A Warehouse process performance evaluation, testing alignment with Supply Chain performance aspirations: An exploratory study

by

Matthew Kenneth Harvey

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Supervisor: Prof. JJ Louw

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Declaration

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December 2020

Opsomming

Die voortdurende behoefte vir voorsieningsketting-doelmatigheid, gepaardgaande met kosteverminderingsinisiatiewe binne die wêreldwye mark, vereis van besighede om anders oor gedurig-veranderende kliënte-vereistes te dink. Hierdie konsep het die navorsing gedryf; om ’n begrip te ontwikkel vir al die ondersteuningsprosesse en aktiwiteite wat bydra tot ’n besigheid se voorsieningsketting op ’n strategiese-, taktiese- en operasionele vlak. Die doelwitte en kritieke fokus is beter produktiwiteit, verhoogde netto wins en kliëntediens deur prestasiebestuur. Gevolglik is die meting en die bestuur van hierdie prosesse noodsaaklik vir sukses of mislukking daarvan. Hierdie navorsing fokus op die strategiese doel van ’n spesifieke voorsieningskettingstruktuur, die integrasie van selektiewe strategieë en prosesse, terwyl pakhuisbedryfsprosesmeting gebruik word om moontlike prestasie probleme te isoleer, en waarvoor spesifieke bedryfsoplossings gegenereer is.

Die nagaan van bestaande teorieë en kennis rakende voorsieningskettingprosesse en pakshuisbestuur, het getoon dat daar beperkte bewys van belyning tussen die twee konsepte bestaan, ten spyte van die rugsteun wat voorsieningskettingbestuur op opbergingsaktiwiteite plaas. Deur die twee konsepte van ’n voorsieningskettingsvlak af tot by ’n pakhuis operasionele vlak te belyn, is die raamwerk van hierdie studie.

Ten einde moontlike skakels tussen die twee konsepte na te vors, na te gaan en te isoleer, het hierdie tesis ’n gefasseerde navorsingsontwerp gevolg wat sistematies die moontlike skakels tussen besigheidstrategie, voorsieningskettingstrategie en prosesprestasie met spesifieke fokus op pakhuisprosesse te kon aflei. Die eerste fase van die navorsing het die bevindinge van agt empiriese gevallestudies wat as navorsingswerkstukke deur studenteprojekte by die Universiteit van Stellenbosch uitgevoer is, voorgelê. Hierdie empiriese studies is gebaseer op ’n longitudinale navorsingsontwerp wat die kulminasie is van hierdie tesis oor ’n drie jaar tydperk by die Departement van Logistiek.

Die tweede navorsingsfase het ’n in-diepte en uitgebreide literatuuroorsig van onderskeidelik besigheids- en voorsieningskettingstrategie, asook proses- en pakstoorprosesraamwerke, vereis. Die literatuuroorsigproses is as ’n kruissnit-navorsingsontwerp gestruktureer, wat gebruik gemaak het van bestaande teorieë en metodes om gevolgtrekkings en konneksies tussen relevante konsepte te kon maak. Die skakels wat in hierdie oorsig gevind is, het gekulmineer in ’n voorsieningsketting-strategieproses asook ’n pakhuisbelyningsmatriks.

Die derde en laaste fase van hierdie navorsing is geïntegreer en het die eerste twee fases van ’n spesifieke maatskappy as gevallestudie getoets. Die fokus is geplaas op die pakhuis se prestasieuitkomste wat verwant is aan die geïdentifiseerde voorsieningskettingproses

attribute (eienskappe). Oplossings is gevolglik geïdentifiseer om prestasie verwante probleme te hanteer en sodoende by te dra tot algehele verbeterde besigheidsprestasie, asook die herbelyning van pakstoorbedryf met oorkoepelende voorsieningsketting aspirasies wat afgelei is van die onderliggende besigheidstrategie.

Hierdie verkennende gevallestudie het suksesvolle resultate getoon as gevolg van die identifisering van metingsprioritisering deur die integrasie van besigheidstrategie, voorsieningsketting-strategiese aspirasies en prosesse, pakhuis operasionele meting en die afgeleide vlak van prestasie. Die resultate wat in hierdie tesis na vore kom, toon dat belyning tussen besigheids- en voorsieningsketting strategie aspirasies en pakhuis operasionele prestasie moontlik is, en positiewe resultate verwant aan die maatskappy se strategiese doel kan bydra. Die kombinasie van bestaande metodologieë kan die (gevallestudie) maatskappy bystaan om te identifiseer wat gemeet moet word, wat die huidige vlak van prestasie oor verskillende pakhuisprosesse is, asook help met ’n kernoorsaakanalise om begrip te verkry oor watter probleme eerste hanteer moet word. Daarna kan spesifieke oplossings ontwikkel en geïmplementeer word om prestasie, wat aan die maatskappy se algehele voorsieningsketting aspirasies verwant is, te verbeter.

Abstract

The ever-present need for Supply Chain efficiencies coupled with cost reduction initiatives within a globalised marketplace require businesses to think differently about how they meet every-changing customer demand. This concept has driven this extensive research, to develop an understanding of all supporting processes and activities that contribute to a business's Supply Chain on a strategic, tactical and operational level. The goals and critical focus are enhanced productivity, increased bottom-line profits and customer service, through performance management. As a result, the measurement and management of these processes are paramount to their success or failure. This research focuses on the strategic intent of a specific Supply Chain structure, integrating selective strategies and processes, while using Warehousing operational process metrics to isolate possible performance issues, for which specific industry solutions were generated.

The problem derived from existing theories and knowledge surrounding Supply Chain processes and Warehousing performance management, is that there is limited evidence of alignment between these two concepts, despite the reliance Supply Chain Management places on Warehousing activities. Therefore, aligning these two concepts from a Supply Chain level down to a Warehouse operational process level, outlines the purpose of this thesis.

In order to research, review and isolate possible links between these two concepts, this thesis required a phased research design to systematically derive possible links between Business strategy, Supply Chain strategy and process performance with specific focus on Warehouse processes. The first phase of this research presented the findings of eight empirical case study examples that have been conducted as research assignments through student projects at Stellenbosch University. These empirical studies are based on a longitudinal research design that represents the culmination of three years of research projects within the Logistics Department.

The second research phase required an extensive and in-depth literature review of Business strategy, Supply Chain strategy and process frameworks, and Warehousing process frameworks, respectively. The literature review process is structured as a cross-sectional research design which makes use of existing theories and methods to draw conclusions and links between the relevant concepts. The links found in this review process, culminated in a Supply Chain strategy process and Warehouse performance alignment matrix.

The third and final phase of this research were integrated, and tested the outcomes of the first two phases on a specific case company. Focusing on Warehouse process performance results related to the identified Supply Chain process attribute. Solutions were then identified to combat performance-related problems, to contribute to overall business performance improvement and realign Warehouse operations with overarching Supply Chain performance aspirations, derived from the underlying business strategy.

This exploratory case study research led to very successful results, identifying the benefit of metric prioritisation through the integration of Business Strategy, Supply Chain strategic intent and processes, Warehousing operational metrics and the derived level of performance. The results presented in this thesis demonstrate that alignment between Business and Supply Chain strategic aspirations and Warehousing operational performance is possible and can develop positive results related to the company's identified strategic intent. This combination of existing methodologies could help the case study company to identify what they should be measuring, what the current level of performance is across different Warehouse processes and assist in Root Cause Analysis to understand which problems need to be addressed first. Thereafter, specific solutions can be developed and implemented to improve performance, related to the company's overall Supply Chain performance aspirations.

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List of Abbreviations

3PL	Third-party Logistics provider
APQC	American Productivity & Quality Center
B2B	Business to Business
B2C	Business to Consumer
BSC	Balanced Score Card
C&Q	Cost and Quality
C2C	Cash to cash cycle
CDU	Chronic Dispensing Unit
CM	Customer metrics
COGS	Cost of goods sold
CSCMP	Council of Supply Chain Management Professionals
DC	Distribution Centre
EM	Employee metrics
ERP	Enterprise Resource Planning
FIFO	First in First out
FM	Financial metrics
FMCG	Fast-moving consumer goods
FTL	Full Truck Load
GPP	Good Pharmacy Practice
HCTZ	Hydrochlorothiazide
JIT	Just in time
KPI	Key Performance Indicator
KRI	Key Result Indicator
LFTL	Less Than Full Truck Load
LM	Logistics management
M4SC	Management for Supply Chain Framework
MHE	Material handling equipment
NCD	Next collection date
NDOH	National Department of Health
OF	Order fulfilment
OM	Operational metrics

OTIF	On Time in Full
PI	Performance Indicators
PMP	Patient Medicine Parcel
PO	Pick Order
POC	Proof of concept
POF	Perfect order fulfilment
POI	Perfect order index
PUP	Pick-Up Points
QA	Quality Assurance
QC	Quality Checking
RCA	Root Cause Analysis
RI	Result Indicators
ROA	Return on Assets
ROI	Return on investment
ROWC	Return on working capital
RP	Responsible Pharmacist
RTS	Return to Supplier
RWC	Return on working capital
SC	Supply Chain
SCF	Supply Chain flexibility
SCM	Supply Chain Management
SCOR	Supply Chain Operations Reference model
SKU	Stock-keeping unit
SLA	Service-level agreement
SMART	Specific, Measurable, Attainable, Relevant and Timed
SMS	Short Messaging service
SOP	Standard operating procedure
SS	Safety Stock
STO	Strategic, Tactical and Operational level management
TCO	Total Cost of Ownership
USA	United States of America
WERC	Warehouse Education Research Council

WIP	Work-in-progress
WMS	Warehouse Management System
WWII	World War Two

PART 1

INTRODUCTION

- Chapter 1: Introduction and Background

This part of this research document outlines the introduction and background to this research document. The chapter presented in this part is used to identify some of the key concepts, methods and techniques applied in this document. The purpose of this chapter is to introduce and outline the problem statement, the overarching research questions, design and methodology used within the study and how all these elements fit together in the structure of this thesis.

Chapter 1: Introduction and Background

1.1. Introduction, Background and Motivation

Supply Chain Management outlines the integrated nature of the business environment most companies find themselves involved in today. Businesses rely heavily on the division of key core business competencies that are facilitated by external companies, to be able to meet the ever-changing demands of their customers. The key to the success in this environment is the creation of a business network that links different companies, each responsible for different stages of the design, procurement, development and delivery of a product or service. It is this integrated network and overlap of business processes that highlights the reliance businesses have on their supply networks. These networks allow businesses to focus on their own core business competencies while being able to identify and outsource what is not a core competency. This process outlines the development of the Supply Chain concept and highlights the need to integrate and manage it.

In support of a Supply Chain network are Logistics functions. These functions act as the facilitators of all forward and reverse flows within a Supply Chain. The flow of products, information, and revenue up and down the chain is critical in providing a high-quality service to the customer as quickly as possible, whilst ensuring that the development and preservation of Business to Business (B2B) relationships is achieved. Historically, customers have not always been in charge of the tempo at which Supply Chains react to customer needs but this is slowly changing. This outlines the ever-changing nature of Supply Chain Management and pinpoints the need for Logistics to remain competitive.

Most Supply Chains require a central point for the consolidation and redistribution of products and service between all the different role players within the network. These central points are known as Warehouses or Distribution Centres (DC). These facilities perform a linking function between suppliers-suppliers and customers-customers that operate within the same supply network. It is this type of operation where competitive advantage can be won or lost. Ultimately, Warehouses have become customer-service facilitators, their processes are built around the most cost-effective and efficient way to deliver an outstanding service to their customers. Warehouses today operate as performance-driven, customer-service facilitators.

It is the responsibility of the Warehouse manager to ensure that enough inventory is held to meet ever-changing customer demand, while simultaneously maintaining low levels of inventory to reduce capital investment in inventories. This combination of high customer satisfaction and low cost requirements, brings about the importance of Warehousing performance management (Coyle, Langley Jr, Novack & Gibson, 2008:319).

It is also important to ensure that appropriate performance in Warehouse Operations is repeated from top management down to on-the-ground operators. This is key for operational success as well as Supply Chain success to be achieved. Warehouses also act as important connectors between the upstream and downstream sections of a typical Supply Chain structure. Over all, Supply Chain strategy provides the direction for an individual facility's operational strategy, as outlined by Cooper, Lambert and Pagh (1997).

Customers today are spoilt for choice regarding the variety and range of products being offered to them. Simultaneously, the availability of the internet and the capabilities customers have to order anything online, at any time and have it delivered to their doorstep, has put massive pressures on organisations seeking to facilitate these demands. Competition between companies over price, market share as well as customer/client base is evident, so how then does a company differentiate itself in this type of environment?

The answer to increased customer demands is: *Service level*, customer satisfaction drives sales volume and consequently revenue. Satisfied customers purchase greater volumes more frequently, which in turn generates better revenues and shareholder returns, while poor service pushes customers toward other providers that can do more for the same money. The result is a highly competitive environment driven by the demands of the consumer, requiring improvements in Supply Chain performance. This is difficult to do, due to the lack of control individual businesses have as well as the reliance they have on external parties. The identification and absolute acceptance of a unified, chosen Supply Chain strategy is paramount to Supply Chain success. All businesses involved in the chain are linked in one continuous process, like an anchor chain. Each business operates by executing their individual processes and operations while keeping the entire supply chain's strategic objectives in mind.

Aligning the performance of a Warehouse with that of the rest of the Supply Chain strategy is critical to sustainable performance enhancements. This study will endeavour to measure and benchmark the performance of the Warehousing element of the Supply Chain by means of a specific exploratory case study example. At the same time an analysis of multiple Supply Chain processes and Warehouse operational performance frameworks will be conducted, to generate a *strategy-process performance alignment matrix* to help integrate these two concepts.

The purpose of this study is to demonstrate that operational performances within one node of the Supply Chain can, indeed, be aligned with the overall Supply Chain's strategic intent. The crossover and linking of operational performance metrics with Supply Chain processes can be used to identify metrics that directly impact the Warehouse's performance and indirectly facilitate a higher level of customer service.

This integration between Supply Chain performance attributes and Warehousing process metrics provides a conceptual analysis tool for companies to assess the alignment between their current and desired performance. The realignment of the business and Supply Chain strategy to accomplish improved operational performance within a Warehouse is the objective. Finally, this alignment will prioritise *what should be measured* as well as outline *performance targets*, as no organisation can do well in all strategies.

1.2. Problem Statement

Organisations that rely on supply chains, both upstream and downstream of the point at which they operate, rely on measuring performance (either good or bad). Measurement allows companies to monitor performance issues in the day-to-day execution of their operational tasks. However, there is very little information available that allows performance measures and levels of performance aspiration to be aligned with the overarching Supply Chain objectives and strategies (Tillman, Manrodt & Williams, 2015). This problem statement drives the identification of a fundamental research methodology to realise these objectives.

From the introduction and motivation as well as the findings from the literature reviews outlined in Chapter 2, 3 and 4, the research problem can be stated as follows:

- No *integrated* Supply Chain process and Warehouse measurement frameworks, which include level 1 performance metrics, are currently available within the public domain.
- The availability of benchmarking results within the Warehousing space is yet to be aligned with the strategic level metrics, resulting in a metric prioritisation and performance gap analysis, in order to better align the Warehouse operational process level with the overall strategic Supply Chain level.

The problem statement outlined the need for specific research objectives to identify a fundamental research methodology to realise these objectives.

1.3. Research Objectives

- To conduct a Business, Supply Chain and Warehouse measurement *framework evaluation* in order to identify the underlying measurement principles that exist in each framework. These frameworks will be aligned with the Supply Chain Operations Reference (SCOR) model attributes which will then be integrated with operational metrics, to assist in prioritising these metrics, to effect improvements in operations that are aligned with selected Supply Chain strategies.
- To develop a Warehouse performance evaluation method that can be utilised to conduct performance measurements within a given case.
- To perform a *gap analysis* to determine the reality of performance as well as identify the target/goal performance in each case.
- To test this method of Supply Chain/Warehousing evaluation to complete an *exploratory assessment* to determine whether Supply Chain process frameworks and operational metrics can be aligned through gap analysis determination in Warehousing performance on a specific case.

1.4. Research Questions

The following research questions are derived from the problem statement in section 1.2. The section below will incorporate research questions pertaining to each of the three phases, aligned by the research objectives in section 1.3.

1.4.1. Phase One questions: Presentation of previous case study results

Q1: What are the performance gaps identified in selecting a specific Supply Chain process strategy?

Q2: How are the identified metrics prioritised within each case's selected Supply Chain strategy to derive beneficial solutions?

1.4.2. Phase Two questions: Framework identification and evaluation

Q3: What are the most popular Performance Management frameworks in the literature that facilitate Business Strategy selection?

Q4: What are the most popular Supply Chain process frameworks present in the literature??

Q5: What are the most popular Warehouse measurement frameworks present in literature?

Q6: Which of these Business, Supply Chain strategies and processes, identified from the literature reviews, can be aligned with SCOR's five main process attributes?

Q7: Which metrics from SCOR align with benchmarked metrics from the selected Warehousing framework?

1.4.3. Phase Three questions: Exploratory case study example

Q8: To what extent can Supply Chain strategy-process frameworks and Warehouse operational metrics be integrated to prioritise improvements in overall performance of the Warehouse, in line with the corporate and Supply Chain objective?

1.5. Research Approach and Methodology

Similar to Cilliers (2015), a phased research approach was used to conduct this research. Due to the integrated nature of this report, it was necessary to conduct three separate research designs and methods, as outlined below:

The first phase presented eight quantitative case study projects conducted at Stellenbosch University within the Department of Logistics. This longitudinal design presented each empirical case as a Warehouse metric benchmarking study, used to identify performance gaps within operational Warehouse processes in order to generate case-specific solutions, to improve performance (Yin, 2009:23).

The second phase outlined a comprehensive literature review process whereby secondary, non-empirical literature was used (Mouton, 2001:175–180). This qualitative approach focused on popular Supply Chain and Warehousing performance measurement frameworks which were reviewed independently. Phase 2 outlines a proposed strategy-process performance alignment matrix between the identified Supply Chain process frameworks as well as the Warehousing measurement frameworks. This was done to outline the possibility of aligning operational level metrics with strategic level Supply Chain objectives as a proof of concept that such integrations are possible.

The third and final phase of this research was to integrate the *strategy-process performance alignment matrix* identified in phase 1 and the ***applied methodology*** in phase two and test them on a case company. This case study was conducted through its own ***applied research design and methodology*** (Saunders, Lewis, Thornhill & Bristow, 2016).

In order to determine whether or not the integration of Supply Chain frameworks and Warehousing measurement frameworks could be achieved, the following four steps were used, in Part 6 of this report, during the case study portion of this research: (1) Identify the chosen organisation's Supply Chain strategy through semi-structured interviews; (2) Derive, calculate and prioritise Warehousing process metrics based on the company's overarching strategy; (3) Identify process inefficiencies and problems based on a comprehensive process review and finally; (4) Generate solutions that could be implemented to resolve the problem areas and improve performance.

1.6. Structure of the thesis

The outline of the thesis is critical to provide structure for the reader to follow the study's progression. This thesis consists of fourteen chapters that follow a logical sequence and represent the integrated nature of the methodological framework. The overall structuring of this thesis makes use of the four frameworks approach identified by Quinlan, Babin, Carr, Griffin & Zikmund (2015:7). The four frameworks are *Theoretical framework, Conceptual framework, Methodological framework,* and the *Analytical framework*, each of which helps describe the different components inherent within academic research. These four frameworks helped outline the structure of the thesis by identifying the six different parts presented in this document, each linked to one of the four research frameworks stated above. These links are further outlined in Figure 1.1.

PART 1: INTRODUCTION

Chapter 1: Introduction and Background

The introductory chapter outlines the background and motivation overview of the existing concepts, the purpose of which is to introduce the topic, research scope, the problem statement as well as the research objectives and methods used through this research document.

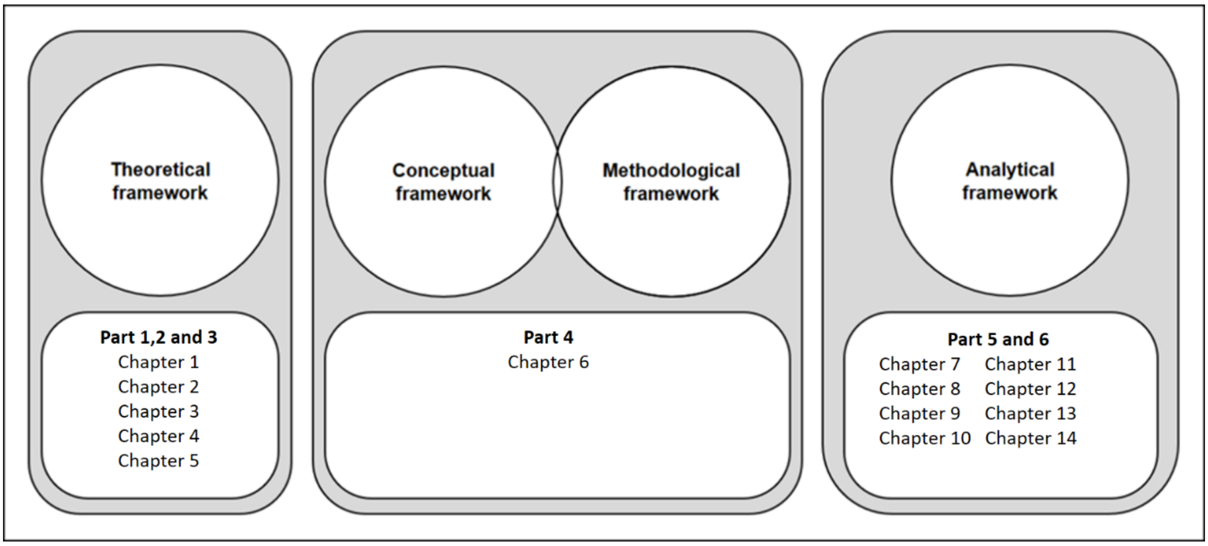


Figure 1.1: Structure of the thesis linked to four research frameworks
(Source adapted from: Quinlan et al., 2015:7)

PART 2: REVIEW OF FUNDAMENTAL LITERATURE

Chapter 2: Literature review - A Supply Chain perspective

A review of the theory and underlying literature, focusing on the concept of Supply Chain Management and Logistics. This review incorporates the integration and development of these two concepts over the years, and the roles and responsibilities of each in today's fast-moving consumer goods market (FMCG). To drive improvements in the facilitation of ever-increasing customer expectations.

Chapter 3: Literature review - A Warehousing perspective

The identification of Warehousing's role within the Supply Chain network to facilitate an understanding of its roles and responsibilities in terms of process execution. To identify the importance of performance measurement and metric benchmarking is also outlined in the Chapter.

Chapter 4: Literature review - A performance management perspective

The focus on performance management helps to clarify the role this field plays within the Business, Supply Chain and Warehousing context. The identification and understanding of the components and purposes of performance measurement as well as the evolution of the field help define how this topic can be incorporated into this research document.

PART 3: REVIEW OF APPLIED LITERATURE

Chapter 5: Business, Supply Chain and Warehouse frameworks review

This chapter focuses on Business, Supply Chain and Warehouse framework reviews, identifying a select number of industry relevant frameworks that are readily available within the public domain. These frameworks are reviewed to outline and understand each one's methodology and structure while helping define how they would align with the SCOR reference model within the *strategic-process and Warehouse performance alignment matrix* (Chapter 8).

PART 4: DESIGN AND METHODOLOGY

Chapter 6: Research design and methodology

The fundamental research design and methodology outlines a phased research approach, each phase outlining its own research objective. The first phase, outlined in *Chapter 2*, *Chapter 3* and *Chapter 4*, analyses existing literature to identify potential links between different Supply Chain frameworks and Warehousing frameworks, respectively, whereafter the alignment of Supply Chain process metrics with those identified within the Warehousing space is presented.

The conceptual design to integrate these two concepts outlines the scope and purpose of this research document. The second phase outlines exploratory case study examples of metric prioritisation based on a selected Supply Chain process strategy. The presentation of these cases demonstrates the potential of linking Supply Chain process strategy with operational level metrics to enhance organisational performance. The third phase applies these research findings to a specific case to further demonstrate the application of this alignment concept.

PART 5: ANALYTICAL FRAMEWORK

Chapter 7: Presentation of previous performance evaluation cases *Phase 1*

Outlines the findings from previous case study findings related to performance benchmarking and gap analysis. To demonstrate the potential results and findings generated from this research approach is outlined in this chapter, while outlining an ***applied methodology*** that will be used in phase 3 of this document.

Chapter 8: Supply Chain - Warehouse framework review and integration *Phase 2*

The identification of the most popular Supply Chain process frameworks presented in Chapter 5 were reviewed and aligned with the SCOR reference model. The integration of the selected Supply Chain models to the SCOR reference model, which outlined metrics with five different Supply Chain process attributes.

A review of Warehousing measurement frameworks also presented in Chapter 5 was conducted to identify a metric repository that was then aligned with the findings from the Supply Chain framework integration. The integration led to the development of the *strategy-process performance alignment matrix,* which is presented in Phase 2-Chapter 8 of this report.

PART 6: DATA COLLECTION, ANALYSIS AND RESEARCH RESULTS

Chapter 9: Case study introduction and process explanations *Phase 3*

This chapter outlines the ***applied research methods*** and concepts that are used to explain and map the operational processes within the identified case company. This chapter outlines which Warehouse processes exist and how each of them interlinks across the different functional areas.

Chapter 10: Case study strategic intent and attribute alignment result *Phase 3*

Chapter 10 presents the case study findings for the conceptual alignment of Warehouse operational level metrics within Supply Chain strategic intent to drive performance improvements within a metric hierarchy.

Chapter 11: Case study potential symptoms and problem areas *Phase 3*

The case study outlines system and process issues that derive potential losses in opportunity cost for the company. These issues are derived from the above-mentioned process explanations within the data analysis section outlined by Chapter 9.

Chapter 12: Case study solutions generation *Phase 3*

The prioritisation of metrics, outlined in Chapter 10, allows for performance gaps to be identified and performance priorities to be established to assist overall performance improvement, in the right direction. From this, case-specific solutions could be generated to address specific performance gaps and problem areas identified in Chapters 10 and 11.

Chapter 13: Case study solution validation and justification *Phase 3*

This chapter is comprised of three fundamentally linked sections. These three sections outline all the stated solutions in Chapter 12 and presents them in three different themes. Each theme outlines a method of testing, validation and/or implementation.

PART 7: CONCLUSIONS

Chapter 14: Conclusion and recommendations

This research identified the potential impact that integrating *Supply Chain process strategy* with *Warehouse operational metrics* can have on the overall performance of a Warehouse. The presentation of the contributions and limitations that this study has identified will be presented to outline the repeatability of this ***applied methodology*** on other future cases***.***

The future research topics outline and identify other areas in which this methodology could be used to further explore performance measurement and alignment techniques. These topics are derived throughout the entire research document that could be investigated to further the research validity and findings.

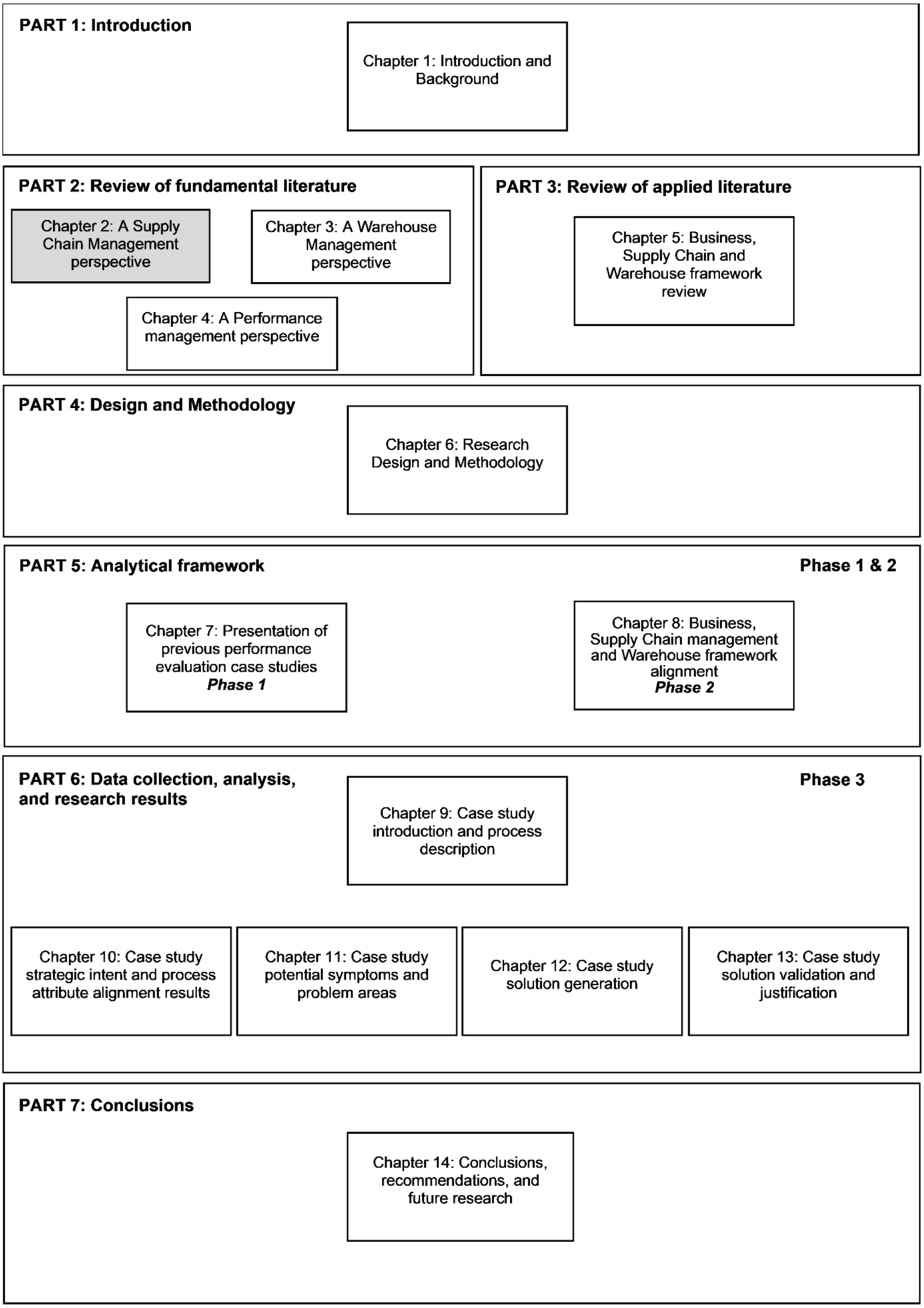
PART 2

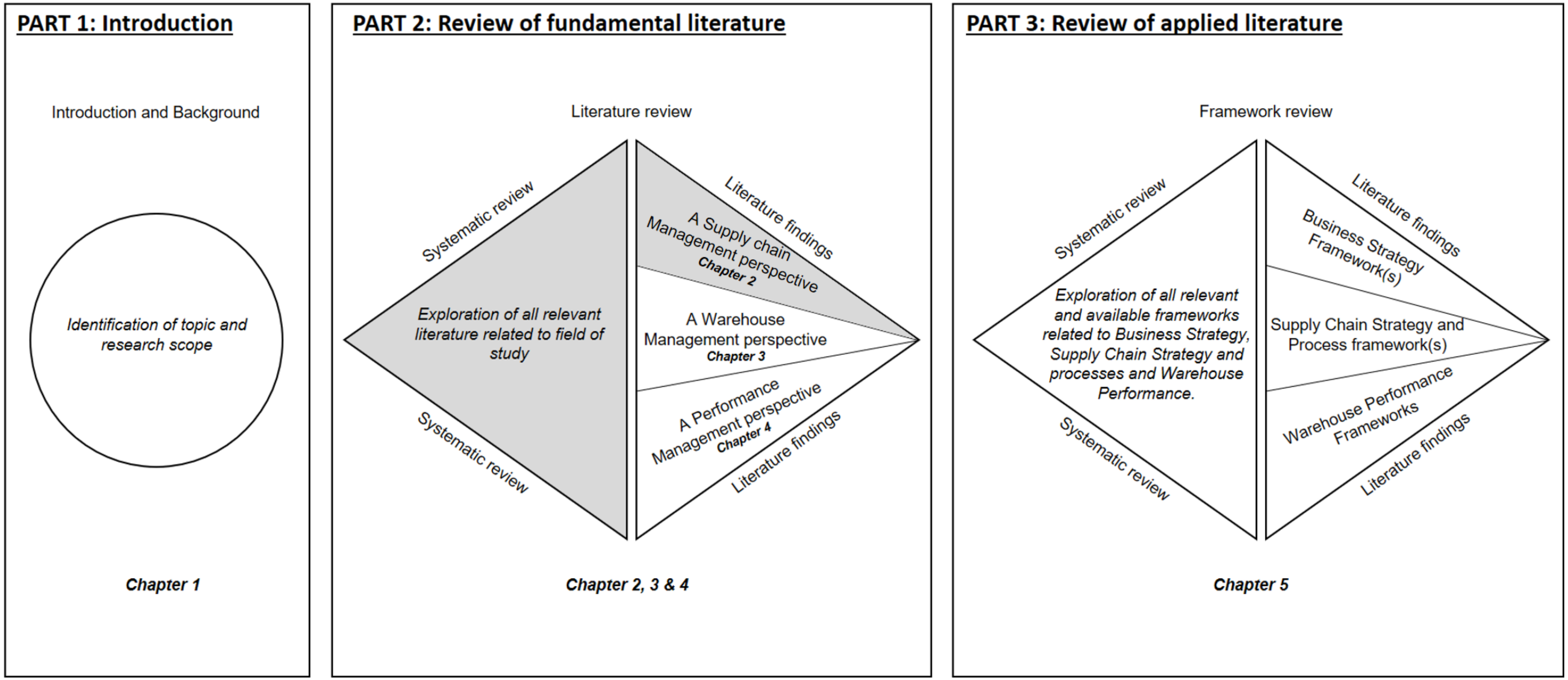
REVIEW OF FUNDAMENTAL LITERATURE

- Chapter 2: A Supply Chain Management perspective
- Chapter 3: A Warehouse Management perspective
- Chapter 4: A Performance Measurement and Management perspective

This section outlines all the relevant literature surrounding the fields of Supply Chain Management, Warehouse Management and Performance management, respectively. The need to understand each field helps to outline the similarities and differences between each of them. This ***fundamental literature review*** outlines the roles and responsibilities of each field to identify connections between them that can be used when outlining the different processes inherent within Supply Chains and Warehouses. This will be beneficial when attempting to conduct performance measurement and management by being able to determine what needs to be measured.

