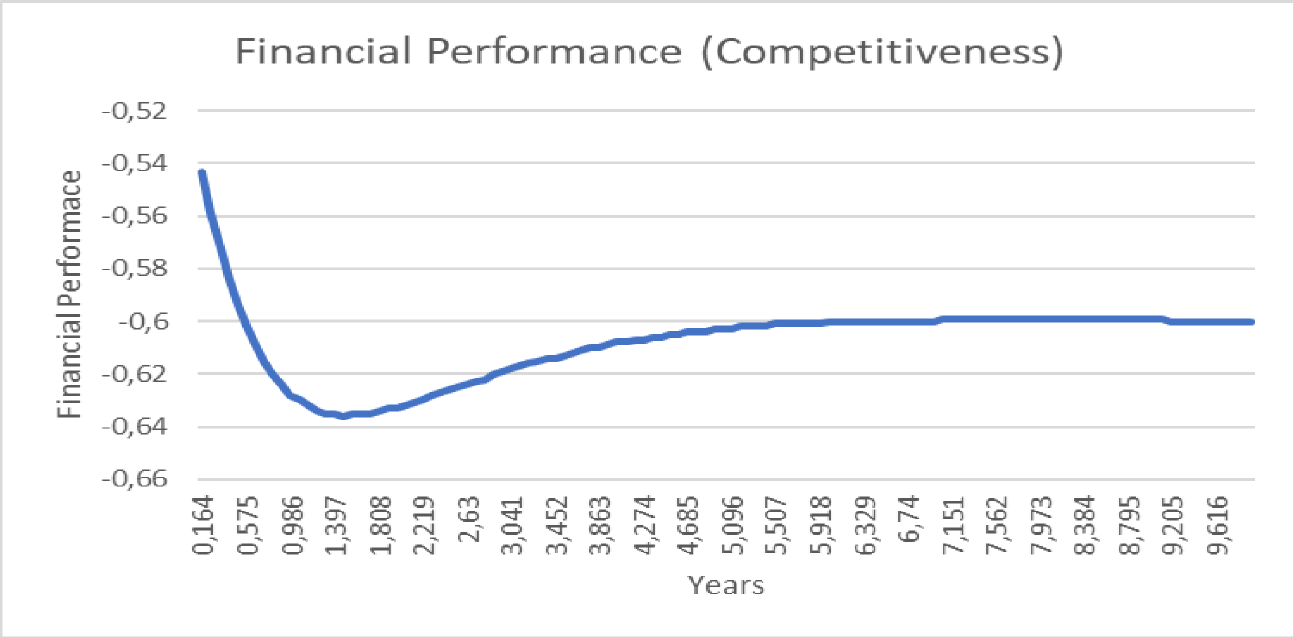


Figure 83: Extreme conditions test effects of one (100%) value (Adoption, Operations Capability Maturity, Digital Culture) on financial performance stock

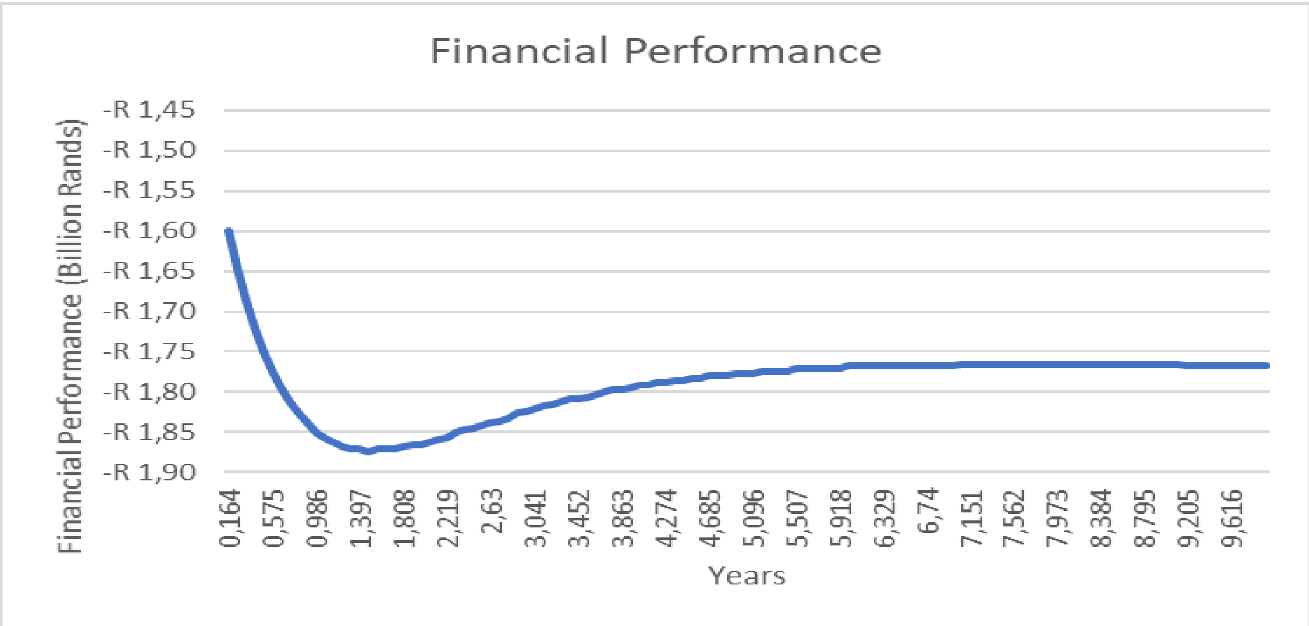


Figure 84: Extreme conditions test effects of one (100%) value (Adoption, Capability Maturity, Digital Culture) on financial performance stock in Rands

Figure 80 depicts the effect of a one-value allocation (100%) on the mathematical expressions that describe the adoption process. When marketing effectiveness, contact rate, and adoption fraction are set to one; adoption remains at one (1) while potential adopters remain at (0) (Total population) which represents 174 potential adopters as calculated and depicted in Table 51. Figure 80 is coherent and conceptually accurate as potential adopters will immediately be converted to adopters when the parameters are set at one (100%), this behaviour is expected even under extreme conditions.

Figure 81 portrays the effect of a one-value allocation (100%) on the mathematical expressions that describe the capability maturity performance in the context of the postal sector. When compliance to quality of service which is directly proportional to the average increase factors and compliance to Electronic Advance Data, which is inversely proportional to the average decrease factors are set at one; the capability maturity begins with a steady increase from 0.334 in year 0.164, reaching 0.7 in year 3.041 and the performance flattens until year 10. Therefore, Figure 81 makes logical sense, and the behaviour is expected even under extreme conditions.

Figure 82 illustrates the effect of a one-value allocation (100%) on the mathematical expressions that describe the digital culture performance in the context of the DPOs. When the average increase factors are set to one (100%) the digital culture begins with a solid increase from 0.46 in year 0.164, reaching 0.786 in year 3.041 and later stabilisation. Therefore, Figure 82 is coherent, and the behaviour is expected even under extreme conditions.

Figures 83 and 84 depict the effect of the one-value allocations articulated in Figures 80 to 82 on the output of the model, the financial performance stock. When the parameters of the operations capability maturity, digital culture, and adoption stocks are allocated one value (100%) as articulated in Figures 80 to 82; financial performance (competitiveness) improves as compared to Figures 79 and 80 when the extreme value was set at zero. The financial performance (competitiveness) stock stands at -0,543 which translates to -R1.6 billion in year 0.164 to -0.6 which translates to -R1.77 billion in year 9.945. Therefore, Figures 83 and 84 are conceivable, and the behaviour is expected even under baseline conditions. The results of the extreme conditions test with 100% allocation are consistent with the propositions developed by Sterman [100] and supported by Barlas [202].

5.2.2.3 Behaviour Pattern Tests

Sterman [100] argues that the purpose of the behaviour reproduction tests is to adequately answer the following questions:

(i) Does the model replicate the expected behaviour?

(ii) Does it endogenously generate intricacy, inspiring the study?

(iii) Does the model engender the several modes of behaviour detected in the physical system?

In the baseline structure portrayed in Figure 85, the different curves illustrate the anticipated performance of each stock (Operations capability maturity, Digital culture, Adoption, and Financial performance), as articulated in their respective reference mode behaviour patterns in Chapter 4, along with the resultant delayed response for digital culture, adopters, and financial performance. The operations capability maturity stock exhibits a goal-seeking behaviour pattern as it approaches its goal value of 0.6 which is the target set by designated postal operators in Southern Africa. The goal is to reach a capability maturity of 1. The capability maturity begins at 0.334 and progressively settles at 0.48, this means that at the current baseline conditions, it will be impossible to reach the initial goal of 0.6; and even far away from the ideal goal of 1 which is measured through the Integrated Index on Postal Development (2IPD). The behaviour reproduction test for operations capability maturity is individually depicted in Figure 86.

The digital culture stock exhibits an s-shaped behaviour and is consistent with the literature and real-life conditions because culture is an integrator and diffuses over time. The digital culture stock is impacted by the adoption stock which results in the digital culture stock exhibiting its s-shaped behaviour. The digital culture stock starts at an initial value of 0.451 in the year 0.164 and eventually reaches a value of 0.673 in 10 years; the behaviour reproduction test for digital culture is depicted in Figure 87. The potential adopters' stock commences at an opening value of 0.981 and displays inverse s-shaped behaviour, ultimately reaching the lowest value of zero after 5.507 years. The adopter's stock commences at an initial value of 0.048 and displays shaped behaviour, eventually reaching a high value of 1 after 3.863 years. It should be noted that the stocks for potential adopters and adopters are associated, which means when a unit of the potential adopters’ stocks flows out, it becomes an inflow to the adopter stock (This relationship is demonstrated by their inverse behaviour patterns). The behaviour reproduction test for adoption is depicted in Figure 88.

The financial performance stock exhibits an interesting s-shaped behaviour, and this behaviour is expected as a result of the impact of the adoption stock and digital culture stock which exhibit an s-shaped behaviour on the financial performance stock. The financial performance is depicted in Figures 89 and 90 as a percentage and Rand value respectively. The financial performance (competitiveness) stock stands at -0,565 which translates to -R1.6 billion in year 0.164 to just below -0.72 which translates to -R2.04 billion in year 9.94.

The overall structure behaviour pattern depicted in Figure 85 illustrates the time lags between capability maturity, adopters, digital culture, and financial performance and is consistent with the literature on behaviour structural tests developed by Sterman [100] and supported by Barlas [202] and Pruyt [203]. The behaviour reproduction tests at baseline values represent the business-as-usual scenario (scenario 1) which is articulated in 5.3.1.1.

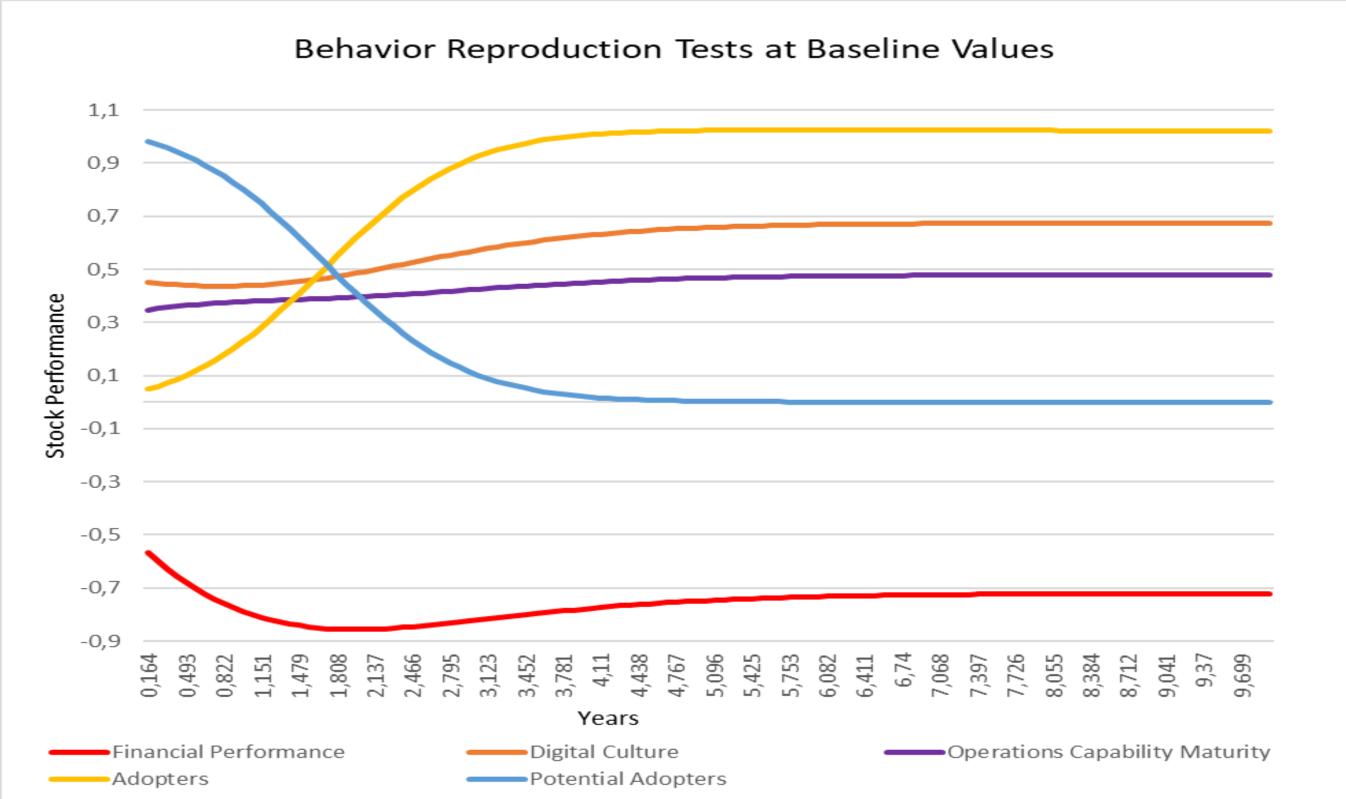


Figure 85: Behaviour Reproduction Tests at baseline values for all stocks

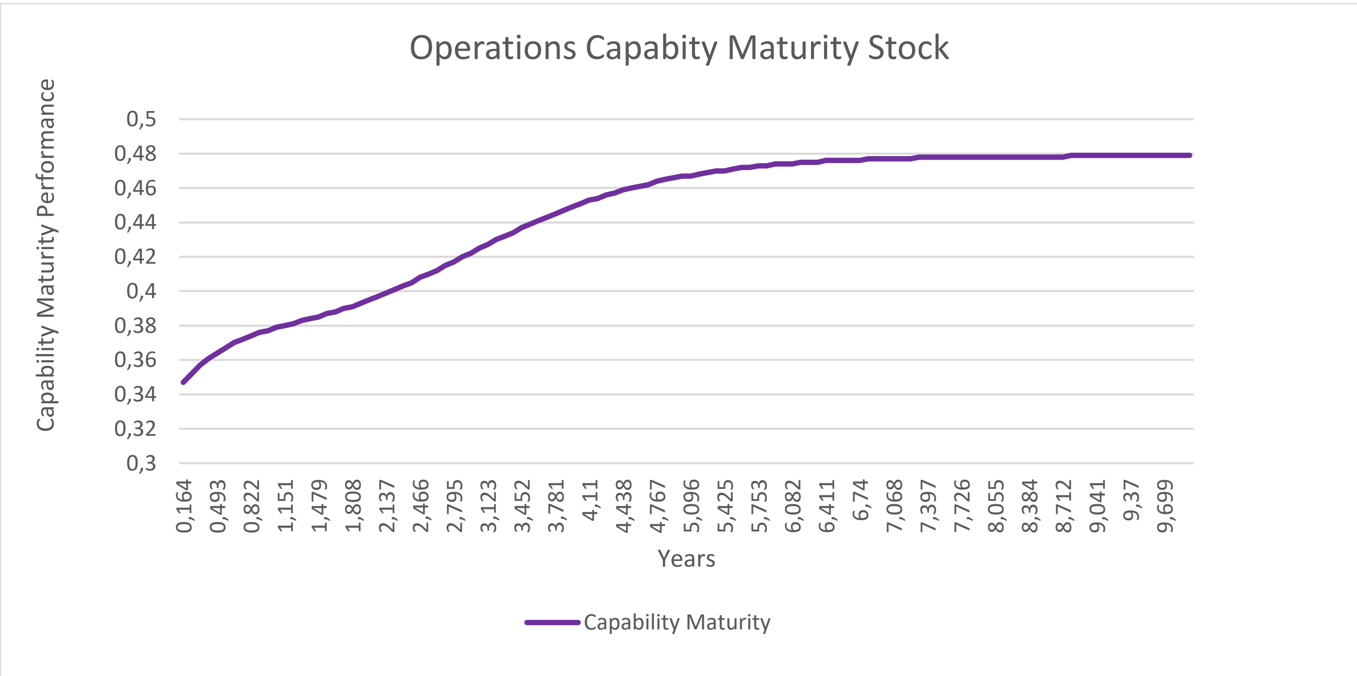


Figure 86: Behaviour Reproduction Tests at baseline values for operations capability maturity Stock