PART 2: CHAPTER 2
LITERATURE REVIEW
A SUPPLY CHAIN MANAGEMENT PERSPECTIVE




PART 1: Introduction
Introduction and Background
Identification of topic and research scope
Chapter 1
PART 2: Review of fundamental literature
Literature review
Systematic review
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Systematic review
Literature findings
A Supply chain Management perspective
Chapter 2
A Warehouse Management perspective
Chapter 3
A Performance Management perspective
Chapter 4
Literature findings
Chapter 2, 3 & 4
PART 3: Review of applied literature
Framework review
Systematic review
Exploration of all relevant and available frameworks related to Business Strategy, Supply Chain Strategy and processes and Warehouse Performance.
Systematic review
Literature findings
Business Strategy Framework(s)
Supply Chain Strategy and Process framework(s)
Warehouse Performance Frameworks
Literature findings
Chapter 5

Chapter 2: Literature review – A Supply Chain Management perspective

2.1. Introduction to Supply Chain Management

The Supply Chain is a stream of facilities, positions or locations linked by transport and supported by personnel, vehicles and information systems that facilitate Supply Chain activities. All these components are required to facilitate movement throughout the chain, for which Logistics management is a major facilitator of the greater chain's objectives. Therefore, these two terms, *Supply Chain Management* and *Logistics management* are not mutually exclusive, as you cannot have one without the other (Coyle *et al.*, 2008:66).

The Council for Supply Chain Management professionals (CSCMP *et al*., 2014a:2) identified each node in a Supply Chain as a link between interconnected processes. These locations are connected by specific value adding activities, known as links. These locations and their accompanying links represent all the facilities, activities and processes within a given Supply Chain. The links represent the movement of all product, funds, information and service activities that facilitate product and service movement throughout the supply chain (Pienaar & Vogt, 2012:57).

Each facility or process must fulfil a specific role within the greater Supply Chain. These responsibilities contribute to the value-added activities, goods and services received as they progress down the supply chain, while information and money move back up the chain, to facilitate such forward flow activities (Coyle *et al*., 2008:14). The outcome of the Supply Chain process is to facilitate customer service. The Supply Chain encompasses all activities between the point of origin to the point of consumption while facilitating all the value-added benefits in between (Lambert, 2008:287). Each facility and its inherent processes within a given Supply Chain is linked to the ones before it and after it. It thus makes sense to understand that even though each one has a specific role or activities to execute, as identified in Figure 2.1, each facility should be driven by the same goals, objectives, and potential outcomes within operations, outlined in the selected Supply Chain strategy.

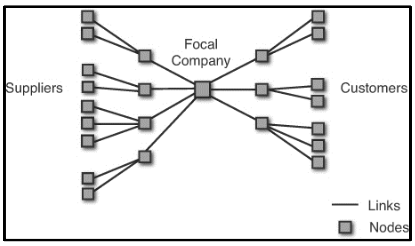

Figure 2.1: Typical Supply Chain network for a corporate enterprise
(Source adapted by: CSCMP et al. 2014a:2)

2.2. The literature review process

The focus of this chapter was to provide context within the field of Supply Chain Management to provide specific insights into the field of study to help define the Supply Chain's role within a business environment. This section outlines a summary of the literary search techniques, terms and methods used to find all the resources used in this chapter, as presented in Table 2.1. This technique of systematically reviewing literature helps to isolate specific topics based on predefined search terms. This process of using specific search terms to isolate literary investigations helps to ensure the most applicable and related resources are found and used when conducting a literature review (Petticrew & Roberts, 2006:9-10).This methodology was used to help define the key search terms and resources available within the Supply Chain. It helped substantiate the reason these resources were selected and included in this literary review section.

Table 2.1: Supply Chain literature review process – Summary of search parameters

Repository/Source database	**Keyword 1**	**Keyword 2**	**Keyword 3**	**Findings**
Closed source offline	Supply Chain	Strategy	Warehousing	Moderate
EBSCOHost collection	Performance	Supply Chain	Management	Moderate
Google Scholar	Logistics	Management	Business	Moderate
	Supply Chain	Customer	Relationships	Moderate
	Supply Chain	Management	Customer	Good
Open Source internet	Supply Chain	Future	Next generation	Moderate
	Supply Chain	Logistics	Management	Excellent
	Supply Chain	Management		Moderate
	Supply Chain	Customers	E-commerce	Moderate
Texted book	Performance	Supply Chain	Management	Moderate
	Supply Chain	Management		Excellent
	Supply Chain	Management	Warehousing	Moderate
	Supply Chain	Performance		Moderate
	Warehouse	Management		Moderate
	Logistics	Management	Business	Good
	Performance	Management	Supply Chain	Moderate
	Supply Chain	Logistics	Management	Good
	Supply Chain	Management	Strategy	Good
	Supply Chain	Management	Logistics	Excellent
	Supply Chain	Performance		Moderate
Boolean operators used: AND/OR/NOT; (*term*); "*term*"				

Although these search words and phrases were used to find the more relevant literature related to the field of Supply Chain Management, these phrases assisted in narrowing down the search; they did not define the outcome of the search. As a result, further exploration into these search results was still required to find the specific literature used in this study. Head (2020:28-30) suggests that this technique also make use of *Boolean operators* such as AND/OR/NOT to refine the defined search even further.

Added to this is the use of synonyms for key phrases to allow for a much wider search; however, this has its drawbacks as it may reduce the accuracy related to the topic in question. Nevertheless, the method of systematic searching did help to focus the literature review enough to derive beneficial results during this stage of the research. One of the initial key findings from this review was the opposing literary opinions and arguments within the field of Supply Chain Management, and which concept encompassed the true meaning of the field.

2.3. Opposing theoretical concepts

There are still differences that exist today between authors, thought leaders and practitioners about what constitutes Supply Chain Management and Logistics Management and how these concepts interlink. This section outlines the different schools of thought regarding these concepts as well as the development of the field.

2.3.1. Conflicting arguments in literature

The difference between the terms Logistics Management and Supply Chain Management is still commonplace throughput the field's history. This difference resulted from the definition and description of each term regarding their roles and responsibilities within industry today as different points of views were developed. Furthermore, different Supply Chain professionals have different opinions regarding what constitutes Supply Management, Supply Chain Management, Logistics Management and Value Management. One viewpoint outlined by Ballou (1999:9) identifies Logistics Management as a subset of the activities preformed in the greater field of Supply Chain Management. This approach is identified in Figure 2.2. Ballou (1999:9) outlines how physical supply from upstream suppliers is collectively represented as materials management (inbound activities), whereas the physical distribution (outbound activities) is aimed at the downstream part of the Supply Chain.

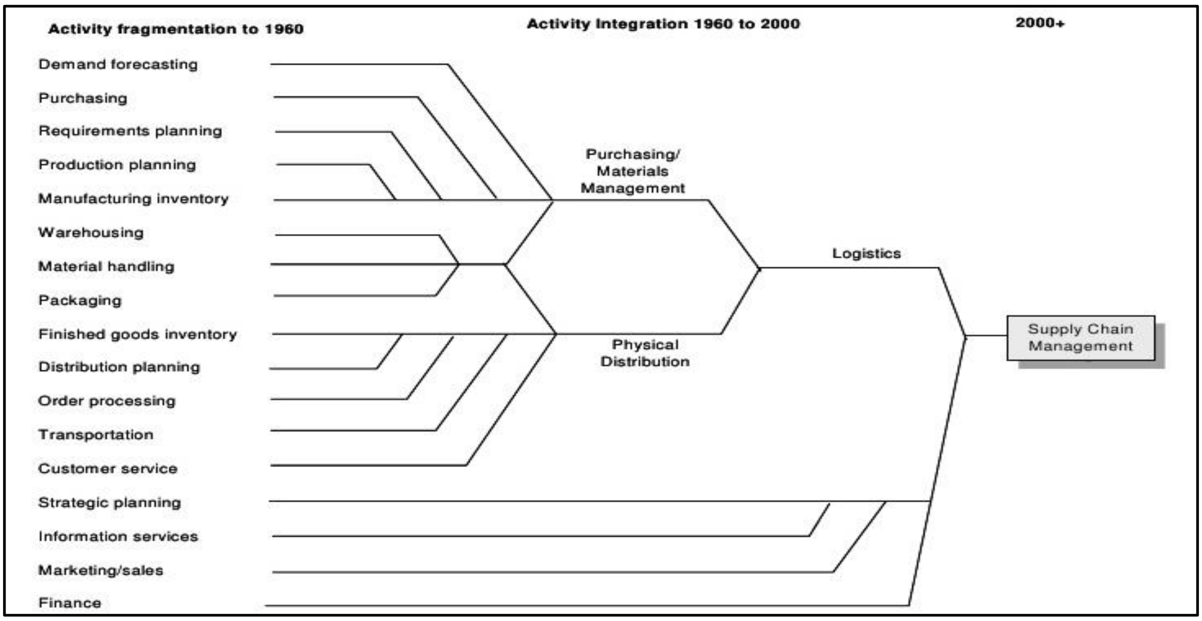

Figure 2.2: The evolution and future of logistics and Supply Chain Management
(Source adapted from: Ballou, 1999:9)

Further outlined by Figure 2.2, is the development of progressive thinking over the past five decades, as indicated by the time axis. This is not always the case. In some instances, Supply Chain professionals value certain aspects of Supply Chain Management over others. According to Burt, Petcavage and Pinkerton (2010:13), Supply Management or procurement activities are the foundation of Supply Chain Management.

Burt et al. (2010:15), further stated that a firm's Supply Chain encompasses all internal functions as well as external suppliers involved in the procurement of goods and services. This viewpoint neglects the latter half of the Supply Chain from the organisation to the customer. It is these conflicting arguments between so many Supply Chain professionals that this section covers.

2.3.2. The four perspectives outlining the Logistics and Supply Chain Management argument

In the early 2000s, a survey was conducted amongst Logistics educators, which found four fundamental perspectives of the *Logistics vs Supply Chain argument* (Larson, Poist & Halldorsson, 2007). This survey outlines all the possible interactions between the two fields. The purpose was to understand conflicting arguments in order to draw accurate conclusions between the two concepts. Figure 2.3 identifies the four possible perspectives as well as their interactions between the two concepts. These four perspectives can be closely linked to the evolution of the Supply Chain concept, outlined in section 2.4.

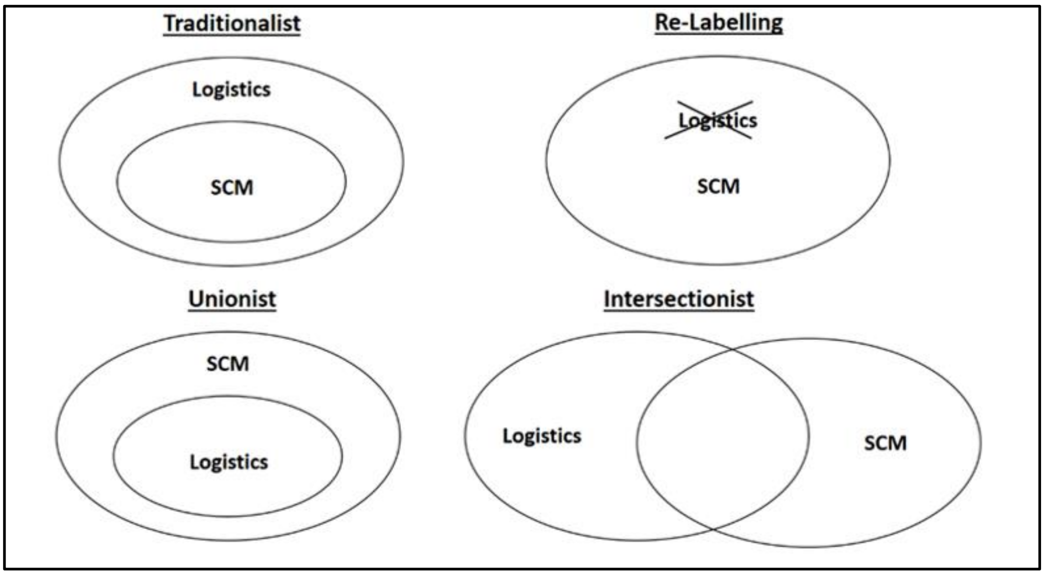

Figure 2.3: Perspectives on Logistics vs Supply Chain Management
(Source adapted by: Larson, Poist & Halldorsson, 2007:3)

2.3.2.1. *Traditionalist*

This perspective outlines the function of Logistics as a concept which incorporates Supply Chain Management within it, as a supporting function. This perspective is clear within the development of the field of study since the early 1960s. This will be discussed further in section 2.4 of this chapter.

2.3.2.2. *Re-labelling*

This perspective of the two concepts is generically seen as a name change. Therefore, all the activities once incorporated under the term Logistics now falls under Supply Chain Management. This further narrows down the reach of Supply Chain Management, as the terms are interchangeable.

2.3.2.3. *Unionist*

This perspective identifies Logistics as a function within the greater concept of Supply Chain Management. The benefit of this perspective is that it includes both strategic and tactical decisions and activities within its definition. While also including multiple functional areas across the organisation, it eliminates functional silos, identified by Lambert (2008:288), within its adoptive organisations.

2.3.2.4. *Intersectionist*

The intersectionist's perspective outlines the belief that all supporting activities, such as marketing, Logistics Procurement and Operations become integrated, while the Supply Chain Management concept is concerned with the strategic objectives of the organisation.

There is no definitive perspective that all Supply Chain practitioners agree on. The outcome therefore depends on the Supply Chain definition and the accompanying activities to which each practitioner conforms. However, the development of this school of thought as well as its concepts is critical to understand, no matter the definition. This understanding which encompasses the evolution of the two concepts as well as how the field got to the current *Supply Chain Management* structure, that we intend on measuring, is discussed in section 2.4.

2.4. Integrating and understanding the concepts of Supply Chain Management and Logistics Management

Supply Chain Management and Logistics Management have become popular buzzwords in corporate industries today. This has not always been the case; confusion around the definition and responsibility of each of the terms Supply Chain and Logistics, as well as the management of these disciplines, has been common throughout history.

The evolution of the industry and its terms used are crucial to understand the complex Supply Chain structures in operation today. Furthermore, understanding the progression in the labour requirements and skills levels required since the early 1900s, is as important. These clearly show how much has changed in the Supply Chain space over the past two centuries. Consequently, understanding the history of the modern Supply Chain and the supporting Logistical activities is critical.

In the post-World War II (WWII) period, in the late 1940s and 1950s, the world's militia were the only organisations to have used the term Logistics. This activity encompassed activities of delivery and maintenance of supply to fighting troops in remote areas of conflict around the world. The scope of the term Logistics used in this era, was solely used as a term for goods provision, such as rations, ammunition, clothing, equipment and spare parts. However, at this stage there was no clear-cut definition for the term Logistics, nor its involvement within private and corporate industries (Robinson, 2019).

Effectively, pre-1960, each service provider that contributed to the availability of goods had to fend for themselves as information and clientele sharing was deemed to be too risky. Since this time, the development of Logistics has been categorised into five core periods, established over the past 70 years, from 1950. Figure 2.4, outlines the four major changes that have occurred within this field. These periods are explained in the sub-sections that follow.

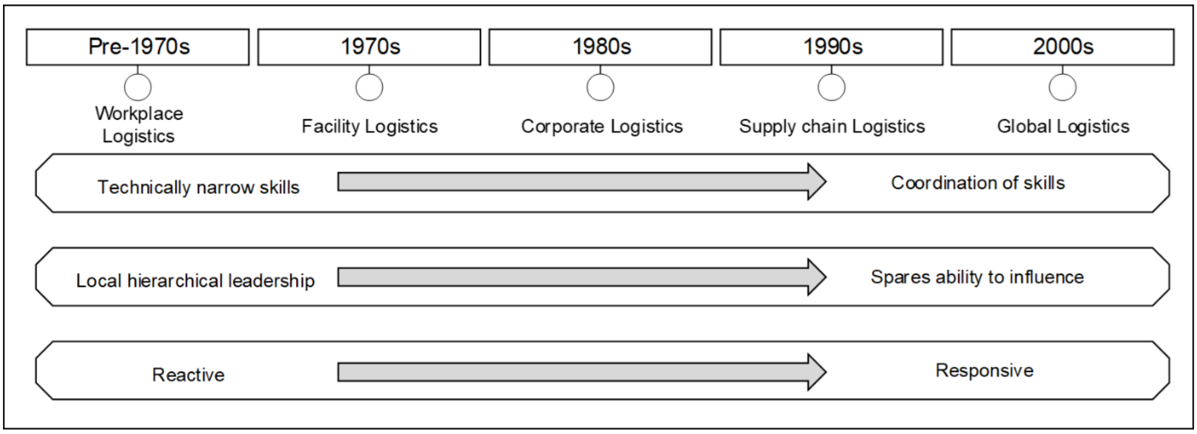

Figure 2.4: Progression of Supply Chain Management and the skills required
(Source adapted from: Blanco, 2013)

2.4.1. Workplace Logistics

This is the development of material flow in a singular work environment. The purpose is to improve efficiency of an assembly factory. Each worker forms part of the greater work force. This worker is tasked with a specific, silo-like, repetitive job that is dependent on the task before it being completed and the next task depends on it being completed. There needs to be speed, efficiency, accuracy, and communication between workers at different functional levels for this system to be successful.

This form of functional work would normally make use of unskilled labour with a localised management hierarchy in order to fulfil day-to-day tasks. This form of process operations was also very reactive to market desires as no forecasting or foresight was given to buyer's behaviour or purchasing trends. This type of system was extremely popular both during and post WWII. This concept was designed by industrial engineers and is more commonly known today as *ergonomics*.

2.4.2. Facility Logistics

Facility Logistics, more commonly known as material handling is the flow of materials in a singular facility/location such as a Warehouse, Distribution Centre, or factory. This phase of Logistics development, requires inter[1]-work station flow and intra[2]-facility flow.

This phase of Logistics, became popular in the 1970s and early 1980s, during the mass production age. In those days, most companies had material handling departments. This activity no longer takes precedence in today's Supply Chain Management environment, due to it being classified as a non-value-adding activity. Moving through the decades a shift in thinking was taking place. Corporates deemed it highly important to automate and mass produce goods on the move. This required goods to move continuously between workstations within a facility. Today, the goal of most high-performing Warehouses and DCs is to limit the amount of movement, each product has to undergo before it is shipped to the customer (O'Bryan, 2016).

2.4.3. Corporate Logistics

As corporates grew and information systems became more comprehensive, the ability to integrate departments (such as Warehousing and material handling) into functions of physical distribution become imperative. The importance of physical distribution became critical for sustainable profit margins and increased competitive advantage. Thus, the first true initiation of Logistics within the corporate environment was brought about in the early 1990s.

Consequently, this form of Logistics become a strategic process to facilitate a singular corporate goal to develop customer service improvement policies, while at the same time reducing the total cost to facilitate this function. Corporate Logistics therefore facilitated the flow of materials and information between different functional areas within that individual corporation.

2.4.4. Supply Chain Logistics

Corporate Logistics constitutes the flow of materials and information between the different functional areas of a singular corporate environment, while Supply Chain Logistics was the development from intra-corporate informational and material sharing to inter-corporate information and material sharing. Corporates began to see their suppliers' suppliers and their customers' customers as part of their own function or flowpath. The SCOR model outlines this concept in Figure 2.5.

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[1] *Inter-This prefix is used to form words that identify a situation between two or more external groups.*
[2] *Intra-This prefix is used to form words that identify a situation within a single group.*

This conceptual view of the entire Supply Chain outlines each organisation involved in the chain executing the same *plan, source, make deliver, return,* and *enable* functions, while simultaneously interacting with other organisations that conduct the same activities (The SCOR Framework, cited in Bolstorff and Rosenbaum, 2012:11).

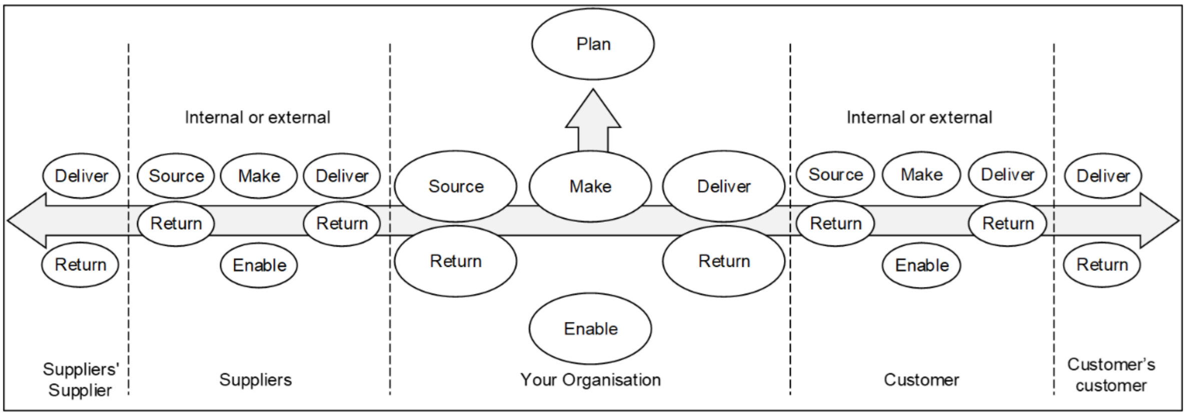


Figure 2.5: The structure of the supply chain
(Source adapted by: The SCOR Framework cited in Bolstorff and Rosenbaum, 2012:11)

According to Hugos (2011:3), in and around the 1990s the term Supply Chain Management became the prominent term used by many corporations and businesses to describe their relationship structure with other businesses. It was at this time that technologies and information sharing became the new hot topic and the term Supply Chain Management replaced Logistics Management. Due to this, some differences arose between the terms Supply Chain Management and Logistics Management. The distinguishing features between these two concepts must be clearly defined in order to understand each term's domain of responsibility. Logistics is what happens within the Supply Chain as identified in Figure 2.2. This term encompasses all the activities or links that connect each of the components in the Supply Chain network. Activities such as inventory management, supply, transportation and Warehousing all form part of activities conduction within the realm of the Supply Chain network and therefore define Logistics.

In Supply Chain Logistics, no one organisation has total control of the chain. Information and strategies must be shared as common goals between organisations in the greater network, in order to facilitate the best customer service at the lowest possible cost. The best way to explain the difference is outlined by Frazelle (2002:11).

A lack of communication and information sharing are two of the most common risks of Supply Chain failure. Good decisions cannot be made without accurate, real-time information on customer demands (Gattorna & Walters, 1996:148).

Consequently, the development of strong, healthy relationships between organisations in the chain is critical to the survival of companies, since customers define the tempo to which organisations must march. The result amongst the fast-moving consumer goods (FMCG) environment, where customers' demands must be met by the next day, are same-day delivery requirements (Stock & Lambert, 2001:104).

Japan's response to the power shift between customers and organisations was the development of the "Kanban"[3] or Just in time (JIT) production system (Gattorna & Walters, 1996:107). This system aimed at eliminating wasteful production and excessive inventory holding and replacing it with minimal inventory and shorter lead times to customers, all the while achieving optimal levels of customer service and satisfaction.

2.4.5. Global Logistics

After the development of the JIT movement in the mid-1950s, and the adoption thereafter in Western societies in the late 1970s, organisations and corporations around the world were obsessed with the idea of limiting inventory, only manufacturing goods when orders were received. After several decades this JIT system was replaced with a slightly different mindset. In the early 2000s, Supply Chain Management shifted once again.

This shift was to move from a JIT approach of production scheduling and inventory holding to a *Lean production* mindset (Frazelle, 2015:1). This allowed corporations, with the help of technological advances in information sharing systems, to forecast potential demands for goods, thus limiting inventory levels, as opposed to the high inventory levels held in the 60s and early 70s. This capability allowed companies to store enough stock in case of unexpected fluctuations in demand. Therefore, organisations can move with the new trends and demands desired by the instant gratification or ***Now*** generation (Van den Bergh & Behrer, 2013:6).

[3] *Kanban def.* ***Kanban*** *(看板) (literally signboard or billboard in Chinese and Japanese) is a scheduling system for* ***lean manufacturing*** *and just-in-time* ***manufacturing*** *(JIT).* ***Kanban*** *is an inventory control system for supply chains. Taiichi Ohno, an industrial engineer at Toyota, developed* ***Kanban*** *to improve* ***manufacturing*** *efficiency (Ohno, 2018).*

For organisations to facilitate the demands of the ***Now*** generation, organisations must look past their own borders to become a true customer facilitator. Organisations must understand what their core competencies are within their own organisations and outsource what is not. Thus, the development of a global market place has led to the natural progression of global Supply Chain networks.

Global Logistics follows the same principles as Supply Chain Logistics, discussed earlier in section 2.4.4. Supply Chain Logistics encompassed the flow of materials, money and information between different organisations within a given network space. Global Logistics is similar in that materials, money and information flow between each link. However, these flows now occur over borders and between countries; thus a Global Supply Chain network is developed (Frazelle, 2002:22).

Similar to the development of global trade, Logistics has expanded to incorporate different components into its Supply Chain to best facilitate customer services. Demand is being met through global suppliers, due to the distribution of technical skills and natural resources around the world. This means that one country is better at producing goods due to its skilled labour or abundant natural resources than another. Therefore, specialisation has taken place. Supply Chain Management and Logistics Management help coordinate these flows through strategic enablement (Coyle et al., 2008:81).

2.5. A customer service perspective – Reason for change

All the role players within a Supply Chain should have the same goal in mind, providing goods to the next link along the chain. The outcome of Supply Chain Management is customer service. Consumer demands are the reason supply chains are developed and run. Without the customer there would be no purpose to the chain. Starting with the end in mind, customer service is the ultimate outcome of the supply chain. Good service to satisfied customers in a timely fashion allows for a profitable Supply Chain and increased competitive edge in the market, while poor service results in increases in lost sales and operating costs. According to Gallo's (2014) research, it costs five to seven times more to bring a disappointed customer back to the organisation they were previously dissatisfied with. However, customers were not always in charge of *what, when* and *where* they received their goods (Stock & Lambert, 2001:104).

Consequently, customer service has changed significantly in the last hundred years. These changes in consumers' buying behaviour occurred when customers found their voice regarding service requirements and expectations. This increase in demanding service levels resulted in the need for Supply Chain thinking and its management, to adapt, rather than die (Ballou, 1999:102). The purchasing decisions and behaviour of customers have changed drastically since the turn of the twentieth century. Customers back then had no say in the delivery time or specification of products, due to the success experienced by organisations during the mass production age (Oracle, 2012:2).

Henry Ford was one of the first manufacturers to introduce the moving assembly line into his Model-T Ford factories in the early 1900s. Ford (1909) stated that, "*a customer can have a car painted any colour he wants so long as it's black*". This is indicative of the thinking of early Supply Chains, as customers were told what they could have and when they could have it. This mass production era was only available in automotive and industrial plants. In the pre-1950s, if customers needed to shop for groceries, their local town centres were their providers. Towns formed around the local markets and grocers, on whom customers relied for their weekly shopping (Vaish, 2014:1).

According to Stock and Lambert (2001:104) by the 1960s and 1970s, supermarkets became a significant role player in the lives of customers. These supermarkets offered up more variety of products than their small, independent competitors, thus drastically increasing the choices for customers and the competition between service providers. It was during this time that the field of Supply Chain Management exposed the power shift between a retailer-driven market to a customer-driven market. The 1970s also saw the adoption of the Japanese Kanban production schedule or JIT within western societies. This concept is further explained in section 2.4.5 above.

The late 1980s brought about the invention of the internet and increased technologies that now allowed customers greater access to information and to a larger marketplace. This was further exaggerated by the invention of e-commerce systems in the mid- to late-1990s. Customers could now order their specific goods online, without needing to visit a *brick and mortar store*. It is in this decade that the power shift significantly changes again, organisations now had to differentiate themselves from others in order to entice customers to spend. Organisations were under further pressure to be cost-competitive, thus the development and integration of Supply Chain Management and its supporting Logistics functions became highly specialised, in order to succeed in a customer-focused economy (Vaish, 2014:2).

At the turn of the century and the arrival of a new millennium, technology and access to the internet become an everyday tool in the world markets. In a time where cell phones and laptops are common place in many homes around the world. Customers can now purchase goods from anywhere and have it delivered directly to their door step within hours (Richards, 2011:2). Understanding what drivers are required to facilitate these customers is critical to Supply Chain Management.

2.6. Five Major Supply Chain drivers

Supply Chain structures take many forms, depending on the type of products and services flowing through them. These structures are designed with the express intent of servicing the customers' demands as efficiently and effectively as possible. Each Supply Chain comprises of up to five major Supply Chain drivers, identified by Figure 2.6.

The overall decisions made regarding each driver will determine how responsively or effectively the chain can service its customers. Consequently, by mixing different combinations of Supply Chain drivers, organisations can tailor their own Supply Chain to whatever form best serves their type of customer. Each of the five Supply Chain drivers will be discussed in the following section.

2.6.1. Production

This driver refers to the production capabilities of the selected Factories and Warehouses within a given Supply Chain. The main concern for Supply Chain professionals when making decisions in terms of this driver, is one of balance. This balance is struck between the decision to be more responsive and less efficient or vice versa. If excess capacity exists within a factory or Warehouse, then high levels of flexibility can be achieved. This will allow an organisation to respond quickly to seasonal demand shocks.

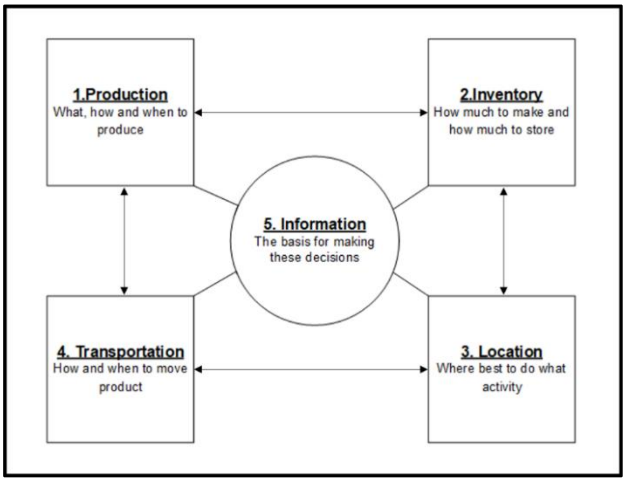


Figure 2.6: Five major Supply Chain drivers
(Source adopted from: Hugos, 2011)

In a facility where little to no excess capacity is available this will limit its capabilities to meet changing demand. There are cost implications involved when being responsive. If excess capacity is available and not being utilised or is not generating financial returns the less efficient it will become. Within the storage element of the Logistics function, three approaches have been identified regarding the storage of goods. These are explained as follows, according to Hugos (2011:10–12):

2.6.1.1. *Stock-keeping units (SKU)*

SKU storage is the traditional approach to storage. This emphasises that all types of products are stored together. This method is easy and the most cost-effective method of storing products.

2.6.1.2. *Job lot storage*

As the name suggests, all goods or product pertaining to a particular job or customer are stored together. This is more efficient than SKU storage and is more beneficial when few customers with large orders are received. This storage type requires more storage area than SKU storage does, possibility increasing the operational costs expected over time due to the need for larger Warehousing facilities.

2.6.1.3. *Cross-docking*

Cross-docking refers to an activity rather than to storage. This activity is outlined by the absence of storage. Due to the fact that the goods that are received are not actually held or stored. These goods are received by inbound suppliers in large quantities. These large quantities are then broken down into smaller quantities and repackaged with other goods, fitting a specific customer’s order. These orders are then shipped to their intended customer without being stored (Frazelle, 2015:114).

Based on the strategic intent as well as the strategic selection, to either be more responsive to a customer or more efficient in terms of asset utilization, will determine what trade-offs occur on the strategic level. These strategic-level decisions about strategic intent and best fit will filter down to the operational level, where corporate culture, operational processes and performance will ultimately be implemented and effected.

2.6.2. Inventory Management

The second driver is inventory, this refers to the function of inventory management within the supply chain. Due to inventory being present at each facility within the supply chain, It is necessary to understand the types of inventories that are kept, as well as their purpose within the chain.

Remember, organisations holding large inventories, are capable of being very responsive. Consequently, this responsiveness is a balance between stock-keeping and the cost of storage. However, to achieve higher levels of efficiency, optimum stock levels must be held. There are five distinctive types of inventories. Each of these inventories plays a very different role within a Supply Chain. The correct combination and quantities of the following five types of inventories are critical in meeting customer demands.

2.6.2.1. *Pipeline or Work-in-progress (WIP) inventory*

Pipeline inventories refers to any and all unfinished inventories or inventories which form part of a larger product. Pipeline inventories can easily exceed the total amount of finished stock being kept within the Warehouse. Thus, sufficient attention and time must be spent by inventory managers on this inventory type.

Managers must refine the amount and speed at which pipeline inventories flow through the chain, as these inventories only have value when they are complete or put together in the correct configuration which is desired by customers(Pienaar & Vogt, 2012:221) .

2.6.2.2. *Cycle stock*

According to Pienaar and Vogt (2012:222) , this type of inventory refers to the finished stock that is kept on hand in sufficient quantities in order to meet average or normal demand. In order for this to be done correctly, adequate market-related information and forecasting techniques must be used to determine the correct levels. If too much is kept, then excessive amounts of capital are tied up in inventory stores, generating no return. As a result, larger storage space is required, further increasing operating costs, while too little prevents flexibility of production demands causing further sales loss.

2.6.2.3. *Safety stock*

Due to customers' erratic demands and ever-changing customer trends within the marketplace, companies store extra stock on hand in case there is a greater than normal demand for a particular good. This type of stock is known as safety stock (SS).

Its purpose is to hedge against an increased demand for a particular good. Every organisation will have its own optimum SS levels, depending on the type of good they sell. This stock is added to the regular cycle stock, mentioned above (Ballou, 1999:331).

2.6.2.4. *Speculative stock*

This stock is treated similarly to commodities prices or exchange rates. For example, when the US dollar exchange rate is weak against the rand. Most South Africans will buy US dollars as it is cheaper now than it was in the past or could possibly be in the future. Similarly, organisations do this with their inventories; they buy as much inventory as possible of a particular commodity, at a particular price. This speculative buying behaviour occurs when the foreseeable price of a commodities is unknown (Coyle *et al.*, 2008:328).

2.6.2.5. *Dead stock*

This refers to stock that has no longer been desired by customers for a significant period of time. This stock should be disposed of, either through recycling, reclamation or reallocation, as it is taking up valuable space that could be put to better use (Ballou, 1999:331).

2.6.3. Location

According to Bowersox, Closs and Cooper (2007:30), location is a simple but very important driver in Supply Chain Management. It refers to the physical geographic location of the facility in the Supply Chain network. It is critical that the facilities are within a service radius of the customer. This will ensure that other operational costs are kept to a minimum as the route to market is significantly reduced. The major decision within this Supply Chain driver is to have a centralised or decentralised location set up.

Centralised, refers to a large facility in one place, rather than fewer, smaller facilities closer to the customer. The choice to centralise operations would be to achieve economies of scale and efficiency. This choice of location strategy limits the available response time to the customers over all, as the facility is now slightly further away from potential customers. The trade-off here would be between cost savings in a large facility achieved through economies of scale, against the cost of a longer distance to transport goods to customers.

A decentralised approach, on the other hand, would allow a Supply Chain to be more responsive to customer demands, due to their proximity to the marketplace. These facilities are not only located closer to the customer but possibly to their suppliers as well.

2.6.4. Transportation

Transportation is the linking element between all the facilities within the network. In order for value-added activities to be achieved by different Supply Chain processes, the goods must move from point A to B, from B to C and so on, until they reach the final customer. Transportation is required right through the Supply Chain from raw materials movement to the finished products delivery.

Transportation further facilitates the global marketplace that we are currently operating in today, identified in section 2.4.5. This allows for a lean manufacturing decision along with efficient service delivery. Without it, no goods can be moved through the supply chain, and therefore, no sales or revenue flows will take place. Transportation is the tool to fulfil customers' expectations (Li, 2014:287–288).

2.6.5. Information

Information allows managers to make good, clear decisions for current and future events. Access to good quality, on-time information is not always possible. Most organisations are reluctant to share operational information about performance or processes, due to the potential of increased risk of competition within the marketplace, even if the company they need to share it with is part of the same Supply Chain. According to Hugos (2011:16) information is used for two main purposes within a supply chain.

2.6.5.1. *Coordination of daily activities*

The previously identified Supply Chain drivers are ineffective without proper communication and coordination between each of their respective fields. It is critical that data, both historical and current, is used to determine the demand from the market and availability of supply, while at the same time maintaining inventory levels and coordinating transport activities to ensure on-time delivery to customers.

2.6.5.2. *Forecasting and planning*

Information needs to be accurately processed and interpreted for Supply Chain managers to anticipate future demands. Production schedules need to be adjusted in order to maintain enough stock to serve average demand for that period. Organisations will need to carry enough SS for slight variations between actual demand and forecasted demand.

Accurate information is utilised in the forecasting and procurement of raw materials for manufacturing processes as well as for marketing campaigns. An industry-related example of this would be that of *a large cosmetics manufacturer*. Information is required for accurate forecasts and procurement for seasonal events such as Christmas and Valentine's day (Appollis, 2017). Without accurate real-time information, high levels of inaccuracy and obsolescence will occur, resulting in lost sales and revenues for the organisation in question.

By correctly implementing and managing the appropriate level of Supply Chain drivers, operational performance can be measured. Performance measures are driven by strategy, business objectives and even financial gain. Continuous improvement is critical to unlock unforeseen potential to continue performance improvements across the supply chain and the business.

2.7. Performance Management and Benchmarking in the Supply Chain

The focus of this section helps to outline the performance management concept within a Supply Chain context. The focus on increased efficiencies within a Supply Chain can be achieved through performance measurement and benchmarking activities. The organisation's business strategy helps translate strategy into performance objectives; however, it is up to the Supply Chain management teams to achieve these expectations. To be able to achieve a stated performance objective, measurement needs to take place and to be able to increase performance, management is required.

To be able to improve performance, organisations need to identify where they are lacking to be able to manage the performance results and to adjust processes to achieve better results. In order to focus on the performance levels, we first need to understand what is currently being measured within a Supply Chain and how these processes translate to quantitative results that can then be managed.

2.7.1. The road to Supply Chain 4.0 by McKinsey: A vision of the future

Customers are becoming more *tech-savvy* in terms of how they interact with their friends, co-workers, family and even organisations. Customers shopping habits have also been drastically influenced by the integration of technology into their shopping experiences. Customers' expectations of individualised customer service and product-specific customisation have increased drastically during the past few years. Businesses must streamline how they produce, ship, package and interact with their customers.

Through appropriate technologies and automated systems integration into current Supply Chain strategies, organisations can achieve greater benefits from competitive advantages over their competitors. Consequently, the abundance of shopping options available to customers drives the competition within the modern Supply Chain today. Organisations have to differentiate themselves in terms of customer service in order to survive and thrive (Alicke, Rexhausen & Seyfert, 2017).

The future of the Supply Chain is *digitalisation*, which enables the Supply Chain 4.0 concept and management criteria for success. This is an expected level of performance which organisations strive towards in order to become the most efficient and reliable service providers to their customers. The Supply Chain 4.0 concept is based on four Supply Chain goals as outlined in Figure 2.7 below, developed by Alicke, Rexhausen and Seyfert (2017). These four goals are present within every Supply Chain and act as a generic reference point for organisations to measure themselves by.

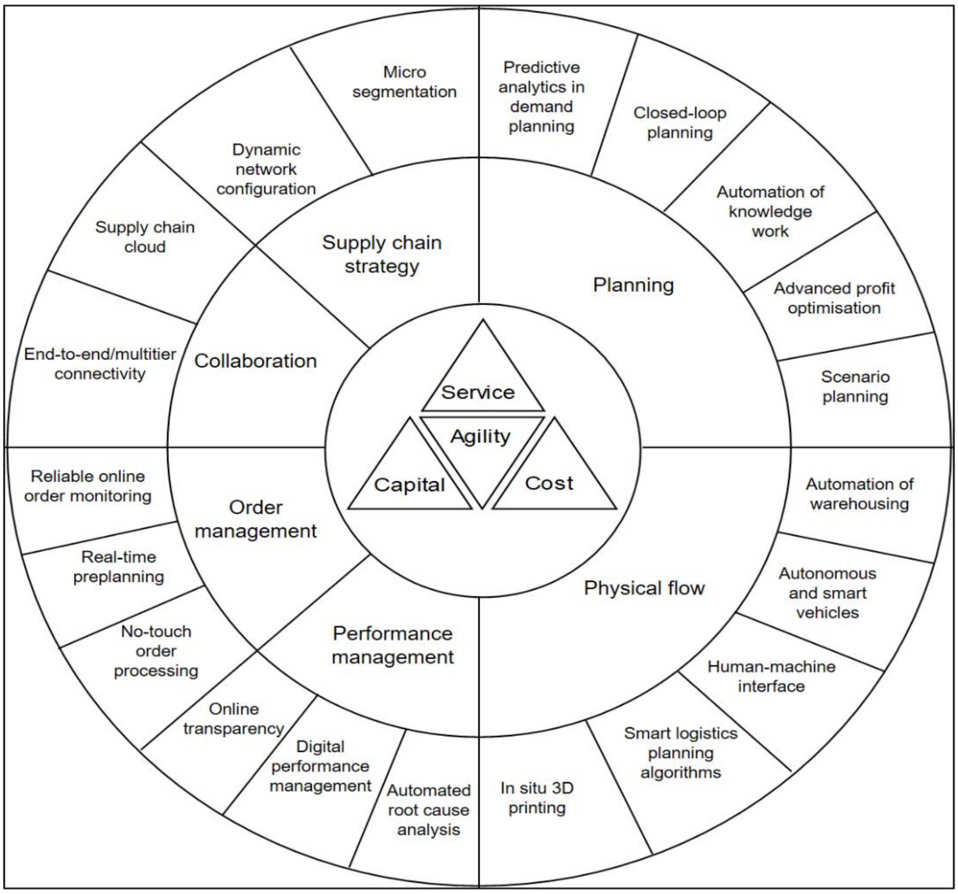


Figure 2.7: The Supply Chain 4.0 concept
(Source adapted by:Alicke, Rexhausen & Seyfert 2017)

These Supply Chain goals are improved upon by *six value drivers*. These value drivers enable organisations to address issues in these six areas in order to implement change programmes to improve performance. The six value drivers are explained briefly below:

***Planning**:* The analysis of big data in order to perform accurate forecasts and planning with regard to consumer desires, through advanced analytics.

Physical flow: The automation and adaptive technologies available in Warehousing and Production will drastically influence the potential for more efficient and reliable supply of goods to customers. The implementation of automated, smart vehicles within the transport industry will limit waste and minimise cost in deliveries. Automation is discussed further in section 3.9.

Performance management: Through the integration of smart technologies, many companies are making use of the fully integrated system to develop dashboards for up-to-date analysis of their performance scores on a minute-by-minute basis.

Order management: Increased automation allows for cost reductions per order as less mistakes with delivery dates and customer availability occur, while reliability increases due to less human error and the implementation of more visible systems improves the customer's experience.

Collaboration: Referred to as a Supply Chain *Cloud,* allows for an integrative structure of communication between the customer, the company as well as the suppliers through a shared information platform.

Supply Chain strategy: Through the adaption of big data and the need for customer-specific customisation of products, micro-segmentation has become a real need for Supply Chain designs. This micro-segmentation concept divides the Supply Chain into hundreds of individual segments for firms to deliver to customers. By creating value through the value drivers identified in Figure 2.8, organisations can improve their customer service experience, while unlocking untapped potential for new growth in revenues and cost reductions. Simply put, by increasing the integration and interpretation of technologies and the data it collects, improvements in supply chain performance can be achieved. Furthermore, as seen in Figure 2.8, the organisation derives positive outcomes from such value driver successes, identified in terms of Supply Chain goals. In each category, more efficient cost reductions are possible, thus unlocking growth potential for an organisation's supply chain.

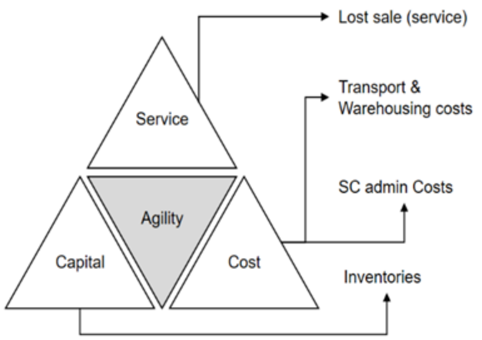
Each Supply Chain goal can be improved upon in the following areas:

Lost sales: In addition to poor or unrealistic service levels being promised to the customer and not being delivered, lost sales also occur when there is poor product/service availability. Therefore, appropriate forecasting and a demand prospectus is important to reach Supply Chain 4.0 status, consequently eliminating lost sales and increasing the potential for profit.

Transport and Warehousing costs: This aspect aims at cleaning up costs by identifying wasteful processes and activities, ensuring that only the essential storage and movement of goods/services occurs. This aspect seeks to eliminate all non-beneficial activities through appropriate technological enhancements in Supply Chain operations.

Supply Chain administration costs: According to Alicke et al. (2017), demand and supply planning, production planning and preparation are largely conducted manually. The objective here would be to automate up to 90% of the administrative processes. This will eliminate errors from occurring and enhance the potential accuracy and throughput the system can handle.

Inventory: Through the implementation of better, more enhanced planning activities, the need to maintain SS becomes irrelevant. Once integration between all the aspects of the system is automated or influenced by technology, better information sharing can take place. As a result, less inventory is required due to better demand sensitivity and forecasting analysis, which will help to eliminate wasteful costly processes and at the same time produce an increase in the bottom line and customer satisfaction.



Baseline (SC 2.0)	Basic (SC 3.0)	Advanced (SC 4.0)	Visionary
50% <	50%	65% to 75%	> 75%
10%<	10% to 15%	15% to 30%	30% to 50%
5%<	5% to 10%	50% to 80%	75% to 90%
20%<	20% to 50%	35% to 75%	50% to 80%

Figure 2.8: Unlocking potential in all Supply Chain categories
(Source: Alicke et al. 2017)

The concept of Supply Chain 4.0 outlines an exciting future for the field of Supply Chain Management, as well as the measurement of the performance potential that could be reached. To reach this potential, specific focal areas need to be identified that outline the different functional attributes a Supply Chain could facilitate. Understanding what needs to be achieved is the first step to understanding what needs to be measured.

Alicke et al. (2017), outlined four potential focal attributes shown in Figure 2.8 that outline potential cost metrics and Total Cost of Ownership (TCO) calculations. The descriptive triangle outlines the different cost components that could be measured if the *Cost Attribute* was deemed to be a priority for a specific company. In order to identify which of these metrics needs to be used to conduct accurate performance measures, the concept and description of the different types of attributes must first be understood.

2.7.2. Performance-process attribute identification for Supply Chain Managers

According to Cohen and Roussel (2013), Supply Chain frameworks act as a means to develop and determine the strategies and processes that the company will follow. This allows the company to be competitive with other companies within the same industry through four overarching attributes. These attributes are generic and seek to represent a larger set of attributes, each specific to different frameworks.

The attributes identified below underpin the understanding that there are four typical areas in which companies focus their Supply Chain strategy. The organisation will have to select one principle attribute to focus on. This decision helps organisations to measure the success or failure of their chosen strategic attribute, while at the same time creating value and profit. These attributes drive a company’s focus strategy, which would identify the most important aspects for the entire chain, not just a specific cost centre.

Table 2.2: Four typical supply chain attributes

Four typical Supply Chain attributes	**Description**
Innovation	The development of new products/services niche market creation
Customer experience	To fulfil the customers’ expectations and deliver goods as promised, when so required.
Quality	Higher quality goods, which demand high profit margins and require higher skills, often used for market differentiation, and increased competitive advantage.
Cost	An attribute whereby the company produces goods in the most cost-effective way possible to produce a standard quality product at very low prices. Competitive advantage is gained by undercutting competition on price, through efficiencies.

(Source adapted from: Bolstroff & Rosenbaum, 2003)

Each of these categories, among others, is critically important to companies. Most leading companies only focus on an individual attribute, while the rest become supporting attributes. Consequently, the key to Supply Chain and performance success, is to excel in only one aspect. This chosen aspect will set the grounding for strategic intent selection and performance measurement to take place (Bolstroff & Rosenbaum, 2003). It will also determine what the most important processes are as well as determining what should be measured first, and which processes are least important and should be measured last.

Through the development and evaluation of a company's Supply Chain strategic process attributes, Warehouse operational processes can be prioritised based on their importance to the company's Supply Chain strategy. These processes then in turn identify the important metrics required to measure these processes. An in-depth metric evaluation and benchmarking activity can benefit a company's performance through an overall Supply Chain strategy and metric evaluation.

The current problem with Supply Chain metric evaluations, identified by Lambert (2008:284) is the type of metrics used by companies. Many popular metrics exist, such as: *perfect order fulfilment index, fill rate* and *lead times*. These are, however, all *customer facing* in that they successfully measure Logistics operational activities and not overall Supply Chain performance.

Based on a study conducted by Tillman, Manrodt and Williams (2015), where 420 respondent companies partook in a performance survey, this study was conducted to understand whether there was a disconnect between Warehouse operational metrics and the respondents' current company Supply Chain strategy selection. Their findings showed that there is such a disconnect between what is being measured in operations and the ultimate supply strategy. Operational performance levels have little regard for the overall corporate strategy, even though the strategy outlines the guidelines and objectives to which operations are designed and developed. This study also outlined the disconnect between the identification of specific metrics which have the capability to measure a specific supply strategies operational intent.

Consequently, research conducted by Harvey (2017), outlined the concept whereby a performance evaluation case was conducted on ***a large cosmetic manufacturer*** in Cape Town, South Africa. This attempted to prioritise the operational metrics with the case's selected supply strategy. Based on a qualitative analysis of the company's Supply Chain process strategy and the definitions that measure the selected strategy, a connection was made between the strategy definitions and the metric calculation definitions. The outcome provided compelling evidence to suggest that such a correlation could be beneficial to the company's overarching performance. The need to be able to measure total Supply Chain performance requires complete transparency of information, between departments within an organisation as well as each node within a given Supply Chain structure.

On an abstract level, each organisation within a supply chain, is concerned with customer service. Each of these organisations wants to move its product or service through the chain to its customers as efficiently and effectively as possible. Each organisation should make use of internal operational metrics to measure the success or failure of these activities. However, these measures must be prioritised based on the Supply Chain process attribute and overarching Supply Chain strategy. Consequently, being able to align these operational metrics based on a selected Supply Chain process strategy, will allow for enhanced Supply Chain performance through improved operational process performance (Lambert, 2008:290).

2.7.3. Supply Chain level management concept

Supply Chain Management relies on integrative processes throughout the Supply Chain to successfully meet customer and business stakeholder expectations. Each of these processes must align with an *overarching business strategy*. The development of these strategies and their underlying processes are essential to achieving Supply Chain success.

Understanding the typical structure of an organisation with its different functional areas of operations is crucial. It is also important to understand at what level decisions concerning strategy are being made and what level of detail is considered when making these strategic decisions. Furthermore, the implementation of these strategies will be conducted through a top-down or collaborative approach. The level of decision-making and implementation that is required at each level is critical (Badenhorst-Weiss, Van Biljon & Ambe, 2017:28).

2.7.3.1. *Hierarchy of decision-making within an organisation*

According to Ballou (1999:38), an organisation's decision-making structure typically occurs at three distinct levels, namely, the *Strategic level*, *Tactical level* and *Operational level (STO)* with the *Enablement* or execution level below this. These decision-making levels also refer to the level of management involved in this decision-making and strategy development process, understanding how each of these management levels measures performance and which performance measures are deemed to be a true reflection of the implemented strategy.

Each function of the organisation is responsible in its own way for conducting business as outlined by the corporate strategy set out by the strategic level management to achieve customer and stakeholder satisfaction. Shareholders judge performance on return on investment (ROI), while customers judge performance not through a specific Supply Chain strategy or set individual metrics but rather through personal satisfaction criteria.

Consequently, the customer's only concern is *Am I getting what I want, when I want it.* If the answer is no, the customer will move to another supplier. It is therefore imperative to the organisation that both these factors be considered when developing a corporate strategy, to which the Supply Chain will align. Typically, there are multiple levels of management to an organisation as outlined in Figure 2.9. This top-down approach to a management structure is most effective due to the defined areas of responsibility and vertical reporting structures that occur.

1. *Strategic management level*

This level of management is generally considered with the *What?* aspect of business operations. This commonly refers to: What are the business's overall goals and objectives within the defined market? Furthermore, it is strategic management's responsibility to define operating objectives for the organisation as well as define its product offering to its market footprint or selected customer base.

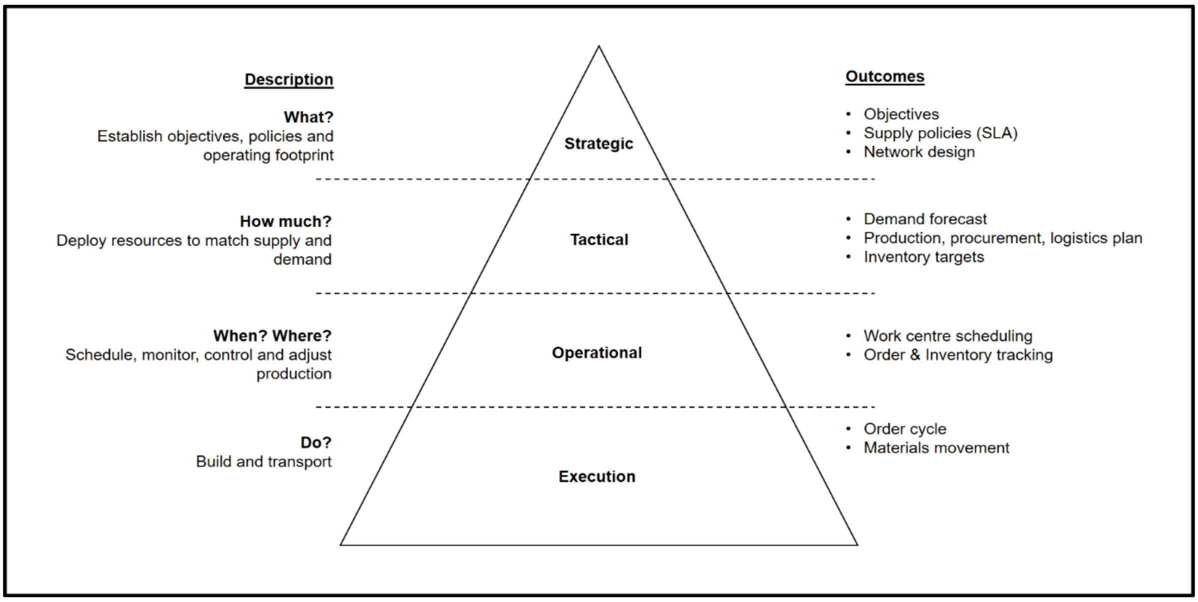


Figure 2.9: Corporate decision-making hierarchy (STO)
(Source: Oliver, Chung & Samanich, 2001)

The strategic management level is also responsible for developing a Supply Chain with its selected surrounding suppliers and customers as well as defining the operating location within its own network. The defining characteristic of this level of management is responsible for establishing the overall operating policies, relationships, and structure of the organisational environment.

2. *Tactical management level*

This level of management requires foresight and planning before operations can commence. It is responsible for matching the supply of product with the forecasted demand, as well as scheduling these orders to meet customer service expectations. This is the *How?* and *How much?* No actual product has been shipped yet, it is just the planning of such movements and in what volumes is it going to be required. It is also imperative at this level to set typical inventory holding and SS levels based on the scheduling and forecasting assumptions and activities. These levels can and will be adjusted over time, but it is critical that these targets be set at this level of management.

3. *Operations management level*

This refers to *when?* and *where?* of Supply Chain Management. Understanding the demand required, based on customer orders, as well as stock available in the DC. Therefore, this level of management is characterised by meeting all the commitments and projections defined at the strategic and tactical management levels. Typically, this level of management refers to the execution of the five main Warehouse activities outlined in section 3.5.

4. *Execution and Enablement level*

Despite this level not being considered a management level, its role is just as important. This execution level defines the Logistics activities that facilitate the overarching organisation's strategy. This level is concerned with the resulting performance from the *Doing* activities, It ensures that the strategic level management policies are being implemented and adhered to, while at the same time ensuring performance levels are being met, through *material management* and *order cycle times*, while monitoring the *human resources* efficiency within operations.

2.7.3.2. *M4SC level management*

Strategy implementation throughout the Supply Chain is not a new concept, the need to implement a cohesive strategy throughout the entire organisation, from strategic level management down to the personnel on the ground is imperative for organisational success. Management for Supply Chain (M4SC), has developed a level management concept, whereby a Supply Chain strategy is implemented into the organisation through multiple steps.

These steps, similar to the STO level implementation outlined in section 2.7.3.1 above, develops and implements a Supply Chain strategy from the top down. This framework does not outline at which level of management the decisions are being made but rather illustrates the progression of Business strategy down to the Supply Chain resources required to fulfil this strategy, while outlining all the steps in between.

Through implementing M4SC, organisations that rely heavily on Supply Chains to operate, can now better align their chosen Business strategies with their Supply Chains. Allowing them to institute pro-active initiatives instead of being reactive to Supply Chain performance results. This approach allows organisations to understand how to deliver a holistic customer service experience and achieve the organisation's Business goals. M4SC has been developed to be used as a framework for implementing proven, repeatable processes to achieve Supply Chain alignment success with an organisation. The M4SC framework is used to implement the SCOR model throughout the organisation.

The use of SCOR and its accompanying process and performance measure will be discussed further in phase 2 of this report. Figure 2.10 illustrates the step-by-step progression of strategy implementation as defined by the M4SC framework.