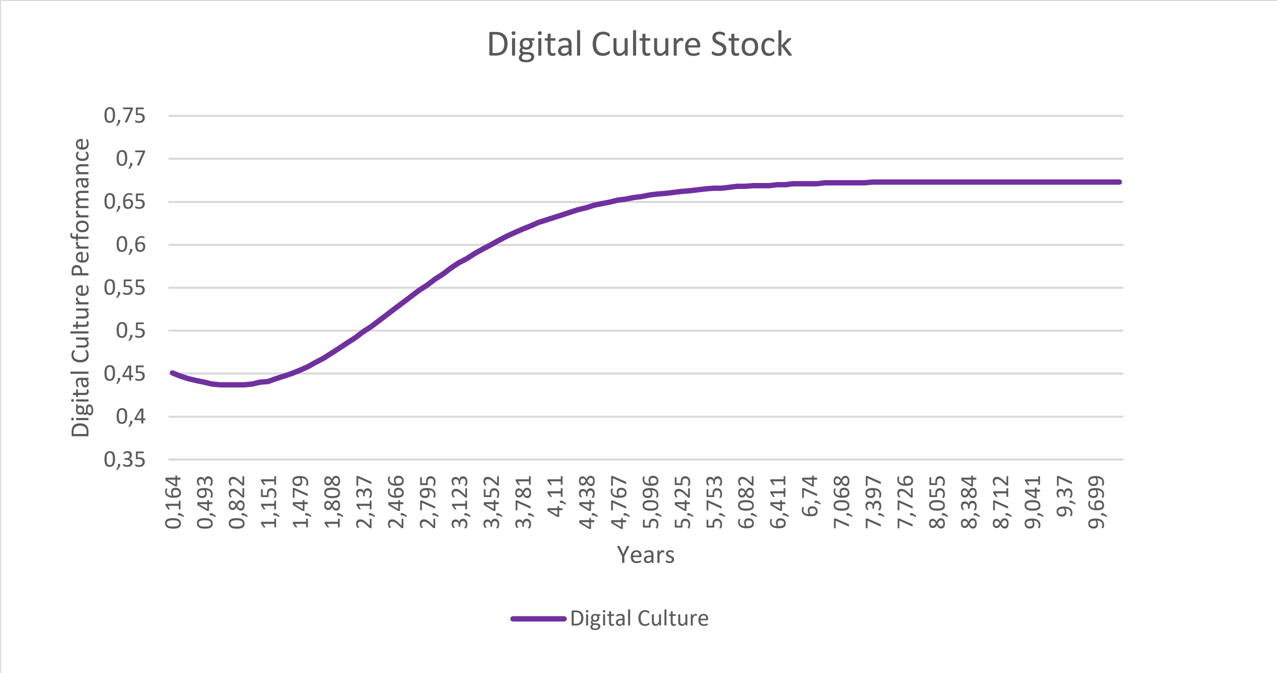


Figure 87: Behaviour Reproduction Tests at baseline values for digital culture Stock

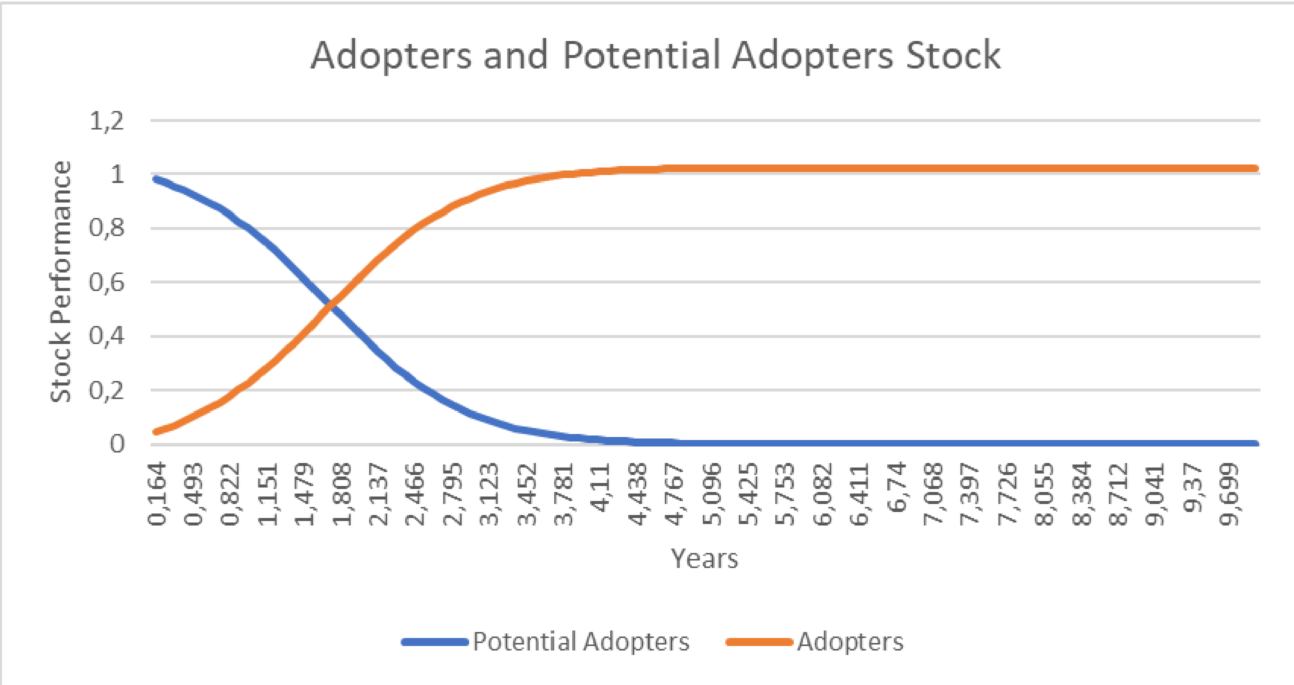


Figure 88: Behaviour Reproduction Tests at baseline values for adoption stock

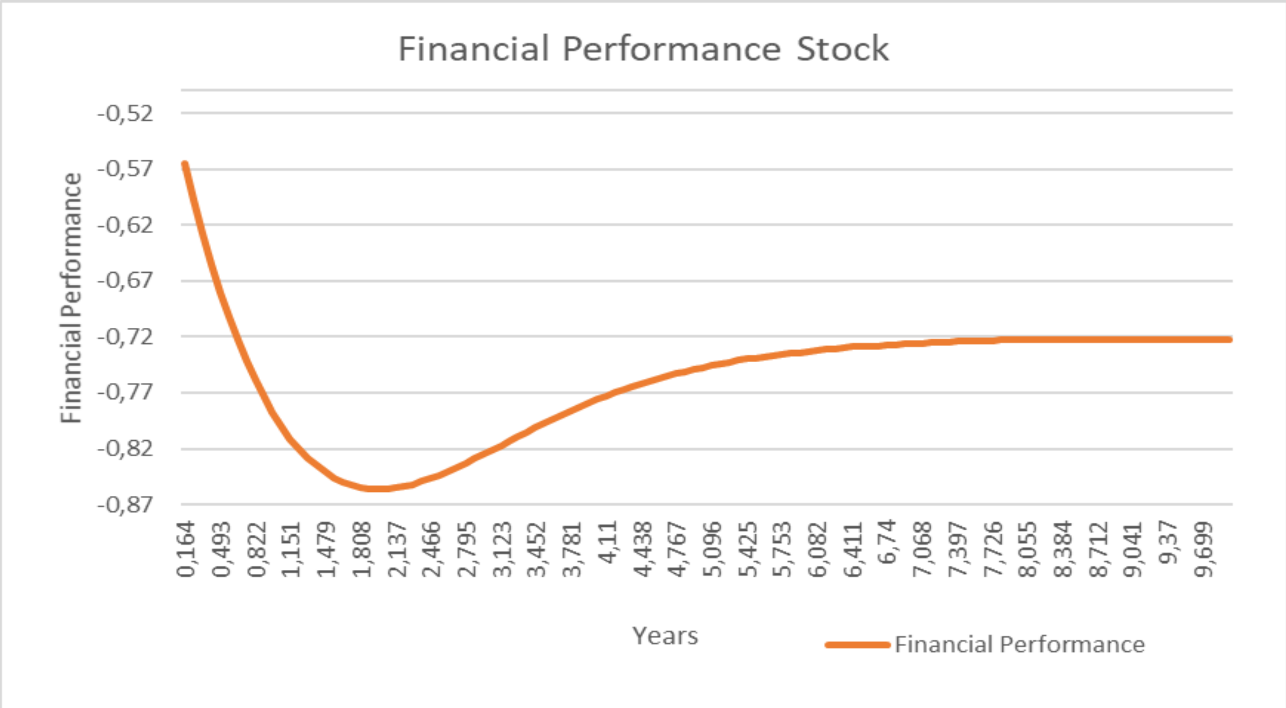


Figure 89: Behaviour Reproduction Tests at baseline values for financial performance

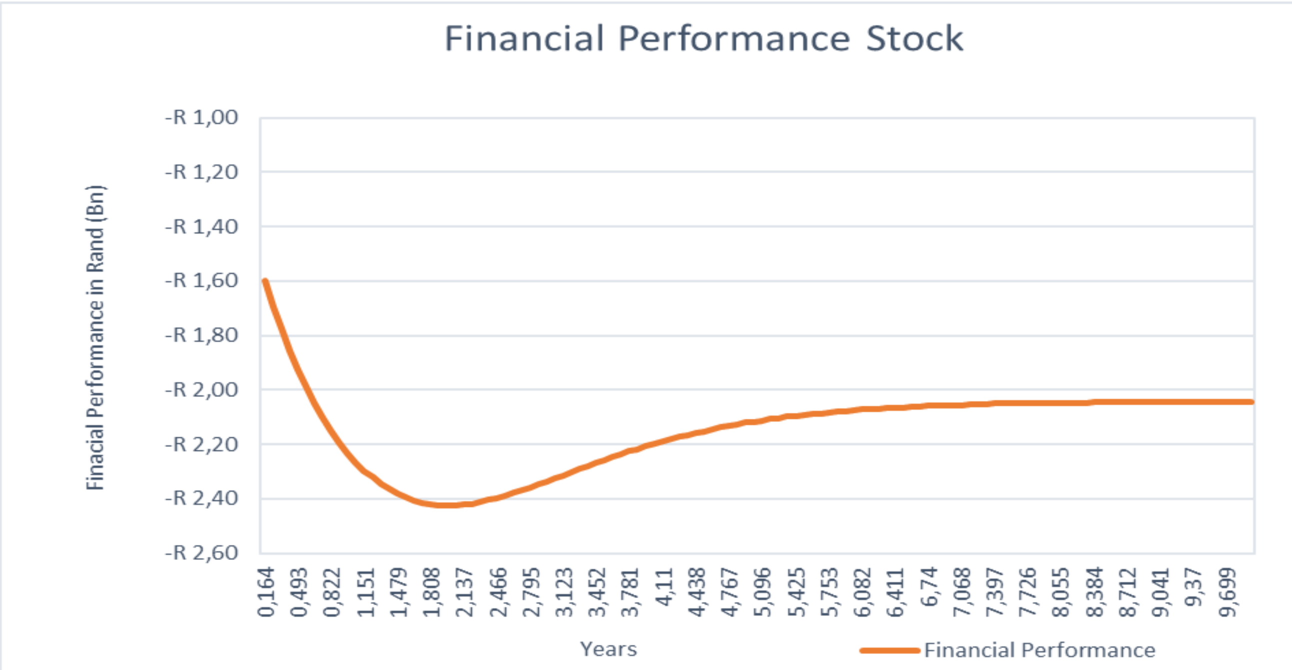


Figure 90: Behaviour Reproduction Tests at baseline values for financial performance in Rands

The section below discusses the policy analysis and design.

5.3 Policy Analysis and Design

Serban [205] theorises that policy analysis is the methodical examination of alternative policy options and the method of collecting and consolidating the testimony for or against each option. It encompasses a systematic approach, creating the means of gathering and reflection, and some efforts to envisage the impact of alternate paths of action. Numerous authors have conceptualised phase models, with the number of phases varying between 5 and 7. Howlett and Ramesh's model categorises five stages which are (i) Agenda setting, (ii) Policy formulation, (iii) Adoption (or decision making), (iv) Implementation, and (iv) Evaluation [206]. The phases of policy devising are depicted in Figure 91 below.

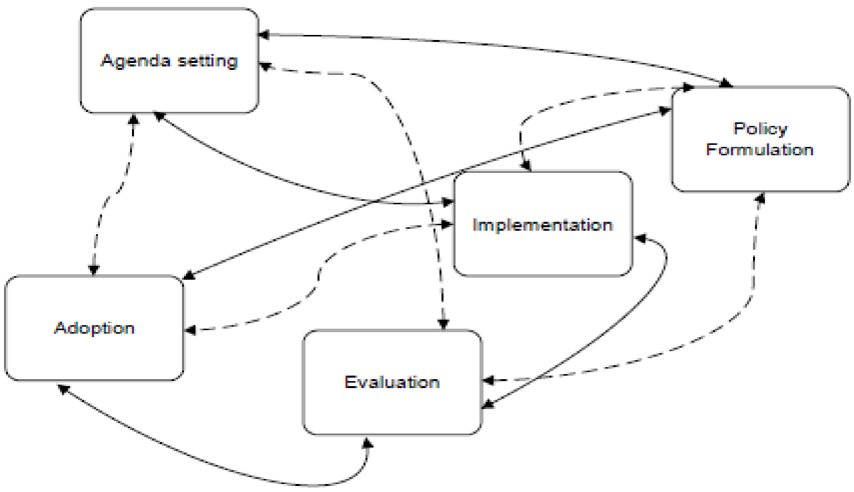


Figure 91: Stages of policy formulation: A turbulent flow [209]

Benoit [206] proposes that:

- The agenda phase denotes the method through which a policy and the problem it is envisioned to address are acknowledged to be of interest to the public.
- The policy formulation phase denotes the method through which the responsible public administration scrutinises the different policy options considered to be probable solutions.
- The adoption phase denotes a method through which policy directions are taken at the governmental level, emerging in a policy direction that favours one or more approaches to dealing with the task at hand.

- At this phase, the policy's execution parameters are established, which unswervingly affect the ensuing outcomes of the policy.

Sterman [100] proposes that policy design incorporates the development of novel stratagems, structures, and verdict guidelines; and the sturdiness of policies and their responsiveness to unpredictability in the model parameters and structure must be evaluated. This comprises their performance under an assortment of diverse scenarios, as well as the interplay of diverse policies.

Sterman [100] proposes that intricate systems habitually engender behaviour which is far from the experience of the past, and proposes that another goal of modelling is to plan and implement policies that transcend the system into a completely new regime of behaviour. To become valued, the decision guidelines in models must act rationally in all settings, in settings where historical information exists but also where it does not exist. Policy robustness implies that decision guidelines must produce products that are plausible and useful even when the inputs to the decisions assume extreme values. Robustness unavoidably means models will contain several non-linear relationships [100].

Wheat [207] argues that quite frequently, system dynamics model-oriented public policy analysis is occasionally constrained to assessing parameter fluctuations instead of planning, assessing, and implementing new stock-and-flow policy structures. In dynamic feedback systems, model-oriented policies are inclined to have inconstant rather than constant impacts on dynamic problems. Therefore, orthodox stationary parameter sensitivity tests may not offer adequate intuitions into the probable effect of a policy. Dynamic parameter tests could produce more accurate outlooks concerning the effect of a policy. The modification of the base model with a dynamic parameter associated with policy interventions creates an exogenous policy interconnectedness and ensures that the "new" dynamic parameter associated with a specific policy intervention varies as a non-linear function of time, creating a more plausible scenario that mirrors real-life situations [207].