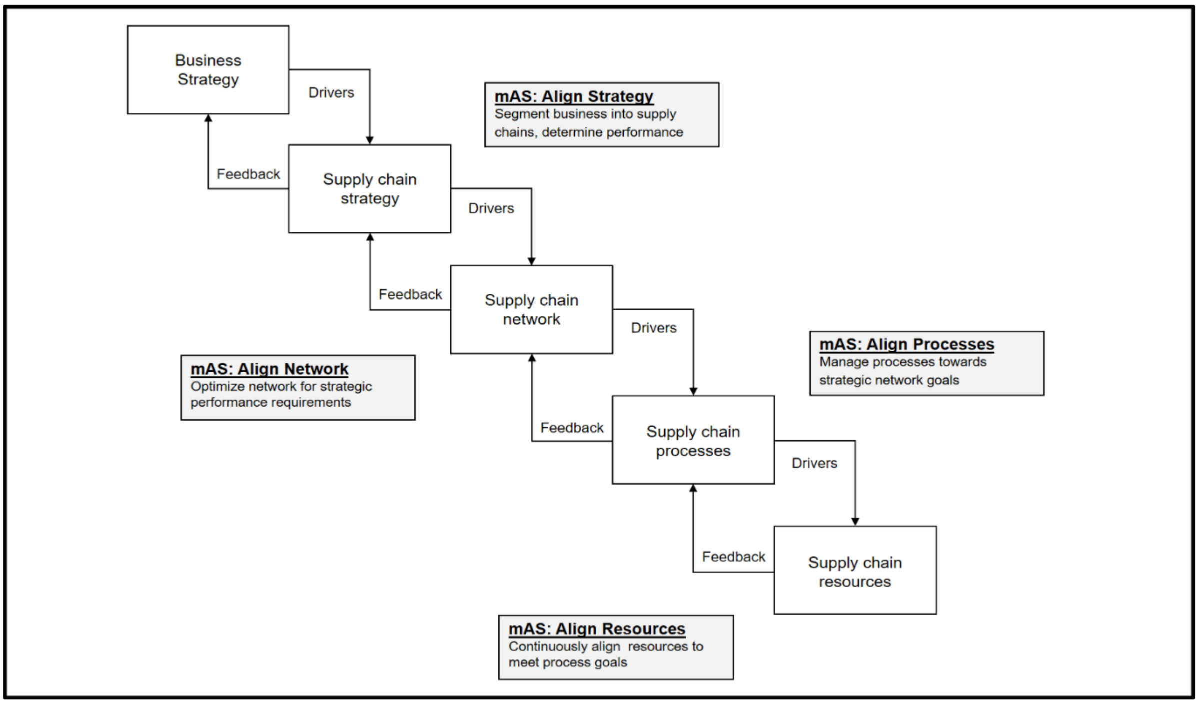


Figure 2.10: M4SC framework for business and Supply Chain strategy alignment
(Source adapted from: Supply Chain Council, 2010)

This process of implementing a step by step development strategy motivates two very important components of strategic implementation. The first is that the previous step influences the preceding step, therefore coherence can be achieved between the business's overarching strategy and what is implemented at the workforce level. Secondly, this step-by-step approach encourages feedback to impact change, therefore it becomes a reiterative process with continuous improvement.

M4SC is based on four alignment techniques that develop and align business strategy into a definitive Supply Chain strategy. These four alignment techniques are identified in Figure 2.10 as, *Align Strategy*, *Align Network*, *Align Processes* and *Align Resources*. These four alignment techniques link directly back to the level of management identified in Figure 2.9, whereby strategic level management aligns Business strategy with Supply Chain strategy as well as network alignment and design, while tactical level management is concerned with aligning processes to meet strategic network goals and achieve top-level business objectives.

Finally, operational level management aligns resources to continuously meet business objectives established in process goals. These different levels of management are responsible for executing different tasks within the organisation. However, each of these different tasks and decisions must be conducted in line with the overarching business strategy set out by the strategic level of management. The need for a common strategic business goal implemented throughout the organisation must also be accompanied by a Supply Chain strategy to ensure stakeholder and customer expectations are met.

2.7.4. Supply Chain measurement and benchmarking frameworks

Within the literature reviewed up to this point, it is evident that performance management plays a pinnacle role in the success or failure of a Supply Chain. Furthermore, within the field of Supply Chain Management, multiple references and findings have been presented that outline specific frameworks that claim to define and implement Supply Chain strategies and processes along with a means to measure these strategies and processes. The need to review these frameworks is critical to better understand how measurement can take place within the Supply Chain. The concept and review of frameworks will be presented as a holistic review chapter which focuses on Business strategy, Supply Chain strategy and processes as well as Warehouse frameworks, presented in Chapter 5. The purpose of this was to isolate each concept's framework to help demonstrate how each of these can be aligned to develop the strategy-process performance alignment matrix in Chapter 8.

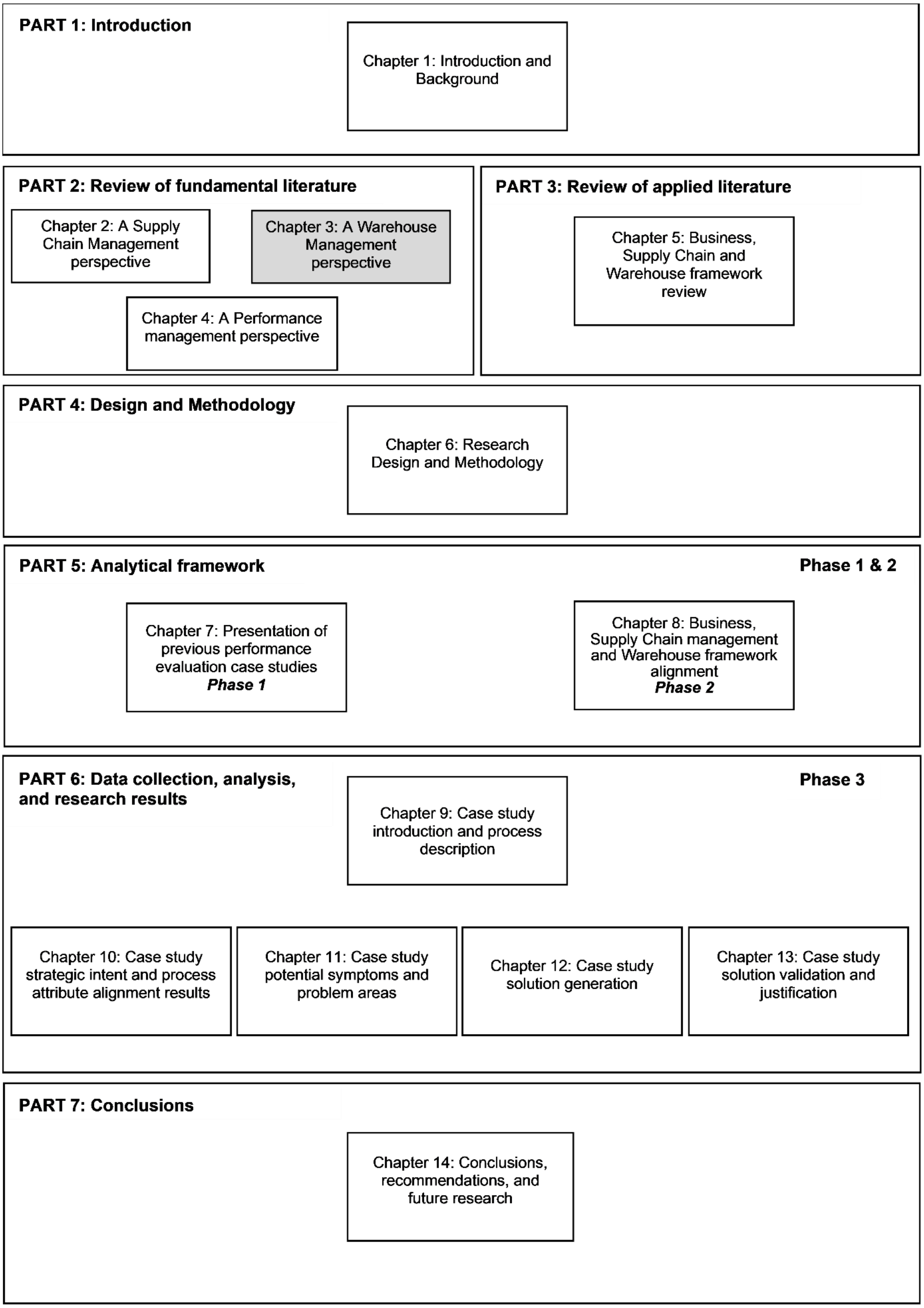
2.8. Summary of Supply Chain literature findings

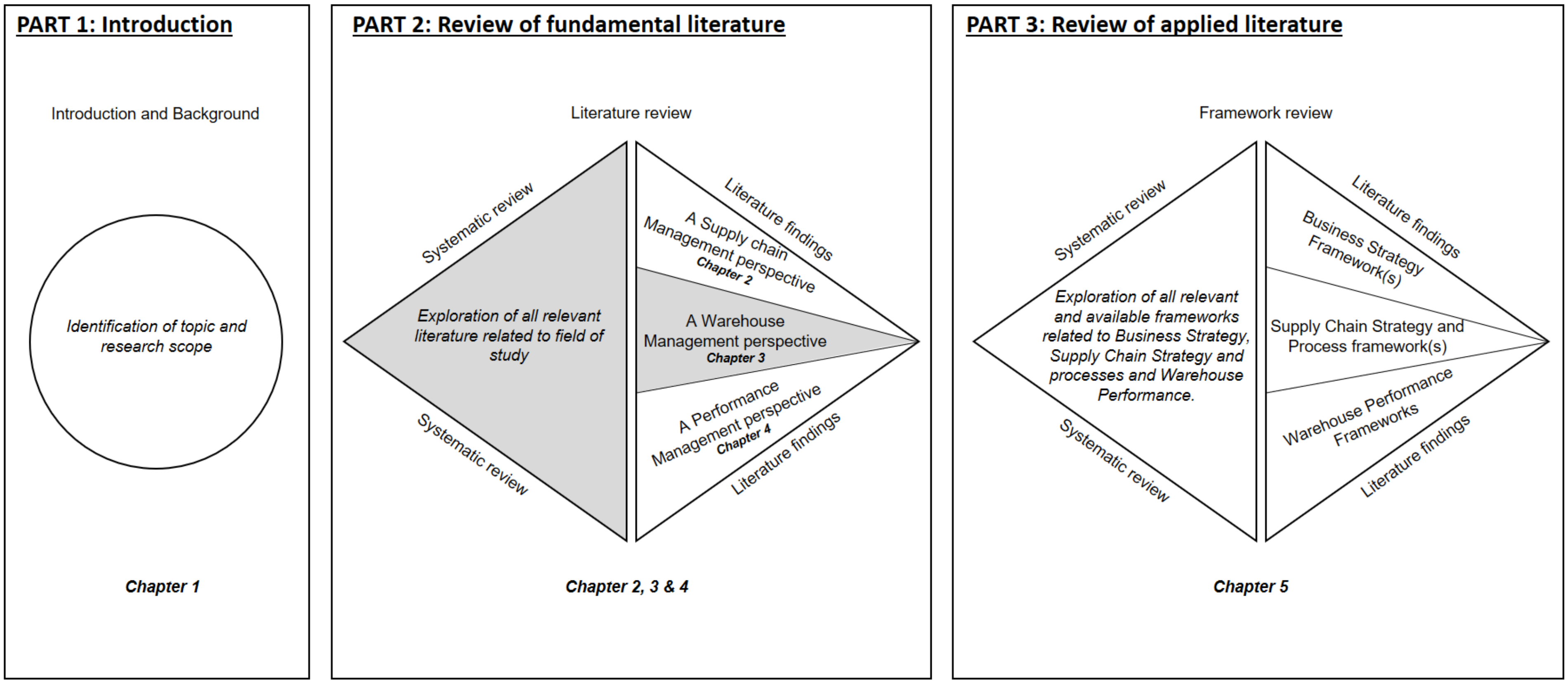
To fall in line with a business strategy and objective, the *Supply Chain network* is designed with the express intent of aligning all the elements of the chain to a singular objective. To help facilitate this objective, *Logistics activities* are used to help achieve the stated Supply Chain goal. The integration and interpretation of this link between these two terms have developed throughout the field's history. This literature review identified *different schools of thought* related to Supply Management, Supply Chain Management, Logistics and Logistics Management and where each of these term's roles and responsibilities starts and stops.

The influence customers play within the design and management of the Supply Chain and the power and control they have over an organisation, through their expectations and demands, is imperative. Being able to connect how and why Supply Chain performance is driven by customer satisfaction is crucial. Despite some differences in opinion, the concept of being able *to measure how well a Supply Chain* is doing is viewed by all thought leaders within the industry as critical to the success or failure of the Supply Chain.

Finally, realising that the performance measurement of Supply Chains should be used as an instrument for growth within Supply Chain Management and applying what *McKinsey* outlines as *Supply Chain 4.0*, to be able to unlock greater performance potential is imperative to Supply Chain success. This *cross-mapping* of measurement metrics with specific Supply Chain processes outlines the purpose of this research. The need to *align the Warehousing operational function* within the *Supply Chain* with a *singular selected Supply Chain strategy* is crucial, in order to understand the current strategic level performance outcomes. This research will test this potential for Warehouse and Supply Chain process performance alignment on a case company, as presented in *Part 6*. All these concepts will be outlined within the data analysis section of this report.

PART 2: CHAPTER 3
LITERATURE REVIEW
A WAREHOUSE MANAGEMENT PERSPECTIVE




PART 1: Introduction
Introduction and Background
Identification of topic and research scope
Chapter 1
PART 2: Review of fundamental literature
Literature review
Systematic review
Exploration of all relevant literature related to field of study
Systematic review
Literature findings
A Supply chain Management perspective
Chapter 2
A Warehouse Management perspective
Chapter 3
A Performance Management perspective
Chapter 4
Literature findings
Chapter 2, 3 & 4
PART 3: Review of applied literature
Framework review
Systematic review
Exploration of all relevant and available frameworks related to Business Strategy, Supply Chain Strategy and processes and Warehouse Performance.
Systematic review
Literature findings
Business Strategy Framework(s)
Supply Chain Strategy and Process framework(s)
Warehouse Performance Frameworks
Literature findings
Chapter 5

Chapter 3: Literature review – A Warehouse Management perspective

3.1. The development of the Warehousing concept – A brief history

The Warehousing concept that we know today is an elegant well-oiled machine, driven to facilitate the supply and demand flow between suppliers and customers. Like all machines, Warehouses are designed and tested before they are implemented to contribute to Supply Chain operations (Cirrus Logistics Ltd., 2017). Furthermore, like machines, Warehouses need to pass certain performance criteria on a regular basis to ensure the best possible results are achieved based on their capacity to operate.

Machines, like cars, have humble beginnings just as the age-old horse-and-cart form of transportation has transformed over many years into the fast-moving and efficient vehicles we use today. Similarly, Warehouses have transformed from merely storing grain for long winters to the massive customer service facilitators we use today. Understanding the history and development of Warehousing concepts can indeed help us understand the importance that these facilities play within the greater Supply Chain (Action storage, 2016).

3.2. The literature review process

The literature review process conducted in this chapter follows the same method outlined by Petticrew and Robert (2006:9-10) and was the same as presented in Chapter 2, section 2.2, with one specific difference; the focus of this literature review was Warehousing, illustrated by Table 3.1. This literature review process helped outline some of the key themes and focal points within the literature to help give scope to the search parameters. Boolean operators were also used during this search to help derive search results focused on Warehousing as well as Warehousing results with a Supply Chain connection within the theory.

The search words and phrasing identified in Table 3.1 were used to find the more relevant literature related to the field of Warehousing. The selected search words and phrases helped to narrow the search results returned. Although the process helped focus this literary review, further investigation into these search results was still essential.

Table 3.1: Warehousing literature review process - Summary of search parameters

Repository/Source database	**Keyword 1**	**Keyword 2**	**Keyword 3**	**Findings**
ABI/INFORM Collection	Warehousing	Logistics	Operations	Moderate
EBSCOHost Collection	SMART	Metrics	KPIs	Moderate
Google Scholar	Warehousing	Management	Supply Chain	Good
	Hierarchy	Measures	KPIs	Moderate
Open Source internet	Warehousing	Management	Supply Chain	Good
		Management	Processes	Moderate
		Simulation	Modelling	Moderate
		Property	Value	Moderate
Texted book	Warehouse	Evolution	Future	Good
		Future	Robots	Moderate
	Logistics	Management	Business	Excellent
	Supply Chain	Logistics	Management	Moderate
	Warehousing	Management	Supply Chain	Excellent
Boolean operators used: AND/OR/NOT; (*term*); "*term*"				

This literature review outlined a significant gap in literature relating to the availability of Warehouse performance benchmarking frameworks. The investigations proved that these frameworks exist but a limited number of these are published in the public domain. This process outlined a substantial gap which in turn helped to identify the problem statement presented in Chapter 6. Despite these limited results for one focal search, the concept of Warehousing and the role it plays within the Supply Chain context is very well documented. In order to justify the literature review process and to provide a sufficient focus to the field of Warehousing, the need to summarise the origins of Warehousing was found to be the best place to start this review.

3.2.1. The early days

According to Ackerman (1997:2), in early human history, storage has played a pinnacle role in the development of societies. This is due to the need to store goods such as meats and grains for scarcer times, when hunting and gathering were the only means to procure food. The introduction of storage allowed early humans to preserve enough food for consumption during periods when food was scarce or unavailable.

These storage facilities were nothing more than a stone pit. These pits were designed to hold large volumes of a single commodity. These storage methods date back to as far back as 9500 BC in the Jordan valley (Action storage, 2016). Although storage dates back a long time, it was the Romans that truly embraced the art of storage for longevity, as a result of their rapidly expanding empire that spanned almost half the globe.

The Romans needed to store essential produce in large volumes, allowing them to make use of the enormous volumes of products flowing through central Rome, *Aelius Aristide* describes Rome as *"the earth's biggest Warehouse"* (Action storage, 2016).

Warehousing in its early years performed a purely storage-orientated function to large groups of people. Throughout history, from the Roman Empire through to early industrialisation in the early twentieth century, Warehouses were responsible for maintaining sufficient supply volumes, through their storage function. It is in these later years that the Warehousing concept truly began to flourish and evolve, as organisations realised the potential that the storage of goods could have on their ability to meet customer demands. The transformation of Warehousing as we know it today had begun (Ackerman, 1997:3). Figure 3.1, illustrates the progression and transformation of Warehousing over time.

3.2.1.1. *Traditional stocking Warehouse*

This type of Warehousing was most commonly used in the earlier 1900s to contribute to the era of mass production. These facilities were only deemed necessary to hold or store goods to meet variations in demand. Goods were received, sorted, and shipped through generic Warehousing processes. Very little regard was given to design, efficiency and forecasting as organisations had not yet seen the need to improve their storage facilities.

According to Lapide (2013), this traditional approach to Warehousing was very time-consuming and costly to business operators, as excessive capacity was used with little to no regard for understanding what was required.

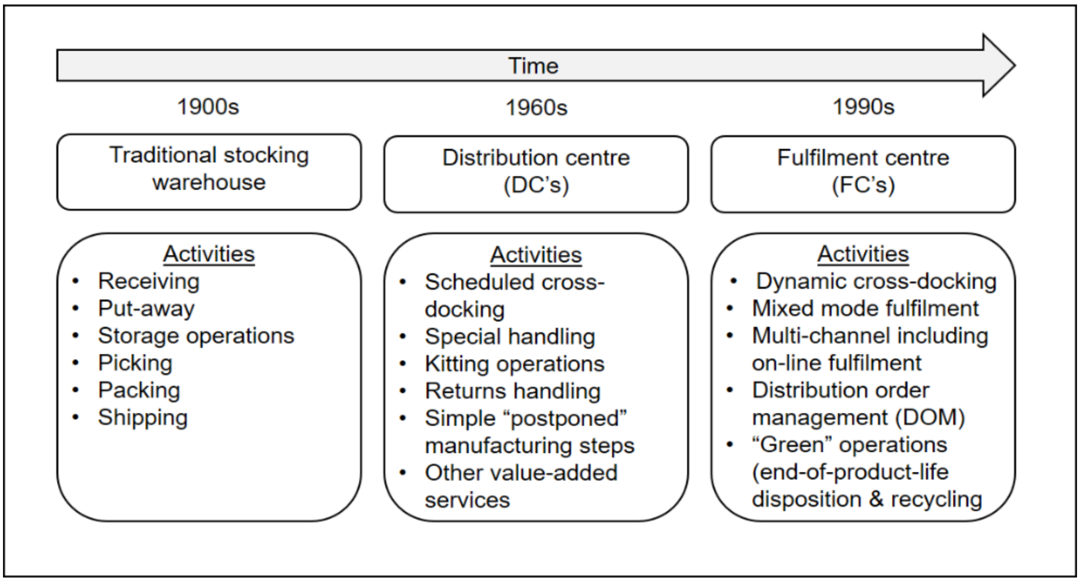


Figure 3.1: The evolutionary role of warehousing within the supply chain
(Source: Lapid, 2013)

3.2.1.2. *Distribution Centres*

Once larger more complex Supply Chains began to develop in the early 1960s, so too did the Warehousing facilities. These facilities were used to increase the speed and accuracy to which the Supply Chain could now service customers (Larson *et al.*, 2007).

This transition between a traditional Warehouse to a DC can be attributed to the consumer's voice within the fulfilment of customer service (Stock & Lambert, 2001:105). Customer service became a competitive advantage that firms could unlock to improve their own bottom lines. Therefore, more complex and sophisticated Warehousing activities began to emerge. Efficiency became key to facilitating customers' demands. Facility managers had to learn to make use of new throughput techniques such as cross-docking as well as facilitate customer returns if they were unsatisfied with their products.

3.2.1.3. *Fulfilment Centres*

Three decades later Warehousing shifted again, this time to be a fulfilment centre. As customers became the ultimate goal of the Supply Chain, Warehouses adapted to become highly complex customer service facilitators, through specialty service coordinators and providers, while limiting costs as far as possible.

These fulfilment centres became essential in the internet market place of e-commerce, where customers now had 24-hour access to stores online. Organisations needed to adapt to the change in consumers' purchasing and consumption habits while still remaining competitive (Stock & Lambert, 2001:104).

3.3. Warehousing in the Supply Chain

The concept of a Warehouse is not solely a means and position for storage. The facility also facilitates the collection and processing of upstream supply. While coordinating the demand for goods to customers downstream, in the correct configurations. Therefore, Warehouses are not just a means of storage but rather a critical element to facilitate Supply Chain operations.

The position of any Warehouse varies between organisations based on the desired design of their supporting Supply Chain network. These concepts are broadly broken down into two facility location decisions. A Warehouse can either be *centralised* or *decentralised* in terms of facility location (The importance of Warehousing, 2018). This concept is further discussed in section 2.6.3 under the *location* element of Supply Chain drivers.

Despite the decision regarding location on a geographical plan, the location of a Warehouse in terms of the Supply Chain is that it is generally situated in the middle of the network. This refers to a position that is close enough to the suppliers in order to receive, store and distribute stock that is moving through the chain, while being able to process all the stock for storage and redistribution to its intended customers in a timeous and reliable fashion (CSCMP, Keller & Keller, 2014b:6).

The Supply Chain processes that a Warehouse facilitates are the reduction of cycle times and overall costs within the chain. As a result the Supply Chain improves its capacity to facilitate improved customer service operations based on the optimal level of inventory being held to meet ever-changing demands. The storage of inventory further reduces delivery costs to the customers, as the products are now consolidated in one location and are not shipped from multiple locations. The decision to store is therefore a critical one. To support this the following section outlines all the factors that should be considered when deciding to store.

3.4. The reasons for storage

Storage space within the Supply Chain is critical for operations as variance in customer demands and materials supply are inevitable in the real world. Consequently, the decision to store is one of necessity, despite the desire to eliminate inventory holding in the *Supply Chain 4.0 concept*, outlined in section 2.7.1. According to Ballou (1999:470), there are four reasons as to why goods are stored. These reasons will be discussed below:

3.4.1. To reduce transportation/production costs

When dealing with the storage of inventory in facilities throughout the Supply Chain, costs are incurred. The decision to Warehouse may be made due to it being the most cost-effective approach to achieving a finished product.

A trade-off analysis must be conducted between the potential costs of transport and production, versus the incorporation of a Warehousing function into the network itself. Consequently, including the Warehousing function operation could result in a more cost-efficient solution than if it were not done.

3.4.2. Coordination of supply and demand

Organisations that require raw materials for production must secure their supply of raw materials in order to produce enough finished goods to meet demand. However, in some industries the supply of raw materials is not available all year round.

This creates a disconnect between the supply and demand for products, as a variable supply required for manufactured goods meets a steady demand. The solution for organisations is to purchase and store the raw materials when they are available for future demand. Thus, storage is required in order to mitigate this disconnect.

3.4.3. Production needs

The production of specific products sometimes requires storage before they are ready for consumption, e.g. *Wine, Cheese,* and *liquor*. All these products require a specific period of aging and therefore, storage. Ballou (1999:472) further outlines the tax advantages of storage. Goods can be bonded by companies until their date of sale. This process allows the organisations to delay paying tax until the product has been sold. This type of Warehousing is often referred to as a *Bonded Warehouse*.

3.4.4. Marketing considerations

In the literature outline by Lambert (2008:288), breaking down functional silos within the organisation is critical to the success of a good supply chain. Marketing considerations should be considered when the decision to store is made. Marketing personnel are always concerned with how responsive they can be to a customer's order, as outlined in section 2.6. Warehousing facilitates value to the customer, by being situated close to the customer, decreasing lead times and improving delivery performance. Increasing service levels can directly affect the volume of sales achieved by marketing personnel.

3.5. Warehousing processes – An introduction

Warehousing management incorporates all activities and operations within the realm of the physical DC. This responsibility also includes relationship development with suppliers as well as Third-party Logistics providers (3PLs). These 3PLs are responsible for the delivery of goods and services to the customer, based upon their desired order of a specific product. The facility must match products and processes in order to achieve customer satisfaction. As identified earlier in section 2.5, customer service and customer satisfaction play a vital role within Supply Chain Management.

Supply Chain processes allow for the smooth transition of goods to occur between *supplier's suppliers and customer's customers*. In order to achieve this, Warehouses play a key role in the facilitation of these transitions within the chain. (The SCOR Framework cited in Bolstorff and Rosenbaum, 2012:11). The result is a well-integrated process flow, that should be continuously measured for improved performance and the ability to meet management and customer expectations.

Measurement can only take place once a complete understanding of all the processes within a Warehouse have been identified. Figure 3.2. shows how these processes overlap and integrate as well as determine what metrics exist and should be measured. It also shows that Warehousing processes consist of three overarching drivers, namely; inbound, inventory control and outbound as presented by HL Group, (2016).

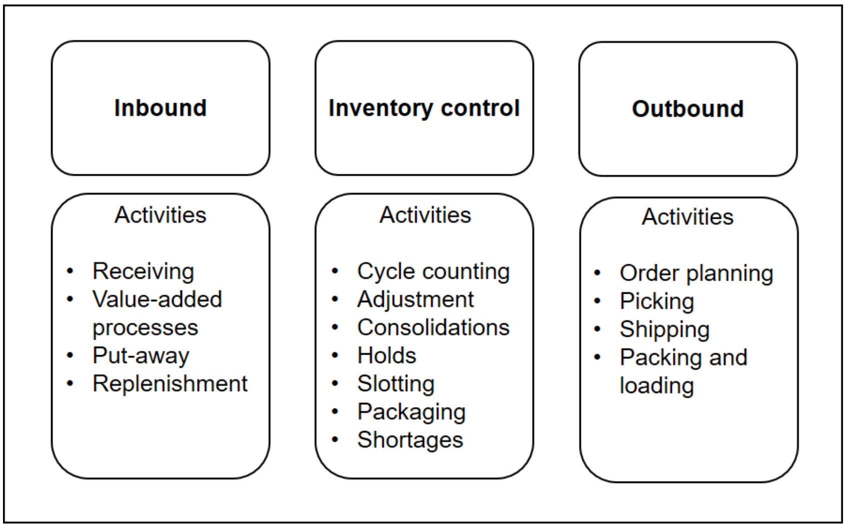


Figure 3.2: Three overarching warehouse process drivers
(Source: HL Group, 2016)

These drivers, identified in Figure 3.2, overlap and include five main Warehousing processes, each with its own area of responsibility and control. The five Warehousing processes as identified by Frazelle (2015:16–18) are as follows:

Receiving: Goods are ordered to replenish stock levels within the Warehouse. Cross-docking items are scheduled and dispatched during the receiving process, they are not stored

Put-away: After goods enter or are received, they are assigned to a storage location. This process is recorded in the Warehouse Management system (WMS).

Storage: Once goods have been assigned to a storage location; personnel must take the goods to the exact bin location. The WMS prioritises the put-away locations and assigns each lot a unique barcode.

Picking: After an item has been ordered Warehousing personnel is instructed, through the WMS to retrieve the identified product. This product is then staged before shipping.

Shipping: In most Warehouses goods are staged for two reasons. Firstly, to ensure all the correct products have been picked for a specific order. Secondly, to consolidate loads to reduce transport costs.

All of the above-mentioned processes and activities are monitored and controlled by the WMS, as outlined in *Figure 3.4: Integration of WMS and the order picking process*. Technology integration is a critical tool employed by Warehouse managers to improve efficiency over the above-mentioned processes. It is also important to consider that most Warehouses operate using 3PL shippers. Warehouse managers are often dealing with external companies for their inbound and outbound delivery services.

3.6. Warehousing processes explained

Warehousing processes fall into one of three drivers either inbound, inventory control or outbound; see Figure 3.2. The reason for this distinction is that there is some overlap in the execution of activities with each overarching driver as each process is reliant on the previous one. These five Warehousing processes will be explained further in the following section and are outlined in Figure 3.3.

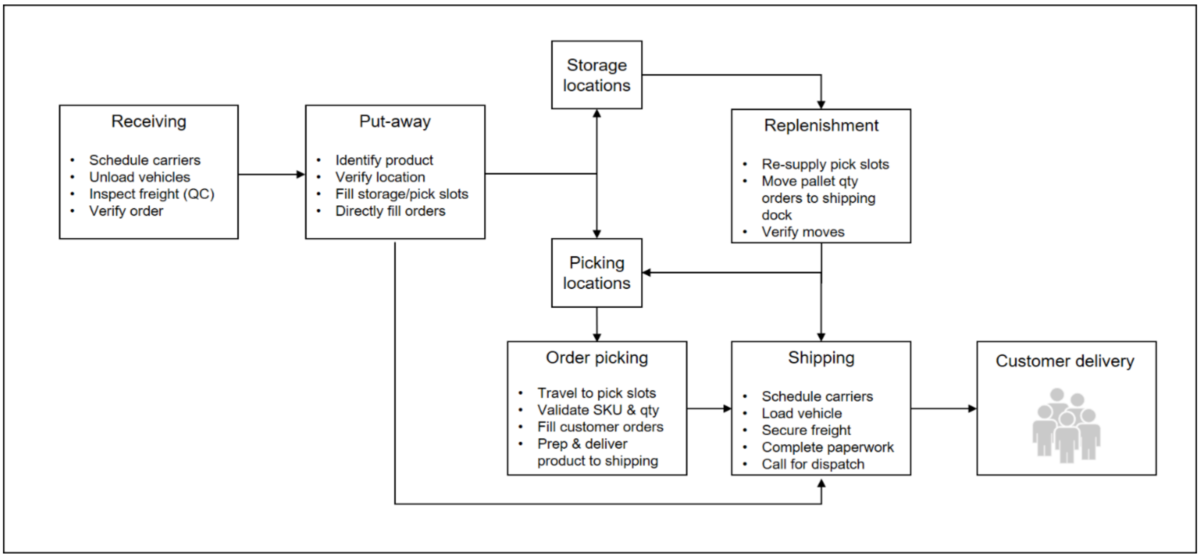


Figure 3.3: Typical warehouse process framework
(Source: Coyle et al., 2008:483)

Figure 3.3 illustrates the physical process flow and interaction that occurs within a Warehouse. The following sections will elaborate further on each process as well as on the interaction between each of these processes.

3.6.1. Receiving

Upon the arrival of new goods at a Warehouse, all the inbound vehicles, either owned or outsourced, must be scheduled in order of inventory loading or unloading to alleviate congestion. This congestion can either appear in the yard, where too many trucks arrive together or in the receiving bay itself when there is too much inventory being received at a given time.

Managing this congestion is crucial to ensure that the stock is not damaged and to ensure a high standard of operating safety for the personnel in the Warehouse. This is managed through planned delivery dates and scheduled times being issued to each of the arriving shippers. This will ensure a steady and manageable flow of goods into the Warehouse.

This scheduled inbound process of receiving goods into the Warehouse is crucial to ensure that the correct stock is being received in the correct quantity, quality and at the correct time. According to Frazelle (2015:109) if garbage is received then garbage will be processed and delivered to the customer. A high standard of Quality Checking (QC) is required to ensure quality deliverables and good customer service are achieved (Ballou, 1999:477).

Once the goods have been received and checked, they must be loaded onto the WMS. This is critical for the following processes in order to be able to track and trace the stock throughout the remainder of the inventory's journey through the Warehouse. Once the goods are scanned and the quantity and quality are verified, the WMS generates an automatic put-away instruction. The WMS recognises the size and contents of the pallet and assigns it to a bin location. From the moment the stock is booked into the system, stock should not move without being scanned from its original location to the following one. This is to ensure that stock counting, forecasting, and picking activities are as accurate as possible.

3.6.2. Put-away

Based on the structure of the Warehouse operations, goods must move from receiving to their identified put-away bin location, as outlined in Figure 3.2, under the *inbound driver*. The defined responsibility is then transposed to a priority list which the material handling equipment (MHE) personnel must complete. The MHE personnel in most cases are responsible for both put-away and picking, to ensure the highest possible asset utilisation for the organisation. They are not defined by one area of responsibility. The process of put-away is simple. Once the goods have been scanned, the MHE driver is instructed by the WMS to place it in a specified bin location. Upon arrival at the bin location, the driver must scan the identified bin and confirm that this stock has been placed in it.

Consequently, in the background of the WMS the available stock quantity of this specific product increases, which is now available for the marketing and sale teams to start selling or to fill orders. The WMS facilitates all the background administration functions almost instantaneously, while at the same time promoting visibility across all departments within the organisation.

3.6.3. Storage

Once the goods are placed into storage, they now become available for use. In most Warehouses, to ensure effective and efficient picking of products, these popular products or *fast movers* are placed in an area of racking known as the *pick face*. The pick face is the section of racking that is at ground level. This allows for faster picking of products at carton level, as multiple cases make up a pallet. Therefore, the storage process within the Warehouse facilitates two very important functions, both of which will be discussed below.

3.6.3.1. *Stock availability*

The storage function allows multiple orders to be received from customers at once, improving customer satisfaction through faster response times and decreasing delivery lead times. The storage of inventory allows for minor economic and demand shocks to be absorbed as SS is held.

3.6.3.2. *Replenishment*

The process of replenishment demonstrates the need to refill specific pick faces and other bin locations when stock is running low. The process is generally outlined by a very simple activity known as a *let-down*. This activity outlines the process of taking a pallet out of one of the bins in the high-level racking and placing it into the pick face. This pallet is then used for pick face picking activity. The WMS plays a very important role in replenishment, in the initial programming and set up of the WMS. Replenishment levels or percentages are set within the system itself. This allows for automatic replenishment instructions to be generated when the stock level of a specific bin reaches the specified percentage or level.

3.6.4. Order picking

Due to the availability of 24-hour access to online shopping through the development of e-commerce systems, customers can now access stores at any time of day from the comfort of their own homes. Both online purchases, as well as bulk orders from other retail customers, are all processed through the WMS, identified in Figure 3.4. The WMS or Enterprise Resource Planning (ERP) system generates a pick instruction that is then sent to the MHE personnel for completion.

The pick instruction identifies the product location in the Warehouse; how much stock is available within that bin; and what quantity of product is required for picking. The pickers must scan the products they remove as well as the bin location, to update the available stock left within that bin location. These goods are then moved to the shipping staging area to be prepared for shipping.

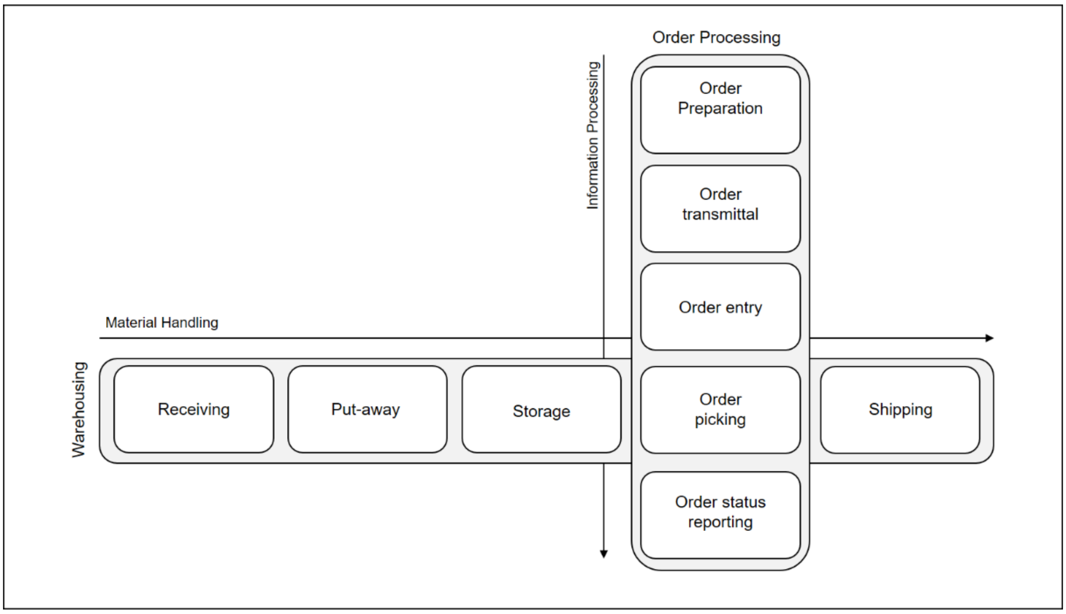


Figure 3.4: Integration of WMS and the order picking process
(Source: Kay 2015:31)

Figure 3.4 illustrates the crossover of activities between the WMS and the physical order picking process. These two concepts interact continuously to ensure that orders are received and picked with the appropriate lead times. This activity sets the level of customer service facilitation. If the stock is available but unable to reach the customer due to poor order picking efficiency, the organisation could lose its competitive advantage as well as potential future sales. The integration of the WMS and the physical process of materials handling is critical to good customer service (CSCMP *et al*., 2014b:16).

3.6.5. Shipping

All the products that have been picked are staged before shipping. This staging process is done for two very important reasons, both of which will be discussed below.

3.6.5.1. *Staging quality checking (QC)*

All the picked goods need to be checked again to ensure that no damaged goods are shipped to customers. It is imperative that all goods are accepted by the shipping company, as they are now responsible for product safety and damage control.

This responsibility is critical for both the shipper and the Warehouse manager. If there are any issues with the products upon arrival at the customer, the shipper is then held responsible. This is critical for 3PL service providers to maintain a good track record with the clients in order to preserve the business relationship. In a case where the shipping company is a subsidiary of the same company as the Warehouse, a root cause analysis (RCA) can be done to improve the shippers or Warehousing processes to ensure that minimal damage occurs in future.

3.6.5.2. *Freight consolidation*

The reason products are staged is to consolidate loads, whereby multiple orders are consolidated in truck loads. There are two distinctions between freight consolidations in road transport. They are either *Full-Truck Loads (FTL)* or *Less than Full Truck Loads (LFTL).* The importance of freight consolidation is to reduce the cost of transport, to ensure that the product price remains competitive within the industry.

This is critical to the understanding of how a Warehouse operates, as each process is reliant on the process conducted before it. It is this level of integration and overlap of activities that increases overall Warehouse performance. This is not to say that inefficiencies do not still occur. However, with appropriate integration and management, performance can be improved. Due to the overlapping responsibility of the MHE personnel, it is critical that this function be optimised to improve the performance of the Warehousing processes. This optimisation of MHE is known as *interleaving* and will be discussed in the following section.

3.7. The Interleaving concept – Elimination of crossover inefficiencies

In the process explanation, goods are picked up at receiving, taken to their bin location, scanned in, and dropped off. Typically, then the forklift travels back to the receiving bay to conduct another put-away. Only 50% of the total distance is beneficial to operations; the remaining 50% is a non-value-adding activity. Figure 3.5 demonstrates this inefficient utilisation, as well as its more beneficial alternative (Frazelle, 2015:134). As identified by Figure 3.5, if the forklift conducted the put-away and then returned (loaded) with a retrieval of a customer's order.

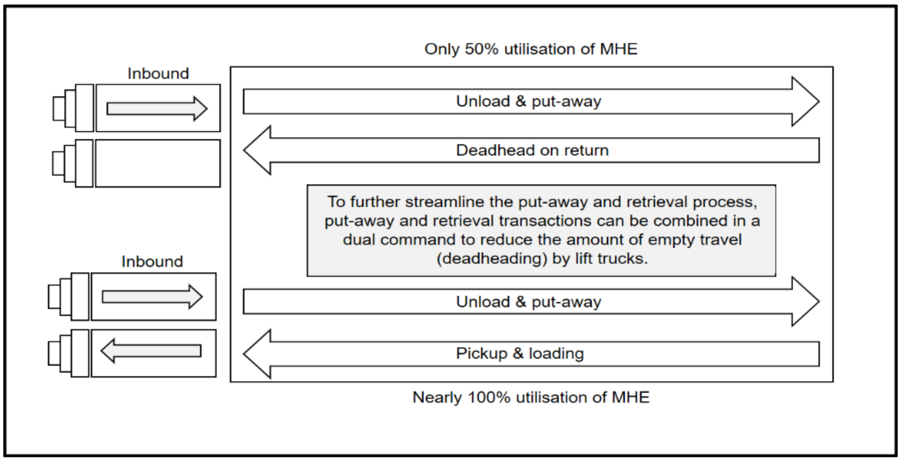


Figure 3.5: The interleaving concept
(Source adapted from: Frazell, 2016:134)

The total utilisation of the distance covered in one round trip would nearly be 100%. The crossover of MHE between the put-away process and the retrieval process do not have to be independent activities. Asset utilisation increases along with put-away and retrieval times.

Understanding the crossover of responsibilities and how each of these processes integrates with the others as shown in Figure 3.4, is critical before any measurement and performance benchmarking can take place. Also, understanding the reliance and importance that is placed on the WMS for operations is crucial. These systems allow for easy information sharing between the different functions of the organisation (e.g. marketing, sales, operation and human resources). This is the major supporting system from which critical data is recorded. If this data is analysed correctly, inefficiencies and issues can be identified and rectified to improve the overall performance of the Warehouse and the underlying processes.

3.8. Public vs Private Warehousing decision

The decision to insource or outsource Warehousing is critical for the organisation to consider. If the choice to insource or own their own distribution centre (DC) is selected, this function must be a core business competency, in order to make business sense.

Even though outsourcing the DC would be easier in the short term, the organisation would then become reliant on an external company and Service Level Agreement (SLA) for many of its operations. There are advantages and disadvantages to both, so how does an organisation decide to own or outsource the DC activities?

The answer lies in the volume of throughput that the organisation expects to flow through their Supply Chain (CSCMP *et al.*, 2014b:25). The comparison between the public/outsource DC and private/owned DC is all based on volume of throughput as identified in Figure 3.6.

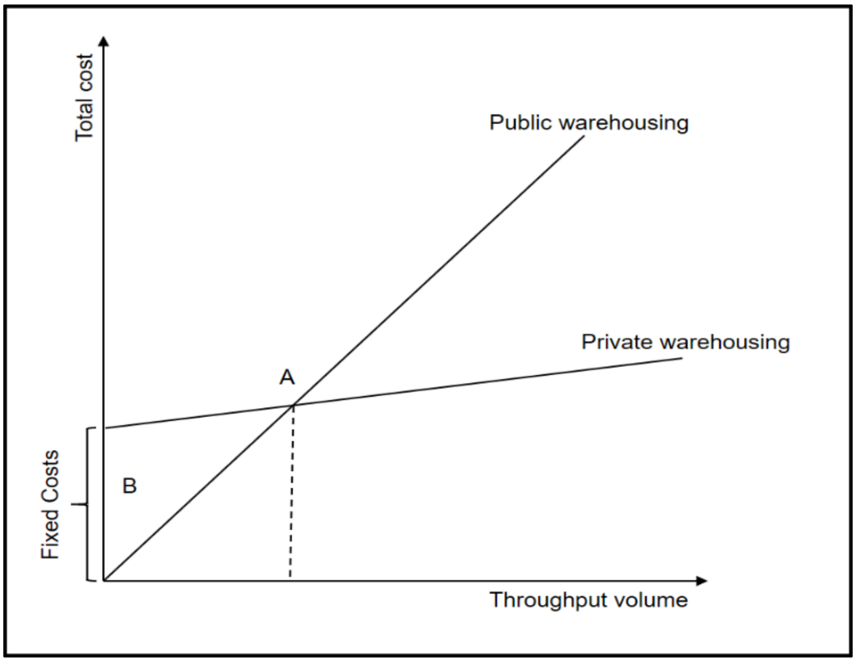


Figure 3.6: Public vs Private Warehousing decisions
(Source: Bardi, E.J. as cited by Coyle et al., 2008:477)

The volume of throughput is the deciding factor between the decision to make use of a public Warehouse or own a private one. This decision is based on the cost of the volume of throughput. Therefore, beyond a certain point, such as ***position A***, the cost of outsourcing is more expensive than the cost of ownership. Consideration of the financial position of the organisation must also be taken into account, as a privately owned Warehousing decision has a significantly high fixed capital cost, ***position B***, while the fixed cost of a public version is zero (Coyle et al., 2008:483).

There are other factors involved in the decision between a public or private Warehouse. These characteristics pertain to the company itself. In each case a company would have to assess each of these factors and identify where they themselves fit. , identifies each of these characteristics and indicates to what level they impact the decision between public and private Warehousing.

Table 3.2: Factors impacting public vs private facility ownership

Firm characteristics	Favours private distribution	Favours 3PL distribution
Throughput volume	Higher	Lower
Demand variability	Stable	Fluctuating
Market density	Higher	Lower
Special physical control needs	Yes	No
Security requirements	Higher	Lower
Customer service requirements	Higher	Lower
Multiple use needs	Yes	No

(Source adapter from: Gibson, 2009 adapted by Coyel et al., 2008:478)

One could argue that despite the capital cost incurred during the initial stage of the Warehouse, these costs will be recuperated through the increased value of the property due to escalations in the property price experienced each year. An example of this is that South Africa experienced 7.2% growth in Warehousing property values in 2017 (Property 24, 2017:1). Through the private Warehousing decision, increased profitability can be achieved through property returns, measured by return on assets (ROA).

Increased efficiencies and performance levels can be achieved if the performance measurement and benchmarking activities are conducted properly. Warehouses must not just make financial sense; they should make performance sense. Therefore, expectations for Warehousing performances must be set and continuously analysed to determine their good and bad points. Only then can high performance and efficient Warehousing practices be achieved.

3.9. Warehouse automation – The strategic catalyst

Warehouse automation refers to moving from physical labour performing repetitive tasks to the introduction of machines performing multiple tasks. Warehouse automation is the future of DC operations within the supply chain. Automation has the potential to unlock performance levels not yet seen by DC operators.

The automation of a Warehouse goes beyond the *four-walls* savings. Four walls refers to the physical DC processes such as receiving, put-away, picking, storage, retrieval and shipping as outlined in section 3.6. Automating these processes will increase quality checking (QC) and save on other equipment expenses usually required in the DC.

Automation will reduce labour inefficiency within the labour force as machines are not restricted by an available trained labour force, fatigue, or labour union constraints. The motivation for Warehouse automation is driven by two factors; *better performance* and a *reduction in costs*. In a marketplace where customer satisfaction is the outcome of the Supply Chain and competitive advantage achieved over one's competitors is the goal, automation is the solution.

3.9.1. Beyond the physical distribution centre

Automation not only improves the performance of the physical DCs but has a resounding impact on the rest of the Supply Chain. Warehouse automation drives value in three different levels of the Supply Chain. Automation unlocks massive strategic advantages throughout the entire chain, each of these is illustrated in Figure 3.7.

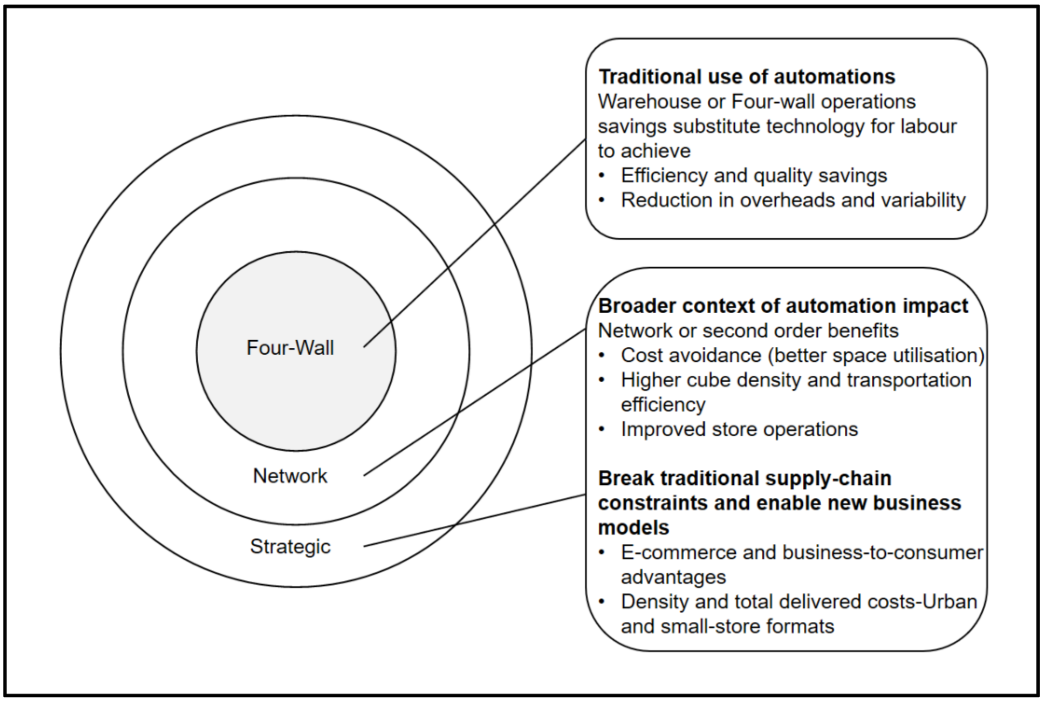


Figure 3.7: Warehouse automation unlocked in three levels of the supply chain
(Source adapted from:Kupper, Lorenz, Krizek, Kuhlmann, Maue, Lassig & Buchner, 2019)

Level 1: Four-wall perspective*:* This level refers to the replacement of labour within the Warehouse processes involved in the DC. The reduction in labour force leads to greater savings and increase operational efficiencies derived from the use of robots and computer systems to work continuously and consistently. Warehouse automation reduces the variability in supply through physical processes such as increased process performance achieved in receiving and picking times, unlocking throughput volumes and increased customer satisfaction.

Level 2: Supply Chain network: Through the implementation of an automated system within the DC, increased space utilisation of both racking and floor utilisation can be achieved, due to the increase of the DC's storage capacity. This is advantageous as existing DCs can unlock new efficiencies without increased property investment costs being incurred.

Level 3: Strategic Advantage, New supply chains: The Warehouse automation breaks down previous Supply Chain constraints, as e-commerce has become commonplace in today's societies, Business to Customer (B2C) transactions will increase. Therefore, both efficiency and service levels increase through reduced cycle times from order receipt to customer delivery. Increased customer satisfaction can be achieved through better efficiencies in cost, such as transport, DC variable cost reductions and minimised lost sales from incomplete orders can be realised.

Automation is identified as the turning point for e-commerce performance improvements, as the e-commerce field today struggles with the complexity of service provision, high costs per order as well as customer responsiveness. Automation can alleviate these issues by reducing the cost and complexity of SKU orders by using dynamic virtual picking slots.

3.9.2. Opportunity for Warehouse automation

Warehouse automation has been identified as the cornerstone for improved performance, lower space requirements, reduced costs and higher throughput, all of which impact the Supply Chain's and Business's ROI. Due to the improvements in technology more Warehouse processes can be automated while making use of machines that can handle multiple tasks. These enhancements in technology allow for a *Brown Fields*[4] *Warehouse* to be transformed into an automotive masterpiece of performance enhancement. The real enhancements and efficiencies lie in *SKU or each picking,*[5] with particular focus on two of the most expensive Warehousing processes – *picking* and *sequencing*.

Customers now order a single item through an e-commerce website and expect it to be delivered within 24 hours. The future is optimising the SKU picking and sequencing processes within the DC.

[4] *Refers to a warehouse that was designed for a different purpose but is being used to fulfil the current need.*
[5] *Each picking refers to a process whereby individual items are picked instead of case quantities*

This opportunity is outlined by Figure 3.8, which presents two scenarios, both indicated by the ***AB*** and ***CD*** lines. Warehouse automation has the potential to unlock value within DCs that have not been accessible before. With any new technology, the experience curve favours the *early mover*. Thus, the opportunity is available for further enhancements to SKU picking. This will reduce total cost per order, streamline the picking and sequencing processes as well as increase customer service and satisfaction.

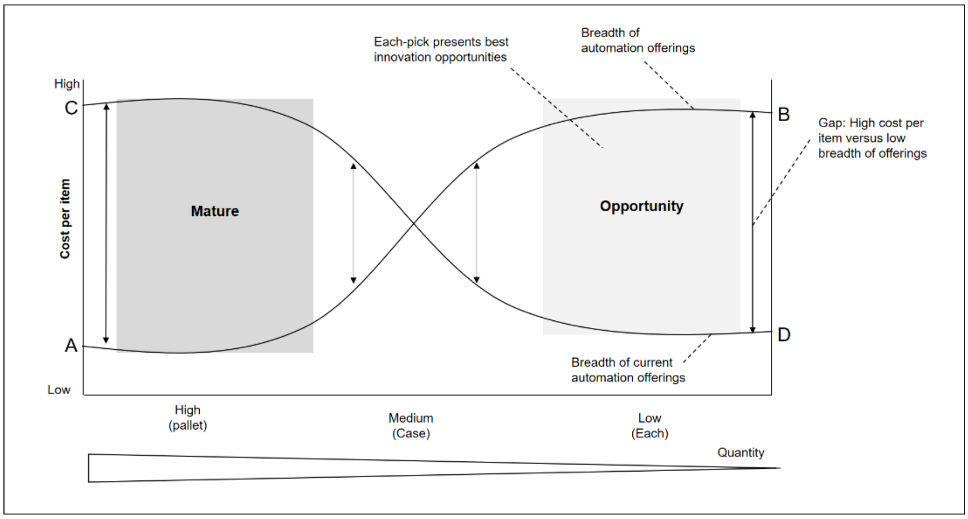


Figure 3.8: Evolving Supply Chain opportunities for SKU/Each automation
(Source adapted from: (Kupper et al., 2019)

The x axis identified in Figure 3.8, outlines the type of product (either pallet, case or SKU and its quantity) that is being processed, while the *y-axis* outlines the prospective costs. The ***AB line*** identifies the cost per pallet being processed to be minimal as identified by ***point A***, while a high quantity is processed, making it very efficient. However, due to e-commerce popularity, SKU processing is becoming more critical to customers and organisations. Given the current available technologies within DCs, exceptionally high costs are still being experienced in SKU picking, ***point B***.

The opportunity lies in improving these technologies to achieve significant cost reductions, identified by the lightly shaded area, labelled *opportunity* movement from ***point B*** to ***point D***. Through the automation of SKU processes, costs can be drastically reduced.

This will increase Warehousing performance through enhanced pick times, order cycle times and pick accuracy, resulting in improved customer service and satisfaction. In a world where e-commerce and high levels of customer service are expected and despite this opportunity, several areas of concern need to be considered before automated systems are implemented.

3.9.3. Avoiding automation implementation failure

Although Warehousing automation has been identified as the next step in performance improvement through cost reductions and increased efficiencies, avoiding implementation failure is critical to achieving automation success. Therefore, many organisations adopt new technologies without first considering what they really need, or do not facilitate the change and implementation of technology correctly.

To avoid this, many 3PL service providers are available to assess the business's needs as well as iron out any technical issues they may experience along the way. Before a company commits to implementing such technologies, a full due diligence should be conducted in line with the business's and Supply Chain managers' strategic objectives. 3PL service providers need to understand what the company needs and how long it will take to implement and at what cost. Only then can new levels of performance across all the levels of the Supply Chain network be achieved, through Warehouse automation.

3.10. Performance Management and Benchmarking in the Warehouse

"With competition, everyone has to try harder" – Harold H. Greene

The concept of benchmarking relies upon the comparison of an individual organisation's performance against the aggregated performance of the industry in which it operates. The purpose of benchmarking is to facilitate an understanding of an organisation's performance relative to its competitors (Tillman, Manrodt & Williams, 2019:6–7).

To be able to improve performance, organisations need to identify where they are lacking in order to improve. Benchmarking activities allow a Root Cause Analysis (RCA) to be conducted to discover where exactly an organisation is losing out to its competitors. Consequently, organisations learn from one another, increasing performance standards and improving customer service. Therefore, in order to remain competitive, organisations must measure and compare continuously. Identifying repositories of information to use as a means of comparison for an organisation's performance against the industry's average and the industry's best is not easy. The need for an available measurement framework is apparent.

3.10.1. Measurement of Warehousing process performance through KPIs and WMS

Warehousing facilities are defined by the products that are processed through the facility. These products are processed through inbound, inventory control and outbound activities. Each of these processes is outlined in section 3.6.

Each of these processes is organised and managed through the WMS. This system can record all of the processing data from the activities being conducted in the DC. This data must be analysed and interpreted into meaningful information. This data should then be used to calculate key performance indicators (KPIs).

These KPIs represent how well or badly the DC operations are being conducted within each of the five Warehouse processes. These results identify well-performing areas, areas of moderate success and low-performing areas. These three distinctions are critical, as not all KPIs calculated are valuable to the DC.

The reason is that the organisation should determine their strategy and the DC is used to facilitate this strategy. If a company decides to be reliable to customer orders, then the *perfect order index (POI)* or *perfect order fulfilment (POF)* could qualify as being more important than that of Warehouse capacity. Furthermore, identifying major issues is critical to ensuring the longevity of operations and customer service delivery.

Each of these KPIs is calculated in different ways depending on the definitions of the calculation used. For example: POI and POF attempt to measure the same four aspects, which are:

- Delivered with correct documentation
- Delivered to the correct location
- Correct product as requested
- Undamaged product upon delivery

All the results of these different aspects are multiplied together in order to derive either the POI or *POF index*. In industries, there are multiple ways in which the same type of KPIs could be calculated. However, in Warehousing, different schools of thought can agree on what is measured. The discrepancy is not in *what is measured* but, *how its measured*. This discrepancy will be discussed further in phase 2, Chapter 8, of the data analysis section of this study.

The need to measure is apparent and organisations need a method to identify how well they are operating. KPIs, if analysed properly, identify the current level of performance achieved. These KPIs also facilitate the ability to perform an RCA on the business.

Key performance indicators allow management to set expectations on performance and measure whether these expectations are being met. If these expectations are not being met, the RCA provides a method to identify all possible reasons as to why not? It then enables issues to be rectified through the implementation of specific solutions, in order to mitigate any ongoing inefficiencies with operation. Consequently, not all calculated metrics are KPIs, therefore organisations must measure what matters. In order to measure what matters each metric must be SMART, this will identify whether or not a metric is in fact a KPI (Doran, 1981:36).

3.10.1.1. *SMART metrics*

The term SMART is a *mnemonic acronym*[6] used to represent five measurement criteria that all metrics should have in order to be considered valuable KPIs. This acronym was developed in the field of business administration by Doran (1981:35–36) and was used to set management goals and objectives within the business environment.

Since then the acronym has been used in the field of project management, personal development, human resources, and performance measurement. This acronym describes five measurement criteria that all good measures should have, according to Doran (1981:35–36) these measures are:

S-Specific: Must be relevant to what is intended to be measured, pertinent to a specific area, process, or field.

M-Measurable: Must be able to quantify a value to represent improvements in performance.

A-Attainable/Achievable: Proposed results from measurement must be within reason/realistic, must be reachable with given resources.

R-Relevant: Measures must be relevant to the process or company being measured.

T-Time: The results of measured process are shown for a relevant period.

The first step of performance measure is ensuring that each measure being used fits all the above-mentioned criteria. This is good practice as it allows for meaningful information to be collected and interpreted to make good management decisions.

[6] *Mnemonic acronym: This is the creation of a pronounceable word created from the first letters of the full name given to anything.*

If one of these criteria were missing, for example: *Time,* good business decisions could not be made using these measures as there is no way of knowing if these measures are relevant to the current operating period. The identification of measurement criteria for metrics to become meaningful KPIs is critical. KPIs are not the only performance measures that exist, there are generally four different types of performance measures.

3.10.1.2. *Types of performance attributes*

In any organisation understanding performance levels is critical to understanding whether goals are being achieved. For this understanding to take place it is important that past results, current results, and future goals are all considered when determining the performance levels achieved.

Past results set the base which organisations must improve upon, while current results determine where they have improved and by how much they have improved. Finally, understanding the performance base and current performance, new performance goals or targets can be set for the future. Understanding the different types of performance measures that exist can clearly define which types of measure are used when the following four performance measures have been identified: (KPI.com Infographic: 2018)

Key result indicators (KRIs): These metrics provide a holistic view of past performance and are best used for strategic level management review.

Performance indicators (PIs): Identifies to staff on tactical and operational level what needs to be done.

Result indicators (RIs): Identifies to staff on tactical and operational level what has been done.

Key performance indicators (KPIs): Identifies to staff on tactical and operational level what needs to be done for considerably improved performance.