Table 53 recaps the forms of information that postal players can add to the different phases of the policy construction procedure to develop vigorous policies.

Table 52: Types of information that public health actors can contribute at the various stages of the process, adapted from [209]

Stages	Information to be transmitted by postal actors
Agenda setting	Problem configuring • Finding a problem and assembling evidence that shows the scale of the problem. • Detailing the cause and effects of the problem. • Questioning frameworks. • Finding the significant, appropriate data for describing the problem.
Policy formulation	Forecasting • Identifying which levers to pull and which policies require intervention. • Defining the implications of current or planned policies and recording their effect on postal services and their causes. • Describing the effects of each choice. • Detailing the impending costs and benefits of all strategic scenarios using information engendered from prediction.
Implementation	Monitoring • Recording the implications of past adopted policies and partaking in their enactment. • Conducting scrutiny and learning from experience to ensure mistakes are learned from and eliminated in the implementation of similar policies in other settings.
Evaluation	Evaluation • Constructing monitoring mechanisms. • Highlighting inconsistencies between the policy's anticipated and real results. • Carrying out intricate evaluations.

This research has brought to light the underperformance of the Southern African postal sector against its peers as measured in the integrated index on postal development (2IPD) and the digital readiness index (DRI). These results are reflected in the outcomes of the system dynamics model developed during this research. Policy design and analysis aim to probe several policy arrangements and regulate and design the model to achieve digital transformation through improvement in the integration of key customers into the UPU digital ecosystem to improve adoption, digital culture, capability maturity, and ultimately financial performance (competitiveness) of the postal sector in Southern Africa. The model is generic to the postal sector and can be applied to other designated postal organisations outside Southern Africa.

5.3.1 What-if Scenario Analysis and Policy Design

Morecroft [97] asserts that once the model is considered beneficial from the viewpoint of the client and is validated and verified, policy design could commence through an in-depth what-if scenario analysis. Schoemaker [208] proposes that the deeper aim of scenario analysis is to challenge mindsets by stimulating strategic dialogue and reflection and argues that scenario planning is an orderly process for generating alternative viewpoints about an organisation's future by assessing vital uncertainties that can significantly change the landscape.

In this study, an assortment of demonstrative scenarios is presented including (a) Baseline (Scenario 1), (b) Adoption improvement through the improvement of market effectiveness, contact rate, and adoption fraction (Scenario 2), (c) Operations capability maturity improvement through the improvement of compliance to quality of service and reducing non-compliance to Electronic Advance Data (Scenario 3), (d) Digital culture improvement through the improvement of postal digital readiness index, improvement in the number of staff who underwent train-post courses, reducing the turnover of CEOs in ten years, eliminating absence of enterprise architecture blueprint, reducing major obstacles to digital postal services, and improving penetration rates of digital posts (Scenario 4), (e) Financial performance improvement through closing the USO shortfall, reduction of staff cost, operational costs, and transportation costs (Scenario 5), and (f) All the improvements allowed to interact with one another in a dynamic setting (Scenario 6).

5.3.1.1 Baseline-business-as-usual (Scenario 1)

The underlying assumption of the baseline scenario is that the existing drifts and policies related to the postal sector in South Africa (which were used to validate the model) and Southern Africa will proceed into the future as presented in the stocks and flow model developed in this study and whose baseline results for all the stocks were presented in Figure 85 and the individual stocks at baseline are presented in Figure 86 to Figure 90. The business-as-usual provides a platform (baseline) against which all other policy intervention scenarios are compared to. In summary, the baseline scenario capability maturity, digital culture, and financial performance reach 0.48, 0.673, and -0.72 (-R2.04 billion) in the year ten years respectively if the current trajectory persists. The baseline scenario was discussed in detail in 5.2.2.3.

5.3.1.2 Adoption

5.3.1.2.1 Adoption improvement (Best-case scenario 2)

In the baseline conditions, results as depicted in Figures 85 and 88, the adoption stock is modelled as a function of marketing effectiveness, adoption fraction, and contact rate. The adoption stock found that at baseline conditions, the adopters and potential adopters will be the same at around 2 years and all the potential adopters would have fully adopted in around 4 years. The baseline is modelled against parameters of (i) Marketing effectiveness of 20%, (ii) Adoption fraction of 15%, (iii) Contact rate of 25 clients per annum, and (iv) Dis-adoption rate of 0% as there are no adopters that have exited the digital ecosystem.

The 50% case scenario proposed is similar to the base-case scenario from a balancing loop variable perspective with a dis-adoption rate of 0% while the reinforcing loop variables are ramped up as follows; (i) Marketing Effectiveness increases by 50% (from 20% to 30%), (ii) Adoption Fraction increases by 50% (From 15% to 22.5%), and (iii) Contact rate increasing by 50% (From 25 to 38 customers per annum). The 50% case scenario is depicted in Figure 92 below, and it shows that adopters and potential adopters will be equal in 8 months with full adoption within 18 months. This scenario is not probable as it goes against industry norms. Therefore, the best case in the context of adoption stock is depicted in Figure 93 where the adoption parameters are (i) Marketing effectiveness is 20%, (ii) Adoption fraction is 15%, (iii) Contact rate is 25 clients per annum, and (iv) Dis-adoption rate is 0% as there are no adopters that have exited the digital ecosystem. It should be noted that the best-case scenario as depicted in Figure 93 is identical to the behaviour reproduction test at baseline conditions depicted in Figure 88. The results are consistent with the literature on the application of the Bass diffusion model as proposed by Sterman [100] and supported by Wu and Olson [209] in their work on contagion effects in account risk management.

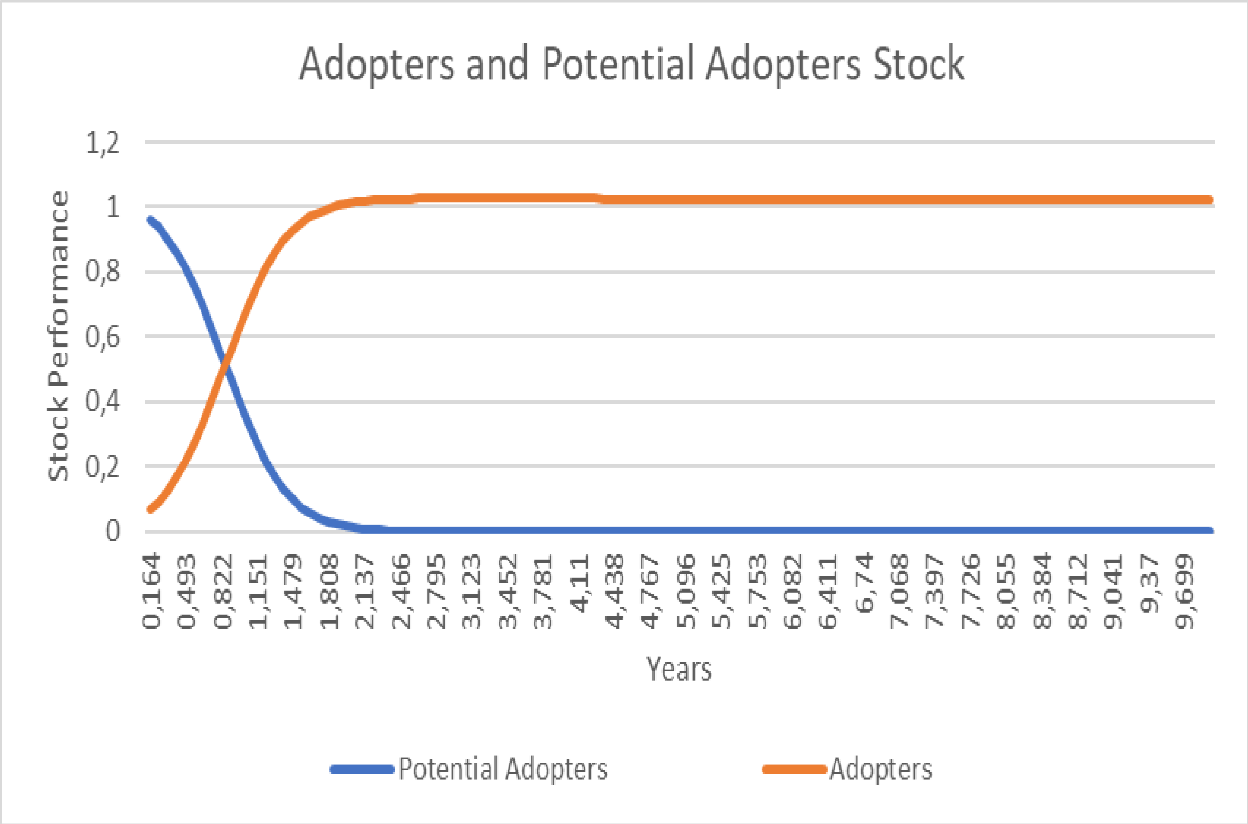


Figure 92: 50% increase in adoption parameter values for adoption stock

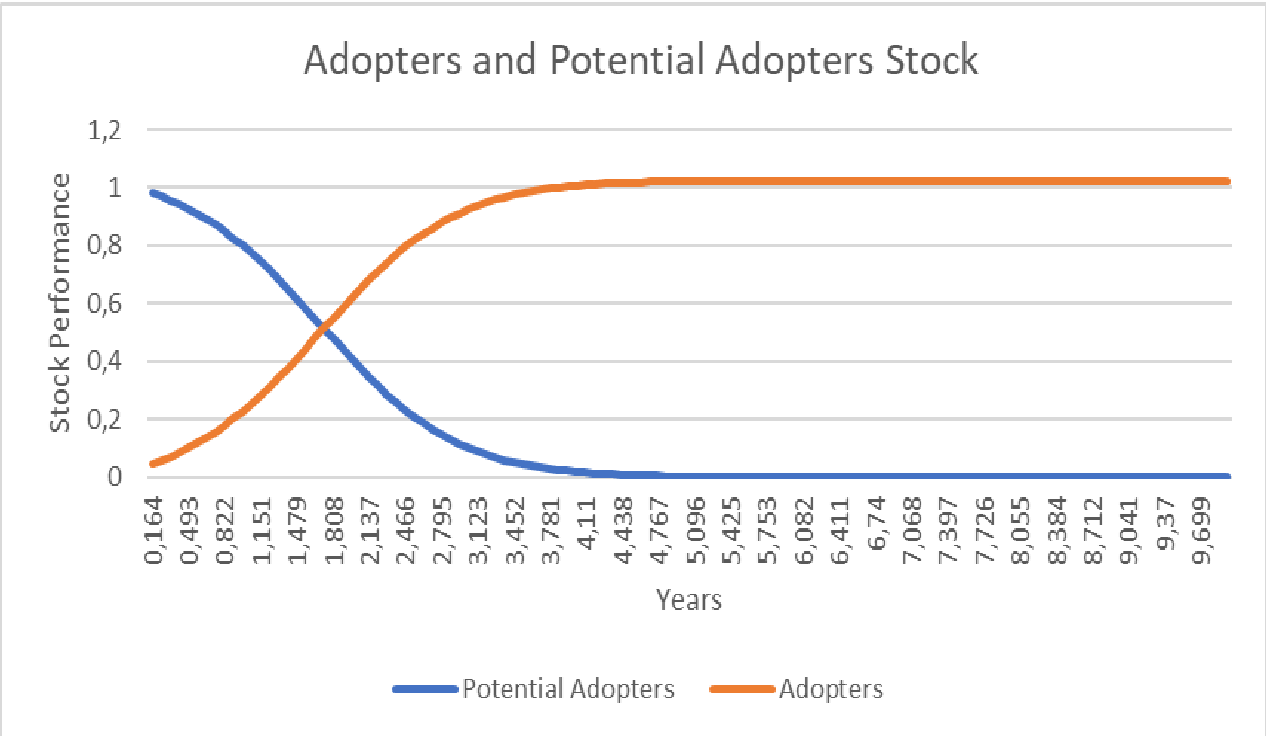


Figure 93: Best-case scenario for adoption stock

5.3.1.2.2 Adoption decline (Worst-case scenario 3)

The reinforcing loop parameters of the best-case scenario are left unchanged (Contact rate of 25 customers per year, adoption fraction of 15%, and marketing effectiveness of 20%) while the balancing loop parameter which comprises of dis-adoption rate (Adopters dropping out of the ecosystem for one reason or another) is set at 20%. The worst-case scenario is depicted in Figure 94 which reveals the impact of dis-adoption on the adoption stock. The results reveal that adoption will peak at year three with about a 60% adoption rate. However, the undesired effects of dis-adoption (representing diverging interests) will creep in and drive adoption downwards which will result in 20% adoption at the end of the ten-year simulation period. The drop in adoption results in a nose-dive trajectory for all the other stocks (Digital culture, capability maturity, and financial performance) as depicted in Figures 95 to 98.

Figure 95 depicts operations capability declining from its baseline conditions of 0.48 in ten years to 0.4 after a 20% drop in adopters. The decline from baseline to after impact of dis-adopters represents a drop of 17% in capability maturity. Figure 96 depicts digital culture declining from its baseline conditions of 0.673 in ten years to 0.464 after a 20% drop in adopters. The decline from baseline to after impact of dis-adopters represents a drop of 31% in digital culture. Figures 97 and 98 depict financial performance declining from its baseline conditions of -0.72 (-R2.04 billion) in ten years to -0.915 (-R2.59 billion) after a 20% drop in adopters. The decline from baseline to after impact of dis-adopters represents a drop of 21% in financial performance in terms of Rands. The results of the impact of dis-adoption or un-adoption by stakeholders are consistent with the work undertaken by [210] whose work focused on the adoption of improved agricultural inputs by farmers in Uganda.