For the purpose of this research, KPIs will be the main performance measure used in the data collection and results section. The reason for this choice of performance measure is the desired outcome of identifying potential for considerable improvements in performance. Phase 1, Chapter 7 of this research, will elaborate further on performance measurement and how the KPIs can be used in a case study context. Consequently, understanding how Warehousing processes and the WMS interact with one another as well as deriving meaningful measures from this information is the goal. However, what good are measures if they are not compared to industry norms and perhaps compared to the best in the industry? In order to determine our performance relative to our competitors, benchmarking activities must take place.

3.10.2. Introduction to the WERC benchmarking framework

The need to understanding how the use of Warehouse performance frameworks can benefit an organisation to understand not only how well they are currently doing compared to their competitors but also for them to understand how far off from being the best they are. This will provide a useful insight into how well an organisation is doing, as well as identifying areas for improvement. One of the most relevant, prominent, and popular frameworks geared to conduct Warehouse performance benchmarking is the Warehouse Education Research Council (WERC) watch framework presented by Tillman et al. (2019). This repository makes use of annual performance surveys to outline the most popular metrics currently being measured in industry as well as outline performance thresholds and benchmarks based on respondent feedback. The WERC framework is an exceptional tool that can and should be used to conduct performance measurement.

The purpose of the WERC repository is to provide practitioners with a means of understanding the key operational metrics inherent in a Warehouse as well as an understanding of how these metrics have changed over the years. This is critical for most practitioners, because as trends and customer buying behaviours change, so too does the importance of different metrics. However, the metrics must always align with the Supply Chain strategy. If they do not, there is a disconnect between what is measured and what needs to be measured. All management levels, as outlined by Ballou (1999:38), were analysed to determine their level of understanding as well as the depth to which strategic intent was understood in each study. This integration of multiple level management further outlined the important differences between which measures should be included. Therefore, Annexure A, Figure A.1. illustrates the percentage of each respondent against their management level.

These respondents were also categorised based on the different industries that they operate in. This allows for companies to compare themselves not only with industry standards but also to determine how many of their competitors are involved in the metrics being used. Figure A.2. outlines the percentage results of different management levels per industry, involved in the composition and collation of these results.

It is important to note that these repositories' respondents reside within the United States of America (USA). However, this repository is the only one available for the purposes of this research. The identification of the number, management level and region these respondents' responses have identified are the top twelve most popular metrics across the above-mentioned industries. Table 3.3, outlines these metrics as well as the rank they achieved over three different years. This time analysis shows a popularity movement trend amongst practitioners with regard to operational metrics (Tillman et al., 2015;5).

Table 3.3:Popular metric ranking based on respondents' votes

Trend of metric popularity			
Metrics	2015	2014	2013
On-time shipments (Customer)	1	1	1
Internal Order cycle time, in Hours (Customer)	2	2	2
Dock to stock time, in Hours (Inbound operations)	3	4	4
Total order cycle time (Customer)	4	3	3
Order picking accuracy, percent by order (Quality)	5	5	5
Average Warehouse capacity used (Capacity)	6	8	9
Peak Warehousing capacity used (Capacity)	7	9	12
Backorders as a percentage of total orders (Customer)	8	11	-
Backorders as a percentage of total orders (Customer)	9	-	-
Percentage of Suppliers orders received damage free (Inbound operations)	10	7	8
Lines picked and shipped per person per hour (Outbound Operations)	11	6	6
Lines received and put-away per hour (Inbound Operations)	12	10	11

(Source adapted from: Tillman et al., 2015;5)

This topic forms the basis of phase 2C of chapter 8, and presented in Chapters 5 and 8 respectively. In this research document, an extensive literature review of all available Warehouse benchmarking frameworks was conducted to identify and analyse the most comprehensive measurement framework available. This outcome of this analysis selected a single framework that was then used in *phase 2C (Chapter 8)* and *phase 3 (Chapters 9,10,11,12 and 13)* of this study, to conduct an exploratory study.

3.11. Summary of Warehouse literature findings

Understanding the structure and design of a Supply Chain is critical to understand where an organisation fits within this chain. Furthermore, understanding where the Warehousing facility is situated within the Supply Chain is just as important. A Warehouse is typically positioned within the Supply Chain network where its suppliers have easy access to the facility, and in close proximity to the majority of the customer base. This can either be designed as a centralised or decentralised Warehousing location within the greater network. This design choice is dependent on the volume of products moving through the chain as well as the geographic spread of all its customers.

Distribution centres fulfil three basic overarching processes, inbound activities, processing activities and outbound activities. Each of these overarching activities is supported by five Warehousing processes, namely, *receiving, put-away, storage, picking* and *shipping*. In conjunction with these Warehousing processes is an information support system or WMS. This system allows for the tracking and tracing of stock as it moves through the processes and areas within the DC.

The importance of the WMS is not only its ability for the organisation to understand current stock levels or improve the ability to service the customer; it facilitates the execution and evaluation of the DC's process activities and performance. The ability to measure how well a facility is doing in operations is critical to improving performance. Furthermore, it has been identified that not all metrics are KPIs, which makes the point that not all data is information.

Understanding what needs to be measured and what the organisation's expectations are before it is measured is also critical to performance management. This can be achieved through the development of a metric hierarchy. This statement is summed up perfectly by Winston Churchill who said:

It is no use saying, "we are doing our best", you have to succeed in doing what is necessary.

– Winston Churchill

Consequently, metrics must be prioritised to determine what needs to be measured first. This prioritisation method allows organisations to conduct fast action RCAs. This will allow organisations to find and solve performance issues within operations faster and more effectively than ever before. Gartner (2016) outlines what a KPI prioritisation could look like in Figure 3.9.

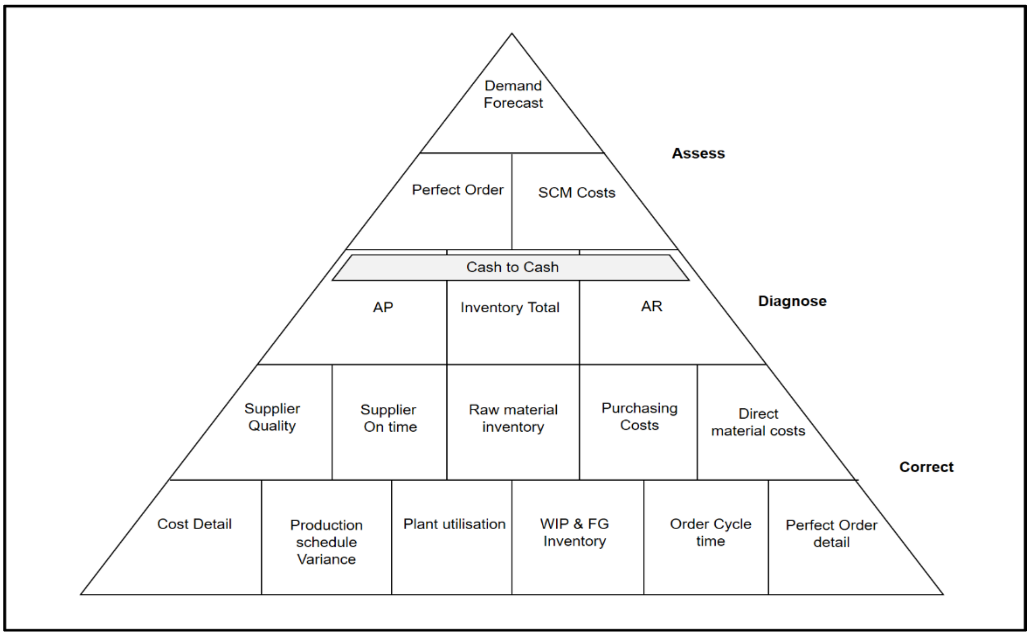
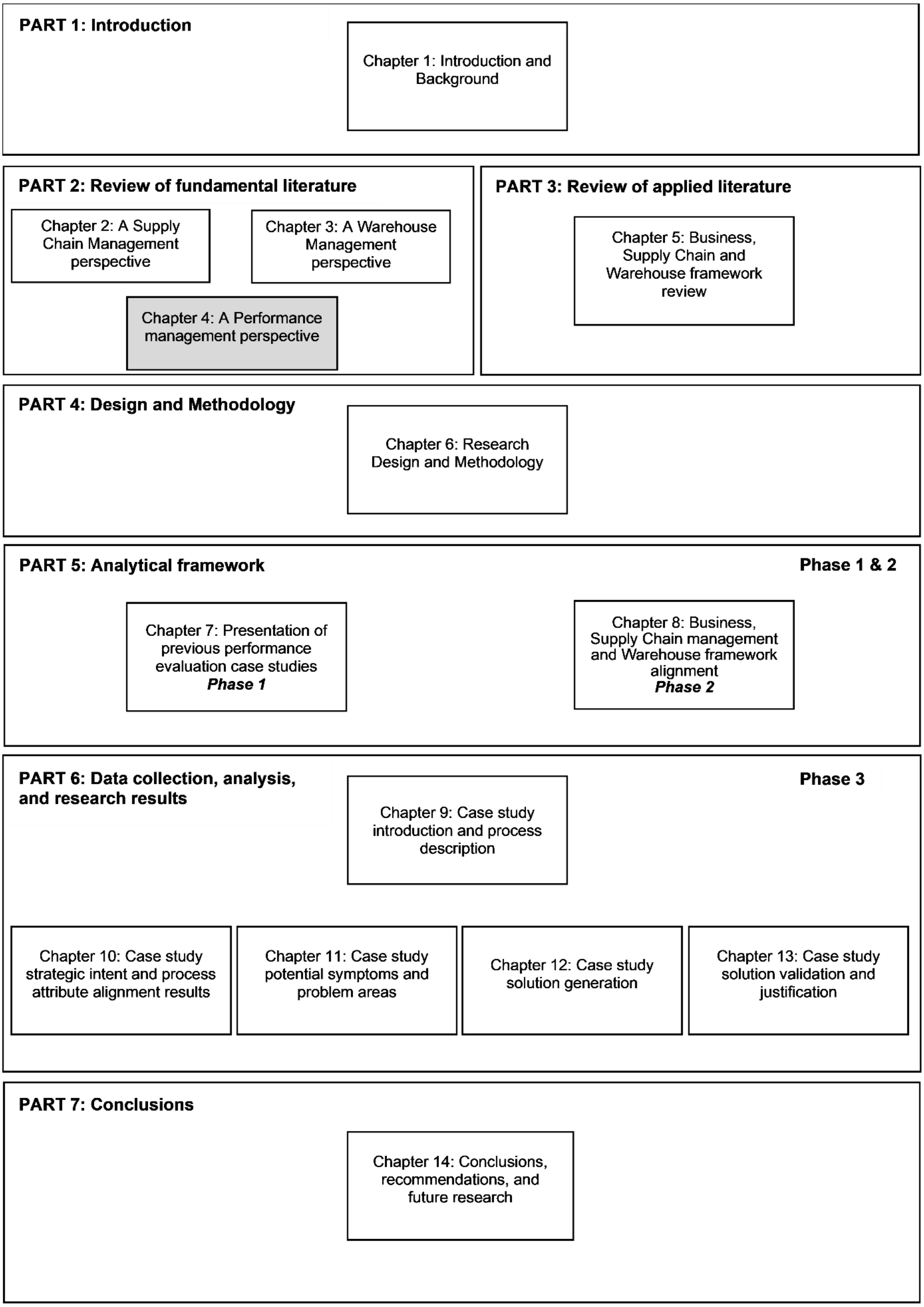


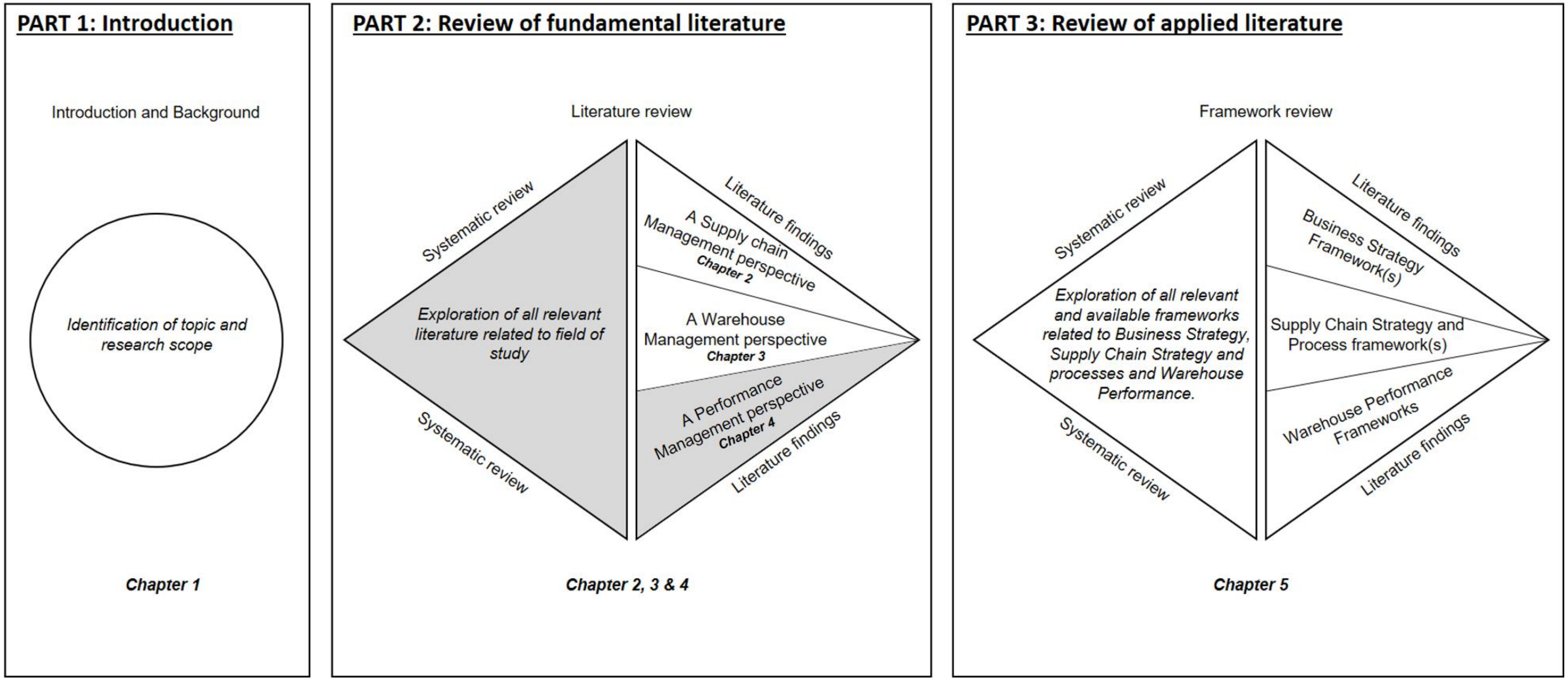
Figure 3.9: Example of the prioritisation of performance metrics
(Source: The Gartner Supply Chain hierarchy of metrics benchmarking, 2016)

Identifying what decision should be taken at each level, to help facilitate good decision-making is critical to performance success. However, another method of improving performance is that of benchmarking. This describes the ability of a facility to measure itself against the industry norms as well as the best in industry scores. This is advantageous as it identifies areas of competency and areas that require improvement, as well as quantifying the competitive advantage gained or lost from operations within a given period.

This concept will be tested on multiple cases to determine whether metric prioritisation can influence the development of operational solutions to improve a company's performance. This will be outlined in *phase 1* of the data analysis section of this report.

PART 2: CHAPTER 4
LITERATURE REVIEW
A PERFORMANCE MEASUREMENT AND MANAGEMENT PERSPECTIVE




PART 1: Introduction
Introduction and Background
Identification of topic and research scope
Chapter 1
PART 2: Review of fundamental literature
Literature review
Systematic review
Exploration of all relevant literature related to field of study
Systematic review
Literature findings
A Supply chain Management perspective
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PART 3: Review of applied literature
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Systematic review
Exploration of all relevant and available frameworks related to Business Strategy, Supply Chain Strategy and processes and Warehouse Performance.
Systematic review
Literature findings
Business Strategy Framework(s)
Supply Chain Strategy and Process framework(s)
Warehouse Performance Frameworks
Literature findings
Chapter 5

Chapter 4: A Performance Measurement and Management perspective

4.1. Introduction and Background

The global business environment we find ourselves in today requires organisations to think differently about how they remain competitive in a low cost, consumer-centric economy. The increased competitiveness between organisations have highlighted the increased focus on performance measurement, within the past few decades. Organisations need to find new and innovative ways in which to gain competitive advantage while adding value throughout the chain in a highly competitive globalised market. In order to do this, organisations turned to focusing on their current strategies and in turn began to measure how well they were meeting their goals (Gawankar and Kamble, 2015:6).

Companies are focusing more and more on their Supply Chain to enhance performance and drive customer satisfaction. To do this, it is critical that an organisation's Business Strategy and their Supply Chain strategy interlink and are aligned. This means that the business's overarching objectives must be translated to and be supported by Supply Chain strategic intent. This will ensure that day-to-day operations are focused towards the business's overarching objectives (Cohen & Roussel, 2013:189).

Performance management is the key to complete organisational success at any management level. If all areas and levels of the business are pulling in the same direction then the level of performance achieved will be excellent. If, however, there is a misalignment of the Business Strategy and the Supply Chain strategic intent the organisation will never realise its full performance potential (Cohen & Roussel, 2013:187). The importance of performance management's involvement throughout Business and Supply Chain execution is critical as it will provide a synopsis of what is working and what isn't.

Organisations are slowly realising the importance of measuring their Supply Chains and all its encompassing subsets, such as Warehousing and Logistics, in line with is Overarching Business strategies. Performance management is the concept that identifies how well this alignment has been achieved as it helps to outline how well the organisation is doing. The trick is ensuring maximum performance from a given organisation and its surrounding Supply Chain in meeting its objectives.

This increased focus drew more and more attention towards how a company should go about conducting performance measurement, as it was still unclear what should be measured and what shouldn't. For a long time, organisations were solely focused on financial indicators to determine their level of performance achieved.

These indicators have changed throughout the years to include other non-financial performance measures such as customer-, process- and people-focused measures to develop what is now called a dynamic multidimensional performance framework which is based on the Balanced Score Card (BSC) framework presented by Kaplan and Norton (1996). Understanding performance measurement is critical before attempting to manage the derived performance through a reiterative process of measurement and review (Neely, Adams and Kennerley, 2002:15).

4.2. The literature review process

This literature review section outlines some of the keywords and phrases used during the literature review. The use of the systematic review methodology helps identify the search parameters to narrow the scope of findings resulting from the investigation. Added to this, the use of Boolean operators was also used during this search to help derive search results focused on the field of performance management. The search words and phrasing identified in Table 4.1 were used to find the more relevant literature related to the field of Performance measurement and management. The selected search words and phrases helped to narrow the search results returned.

Table 4.1: Performance management literature review process

Repository/Source database	**Keyword 1**	**Keyword 2**	**Keyword 3**	**Findings**
ABI/INFORM Collection	Performance	Supply Chain	Measurement	Moderate
	Supply Chain	Strategy	Process	Excellent
		Performance	Metrics	Good
EBSCOhost	Performance	Management	Supply Chain	Good
	Supply Chain	Management	Benchmarking	Moderate
Elsevier SD Freedom	Performance management	Supply Chain		Moderate
Google Scholar	Supply Chain	Performance	Metrics	Moderate
ProQuest ABI/INFORM Collection	Performance	Management	Balance scorecard	Excellent
SAGE research methods	Performance	Supply Chain	Measurement	Moderate
ScienceDirect	Performance	Management	Supply Chain	Moderate
Texted book	Performance	Supply Chain	Measurement	Good
	Performance	Management	Supply Chain	Moderate
	Supply Chain	Management		Moderate
Wiley Online Library	Performance	Management	Supply Chain	Good
Boolean operators used: AND/OR/NOT; (*term*); "*term*"				

This literature review helped bridge the gap between the Supply Chain Management perspective literature review identified in Chapter 2, and the Warehousing perspective, presented in Chapter 3 as the concept of performance measurement is applicable to both the Supply Chain and the Warehouse. Therefore, understanding how performance measurement and management are conducted will help outline how Business Strategy, Supply Chain strategy and processes as well as Warehousing processes link together and how each of these concepts can be measured and aligned.

4.3. Elements of Performance Measurement

Performance management boils down to the measurement of tasks and objectives to derived feedback on operational execution as well as inform the decision-making processes. Performance management is a reiterative process of measurement and remeasurement, to determine any change in the performance level status quo.[7] This process of performance measurement therefore requires management. Before performance management can take place, an understanding of the two fundamental components that constitute performance measurement must be outlined.

4.3.1. Components of performance measurement

As outlined by Ozan (2008:5) performance measurement is made up of two components, Efficiency and Effectiveness. Efficiency outlines how well a process is executed in terms of the ratio of work done against benefit derived from that work. Effectiveness, on the other hand, outlines the result achieved measured against a predefined goal. These concepts are widely used across many disciplines, including sport. For example, in archery, an efficient archer can hit the target somewhere, disregarding the placement of the arrow on the target. An effective archer can hit a specific position on the target, such as the bullseye.

The concept of performance measurement when applied within the context of a Supply Chain focuses on the same concepts as the archery example. Performance measurement helps outline how effective the Supply Chain processes are in executing day to day operations (hitting the target) while it also outlines how well the processes achieved a stated object (hitting the bullseye). In this way performance measurement can help reconcile how efficient and effective a Supply Chain is.

[7] **Status Quo-** “the existing state of affairs, especially regarding social or political issues”.

Linked to the measurement of the level of performance achieved is its management, in other words defining what the target will be. This is a very important element as there is no point in *loosing an arrow* if you do not know in which direction it needs to go to find the target. The inclusion of performance management as value driver within the supply chain is critical to the success or failure of a supply chain and ultimately the business.

4.3.2. The seven purposes of performance measures

The benefit of performance measurement can be outlined based on the ***seven purposes of performance measurement*** set out by Meyer (2003:30-31). These seven purposes help to facilitate a rationale behind how performance measures can be used. Meyer (2003:30-31) outlined the following purposes that define performance measurement, predominantly in larger firms that require further rationale and investigation during the performance management process for better, more well-defined decision-making to take place. These perspectives as identified in Figure 4.1, outline all seven of these aspects.

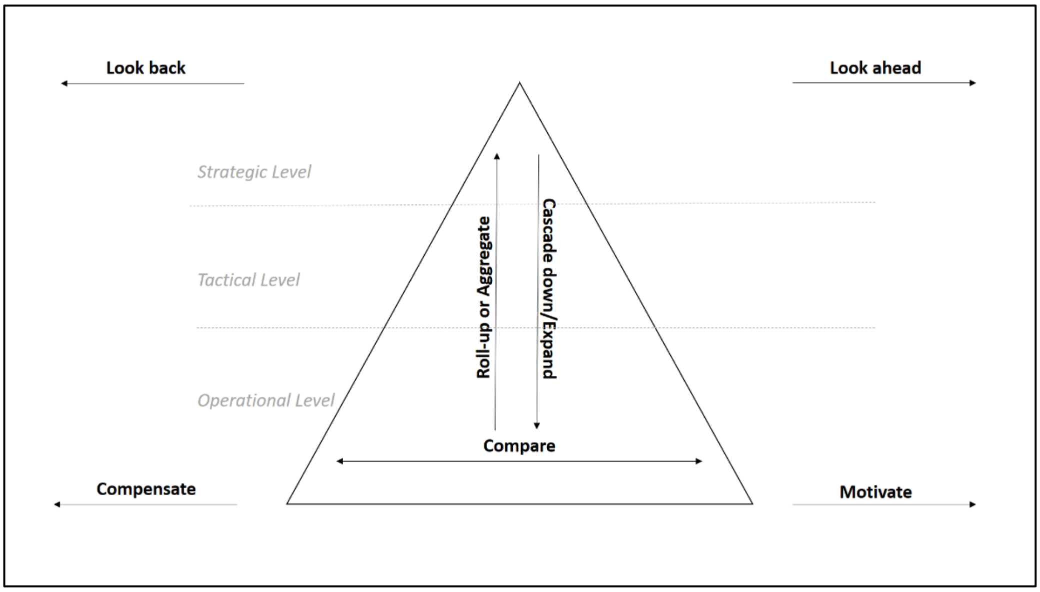


Figure 4.1: The seven purposes of performance measurement
(Source adapted from: Meyer, 2003:31)

From an organisational perspective, the most common purposes defined in Figure 4.1, identify the ***look back***, ***look forward***, ***compensate,*** and ***motivate,*** as these are the most common purposes of performance management found in both Small and Larger firms. These purposes are defined outside of the organisation pyramid. Furthermore, the ***look back and look ahead*** are placed at the peak of the pyramid as measures with the purpose of focusing on *strategic level* related performance measures. The ***Compensate*** and ***Motivate*** type measures focus predominantly on the *tactical level* or individual person involved in day-to-day operational execution.

For larger, more complicated organisations, the requirement to be able to ***roll-up/aggregate*** or ***Cascade down/Expand*** performance measures becomes more relevant as the size of the organisation increases. This furthers the level of complexity in terms of performance management but can also drive the alignment between Business strategies (Strategic level), Supply Chain strategic intent (Tactical level) and Warehousing processes (Operational level).

The alignment of a business strategy with a Supply Chain's strategic intent across all three of these levels namely, *Strategic, Tactical* and *Operational,* outlines one of the major underlying themes discussed in this research document. Organisations need to move away from traditional performance measurement concepts and towards a dynamic performance management technique.

4.3.3. Traditional performance measurement

Many companies in operation today, are conducting measures related to their daily operations, even if it is just to manage the cost of doing business. In the present business environment, an impressive amount of financial metrics is available due to the stringent tax requirements imposed by governments and the increasing pressures from shareholders requiring annual financial breakdowns to understand how well their investments are doing. Performance measures are predominantly lagging indicators outlining to the business what has already gone wrong; this concept of identifying issues after they have occurred is restricting Organisational success as they are not aware of the issues until such time as it is too late to react. The concept of performance measurement encourages organisations to be proactive in the measurement of their Supply Chains. The difficulty is for organisations to understand what they should be measuring, in a traditional scenario as outlined by Andersen, Bredrup, Bredrup, Pedersen, Prytz, Rolstadas, and Torvatn (1995:170) in Figure 4.2, an organisation will deconstruct business objectives to develop plans and ultimately measures.

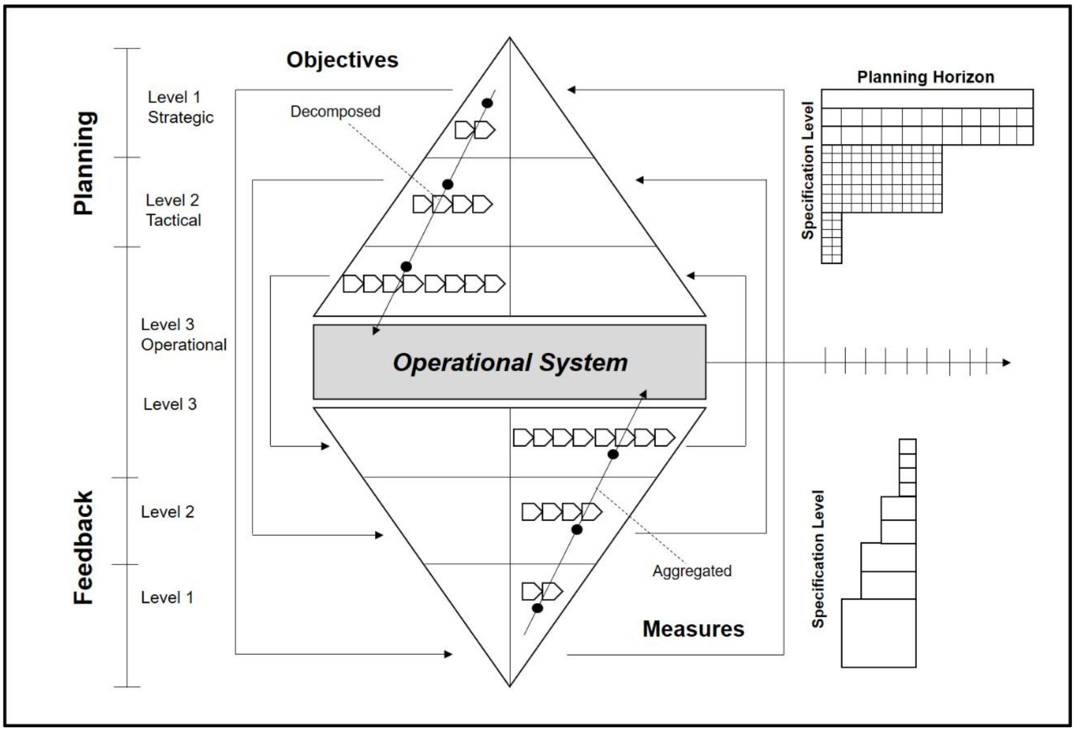


Figure 4.2: The planning hierarchy-Deriving measure from strategy
(Source adapted from: Andersen et al., 1995:170)

These plans then aggregate measures as feedback for the implemented plans level of success. This concept is presented in Figure 4.2. The willingness and need to aggregate performance measures has been the best argument for the continuous focus on financial indicators. Most often, operational level indicators for flexibility, time and quality are difficult to aggregate to a strategic level and therefore, play a minor role in the overall performance evaluation (Andersen *et al*., 1995:170). This silo-like approach to performance measurement saw the aggregation of departmental performance on the corporate level and has therefore become obsolete. As interdepartmental processes are adopted so, too, are interdepartmental performance indicators. This interrelated measurement will reflect the true nature of performance; by breaking down the operational silos the true level of performance can be determined (Cohen & Roussel, 2013:207).

4.4. The evolution of Performance measurement to management – From recommendations to frameworks

The concept of performance measurement has changed over time, initially focusing on fundamental performance measurement recommendations around the mid-1980s, to performance management used in industry today as presented in Figure 4.3 by Folan and Browne (2005:675). The progression of performance measurement and the management thereof has seen significant developments over the past 40 years; this is evident based on the work presented by Neely *et al.* (2002:13) and the paper presented by Sushil and Sagar (2013:952-962).