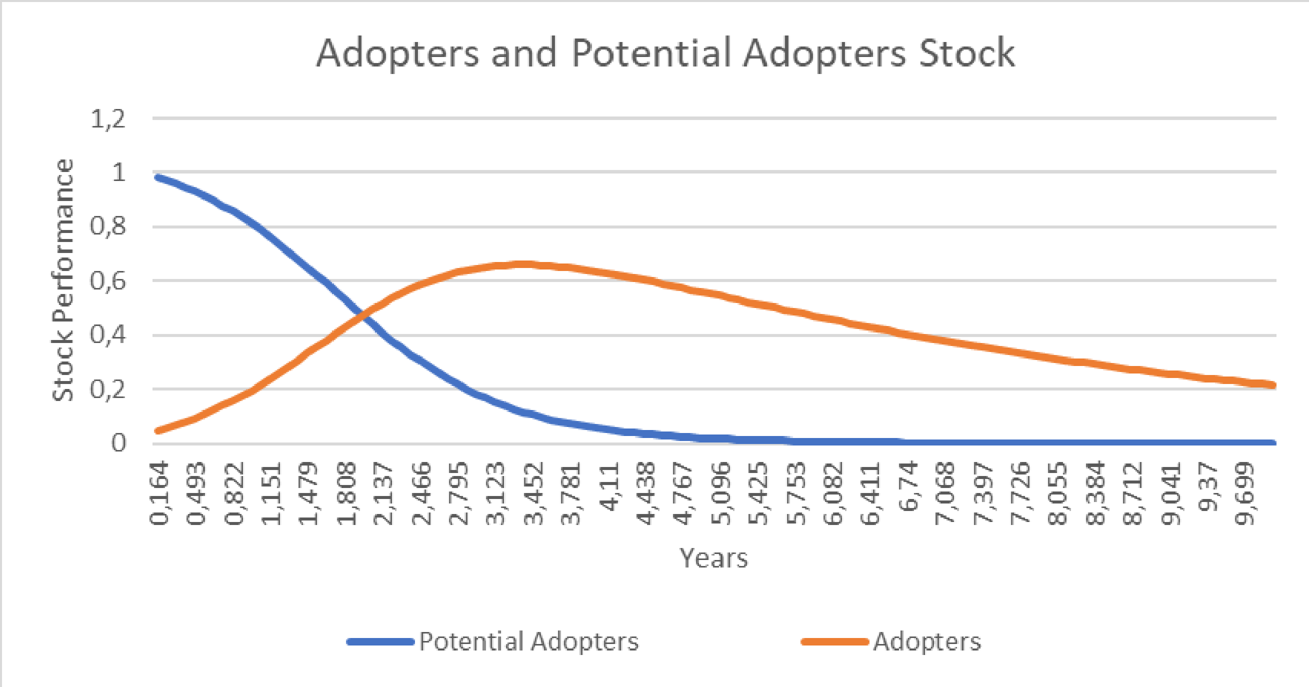


Figure 94: Worst-case scenario for adoption stock

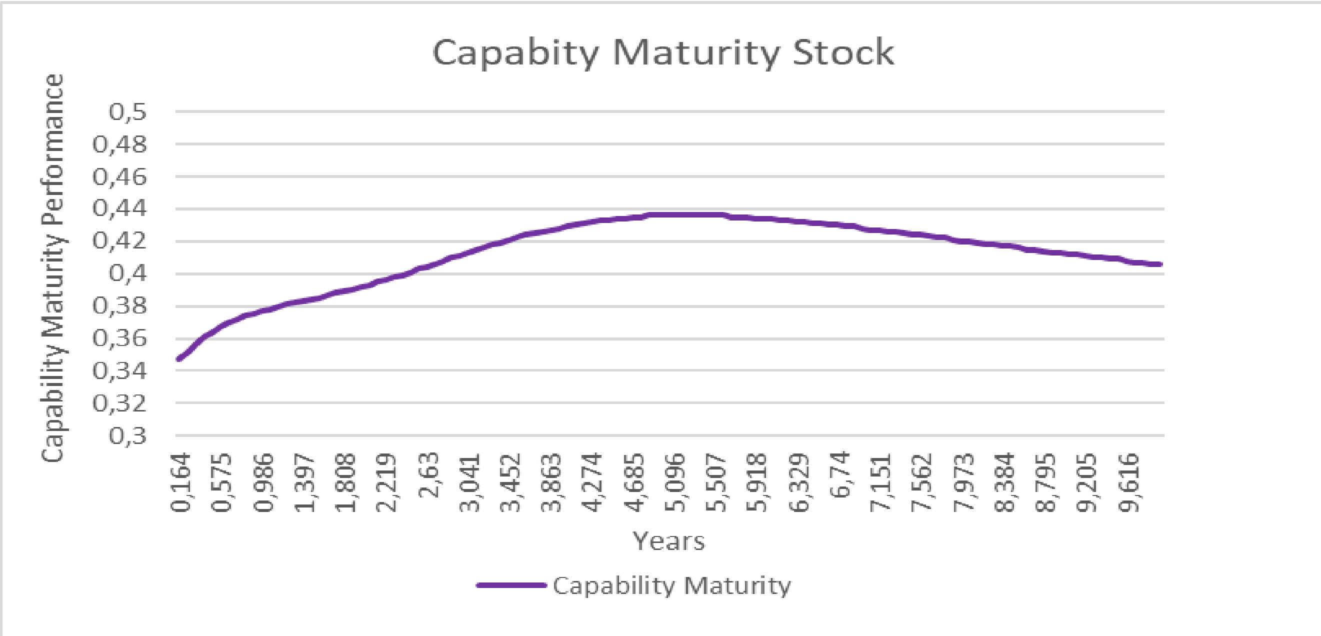


Figure 95: Impact of 20% drop in adopters on operations capability maturity (baseline)

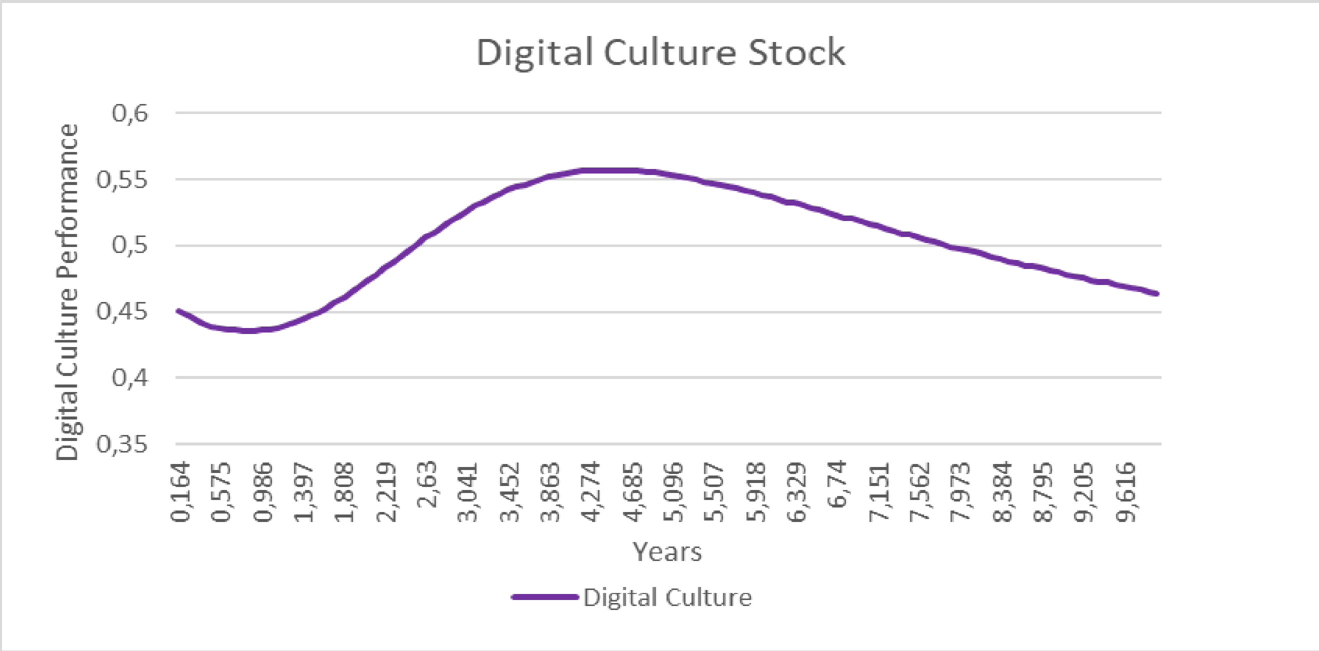


Figure 96: Impact of 20% drop in adopters on digital culture (baseline)

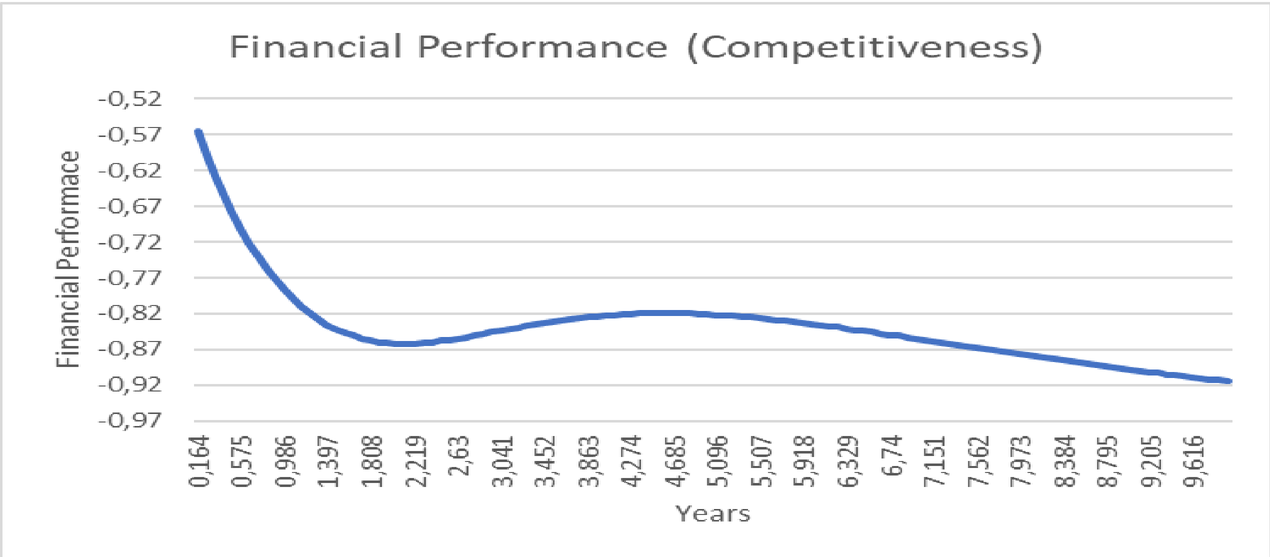


Figure 97: Impact of 20% drop in adopters on financial performance (baseline)

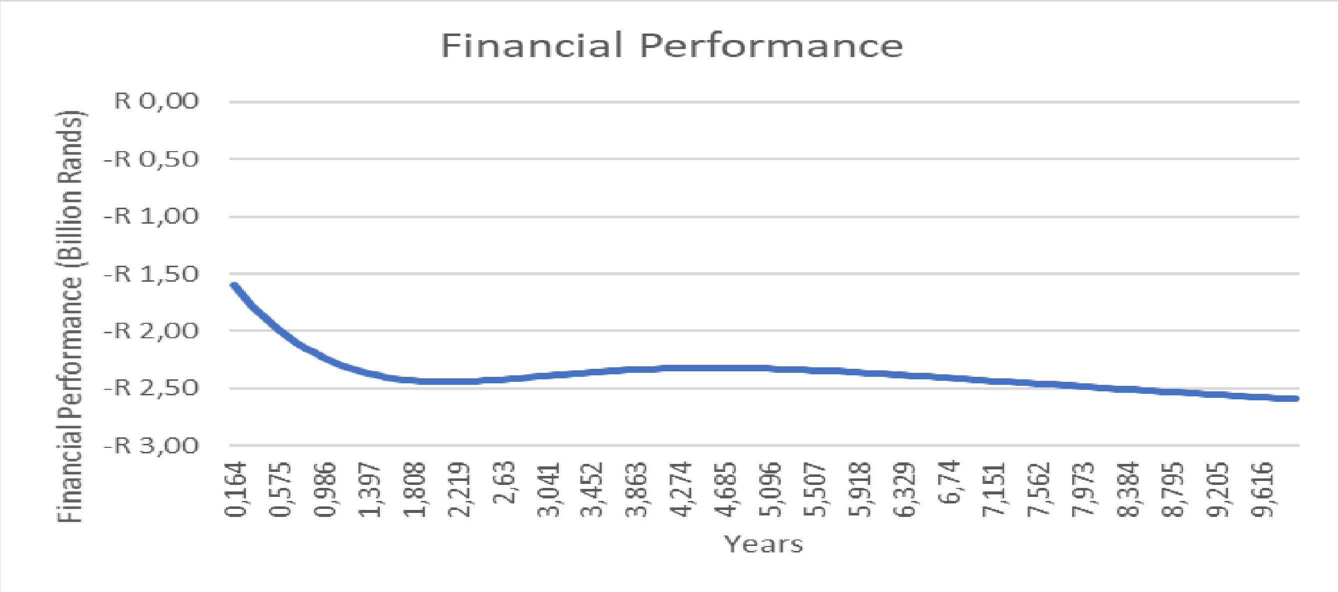


Figure 98: Impact of 20% drop in adopters on financial performance in Rand value (baseline)

Figures 95 to 98 depict the vital role that adoption plays in the overall competitiveness of the postal sector. The results demonstrate that a drop in the number of adopters has a devastating effect on all the stocks, all stocks then assume a sharp decline.

5.3.1.3 Digital Culture Improvement (Best-case Scenario 4)

In the baseline conditions as depicted in Figure 85 and Figure 86, digital culture is modelled as a function of the postal digital readiness index, and train post as reinforcing loop parameters that are within the control of the postal sector. The balancing loop parameters within the control of the postal sector are the absence of an Enterprise Architecture blueprint and the change of CEOs over ten years. The digital culture stock was found at baseline conditions, digital culture takes an s-curve trajectory consistent with culture as an integrator and will peak at about 4.8 years and flattens at 0.647 until the end of the simulation period of ten years. The baseline is modelled against parameters of (i) CEO turnover of 0.7, (ii) Absence of Enterprise Architecture (EA) blueprint of 0.9 which means there is poor EA presence, (iii) Postal readiness index of 0.516, and (iv) Train post of 0,001.

The best-case scenario depicted in Figure 99 is modelled against parameters of (i) CEO turnover of 0.2 (Meaning two CEOs in ten years), (ii) Absence of Enterprise Architecture (EA) Blueprint of 0.1 which means there is an excellent EA presence, (iii) Postal readiness index of

0.699 which represent a 26% improvement from baseline levels, and (iv) Train post of 0,1 which means 10% of employees trained in train post modules. The results are consistent with research on a system dynamics approach to organisational culture by Ceresia [211] and Trivellas *et al.* [212].

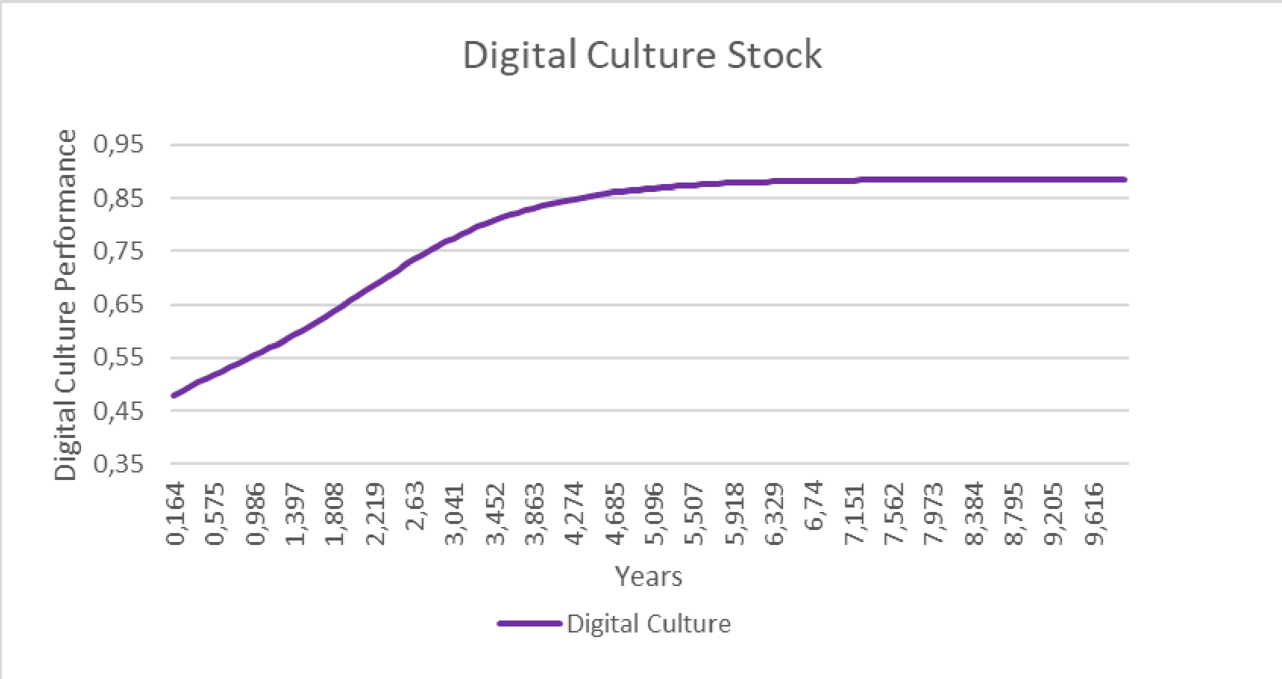


Figure 99: Best-case scenario for digital culture stock

5.3.1.4 Operations Capability Improvement (Best-case Scenario 5)

In the baseline conditions as depicted in Figures 85 and 87, digital capability maturity is modelled as a function of the capability maturity goal and compliance to quality of service on the reinforcement side of the loop. The balancing loop parameter that is modelled is non-compliance to electronic advance data (EAD). The capability maturity stock was found that at baseline conditions, capability maturity assumes a goal-seeking and peaks at about 5 years and flattens at 0.48 until the end of the simulation period of ten years. The baseline is modelled against parameters of (i) Compliance to quality of service of 0.42, and (ii) Non-compliance to Electronic Advance Data of 1-0.8895.

The best-case scenario depicted in Figure 100 is modelled against parameters of (i) Compliance to quality of service of 0.8 which means a 47.5% improvement and (ii) Non-compliance to Electronic Advance Data of 1-0.95 which translates to a 6.4% improvement in compliance thereby reducing non-compliance by 77.9% ([(1-0.95) - (1-0.8895)/(1-0.95)]*100). The capability maturity stock was found that at best-case conditions, capability maturity assumes a goal-seeking and peaks at about 5.5 years and flattens at 0.76 until the end of the simulation period of ten years. The improvement from baseline conditions represents a 37% improvement in capability maturity stock. The results are consistent with the literature on the system dynamics approach to modelling capabilities and resources by Warren [187] and Rosenberg *et al.* [213].

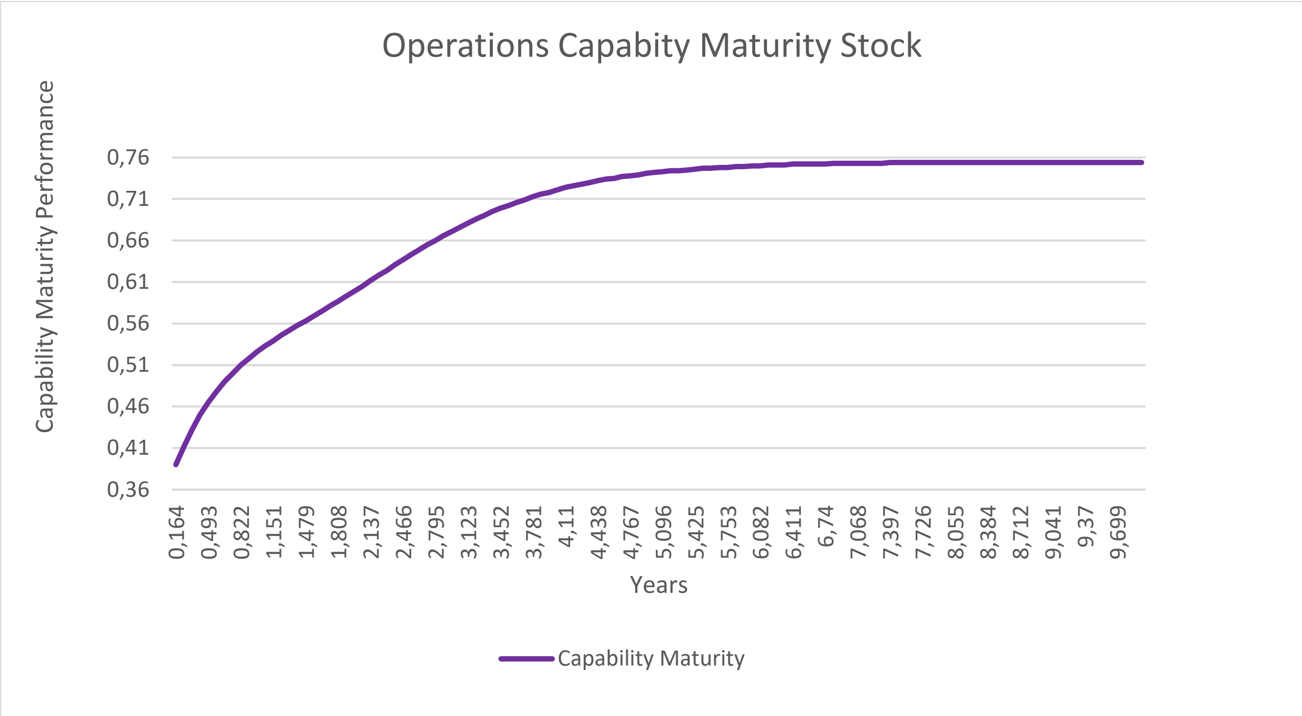


Figure 100: Best-case scenario for operations capability stock

5.3.1.5 Financial Improvement (Best-case Scenario 6)

In the baseline conditions as depicted in Figures 85, 89, and 90, financial performance is modelled as a function of revenue, other operating income, Universal Service Obligation (USO) Actual, USO Shortfall, and Rural Population on the reinforcement side of the loop. The balancing loop parameters that are modelled are staff expenses, operating expenses (OPEX), transport costs, and depreciation. The financial performance stock was found that at baseline conditions, financial performance drops to -0.85 (-R2,4 billion) in 2 years and climbs and flattens at -0.72 (-R2.04 billion) until the end of the simulation period of ten years. The baseline is modelled against parameters of (i) Revenue of 0.75, (ii) Other operating income of 0.13, and

(iii) Actual USO of 0.086, USO shortfall which are represented on the reinforcing part of the model. The baseline was further modelled against parameters on the balancing part of the model which are (i) Staff cost of 0.8, (ii) OPEX of 0.42, (iii) Transport costs of 0.0551 and (iv) Depreciation of 0.06.

The best-case scenario depicted in Figures 101 and 102 respectively, are modelled against parameters of (i) Revenue of 0.75, (ii) Other operating income of 0.13, and (iii) Actual USO (Universal Service Obligation) of 0.086. The financial performance stock was found that at best-case conditions, it begins at 0.687 which translates to R2,09 billion, and takes a dip and settles in 2.2 years at 0.079 which translates to R0,240 billion. The best case was further modelled against parameters on the balancing part of the model which are (i) Staff cost of 0.67, (ii) OPEX of 0.7, (iii) Transport costs of 0.2 and (iv) Depreciation of 0.06. The new contributions of expenses make up 100% of the 40% threshold of total expenses to total revenue as best practice. The results are consistent with the research on strategic management dynamics by Warren [187] and Trivellas [212] whose research was on business strategy effects on organisational performance.

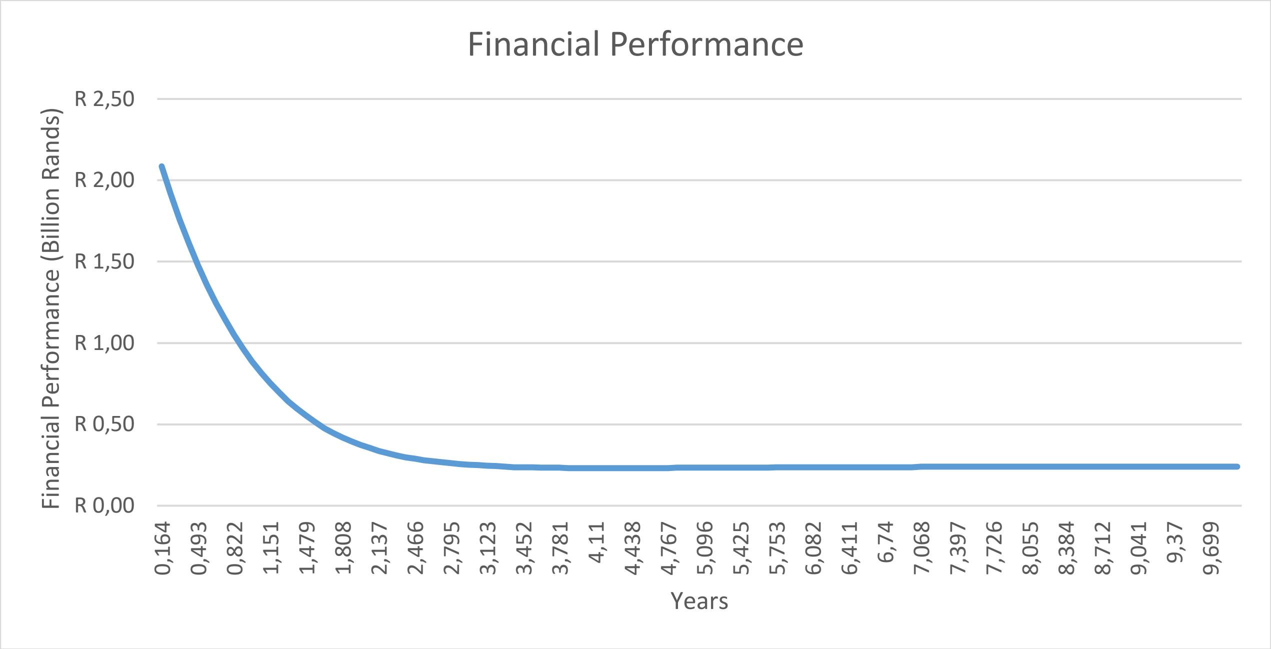


Figure 101: Best-case scenario for financial performance stock

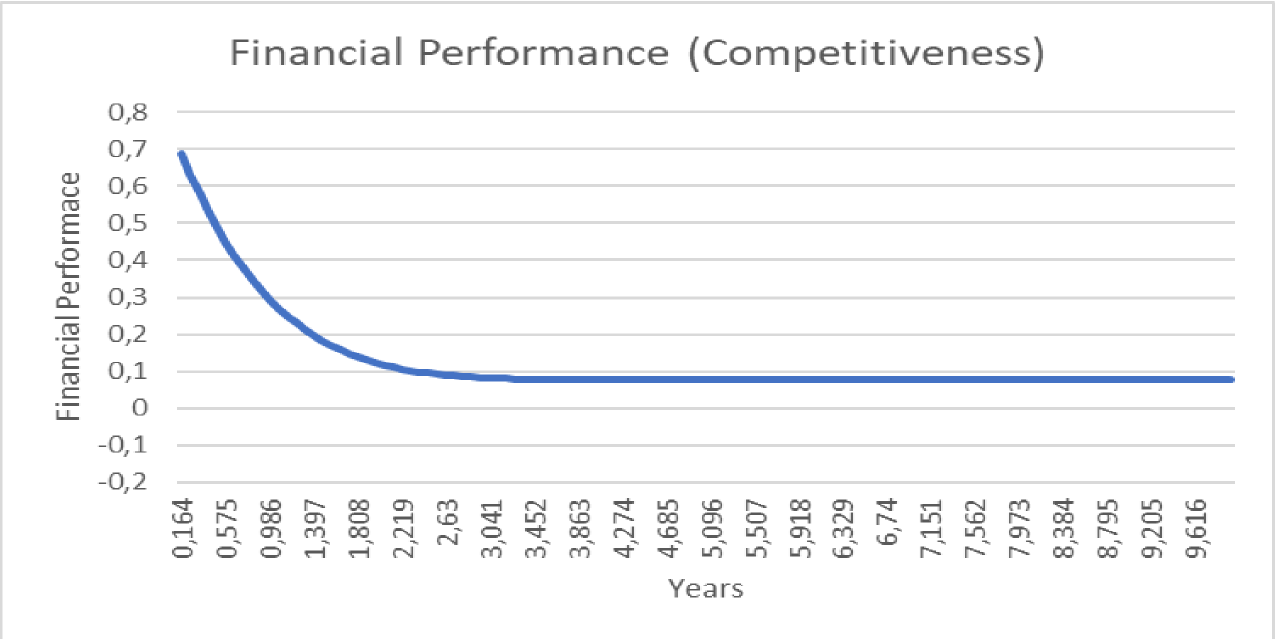


Figure 102: Best-case scenario for financial performance stock in Rand value

5.3.1.6 Adoption (Best-case Scenario Vs Worst-case Scenario)

Figure 103 attempts to compare the best-case (BC) performance of the adoption stock against the worst-case (WC) performance of the adoption stock. The worst-case (WC) scenario as depicted in Figure 94 reveals the impact of dis-adoption on the adoption stock. The results demonstrate that adoption will peak at year three with about a 60% adoption rate. However, the undesired effects of dis-adoption (representing diverging interests) will creep in and drive adoption downwards which will result in 20% adoption at the end of the ten-year simulation period which is detrimental to the sustainability of the postal sector. The best-case (BC) scenario also depicted in Figure 103 reveals that at baseline conditions, the adopters and potential adopters will be the same at around 2 years and all the potential adopters would have fully adopted in around 4 years.

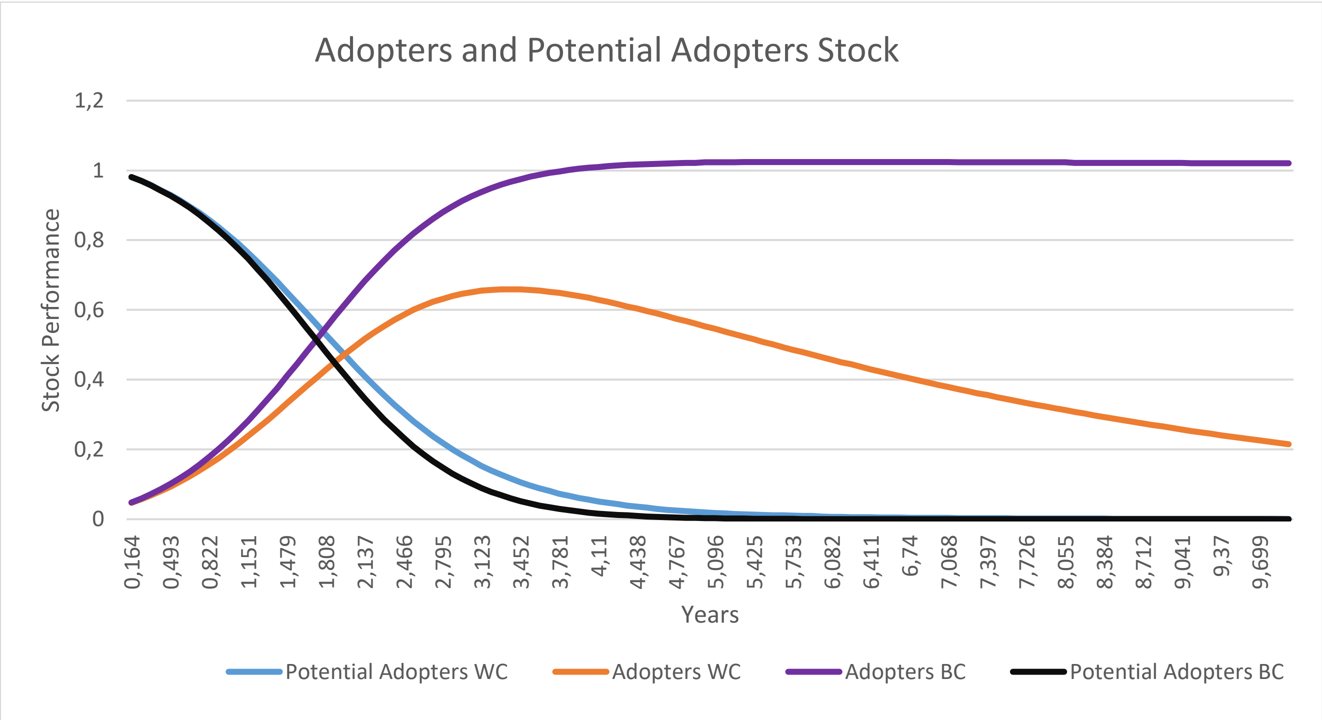


Figure 103: Best-case scenario vs worst-case scenario for adoption stock

5.3.1.7 Overall Performance (Interaction Of All Stocks, Scenario 7)

In the overall best-case structure depicted in Figure 104, the different curves illustrate the desired performance of each stock (Operations capability maturity, Digital culture, Adoption, and Financial performance), as articulated in their respective reference mode behaviour patterns in Chapter 4, as well as the subsequent delayed response for digital culture, adopters, and financial performance. The operations capability maturity stock exhibits a goal-seeking behaviour pattern as it moves to its goal value of 1 which is the maximum point that can be reached; the ultimate goal is to reach an operations capability maturity of 1. The operations capability maturity commences at 0.334 and progressively settles at 0.9, this means that at the best-case conditions, it is possible to exceed the 0.6 sets for Southern Africa and closer to the ideal goal of 1 which is measured through the Integrated Index of Postal Development (2IPD).

The digital culture stock exhibits an s-shaped behaviour and is consistent with the literature and real-life conditions because culture is an integrator and diffuses over time. The digital culture stock is impacted by the adoption stock which results in the digital culture stock exhibiting its s-shaped behaviour. The digital culture stock starts at an initial value of 0.479 in the year 0.164 and eventually reaches a value of 0,947 after ten years. The potential adopters' stock commences at an opening value of 0.98 and exhibits an inverse s-shaped behaviour, ultimately reaching a low value of 0 in 2,5 years. The adopter's stock commences at an opening value of 0.049 and exhibits an s-shaped behaviour, eventually reaching a high value of 1 in 2,5 years. It should be noted that the stocks for potential adopters and adopters are interconnected, which implies that when a unit of the potential adopters’ stocks flows out, it becomes an inflow to the adopter stock (This relationship is demonstrated by their inverse behaviour patterns).