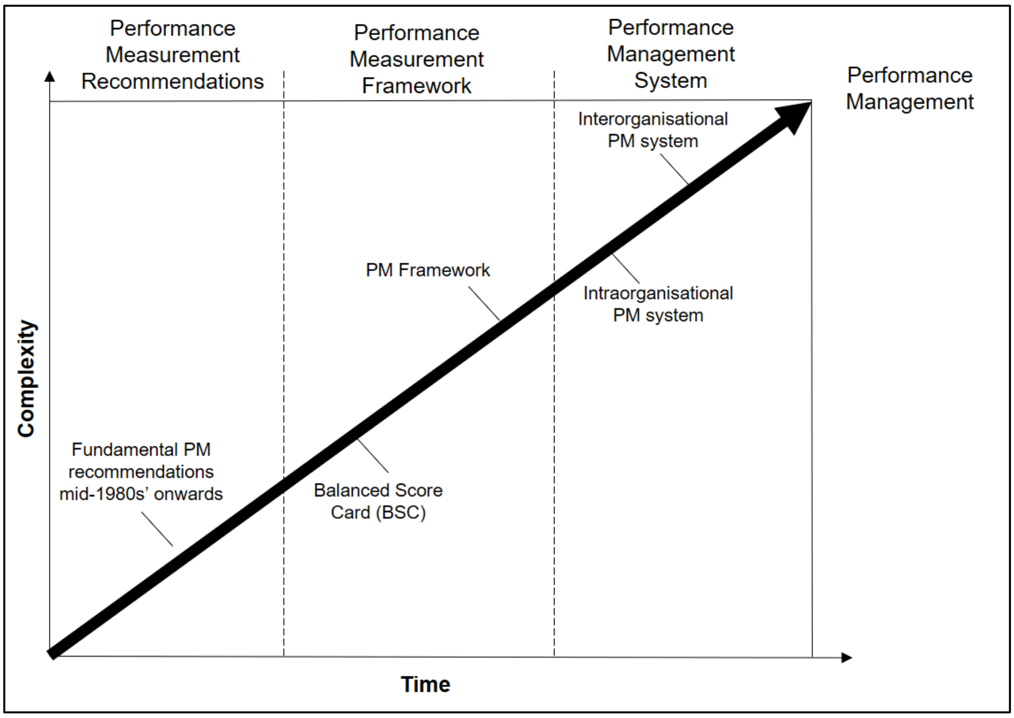


Figure 4.3: The evolution of performance measurement
(Source adapted from: Folan and Browne, 2005:675)

Both bodies of work examined the research trends related to the concept of Performance management recommendations, frameworks and systems, and how these concepts have changed through the years. These investigations help outline the progression of both academic and industry's change in thinking related to the Performance management field and how best to conduct performance measurement.

A brief review of the fields of study shows trends which have been presented within this chapter to outline some of the key focuses, practitioners like Kaplan and Norton (1996) and Neely *et al*. (2002) have presented in their frameworks.

This is important that if one of these frameworks is going to be used to conduct a performance measurement case study, the most relevant and suitable framework or system must be used to ensure accurate measurement and management of a case company's performance.

4.4.1. Performance Measurement Recommendations

The initial fundamentals of the performance measurement concept, referred to either as systems or frameworks begins with a performance measurement recommendation. This recommendation outlines a suggested course of action related to performance measurement. If a series of recommendations have been aggregated, a performance measurement framework can be determined. Although at the time of these recommendations during the late 1980s to mid-1990s, the recommendations determined what measures will be used to conduct performance measurement. This subjective approach to selecting performance measures created conflict between professionals about what should be used as performance measures. The work presented by Folan and Browne (2005:665) has outlined that developing and integrating these contrasting perspectives of performance measurement recommendations into a unified framework that satisfies all is unrealistic.

4.4.2. Performance measurement Frameworks

The development of performance measurement frameworks has seen significant work being done related to the creation and implementation of PM frameworks. A framework refers to a predetermined or agreed-upon set of recommendations that will be presented as part of that framework. The concept of PM frameworks helps define the measurement boundaries, this means to say, the framework intends to only measure what is deemed to be important. It is critical to distinguish between a procedural framework and a structural framework.

- Structural frameworks: are focused specifically on administrative and selection elements of performance measurement
- Procedural frameworks: are focused on the process of conducting performance measurement.

It is widely understood, as outlined by Folan and Browne (2005:669) that each PM framework lacks what the other has. A Structural PM framework does not include a procedural complement while the procedural component lacks a definitive guide of what should be included. It is at this point that Performance measurement systems become available. A Performance measurement system incorporates both a structural and procedural element, as well as several other measurement tools to be able to use these frameworks within industry.

4.4.3. Performance Measurement Systems

When comparing Performance measurement frameworks and Performance measurement systems there are a lot more performance measurement frameworks available than there are systems as presented by Folan and Browne (2005:669) and Neely *et al.* (2002).The majority of the PM systems that are developed in companies are a collection of best practices that have been combined with an existing PM framework. Currently, the most prominent Performance measurement system available in academia today are presented below as outlined by Neely *et al*. (2013:963):

- The Performance pyramid (SMART)
- The Balanced Score Card (BSC)
- Performance Prism
- EFQM-Excellence model

Research conducted by Folan and Browne (2005:671) presented a comparison of these four performance measurement systems, as illustrated in Table 4.2: Summary of most prominent Business Performance Measurement frameworks. This table outlines the most proficient Performance measurement frameworks available for use in industry today. This outlines significant gaps within Performance measurement capabilities, despite each of these frameworks being used across industry-specific case studies, each of them in its own way struggles to present a complete performance measurement approach that can be applied across all examples and industries.

In most cases these frameworks and systems are used as guidelines and instructions to the creation of a specified performance measurement framework based on a case example. Therefore, the development of a performance measurement system is critical to conduct accurate performance measurement and manage the results, but first we need to understand what type of metrics exist before measurement can take place.

Table 4.2: Summary of most prominent Business Performance Measurement frameworks

Name of PMM frameworks	Researcher	Year of origin	Issue(s) Highlighted	Dimensions of performance measurement	Contribution(s)	Limitation(s)
Performance Pyramid (SMART)	Cross & Lynch	1988	Identification of performance measures for organisational hierarchy	Market, Financial, Customer satisfaction, Flexibility, Productivity, Quality, Delivery, Cycle time, Waste	It highlights the results are lagging indicators and determinants are leading indicators.	Considerations of non-financial measures, stakeholders and their behavioral aspects related to performance have been neglected.
EFQM-Excellence model	European Foundation	1991	Organisational improvement by self-assessment	Leadership, People, Policy and strategy, Partnership and Resources, Processes, Key Performance indicators	It is a non-perspective framework based on nine criteria related to enablers and results for self-assessment to improve.	It does not consider the dynamics of a changing external environment.
Balanced Score Card	Kaplan & Norton	1996	Complements financial measures with non-financial performance measures	Financial, Customer, Internal processes and Learning and Growth perspectives	Most dominating and highly used performance measurement framework which highlights non-financial measures compliment to financial performance measures.	The problems to identify cause-effect relationships between linkages of different perspectives, static nature of performance measurement and major stakeholder related to performance are not adequately addressed.
Performance Prism	Neely *et al*	2001	The stakeholder orientation	Stakeholder satisfaction, stakeholder contribution, Strategies, processes, and Capabilities	It highlights a comprehensive view of different stakeholders related to the performance of any enterprise and new stakeholders.	It gives little way about how performance measures are being realised and hardly any consideration is given related to use of the framework for existing PMS.

(Source adapted from: Neely et al., 2002:953 & 958)

4.5. Types of measurement metrics

Metrics are the building blocks to performance management; these metrics are used as result indicators used to determine the outcome of a given process or objective. A metric can quantify the level of performance that was achieved. It is critical that the correct type of metrics is reviewed when determining level of performance achieved. Understanding the different types of metrics is critical in the development of Performance measurement system (Andersen *et al.,* 1995:177).

4.5.1. Hard vs Soft metrics

The physical characteristics help distinguish between Hard and Soft metrics each of which play a role in the measurement of business objectives.

- **Hard metrics:** These types of metrics focus on empirical facts that can be measured directly. They are deemed to be objective, accurately known, and hierarchical. This is essential for unbiased and accurate measurement to take place.
- **Soft Metrics**: These are metrics that are intangible and must be measured indirectly. The best example of a soft metric would be the evaluation of a respondent's attitude when asked a question. These metrics are however, subject to observer bias and can vary based on the situation being measured.

The comparison between soft and hard metrics can result in confusion and incorrect or inappropriate measures being used to conduct performance measurement. Throughout the development of the field as stated management by numbers is one of the critical failings of performance management, this in turn explains why financial metrics have been the main focus of performance measurement, throughout the early years of the field's history. For example, *customer satisfaction* cannot be measured solely by hard metrics.

4.5.2. Financial vs Non-Financial metrics

Collectively, financial, and non-financial metrics are both types of Hard metrics. Both these types of metrics are required to conduct performance measurement, Table 4.3, outlines some common financial and non-financial metrics that are used in traditional performance measurement (Andersen *et al.,* 1995:178).

Table 4.3: Breakdown of types of financial and non-financial measures

Financial performance metrics	Non-financial metrics
Budget vs Actual variances	Inventory turnover
Product/Product group profitability	Labour efficiency
Cash flow	Capacity utilisation
Return on total capital	Defect ratio
Overhead absorption	Lead times
Customer profitability	Delivery precision

(Source Adapted from: Andersen et al., 1995:178)

The only problem with these types of performance measures is that they are mostly retrospective. The difficulty of retrospective measurements is that the performance level is derived and reviewed to determine what ***went*** wrong not what is ***going*** wrong. These metrics predominantly focus internally on determining the level of performance. This results in a narrowed perspective of performance, because without comparison to others or to a common standard how do we derive the true level of performance. The process of integrating different types of metrics to derive accurate performance measurement is critical in the management of performance achieved. For good performance measurement to take place, different methods need to be incorporated. These methods differ from organisation to organisation around the world.

4.5.3. Achievement vs Process metrics

The difficulty in distinguishing between *Hard* and *Soft* metrics is understanding what needs to be measured to derive the true sentiment of the level of performance achieved from a given objective. This brings about a discussion related to Achievement metrics vs Process metrics as well as a discussion about different organisational cultures around the world.

Achievement metrics as adopted by the Western world focuses on achievement derived, such as financial efficiency and as a result achievement, whereas the Japanese perspective is more focused towards process measurements. The measure is used to determine what important characteristics impact the output of a given process.

The key difference between these two types of performance measurement styles is the time horizon. The Western perspective looks for a short payback period from implemented changes while the Japanese perspective expects a balanced result that will be derived eventually. Therefore, the focus here, unlike the Western perspective is to focus on continuous improvement from all areas, not just to solve the single issue.

4.6. Different development approaches to Performance Measurement System

The development from performance recommendations to frameworks to systems as presented in section 4.4, outlines one specific theme; currently measurement frameworks are available in industry, but which one should be applied in which scenario. To be able to decide on which framework will be used for a performance management case study, we first need to understand what are the different methods for the development of performance measurement frameworks. The development of these frameworks makes use of one of the three methods discussed below:

4.6.1. Top-down approach

The top down or cascading approach was outlined by Andersen *et al.* (1995:182) and Meyer (2003:31) respectively. This method of performance measurement is the most traditional approach as it attempts to manage performance based on a predefined set of objectives. Normally, these objectives are defined at a business's strategic level, whereafter operations execute according to the predefined or stated objectives. During this trickle-down, performance measures are derived to determine the success or failure of the strategic level objectives. This method reiterates a top-down approach whereby upper management dictates expectations based on the selected strategic objectives, tactical and operational level management and personnel are not involved in this process whatsoever.

4.6.2. Bottom-up approach

The bottom up approach is based on an individual set of responsibilities based on the job description. Everyone is responsible for defining possible improvements within their area of operation. All these improvements are then rolled up together to determine overall performance achieved. The difficulty with this method is the lack of focus and direction for performance improvements. Everyone is focused on their own contribution to increase the level of improvement, but these improvements may not be what the organisation requires.

4.6.3. Combination of Top-down and Bottom-up approach

The combination approach attempts to include both methods into a comprehensive performance measurement method, to help develop a dynamic and comprehensive framework for measurement and in turn management. The combination of these methods helps to develop performance priorities based on strategic, tactical, and operational level requirements.

The result of this prioritisation outlines to the company at all three management levels, what is most important and what is least important. Therefore, the entire organisation is aligned with to the objectives and can focus their efforts accordingly.

The purpose of this review up until this point is to understand what are the components that make up an effective performance measurement framework/system: to outline how these frameworks are developed; to evaluate what and how these frameworks conduct performance measurement; as well as what types of measure and metrics are available and are used in these frameworks. The outcome of this is to help determine which performance measurement framework will be best suited to conduct a strategic-alignment with operational processes to attempt to define, realign and prioritise an organisation's performance environment.

4.7. Summary of Performance Management literature findings

At this point, we have discussed the elements of performance measurement and outlined that the process of performance measurement needs to be efficient and effective in order to derive maximum benefit. Furthermore, the review of previous trends in the field of performance management from a *traditional recommendations* method to a *framework approach* and then final to a *performance systems approach*, helps to outline the best methods for conducting performance measurements within an organisation.

Finally, the discussion around the three methods (*Top-down, Bottom-up and Consolidated approach)* that are used when developing a performance measurement model is important, as it informs which frameworks, that are currently available, will be best suited to be incorporated into a *strategy-process performance alignment matrix* as presented in Chapter 8. Another critical element of performance measurement is benchmarking, this is to derive a performance measurement result that can be compared and recalculated year on year, with credibility, to determine whether an organisation has achieved a performance improvement or not.

As a result, a deeper understanding of each of the identified frameworks presented in section 4.4.3 was required, in order to identify the performance measurement framework that was best suited for alignment with the SCOR reference model. The analysis, presented in Chapter 5, reviews each of these frameworks to help determine which one would be best suited to provide a Business strategy perspective to the strategy-process performance alignment matrix further benefiting the alignment of strategy, processes, and metrics.

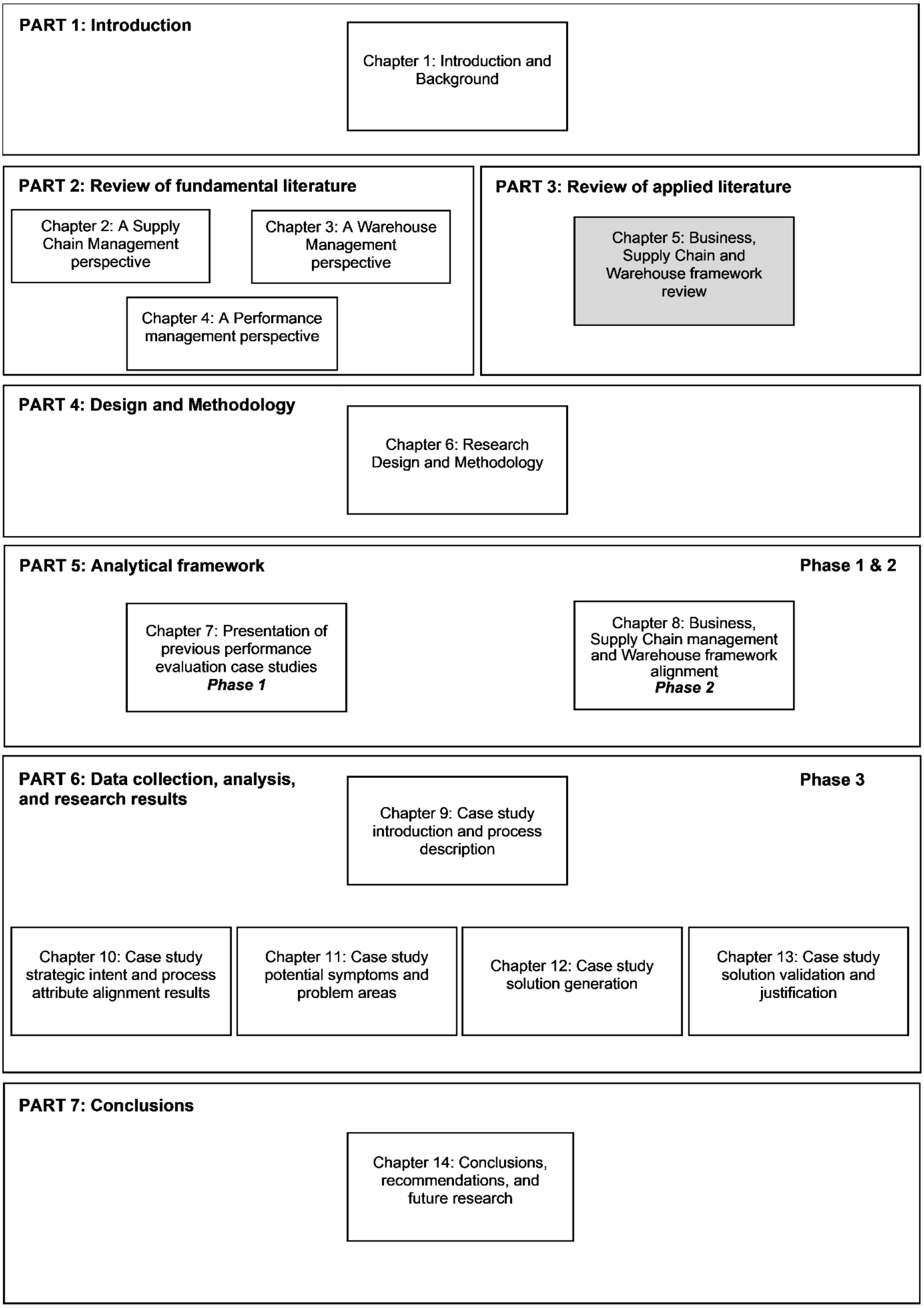
PART 3

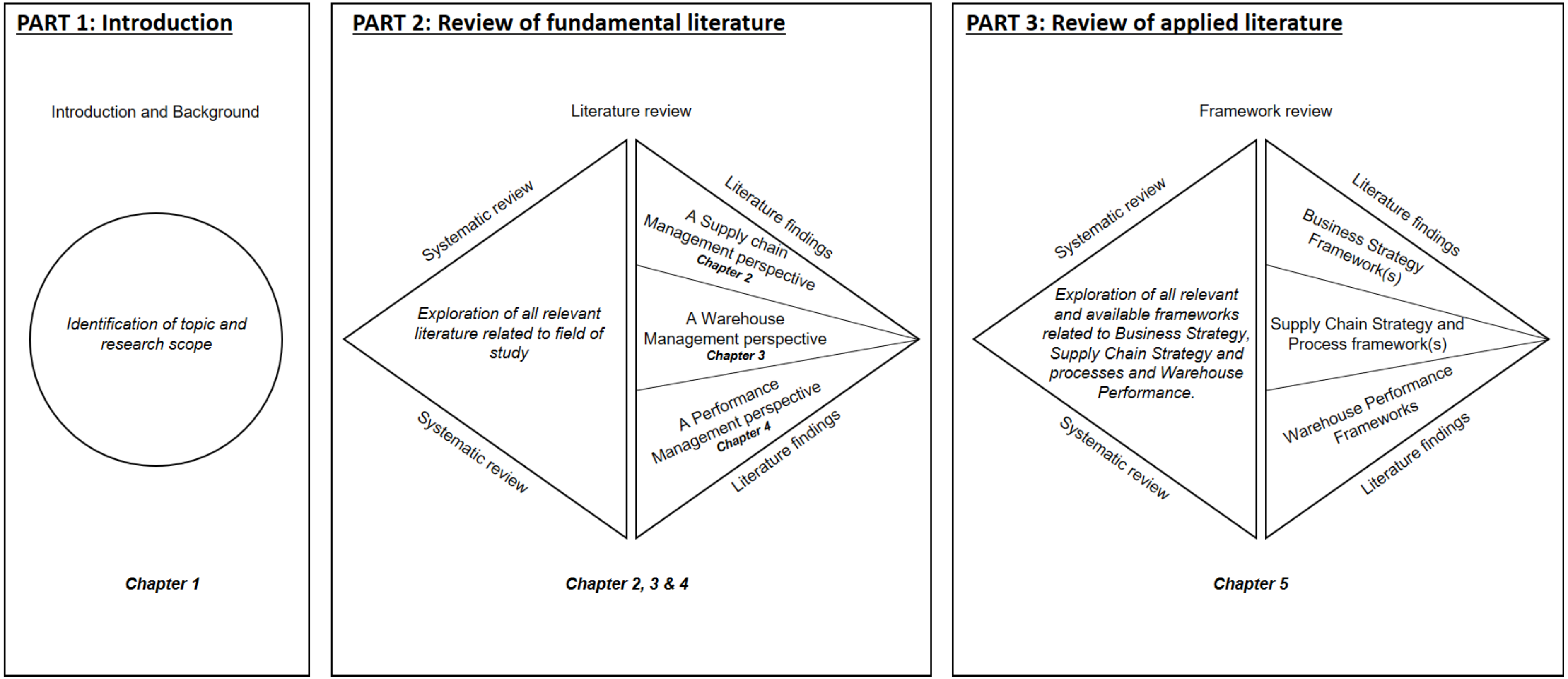
REVIEW OF APPLIED LITERATURE

- Chapter 5: Business, Supply Chain and Warehouse framework review

This part presents a single chapter which focuses specifically on applied literature related to Business strategy, Supply Chain management and Warehousing frameworks. The purpose for this review of applied literature, was to identify which frameworks are the most prominent, readily available and being applied in industry today. This chapter further focuses on presenting only those frameworks that could be aligned with the SCOR reference model at a later stage.

PART 3: CHAPTER 5
LITERATUE REVIEW
SUPPLY CHAIN PROCESS AND WAREHOUSE PERFORMANCE FRAMEWORK

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Chapter 5: Business, Supply Chain and Warehouse framework review

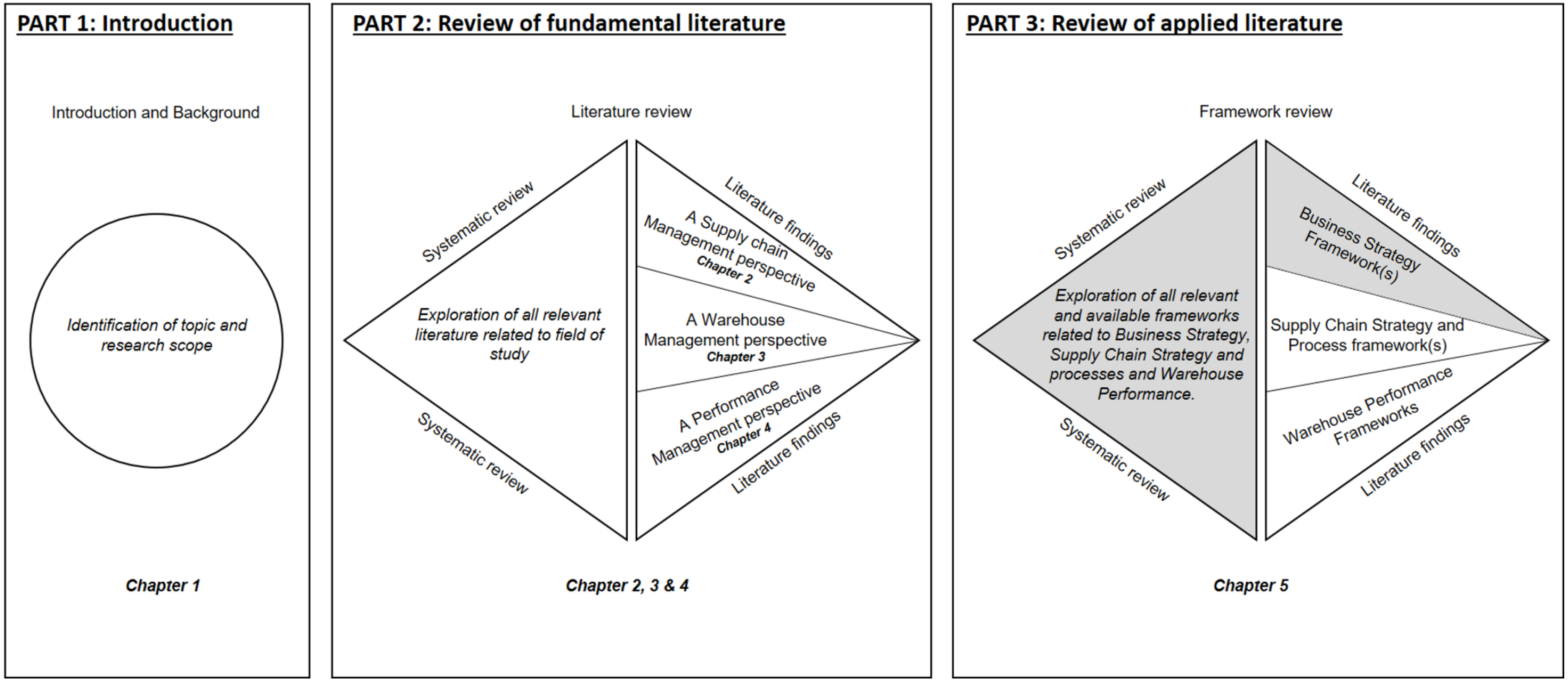
According to Gattorna (2010), Supply Chains are not merely part of the business but rather that they should be considered *the business*. The Business strategy and the Supply Chain strategy should reflect the same goals and objectives. Unfortunately this is not always the case. Most organisations comprise of a multitude of Supply Chains that look more like a *big bowl of spaghetti* rather than a *fine tuned conveyor belt* that one would expect to see in top performing companies (Gattorna, 2010:4).

Supply Chain alignment with Business strategy is critical in order to meet customer expectations as well as stakeholder returns. Implementing an extensive Supply Chain strategy that supports and measures critical processes is crucial to organisational success. Similar to Bolstrorff & Rosenbaum (2003), the SCOR model was used as the central Supply Chain framework upon which this study will be based. Bolstrorff & Rosenbaum (2003), outlined the advantages of correct implementation of the SCOR model and the resulting improvements this model had on the cases presented in the book. The SCOR model was also found to be one of the most comprehensive process frameworks available within Supply Chain literature today. The SCOR model was used as a base for cross-mapping different Supply Chain process frameworks and linking these frameworks with Warehouse metric frameworks.

This research document presents a similar argument, with one distinct difference. In this exploratory research, one Business Strategy framework, four selected Supply Chain process frameworks and one Warehousing performance framework were assessed and aligned with the SCOR model. The main attributes from each of these chosen frameworks will be aligned with the five SCOR attributes namely, *Reliability*, *Responses*, *Agility*, *Cost* and *Assets* (APICS, 2017).

The purpose of this framework review is to outline and understand the most useful Supply Chain and Warehousing frameworks available within industry today. This review will conclude with five chosen frameworks being presented within a strategy-process performance alignment matrix. This matrix will align each of the identified frameworks with the five SCOR reference model attributes. The outcome of this will demonstrate a method for organisational alignment from a defined business strategy, through a Supply Chain strategy model and into a Supply Chain process framework. This alignment will also include a performance measurement prioritisation within a Warehousing context. The concept was then tested through an exploratory case study to evaluate performance.

In order to appropriately conduct this review, considerations were given to a typical organisation's structure to understand the method behind strategy selection on a *Strategic* management level, and how this translates down the different management levels to impact performance on an operational level. This is best described by Oliver *et al.* (2001), as presented in Chapter 2. The reason for this was to understand the different types of frameworks that exist but to also outline that there are different types of frameworks used to measure different levels. Therefore, in order to truly align Business Strategy, Supply Chain strategy, Supply Chain processes and Warehousing process metrics we need to start at the beginning, with an organisation's Business Strategy.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5.1. The Strategic level: A Business Strategy framework

The identification of existing performance measurement frameworks is critical before a selection can be made. This selection will mean that the chosen framework will used to demonstrate a strategic-operation process alignment for an organisation, as presented in part six of this document. Based on the research conducted by Sushil *et al.* (2013:952-962), Neely *et al*. (2013:11-13) and Andersen *et al.* (1995:170), they all outlined the key characteristics of what constitutes a good performance measurement framework. The following frameworks have been identified in the aforementioned literature as being the most dominant frameworks in Performance management. Each of these frameworks will be reviewed briefly to outline each framework's key concepts before identifying which one will be used in PART 6 of this research.

5.1.1. The Literature review process

This chapter focuses on providing context within the field of performance measurement and management to help outline the advancements that have been made within the field over the years. This section also serves as a summation of the literary search techniques employed to find the performance measurement frameworks that have been presented in this chapter (Head, 2020). The reason for this is due to the availability of specific frameworks within the public domain. Therefore, this section presents a summation of the search engines, criteria, key words, and databases used to derive this information (Petticrew & Roberts, 2006:9-10).

The following search engines were used to derive the four performance measurement frameworks presented in this chapter. These frameworks were selected based on the availability and potential link to the Supply Chain and Warehouse concepts as discussed in Chapters 2 and 3. Table 5.1 outlines all the specific search parameters to find the information used within the chapter.

The difficulty with accessing these frameworks was due to the nature of intellectual property; often the most reliable and prominent frameworks are created and owned by private practitioners or large organisations concerned with sharing intellectual property. The availability of all the frameworks used in this review was recorded to outline the reason for only certain frameworks being reviewed. This limitation of access coupled with the scope of the research meant these frameworks were selected for this literature review. Many of the frameworks were not readily available even through the Stellenbosch library website has access and database subscriptions.

Table 5.1: Business strategy frameworks-A literature review finding

Framework	Search Engine	Data Base	Search Terms	Author(s)
Performance pyramid	Stellenbosch University Library	*ABI/INFORM Collection or Business premium collection*	Performance AND Measurement AND Pyramid OR Hierarchy	Cross & Lynch (1988)
	Google	*Online*	Performance Pyramid (Specific Search)	
EFQM-Excellence model	Stellenbosch University Library	*Online*	Performance Framework-EFQM excellence model (Specific search)	European Foundation (1991)
	Google Scholar	*Online*	EFQM Excellence model (Specific Search)	
	Online Source-Prescription email	*Online source (limited access to database)*	EFQM Excellence model (Specific Search)	
Balanced Score Card	Stellenbosch University Library	*None*	None	Kaplan & Norton (1996)
	Google Scholar	*None*	None	
	Hard Copy	*Private*	*None*	
Performance prism	Stellenbosch University Library	*Library*	Performance Prism (Specific search)	Neely *et al.* (2002)

(Source adapted from: Sushil et al.*, 2013)*

5.2. The Performance Pyramid

The performance pyramid or Strategic Measurement Analysis and Reporting technique (SMART) was developed by Cross and Lynch (1988) as a structural framework that was developed based on the new information network. This technique presents a four-level pyramid of objects and measures to ensure an efficient and effective, top-down, link between Organisation strategies and Operations. This model translates customer priorities into strategic objectives (top-down) and roll-up measures (bottom-up) to determine the level of performance achieved. The pyramid as presented in Figure 5.1 outlines a systematic, structural approach to performance measurement.