The financial performance stock exhibits an interesting s-shaped behaviour, and this behaviour is expected as a result of the impact of the adoption stock and digital culture stock which exhibit an s-shaped behaviour on the financial performance stock. The financial performance is depicted in Figures 101 and 102 as a percentage and Rand value respectively. The financial performance (competitiveness) stock stands at 0,684 which translates to R2,07 billion in year 0.164 and settles at 0.332 which translates to R0,970 billion in year 9.94.

It is noteworthy to point out that the best-case overall scenario for all stocks illustrates the core principle of the interplay of variables in a dynamic setting as depicted in Figure 104. The interface of variables results in an improvement of all stocks compared to the best-case performance of the stocks as stand-alone stocks as depicted in Figures 93, 99, 100, 101, and 102.

Figure 105 depicts the best-case performance which is shown in Figure 104 against the base-case performance shown in Figure 85. There is a substantial improvement in the performance of all stocks from their base-case performance as depicted in Figure 103. The financial performance moves from -0,722 in 0,164 years which translates to a loss of R2,04 billion in 9,945 years in the base-case scenario to a profit of 0,322 which translates to R0,970 billion in 9,945 years in the best-case scenario. For the same period, digital culture moves from 0,673 in the base-case scenario to 0,947 in the best-case scenario, while operations capability moves from 0,479 in the base-case scenario to 0,901 in the best-case scenario. The dynamic behaviour of potential adopters and adopters in the base-case scenario reach values of 0 and 1 respectively in about four years while in the best-case scenario, the adopters and potential adopters reach values of 1 and 0 respectively in about 2 years, which is an improvement of 50% in performance. The results are consistent with the systems theory that "the whole is greater than the sum of its parts" articulated by Meadows [93], Sterman [96], Haraldsson and Sverdrup [214], and Ennen and Ritcher [215]. Figure 105 demonstrates this timeless principle of systems theory.

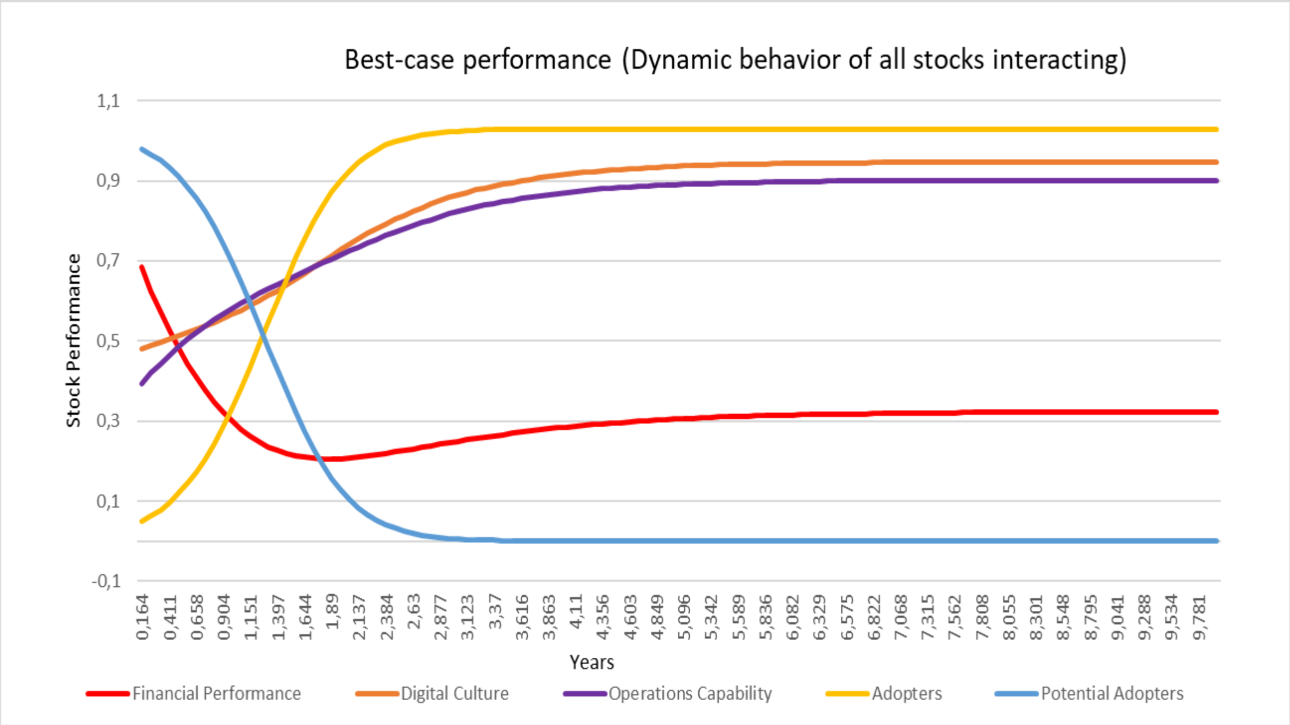


Figure 104: Best-case dynamics of all stocks

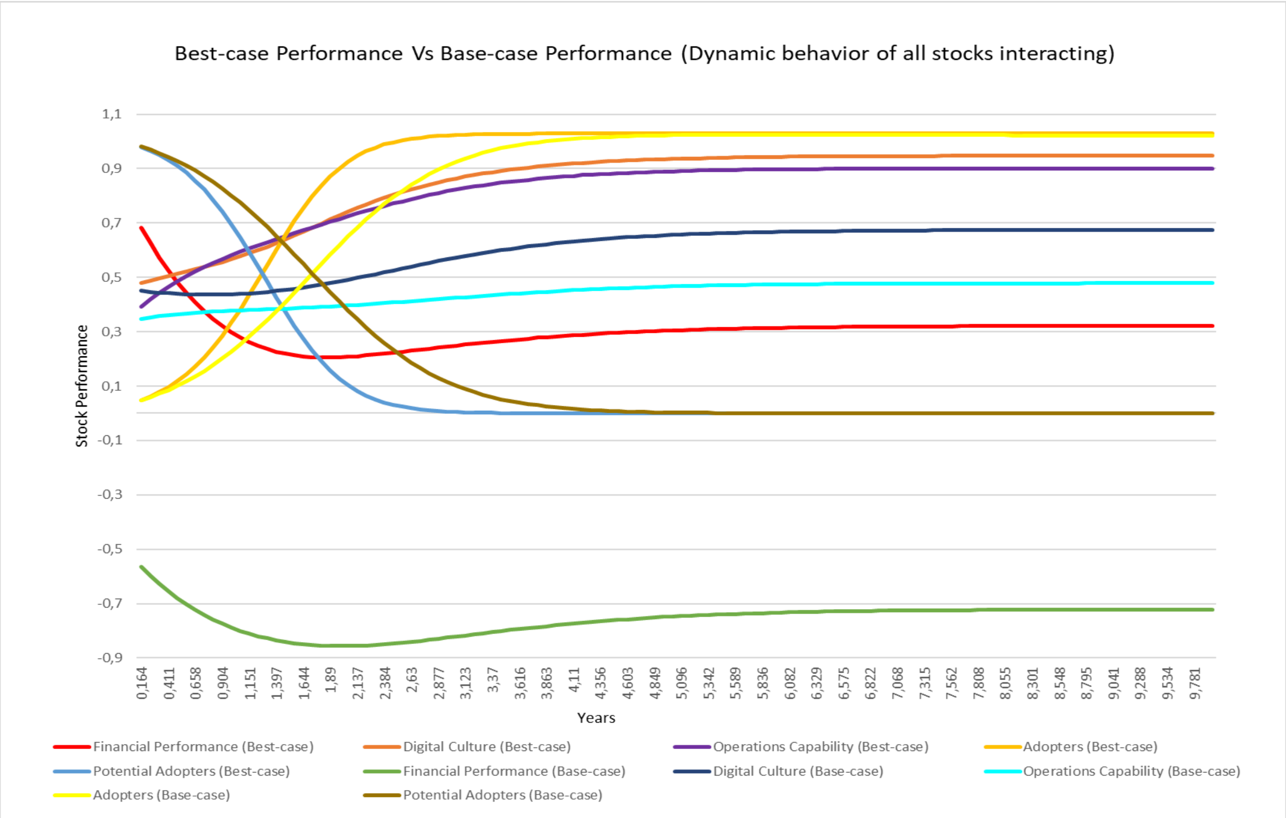


Figure 105: Best-case and base-case dynamics comparison of all stocks

5.4 Chapter Summary

In this chapter, the System Dynamics (SD) model was exposed to structure validity tests which comprised of (i) Direct structure tests which entailed structure confirmation tests, parameter confirmation tests, and dimensional consistency tests. (ii) Indirect structure tests which entailed extreme conditions test, and boundary adequacy test. In the boundary adequacy test, the SD model was modified to include a plausible additional structure in which the following constants were made endogenous to vary with time; based on feedback from (a) Impact increase in adopters (b) Impact decrease in adopters (c) Impact increase in capability maturity (d) Impact decrease in capability maturity (e) Impact increase in digital culture (f) Impact decrease in digital culture (g) Postal readiness index, (h) Compliance to Electronic Advance Data (EAD), and (i) Major obstacles to digital postal services.

During the structure confirmation test and parameter confirmation test, the model was shared with digital transformation experts and policymakers in the postal sector to assure that it mirrors the realities of the postal sector. The dimensional consistency tests were conducted to analyse the SD model's rate equations, and the Anylogic Personal Learning Edition (PLE) software was used to scrutinise the consistency of the dimensions in the model. Structure-oriented behaviour was conducted to guarantee that the model correlates with the literature while extreme conditions tests were conducted to assure that the SD model performs as anticipated even in extreme conditions.

Seven design and analysis scenarios were conducted and covered the following aspects (i) Scenario1 which can be classified as business-as-usual which was based on base-case conditions, (ii) Adoption improvement which is scenario 2, (iii) Adoption decline which is scenario 3, adoption decline results in the overall deterioration of all the other stocks, (iv) Operations capability improvement which is scenario 4, (v) Digital culture improvement which is scenario 5, (vi) Financial performance improvement, and (vii) Combination of scenarios 2, 4, 5, and 6.

The SD model that was conceptualised and constructed in this research and depicted in Figure 74 represents postal digital transformation dynamics in Southern Africa and on a global scale. The model has proved useful to postal administrators and policymakers during the validation and verification phase, and it will prove to be a useful tool for decision-making in the postal sector in Southern Africa and globally. The policy design and analysis conducted in this study afford policymakers and postal administrators a vital tool to explore a range of choices and levers to pull to improve the sustainability of the postal sector. The SD model constructed in this research contributes to the new knowledge that can be utilised by the postal sector to improve the sustainability of the postal sector in Southern Africa and beyond the Southern Africa Region.

The succeeding chapter elaborates on the conclusions and recommendations of the study.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

This doctoral research commenced in developing a suitable model capable of assisting postal administrators and postal policymakers in the Designated Postal Operators (DPOs) in Southern Africa to explore the postal dynamics at play in the sector. This was with emphasis on the drivers and inhibitors of digital transformation prevalent within the postal sector understood to be the determinants of financial sustainability in the sector.

This section commences by reaffirming the research purpose to examine if the aim and purpose of the research have been accomplished. It further reaffirms the research questions and explains where research questions were answered. Subsequently, the contributions of this study to new knowledge are provided. A grounded theory exploratory research as described in 3.6 was adopted to aid in answering the research question in section 1.3 (i) What are the digital postal dynamics (variables) in organisations and the postal sector globally and in Southern Africa? While the research effort and knowledge in Chapter 4 were used as articulated in Section 4.3 and Chapter 5 as articulated in Section 5.22 in answering the question (ii) How do these variables interact with each other in a dynamic setting? Lastly, the research effort and knowledge in Chapter 5 as articulated in Section 5.3. were used to answer the question (iii) What policy designs can be derived from the resulting model to aid policymakers and postal operators in Southern Africa to better manage the digital transformation to deliver value to society and contribute to the financial sustainability of the postal sector in Southern Africa?

The section below recaps the aim (purpose) as well as the objectives of the research as well as articulates how the aim and objectives were addressed.

6.1.1 Purpose and Objectives of the Research

The study purposed to model digital transformation dynamics in the postal sector in Southern Africa, concentrating on factors that inhibit or drive competitiveness in the postal sector. The research was aimed at the development of a tool by which competitiveness (financial sustainability) can be accomplished in the postal sector. This was achieved by finding the key factors that are prevalent in the postal sector and exploring the interface of these factors in a dynamic setting using system dynamics as a research paradigm. Through this research effort, a novel conceptual model that encapsulates the postal digital transformation dynamics was developed and depicted in Figure 74. In addition, this novel model will be particularly useful in Southern Africa and beyond as it integrates key variables such as digital culture, adoption, and operations capability which determine the level of financial performance (competitiveness) of the postal sector.

Developing the system dynamic model was a crucial outcome of the study and was accomplished by adopting the system dynamics research paradigm through the application of Anylogic Personal Learning Edition (PLE). The novel model was verified and validated by sharing it with the postal sector experts in the field of digital transformation. The model's simulation results mirrored the reality of postal dynamics in Southern Africa and beyond. The model was subjected to direct and indirect structure tests to assure its validity through a comparison of the novel model structure with knowledge of the real-life system. The novel model passed all the tests subjected to it and is deemed to be logical for its intended purpose and considered useful to the postal sector. These tests are articulated in sections 5.2.1 and 5.2.2. Section 5.2.1 articulates direct structure tests which encompass structure confirmation tests, parameter confirmation tests, and dimensional consistency tests. Lastly, section 5.2.2 articulates structure-oriented behaviour tests which encompass boundary adequacy tests, extreme conditions tests, and behaviour pattern tests.

The simulation results after appraising and validation of the model as covered in Chapter 5 illustrate that adoption of the UPU digital ecosystem by key clients, digital culture, and operations capability all play a pertinent part in the financial sustainability of the postal sector. The other important insight gained from the study is that the impact of a decline in adoption has a devastating blow to the performance of all other stocks and this is discussed in section 5.3.1.2.2 and depicted in Figures 94, 95, 96, 97, and 98.

The section below restates the research questions as well as indicates where in the study the research questions were answered.

6.1.2 Research Questions

To explore the opening research question stated in section 1.3 (i) "What are the digital postal dynamics (variables) in organisations and the postal sector globally and Southern Africa?" A detailed literature review was undertaken and culminated with an exploratory study undertaken using the Grounded Theory research strategy to build a new theory on postal digital transformation dynamics. The findings revealed that adoption, digital ecosystem, shared vision, customer insights, digital culture, diverging interests, digital investment, operational excellence, digital capabilities, and digital competitiveness are the key variables that define digital postal dynamics in the postal sector globally and Southern Africa as the focus of this research. The outcomes of the exploratory research were utilised to construct a conceptual model which is depicted in Figure 106 below and was discussed in detail in Chapter 4, section 4.2.

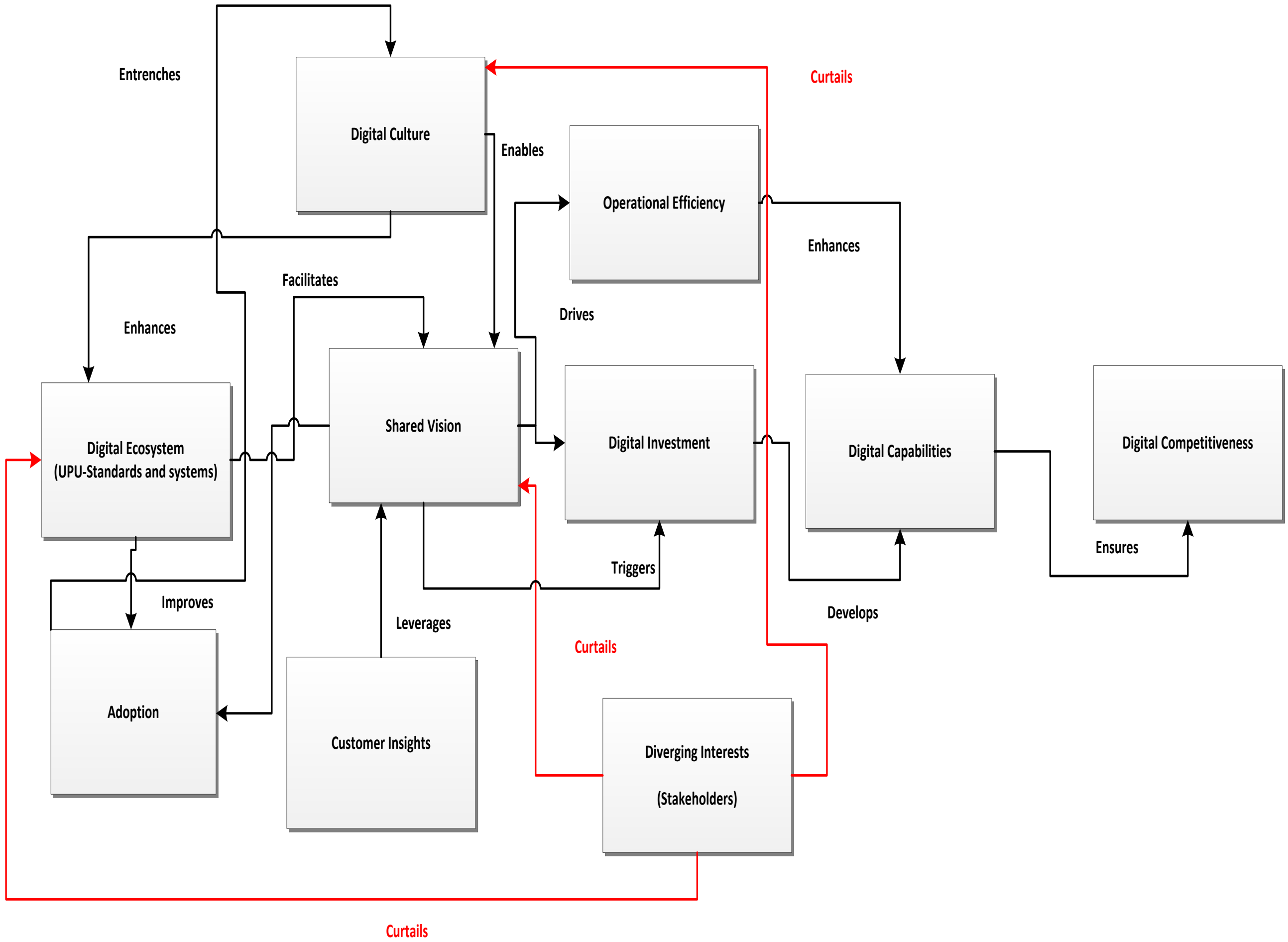


Figure 106: A conceptual model that answers research question 1

The conceptual model depicted in Figure 106 was a precursor to investigating the succeeding research question stated in 1.3 (ii) "How do these key variables interplay in a dynamic setting?" This question was answered with the aid of the Anylogic simulation software. The SD model was conceptualised, formulated, verified, and validated. The SD model was discussed in Chapter 4 under Section 4.4.2. The model was conceptualised and formulated to demonstrate the interaction of the streamlined variables as articulated in Figure 63 and Table 45. The four variables that emerged were digital culture, operations capability maturity, adoption, and financial performance.

The four stocks and their respective flows answered the second research question "How do these key variables interplay in a dynamic setting?" is articulated below which depicts the stocks and their corresponding factors (flows) that inhibit or drive the overall performance of the four stocks as they interact in a dynamic setting.

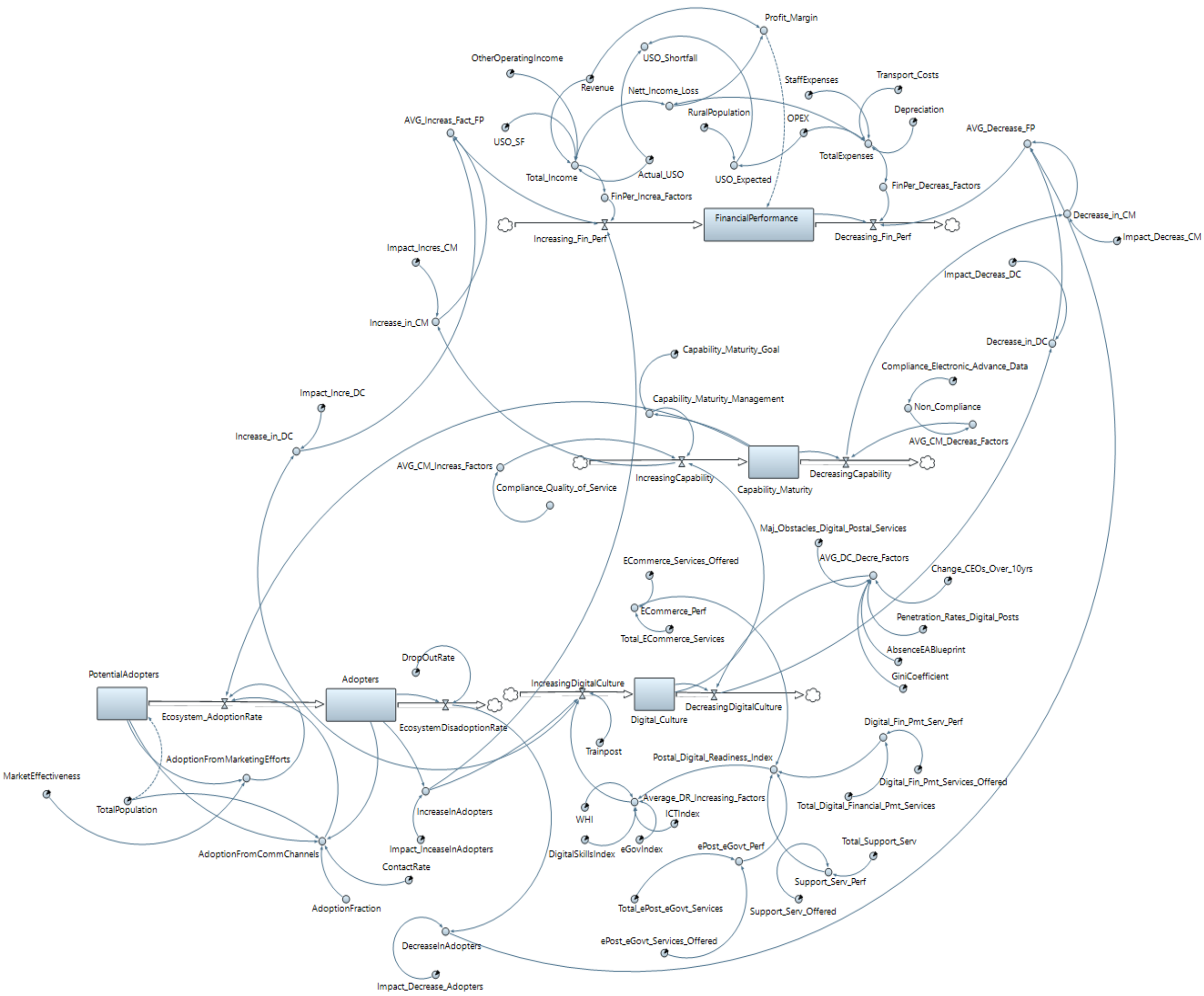


Figure 107: A System Dynamics model that answers research question 2

Lastly, the validated stock-and-flow system dynamics model was utilised to explore and answer the last research question stated in 1.3 (iii) "What policy designs can be derived from the resulting model to aid policymakers and postal operators in Southern Africa to better manage the digital transformation to deliver value to society and contribute to the financial sustainability of the postal sector in Southern Africa?" This research question was answered by simulation of "what-if scenario" analysis culminating with policy scenario analysis and design as articulated in Chapter 5 in section 5.3.1. The overall best-case scenario is depicted below and discussed in full in Chapter 5 which articulates the policy designs to be implemented to turn around the state of decline of the postal sector to a state of financial sustainability. The section below articulates the contribution of the research to a new body of knowledge.

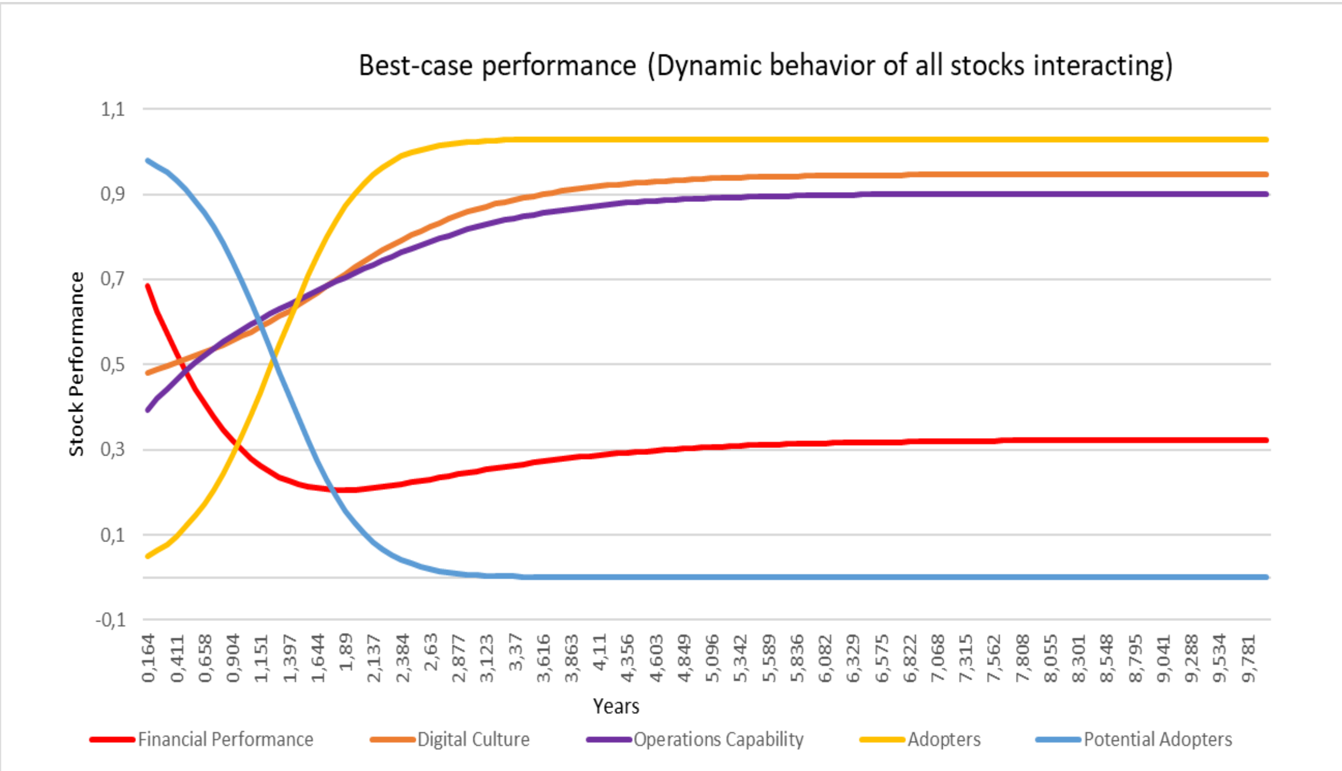


Figure 108: Overall base-case scenario that answers research question 3

The model was presented and tested, and various policy interventions were explored. It is concluded that the implementation of the best-case scenario with associated policy interventions as discussed in Chapter 5 confirms the hypothesis and will improve all four stocks (digital culture, adoption, operations capability, and financial performance). The policy interventions will improve adoption which has a positive effect on operations capability maturity characterised by the 2IPD, digital culture and lastly financial performance which is a requirement for the competitiveness of the postal industry now and in the future. The adoption of the digital transformation agenda will propel the postal sector in Southern Africa to be competitive. This is supported by literature from Swiss Post [17] which articulates the digital transformation journey of Swiss Post. Swiss Post remains unparalleled on the 2IDP ranking and has been in pole position for years due to the execution of its digital strategic outlook.

6.1.3 Contributions to the Body of Knowledge

Kraus et al [216] postulate that digital transformation has sparked immense interest among academics in recent decades, which is consistent with digital transformation which is consistent with the proposition in the report by UPU [43] where it is proposed that the world is on the cusp of a digital era that is transforming society and organisations across the world. This is an era also known as the Fourth Industrial Revolution. Therefore, digital transformation is a young and evolving discipline both from academic research and industry practices perspectives.

Mokgohloa *et al.* [217] have drawn on adoption theories (Theory of Reasonable Action, Technology Adoption Model, and Diffusion of Innovation Theory to propose a theoretical framework that describes the drivers of postal development excellence. Mokgohloa et al [145] refined research and findings in [217] through further research and proposed that adoption and technology diffusion processes are very complex and entail multiple interdependent drivers and barriers which are dynamic and encompass several feedback processes that demonstrate non-linearity characteristics. The research revealed that a system thinking approach that intrinsically integrates feedback systems is appropriate for complex spectacles such as the adoption of technology and digital transformation in the postal sector which is underpropped by multiple stakeholders with often contrasting interests. A systems approach in contrast to traditional “linear” technology adoption models (TRA, TAM, TAM 2, UTUAT, TOE, BOE and ADOPT) was discovered to be the proper approach to dealing with the interaction of barriers and drivers that are at play in a dynamic setting in the context of the postal sector in Southern Africa.

Mokgohloa *et al.* [218] further refined the insights in [145] through an exploratory study that adopted a Grounded Theory research strategy which culminated in the ten variables that emerged from the grounded theory process which are adoption, shared vision, digital competitiveness, digital ecosystem, digital capability, digital investment, diverging interests, customer insights, digital culture, and operational efficiency. These emergent variables were the foundation of a conceptual framework characteristic of the postal digital dynamics in the postal service in Southern Africa.

Mokgohloa *et al.* [219] developed the Causal Loop Diagrams (CLDs) based on insights from the conceptual framework developed in [218] to comprehend the complex interactions between the variables. The CLDs attempt to conceptualise the complex phenomenon of adoption and diffusion of a digital transformation agenda in the postal sector in Southern Africa. The causal loop diagrams were further refined into a restated hypothesis depicted in Figure 64 based on analysis summarised in Table 46 and culminated with a preliminary novel model illustrative of the dynamics in the postal sector and depicted in Figure 67. The model was verified and validated with real data from a postal administration in Southern Africa and was subsequently improved to derive a novel model depicted in Figure 71. Simulation results which are based on the System Dynamics model depicted in Figure 71 provide vital insights into postal digital transformation dynamics triggered by the interaction of adoption, digital culture, operations capability, and financial performance variables and their respective drivers and inhibitors in a dynamic setting in Southern Africa and globally.

Largely, the System Dynamics replication results demonstrate that the adoption variable plays an indispensable part in the overall performance of all the model variables. A drop in adoption as depicted in Figure 94 and the drop in adoption brings with it a devastating decline in the performance of all stocks as depicted from Figure 95 to Figure 98 and is consistent with propositions by Sterman [100] and supported by Wu and Olson [209]. The system dynamics simulation further illustrated that when the stocks are improved as stand-alone as discussed in Scenario 2, scenario 4, scenario 5, and Scenario 6 and depicted in Figures 93, 99, 100, 101, and 102 respectively; and when the parts (stand-alone improvements) are allowed to interact with each other in a dynamic setting as discussed in scenario 7 and depicted in Figure 104, it reveals that all the stocks improve greater than the performance in the stand-alone improvements and is consistent with the propositions of Meadows [93], Sterman [96], Haraldsson and Sverdrup [214], and Ennen and Ritcher [215]. This insight is vital and confirms the underlying foundation of the system theory perspective that "The whole is greater than the sum of its parts". The behaviour of the system dynamic model is consistent with systems theory. The different scenarios illuminate the levers that postal administration and postal policymakers can pull to improve postal sustainability in Southern Africa and beyond.

The study presents a scientific and systemic approach to improving operations capability maturity and overall sustainability of the postal sector. The novelty of the new body of knowledge lies in the mathematical equations developed and applied in simulation processes for the analysis and policy design interventions to design a sustainable postal industry. This novel knowledge is the outcome of a meticulous research effort, based on the replication results derived from the novel SD model developed in this study. The outcome of the study provides meaningful insights and applications to innovative policy interventions that would provide positive results when applied to digital transformation in the postal sector in Southern Africa and other developing countries that are not performing as measured by the Integrated Index on Postal Development (2IPD). The new knowledge will significantly assist the respective postal administrations to focus on which levers to pull to assure the financial sustainability of the DPOs.

The section articulates the recommendations that emanated from the research.

6.2 Recommendations

Ogano [143] proposes that research is a moderator for new ideas, and as a result, vigorous enactment of study into practice is imperative. The outcomes of this research through policy analysis and design which was conducted in Chapter 5 indicate that the performance of the postal sector in Southern Africa is a complex phenomenon that requires postal administrators (management) and policymakers to take drastic steps to assure competitiveness and financial sustainability of the postal sector. The development of the SD model is to visualize the interactions between adoption, operations capability, digital culture, and financial performance stocks. This would assist postal administrators (management) and policymakers to recognise which levers to pull to drive-up financial performance and thereby make informed decisions to improve the postal service.

The findings of the research offer implications for Designated Postal Organisations (DPOs) and policymakers. The recommendations are divided into two classes which policymakers and DPOs should urgently consider for implementation. The recommendations relate to (i) The Designated Postal Operator (DPO), and (ii) Policymakers (Regulators and, the shareholder).

(a) The DPO-specific interventions:

There are internal DPO-specific levers that should be explored to improve the financial sustainability of the DPO which are captured in the best-case scenario articulated in Figure 104. The interventions include (i) Improving marketing effectiveness to at least 20%, improving adoption fraction to at least 15%, and improving contact rate to at least 25 key customers per annum (ii) Managing and preventing "dis-adoption" by key customers, (iii) Improving the postal readiness index to at least 90% by (1) Increasing the number of digital financial payment services offered, (2) Increasing the ePost and e-Government services offered, (3) Increasing the number of total support services offered, (4) Increasing the number of e-commerce services offered; (5) Expand physical services features in line with integrated product plan (iii) Ensure Enterprise Architecture (EA) blueprint is developed and implemented and communicated to all staff, (iv) Enrol staff in Train-post courses to prepare a digitally competent workforce and ensure at least 10% are trained by 2025 with the remainder scheduled to complete training before 2028 , (v) Improve compliance to quality of service to above 85% and compliance to electronic advance data (EAD) to above 95%, (vi) Ensure cost optimisation of staff expenses, operating expenses to ensure that total expenses do not exceed the best practice of 40% of the total revenue. This is a critical success factor to ensure the sustainability of the DPO.

(b) The policymakers-specific interventions:

There are specific policymaking levers that policymakers (Shareholders) should leverage to improve the financial sustainability of the postal sector. These levers are as follows, (i) Ensure that Designated Postal Operators receive the due USO (Universal Service Obligations), the DPOs should receive a percentage of their total expenses as USO. This is calculated on the percentage of the rural population, in the pilot study in the context of South Africa; the rural population stands at 33%.

The rationale is that total expenses are inclusive of shared services (e.g., ICT, Human Resources, Properties, and Finance), and operations (Retail, delivery, and depot staff expenditure, transportation expenses, and sundry expenses), rural operations are not profitable compared to urban and metropolitan operations and due to USO requirements, postal services are a universal right and even rural citizens are entitled to the services regardless of viability. Therefore, a USO compensation of 33% of total expenses in the context of South Africa as an example, will assure the sustainability of the postal service if the current situation persists and could be reviewed accordingly if the situation improves. This is consistent with the research undertaken by the United States Postal Service [220] which argues that while physical mail is declining as the adoption of digital solutions rises, a large portion of the population, especially in rural and remote areas, depends on postal services due to broadband challenges and expensive electronic gadgets to access digital services. This research further argues that the issue of trust in digital services is an inhibitor towards full adoption.

In ensuring that there is a shared value, policymakers should shift the paradigm in the mandate of DPO and take into cognisance the advent of the digital age that should drive the next evolution of the USO [220]. The policy should shift gears from communication to trade facilitation and this will push the DPOs to relevant business models for the e-commerce ecosystem. As e-commerce booms, a large portion of the population in rural areas and remote areas still depend on parcel delivery for necessary supplies and other postal services such as financial services that are limited in rural and remote areas which makes USO still a relevant policy intervention.

(ii) The stability of the Executive is of prime importance and in particular the role of the Chief Operating Officer (CEO) or Postmaster General (PMG). The Board of Directors and in particular the shareholder should protect the office of the CEO/PMG and ensure that the CEO/PMG completes their terms. This study's findings point out that instability in the role of CEO/PMG results in instability of the entire organisation. The CEO/PMG must be provided with the necessary support from the shareholder and the CEO/PMG be allowed to execute their responsibilities without political hindrance. The instability at the top echelons of the organisation results in a morale decline and a toxic culture emerging which undermines shared vision and cohesion. Several researchers [221];[222];[223] have articulated the role of the CEO in nurturing a stable organisational culture that assures firm performance and argues that a stable executive management team led by a CEO will positively nurture an organisational culture that supports growth and competitiveness of the firm.

The results of this study provide vital insights into how policymakers and DPOs can improve the sustainability of the postal sector in Southern Africa by managing the variables and the levers highlighted in the study. Thus, expecting the provision of postal services to address current and future postal challenges is an essential but complex assignment for the DPOs and policymakers respectively. This model will assist policymakers and DPOs to manage the complexity associated with the fundamental task of ensuring the financial sustainability of the postal sector, and for citizens to benefit from the provision of postal services in respective countries, regions, continents, and globally. A policy brief was developed and embedded as Appendix 4 which articulates the implications for practice and policy as a brief for DPOs and policymakers.

The preceding section articulates the limitations of the study.

6.3 Limitations and Opportunities for Future Research

This research was conducted by concentrating on digital transformation dynamics in the postal industry in Southern Africa. While the literature review and grounded theory research approach were extensive, future research could cover more variables (postal dynamics) and extend the current SD model that was developed in this study. The study only concentrates on policy analysis and design and does not include the domain of implementation, measurement, and evaluation.

Despite the limitations, the positive authentication (verification) and endorsement (validation) of the SD model, the appraisal (testing) of the SD model (including policy analysis and design), and sharing the SD model with postal specialists acquainted with postal realities, offer assurance of the general soundness and rationality (validity) of the study and its discoveries, together with its contribution to novel knowledge.

Future research could explore the implementation, measurement, and evaluation of policy to understand if the appropriate policies and their execution have been mastered in the postal sector by both postal administrators (DPO) and policymakers. Appropriate policies and the art of execution remain a thorn in the public service on the continent resulting in poor service delivery to citizens. This is supported by the research of several authors including Ndalamba [224]; Govender and Reddy [225]; and Ajulor [226].

The preceding section articulated the research outputs produced from this study and the model equations in text form.

APPENDIX 1 and 2: RESEARCH OUTPUTS

Postal Development: Literature Review into Adoption Models

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Abstract - **The changing postal landscape and rise of digitalization powered by the multiple technology revolutions of the 21st century has prompted Postal Operators across the world to expand their services well beyond the original (traditional) service of merely delivering letters which started more than 100 years ago. However, according to the Postal Development Report of 2018, compiled by the Universal Postal Union (UPU), the majority of Postal Operators are under performing on the Integrated Index for Postal Development (2IPD) that measures four dimensions of postal development: relevance, resilience, reach and reliability. The purpose of the study was to review literature on the 2IPD, Industry 4.0, Technology Adoption and Technology Diffusion as key determinants that could lead to postal excellence. The literature points to postal development as a function of postal excellence. Literature further points to adoption and diffusion variables as key determinants for adoption and diffusion of disruptive technologies.**

Keywords – **Fourth industrial revolution, Industry 4.0, technology adoption models, technology, diffusion of technology, technology acceptance**

I. INTRODUCTION

According to [1], while some postal operators in various countries across the globe battle with economic and political turmoil, others are successfully disrupting international trade. There has been a widespread move towards mobile (digital) technologies throughout the developing world. [2] postulates that societal anatomy is rapidly changing and that the digital age has shepherded in changes in consumption patterns that have resulted in the evolution of the customer of the future complete with their unique needs and expectations.

[2] provides a global view of the Postal Sector, highlighting that the postal sector comprises a global network of over 677 000 post offices, 5.3 million employees and physical infrastructure covering 192 countries.

[3] postulates that limited internet connectivity, incomplete investment and/or recapitalization of the network infrastructure, poor quality of service, limited interoperability and connectivity among the systems (customs, security and civil aviation) of supply-chain stakeholders, as well as ambiguity in postal sector definition in southern Africa are the main reasons for the slow progress.

According to [4], the regional landscape of the postal sector in southern Africa comprise of 50 sorting centers in and a delivery infrastructure of 16, 064.394 delivery points. Of these, South Africa (the South African Post Office) accounts for 26 sorting centers and 14, 106.896 delivery points.

The 14 designated postal operators in the Southern African Development Community (SADC) are Corrios de Angola, ZimPost, Zambia Postal Services Corporation, Tanzania Posts Corporation, Botswana Post, Mauritius Post, NamPost, Eswatini Post, SA Post Office, Seychelles Postal Service, Correios de Mozambique, Societe Congolese des Postes et Telecommunications, Malawi Post Corporation, Commoros Post and Paositra Malagasy.

This review examines existing literature related to Industry 4.0 and technology adoption models. The goal is to obtain insights as to why only 5 out of 173 postal operators on the Universal Postal Union's 2IPDs continue to outperform the rest on the four dimensions of the 2IPD.

The review further examines technology adoption and technology diffusion models as tools towards ensuring that southern African Postal Operators catch up with the best of the best in terms of postal development and postal excellence.

A. Integrated Index for Postal Development (2IPD)

According to [1], the meaning of postal development needs to be refined and further aligned with the United Nations 2030 Agenda embodied by the Sustainable Development Goals (SDGs). The report argues that examining postal development through the lens of sustainable development matters for both the prosperity of the postal sector and the wellbeing of societies around the world.

[1] proposes that assessing the numerous aspects of postal development is no small undertaking, and points out that to overcome this challenge, the Universal Postal Union (UPU) has been leveraging a wealth of big data to analyze the performance of national postal services around the world. One of the outcomes of these efforts, the report argues is the development of the Integrated Index for Postal Development (2IPD).

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Appendix 1: Published Conference Paper (Double click on the document to open the PDF)

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A SYSTEM DYNAMICS APPROACH TO POSTAL DIGITAL TRANSFORMATION DYNAMICS: A CAUSAL LOOP DIAGRAM (CLD) PERSPECTIVE

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ABSTRACT

Postal operators across the globe are faced with inescapable business model disruptions in the era of the digital economy, and Southern Africa is no exception. The advent of the digital age presents both opportunities and threats to business models of the industrial age, as digitalisation has led to the sustained decline of mail volumes as the core business of the postal service for the past 100 years. The replacement of traditional physical mail with electronic alternatives was a spectre that haunted the postal service for more than two decades; and the arrival of the digital age has accelerated the decline of mail volumes at an unprecedented speed as it spreads through almost every sector of society and as the digital economy becomes the preferred platform for conducting business. The digital economy requires postal operators to develop digital competitiveness, which entails investment in digital infrastructure and skills, and to transform their business model in the context of the digital age. The complex dynamics of the process of digital transformation necessitate a systems approach to understanding those dynamics. System dynamics can be a significant tool for comprehending behaviour, especially dynamic behaviour. This paper adopted a high-level modelling approach in which a dynamic hypothesis was developed through the articulation of a sub-system diagram that articulated the dynamic variables at play, a model boundary chart that articulated the nature of the variables (which are both exogenous and endogenous), and causal loop diagrams that explain the dynamic feedback relationship between the variables. This paper focused on the digital transformation imperatives to build the digital competitiveness of the postal sector in Southern Africa. The results point to the complex interaction of the variables that drive the digital competitiveness of the postal sector; and it is by comprehending these complexities that decision-makers and policymakers could steer the postal sector on to a digital-age path and into a sustainable future.

OPSOMMING

Posoperateurs regoor die wêreld word in die era van die digitale ekonomie gekonfronteer met onafwendbare sakemodel ontwrigtings - Suider-Afrika is geen uitsondering nie. Die koms van die digitale era bied beide geleenthede en bedreigings vir sakemodelle van die industriële era, aangesien digitalisering die afgelope 100 jaar gelei het tot die volgehoue afname van posvolumes as die kernbesigheid van die posdiens. Die vervanging van tradisionele fisiese pos met elektroniese alternatiewe was 'n tendens wat by die posdiens vir meer as twee dekades gespook het; en die koms van die digitale era het die afname van posvolumes teen 'n ongekende spoed versnel soos dit deur byna elke sektor van die samelewing versprei en namate die digitale ekonomie die voorkeurplatform word om sake te doen. Die digitale ekonomie vereis dat posoperateurs digitale mededingendheid ontwikkel, wat investering

10

Appendix 2: Published Journal Paper (Double click on the document to open PDF)

APPENDIX 3: MODEL EQUATIONS IN TEXT FORM

Capability maturity rate = Increasing Capability Maturity - Decreasing Capability Maturity

Capability Maturity Management = Operations Capability Maturity Goal - Operations Capability Maturity

Increasing Capability Maturity (ICM) = (Capability Maturity Management + Average Capability Management Increasing Factors) x Digital Culture

Impact of an increase in capability management = Total Increase Impact Factor (Tiif) - (Impact of an Increase in Adoption + Impact of an Increase in Digital Culture)

Decreasing Capability Maturity = Capability Maturity - Average Capability Maturity Decreasing Factors

Digital Culture (DC) = Increasing Digital Culture - Decreasing Digital Culture

Increasing Digital Culture = (Average Digital Culture Factors + Percentage of staff who attended train-post courses) divided by two x Increase in Adopters

Increase in adopters = Adopters x Impact of Increase in Adopters

Decreasing Digital Culture = Digital Culture - Average Digital Culture Decreasing Factors

Adoption from Marketing Efforts (AME) = Marketing Effectiveness x Potential Adopters

Adoption from Communication Channels = Adopters' stock x Adoption Fraction x and Contact Rate x (Potential Adopters' Stock / Total Population

Ecosystem Adoption Rate = (Adoption from Marketing Efforts + Adoption from Communication Channels) x Capability Maturity

Ecosystem Dis-adoption Rate = Dropout Rate x Adopter Stock

Financial Performance Rate = Increasing Financial Performance - Decreasing Financial Performance

Increasing Financial Performance = Average (Increase in adopters + Financial Performance Increase Factors + Average Increase Factors for Financial Performance)

Average Increase Factors in Financial Performance = Average (Increase in Capability Management + Increase in Digital Culture + Increase in Adopters)

Increase in Digital Culture = Impact of Increase in Digital Culture x Increasing Digital Culture

The Financial Performance Increase Factors = Total Income = (Revenue + Other Operating Income + Actual Universal Service Obligation Paid + Universal Service Obligation Shortfall)

Decreasing Financial Performance = Average Decrease in Financial Performance - Financial Performance Decrease Factors

Financial Performance Decrease Factors = Total Expenses (TE) = Transport costs + Staff Expenses + Operational Expenses + Depreciation

Appendix 3: Model equations in the text

APPENDIX 4: POSTAL POLICY BRIEF

Volume 1

POSTAL POLICY REPORT BRIEF

Comprehending the complex systemic structures that drive postal sector decline and discovering the high leverage changes to arrest the decline

Author: Kgabo Mokgohloa, PhD candidate

Supervisor: Dr MG Kanakana-Katumba

Co-supervisor: Prof RW Maladzhi

Postal expert: Mr Sbusiso Xaba

The brief summarises the thesis titled "A systems dynamics approach for digital transformation and complex policy design for the Postal Sector in Southern Africa"

Why does this matter?

The calamities that have befallen DPOs (Designated Postal Operators) in Southern Africa have triggered the near collapse of the sector owing to poor performance on the 2IPD (Integrated Index on Postal Development). This is supported by the score of each Post in Southern Africa obtained on the 2IPD.The deficit in performance by SADC DPOs is fuelled by an overabundance of factors which include rigid or rather out-of-date business models that are not adjusting to the digital age and associated technologies that are disrupting present business models enormously. The outdated business models cannot contend in the 21st century and this results in the majority of DPOs in Southern Africa posting losses year in year out. The lack of financial sustainability of the DPOs leaves the respective governments in their respective countries with no option but to bail out these institutions, which becomes a burden to taxpayers.

Appendix 4: Postal policy brief (Double click on the document to open PDF)

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