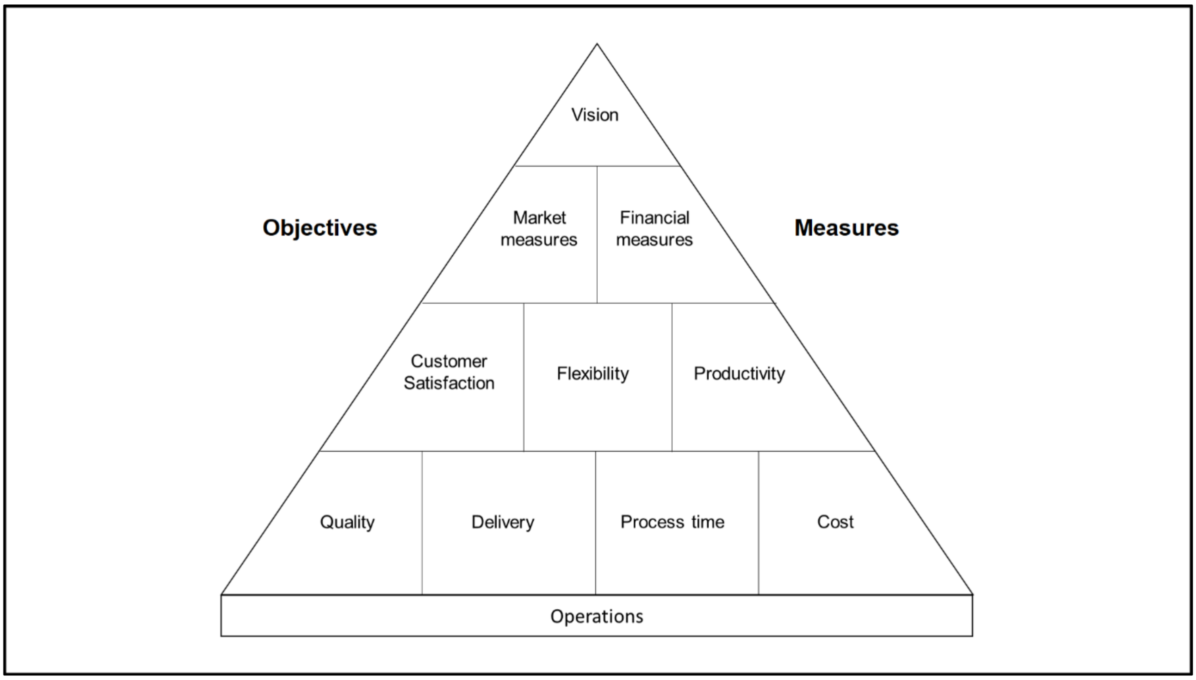


Figure 5.1: Performance Pyramid hierarchy of objectives and measures
(Source adapted from: Cross & Lynch, 1988)

The peak of the pyramid outlines the vision of the organisation this translated into business objectives, derived by strategic level management. The business management then assigns a corporate or portfolio to each business silo, and then allocates resources to help facilitate the strategic objective.

At the second level, the strategic objectives are then refined to outline the expectations each portfolio manager is expected to meet in terms of performance achievement. These expectations are predominantly financially driven, drawing focus to either short-term or long-term objectives. The short-term focus is predominantly revenue generation, while the long-term focus is market penetration, thus securing the new level of revenue over a longer period.

At the third level, more tangible objectives can be defined outlining the impact the organisation has had on customer satisfaction, flexibility, and productivity. Each of these elements is still focused solely on the financial impact they derive in order to be measured. The link between the middle-tier and the top-tier financial and market objectives is managed by their position in the pyramid. Therefore, market measures are supported by customer satisfaction performance results.

Finally, at the base of the pyramid, there are operations all focused on the execution, therefore focused on quality and delivery while at the same time decreasing process time and cost. Due to the focus on customer satisfaction, decreased delivery times and increase quality at a fair market price outlines the operational level objective. As the operational level forms the base of the pyramid, these four elements are the key to achieving higher level results.

5.3. The EFQM Excellence Model

The European Foundation for Quality Management (EFQM) Excellence model used to measure the organisational performance to outline areas of high performance as well as areas that have room for improvement (European Foundation, 1991).

The EFQM excellence model makes use of three integrated components, which are:

- The fundamental concepts of excellence
- The EFQM excellence model
- Radar logic

For the purpose of this literature review, a brief description of each of these components will be discussed in order to understand how this model can be used to conduct performance measurement within an organisation.

5.3.1. The fundamental concepts of excellence

The focus of the fundamental concepts of excellence, as presented in Annexure I (Figure I.1.), is used to outline a method for excellent organisations to continuously seek new and improved ways to achieve customer satisfaction. The EFQM model believes that organisations who achieve excellence have an in-depth understanding of their customers, they can also anticipate the future needs of their customers and are excellent in fulfilling their needs as and when they are required.

The EFQM model has outlined eight practices that have been found to promote organisational excellence and increase customer value. The eight practices are defined as follows

- Adding value for customers
- Creating a sustainable future
- Developing organisational capabilities
- Harnessing creativity and innovation
- Leading with vision, inspiration, and integrity
- Managing with agility
- Succeeding through the talent of people
- Sustaining outstanding results

Based on these eight practices, the EFQM model further defines a broad set of assumptions to derive performance within an organisation. It does not have a set list of rules that need to be followed, but rather offers a set of guidelines or assumptions for self-evaluation that can be used within any organisation.

5.3.2. The EFQM excellence model

The EFQM model is set up based on three criteria supported by nine ideas. Each of these ideas outlines a focus in terms of the measurement strategy presented by the EFQM model. This model's structure is illustrated in Figure 5.2. Each of these three criteria and their supporting ideas will be discussed in more detail in the following sections.

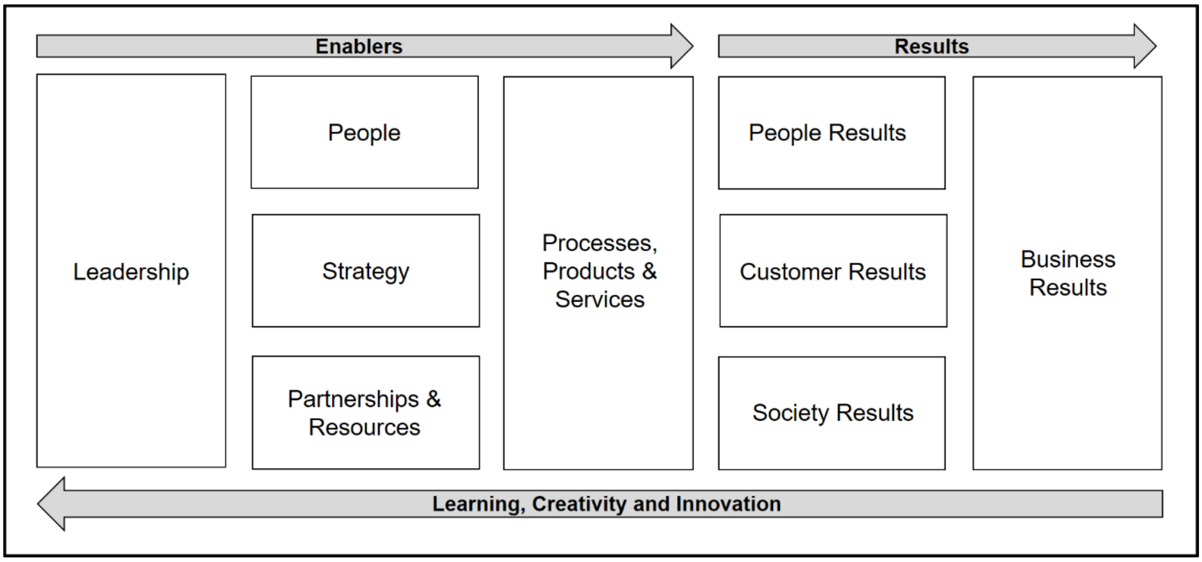


Figure 5.2: EFQM excellence model
(Source Adapted from: European Foundation, 1999)

5.3.2.1. *The "Enablers" criteria*

The enabler criteria are concerned with how the organisation conducts itself, based on its organisation's leadership and culture, it further focuses on the how the staff and resources within the organisation are used.

The model also looks at how the polices and strategies are defined and finally seeks to review and monitor the core business processes used within the organisation. The following ideas all support the enabler's criteria:

1. Leadership
2. People
3. Policy and strategy
4. Partnership and resources
5. Processes

5.3.2.2. *The "Results" Criteria*

The results criteria outline what the organisation achieves. The results criteria focus on job satisfaction of employees, customer satisfaction, the level of Corporate Social Responsibility (CSR) the organisation employs to support the surrounding society and the wider community and uses Key Performance Indicators (KPIs) to determine the level of performance results achieved. The following ideas support the results criteria:

6. People results
7. Customer results
8. Society results
9. Key performance indicator results

Each of these nine ideas is subdivided to define how the concept of excellence can be measured in each criteria and idea within this framework. This model presents a framework for the organisation to self-assess its own level of performance, helping organisations to identify areas of good performance as well as areas for improvement. Once the evaluation is complete, action can take place to change what is not working and to keep what is. The next step of the process would be to score the results of the nine supporting ideas to derive a measurable result. This is done using the EFQM RADAR (European Foundation, 1999).

5.3.3. EFQM RADAR logic

The EFQM RADAR logic is a dynamic assessment framework that outlines a structured method to question the performance of an organisation, as identified in Annexure I (Figure I.2.). This structured approach to questioning current performance helps organisations to derive their true performance level without bias. At the highest level the RADAR logic states that an organisation needs to:

- Determine the results it is aiming to achieve as part of its strategy
- Plan and develop an integrated set of sound approaches to deliver the required results, both now and in the future
- Deploy the approaches in a structured way to ensure implementation
- Assess and refine the deployed approaches based on monitoring and analysis of the results achieved and ongoing learning activities.

The use of the RADAR logic also supports the evaluation method to demine the actual level of performance achieved based on the model and its surrounding criterion. This evaluation is the evaluation method used to derive an EFQM score for an organisation to conduct self-assessment and benchmarking activities to help drive performance levels achieved.

5.3.4. The EFQM evaluation method

The underlying scoring method makes use of RADAR logic. This logic defines a predetermined set of weights based on the EFQM model that help to aggregate the results to a performance level achieved within each of the established enablers discussed in section 5.3.2.1. The RADAR matrix, as presented in Annexure I, is used to derive a score within each enabler. Each weighting is then given a score of 0–100 points, deriving the organisation's current level of performance achieved.

The EFQM model makes use of sound principles and practice to help organisations to measure performance. The model also outlines a method of iteration, whereby measurements can be conducted again and again for a benchmark to be determined. The concept of continuous improvement and benchmarking is essential to performance measurement as this is how organisations can manage their performance.

5.4. The Balanced Score Card

The Balanced Score Card (BSC) approach outlines a specific focus on the need for measurement, to be able to manage an organisation. Organisations should make use of performance measurements derived from the strategies and capabilities, to be able to effectively evaluate the current performance level. Kaplan and Norton (1996:21) reiterate that the majority of organisations attempting to measure today, focus solely on financial metrics while spouting strategies focused towards customer relationship management. The BSC incorporates the financial perspective that most organisations are used to, into four perspectives designed to include other aspects that should be measured as well. These perspectives retain a financial focus; however, they include measurements linked to current customers, internal processes and employee and system performance as well.

Kaplan and Norton (1996:24) developed the BSC framework to provide organisations with a complete and comprehensive framework. The BSC Framework makes use of four perspectives that help focus on performance measurement. These four perspectives are presented in Figure 5.3.

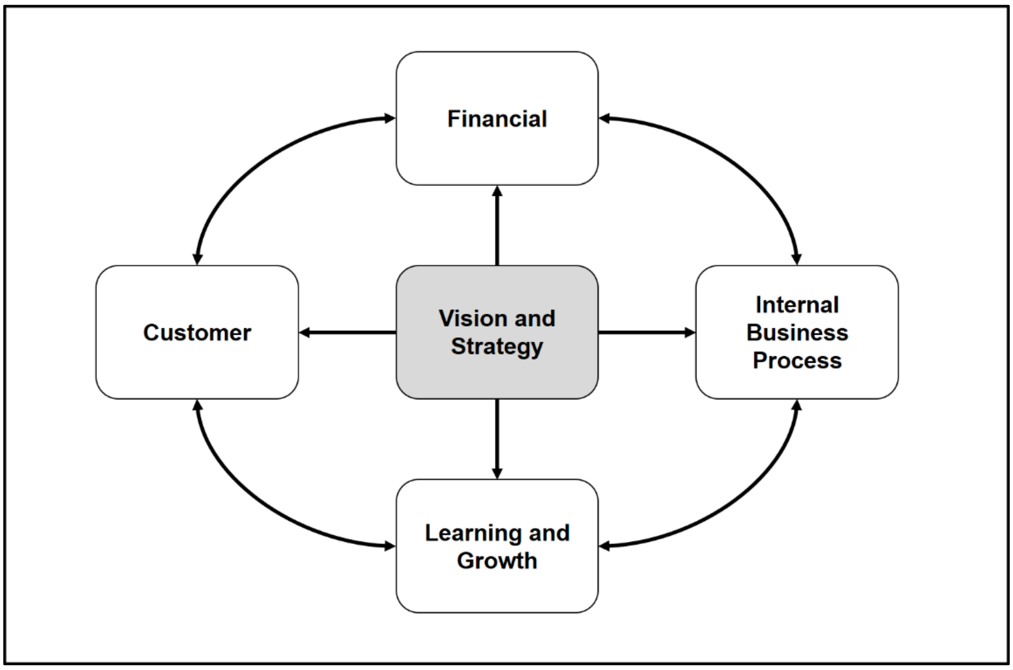


Figure 5.3: The Balanced Score Card Framework
(Source adapted from: Kaplan and Norton, 1996:11)

This framework is used to assist in the conversion from company vision and strategic intent into a clear set of performance measures that can be continuously applied to monitor performance improvements.

5.4.1. Financial perspective

The financial perspective has been retained by Kaplan and Norton (1996:25) as financial measures are efficient and effective in outlining economic/financial consequences of forgone action. This makes the financial perspective a retrospective measure that helps outline what has happened and as such is a 'lagging indicator'[8]. The financial perspective measures the success or failure of the organisation's strategy implementation and execution based on the change in the bottom line; these can predominantly be categories of profitability measures such as operating profit or return on capital.

5.4.2. Customer perspective

Outlines a specific focus on the target audience and designated market segments the organisation is focused on operating in. The overarching organisation strategy is critical in defining the measures than need to be considered in this perspective, as the strategy defines the type of customer segment the business is competing for. The key measures in this perspective focus on customer retention, customer satisfaction, new customer acquisition, customer profitability as well as market share gained within the designated market segment.

5.4.3. Internal-Business-Process Perspective

This perspective focuses inward to identify those factors the organisation must execute internally as part of their operational processes to be able to service their chosen market. This perspective helps the organisation to deliver value to the market, that will attract customers as well as retain them into the future. The internal perspective also focuses on satisfying shareholder expectations through outstanding financial returns.

Where the BSC framework differs from traditional frameworks that may also expand beyond the financial perspective is by including time and quality-based metrics. These traditional frameworks focus on existing internal processes only *(short wave)*, whereas the BSC framework derives entirely new internal processes *(long wave)* the organisation must excel in, in order to meet customer and financial objectives, as identified by Figure 5.4.

[8] Lagging indicator: A **lagging indicator** is any measurable variable that changes as a result of a variable change in target, however this change is only measured after the target change.

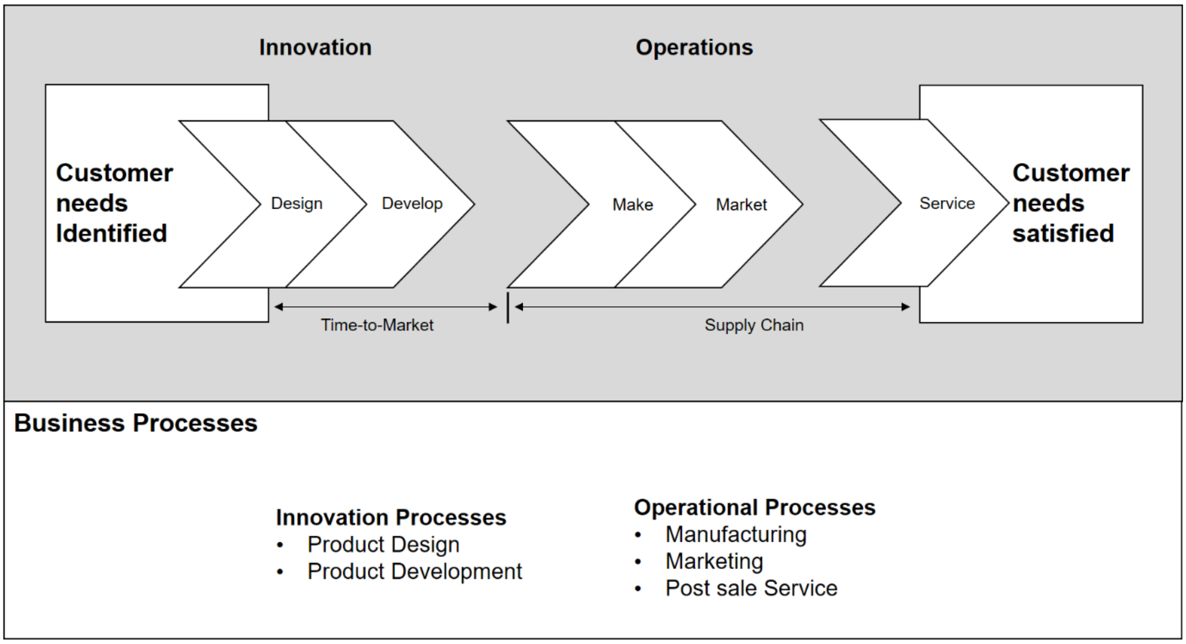


Figure 5.4: The Balanced Score Card: Internal processes diagram
(Source adapted from: Kaplan and Norton, 1996:27)

Where traditional frameworks focus on servicing today's customers with today's products, the BSC incorporates innovation into the internal process perspective that allows for new product designs and development to be included within the organisation's strategy intent (Kaplan & Norton, 1996:27).

5.4.4. Learning and Growth Perspective

This perspective focuses on what the organisation must embody in order to derive long-term growth. This perspective requires an organisation to change and develop in order to achieve the long-wave customer and internal process objectives, particularly in the highly competitive consumer-driven market currently prevailing today. Learning and Growth in the BSC perspective are derived from three sources, namely; people, systems, and organisational procedures. The evaluation of the first three perspectives will typically identify large gaps between existing capabilities of people, systems, and procedures. These gaps need to be managed in order to unlock new levels of performance within an organisation. Organisations can close these gaps by focusing on internal infrastructure development such as skills development, enhancing information technologies and systems, and aligning organisational procedures and routines.

The BSC framework four perspective framework helps to outline different areas of organisations to focus on, not just focusing on Financial metrics but on a combination of value-adding performance measurement areas that can assist an organisation in breaking down performance barriers and unleashing new levels of performance achievement, provided complete organisation alignment is achieved.

This framework presents a new and different perspective from the previous two that have already been reviewed. In order to conclude this review of performance measurement frameworks, one more framework was reviewed; this was the Performance Prism framework.

5.5. The Performance Prism

The performance prism is a three-dimensional framework that has been deliberately designed to be highly flexible in terms of defining a scope for measurement. This prism can be used to conduct a broad or narrow scope depending on the performance measurement requirements and focuses specifically on stakeholders. The term 'stakeholders' as defined by Neely *et al.* (2002) is a combination of investors, customers and intermediaries, employees and labour unions, suppliers, and alliance partners and finally regulators, pressure groups and communities. The performance prism consists of five interconnected perspectives each of which focuses on different aspects related to this performance management perspective. These five perspectives ask specific questions, each question focusing on a different perspective.

1. **Stakeholder Satisfaction:** *Who are our key stakeholders and what do they want and need?*
2. **Stakeholder contribution:** *What do we want and need from our stakeholders on a reciprocal basis?*
3. **Strategies:** *What strategies do we need to put in place to satisfy the wants and needs of our stakeholders while satisfying our own requirements?*
4. **Processes:** *What processes do we need to put in place to enable us to execute our strategies?*
5. **Capabilities:** *What capabilities do we need to put in place to allow us to operate our processes?*

These five perspectives outline the rationale behind the performance prism, as they provide a comprehensive method of defining and organisations performance management focus. Figure 5.5 illustrates these five perspectives within the framework as well as defines what is measured.

Neely *et al.* (2002:164) compare their performance prism framework with the Kaplan and Norton (1996:11) BSC framework. Kaplan and Norton (1996:11) make use of strategy maps in their BSC framework. Neely *et al.* (2002:164) argue that in order to ensure performance measures do not fall short when measuring, as the BSC does not incorporate all five perspectives of the performance prism framework, success maps should be used to ensure strategies translate into measures.

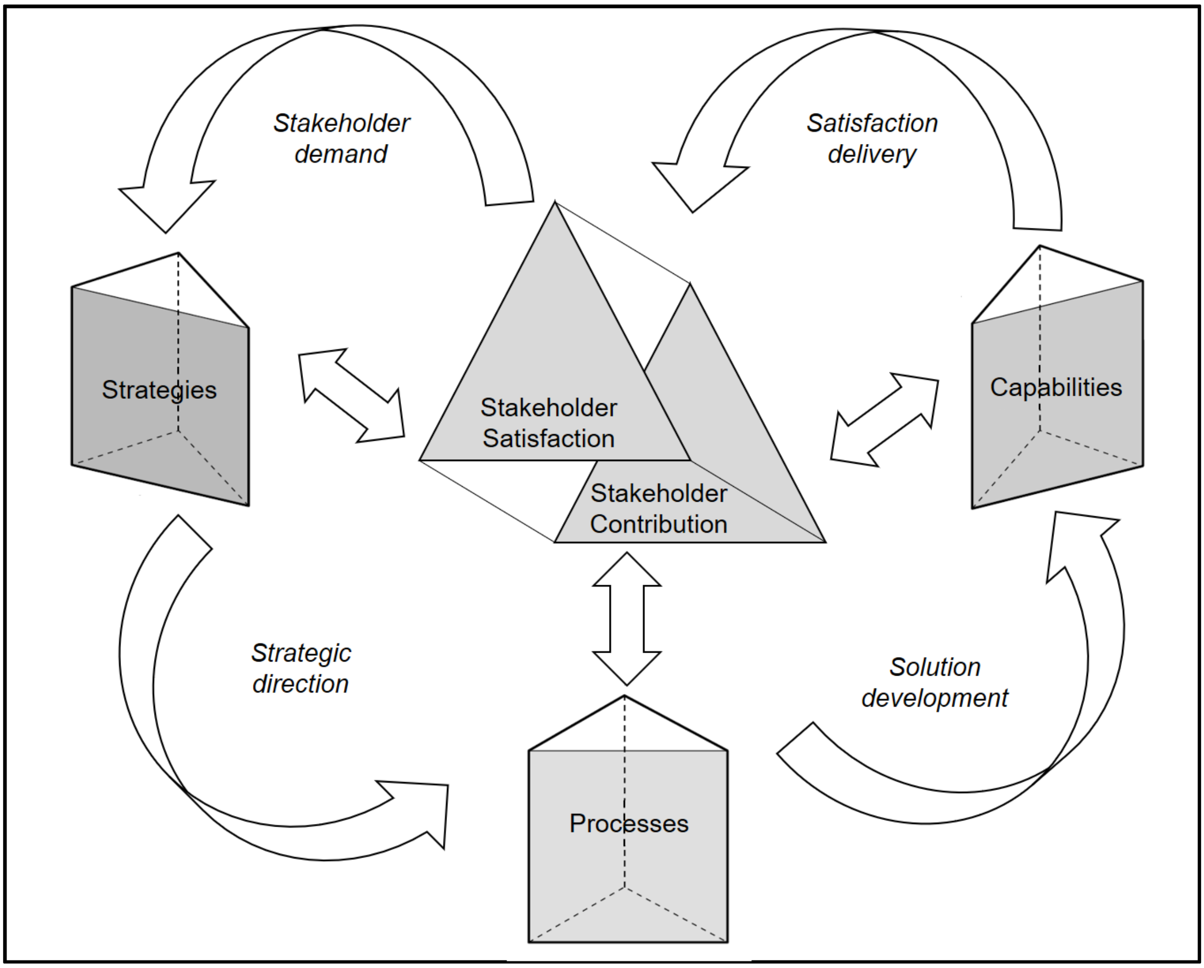


Figure 5.5: The Performance Prism framework
(Sources adapted from: Neely et al., 2002:181)

The performance prism as presented in Figure 5.5 was developed by Neely *et al.* (2002:181) who believe that performance measurement should not be derived directly from the organisation's strategy. They argue that to base performance measures off an organisation's strategy would not help define what needs to be measured.

Neely *et al.* (2002:181) also presented in their work that strategy does not define the destination or target an organisation wished to reach, they rather hypothesise that the strategy defines the path the organisation chooses to take. They assert that an organisation should define its stakeholder groups as this will help define what needs to be measured.

In this framework executives can and must decide which stakeholders are most important, and attempt to fulfill their needs over others. The starting point to implement the performance prism would not be to define strategy but rather define the most important stakeholder groups and assess their needs and want to determine what should be measured.

5.6. Review of Performance Measurement frameworks

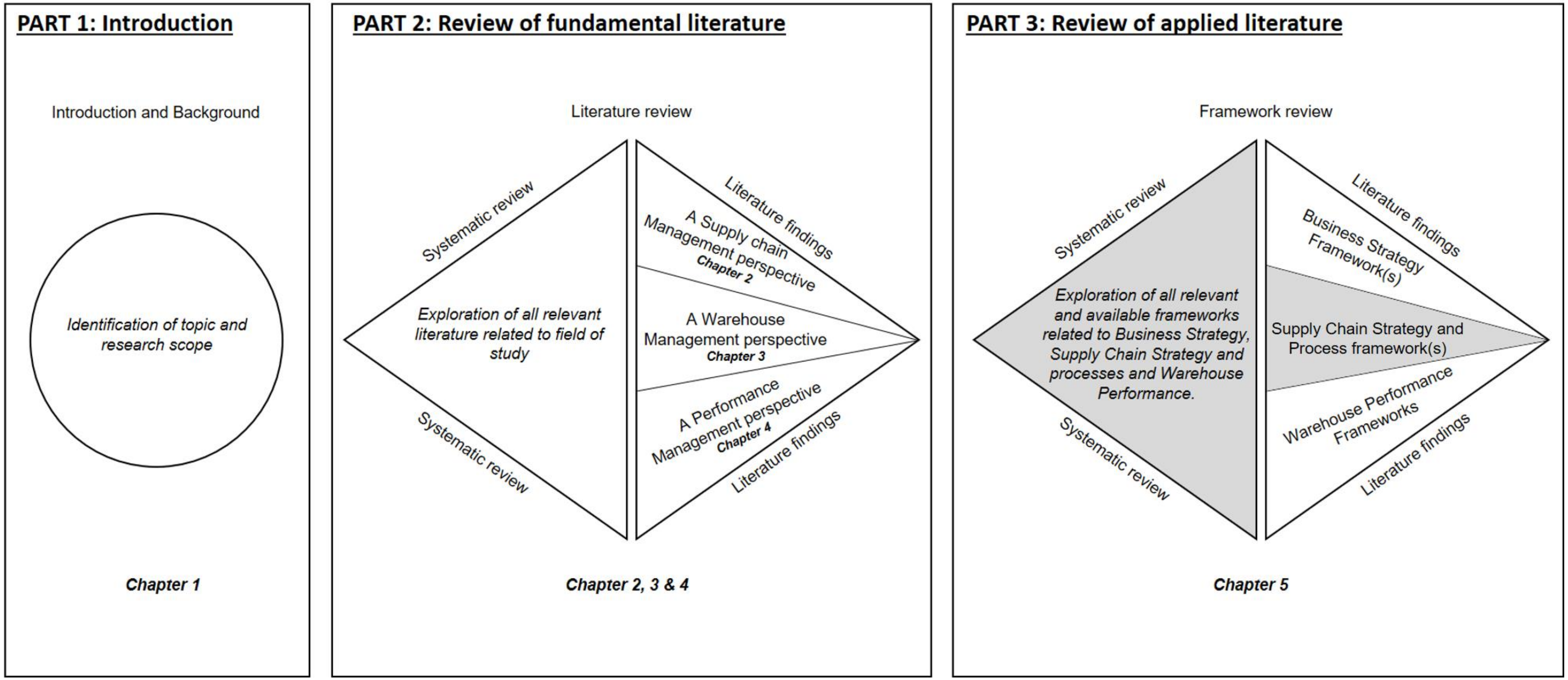
This review is critical in outlining what is needed in a Business Performance Management framework before conducting any performance measurement. Added to this, is an understanding that the different types of measures that are used in performance measurement can and will impact the accuracy and results performance measurement will have on an organisation.

The review of the performance management frameworks in section 5.1, helped outline the existing frameworks that are available in the literature today. It also helps outline which framework is best suited for a conceptual integration with other models and framework that measure at different levels of an organisation's management structure. The integration of a performance management framework is crucial as it will help define the link between business strategy and Supply Chain strategy and ensure the prioritisation of Supply Chain processes is accurate. Thus, the selection of the BSC framework will help support and conceptualise this conceptual alignment between business strategy and supply chain strategic intent.

The performance pyramid presented by Cross and Lynch (1988), outlined a hierarchical structure for performance measurement which aligns well with the hierarchical nature of a typical business structure. However, the performance pyramid does not identify any method of identifying KPIs that can be used to conduct performance measurement.

The EFQM model does base performance measurement of business strategy and provides no flexibility related to a changing environment. The EFQM model does not constitute a continuous improvement friendly approach to performance measurement (European foundation, 1999).

The BSC framework provides a method for continuous improvement and evaluation. It supports the view that performance measurement is based on an organisation's strategy, unlike the Performance Prism, presented by Neely *et al.* (2002), that believes stakeholder needs and wants define what should be measured. The BSC further supports the integration and identification of financial and non-financial perspectives to increase performance measurement validity, which traditional frameworks do not.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5.7. Supply Chain Strategy frameworks

The review of Supply Chain Strategy and process frameworks proved to be quite difficult due to the nature of intellectual property as most organisations are concerned about divulging seemingly sensitive information to their competitors. Therefore, the selection of these Supply Chain Strategy frameworks as well as the process frameworks within this research outline the most relevant and accessible frameworks available in industry today.

The selection of these frameworks was also based on their potential for aligning with the SCOR reference model, on which this research design and methodology is based, as presented in section 6.2. As a result, the following Supply Chain Strategic frameworks were identified.

5.7.1. The literature review process

The process of identifying and acquiring the Supply Chain strategic frameworks was documented to outline the limitations of the search results as well as to define the search engine, search parameters and processes used to retrieve this information. One of the main reasons for this was to outline the restricted availability of this information which ultimately narrowed the scope of selection for the review to take place.

An attempt which was made to include industry-specific frameworks developed and presented by multinational organisations as part of their annual Supply Chain performance reviews was short-lived, as multiple correspondents and requests for information were sent out, none of which were answered. A further electronic conference call was hosted with a prominent Australian Supply Chain professional to attempt to identify another source of information related to Supply Chain performance standards, which unfortunately was declined. Due to the outcome of this review process, unlike those found in Chapter 2, 3 and 4, this chapter's literature review sources were derived based on those frameworks that are readily available within the academic field as well as certain frameworks which were made available through Stellenbosch University databases.

5.7.2. Gattorna – Strategic Alignment model

Alignment, particularly *strategic alignment*, is not a new concept to organisations, especially those focused on Supply Chain success. Why then, do organisations still see supply chains as a means of cutting costs instead of a performance-enhancing mechanism? Gattorna (2010:17) stated that alignment is not a new concept, rather that it is a concept found in nature. Gattorna (2010:17), likened it to geese flying in a *V-formation.* When doing so they can fly 70 percent further than a single goose can fly solo. This is the principle on which the *strategic alignment model* is based. Re-engineering a Supply Chain from the customer's requirements back up to a corporate strategy, organisations can achieve their own *V-formations* for Supply Chain success. Figure 5.6 illustrates the strategic alignment model methodology.

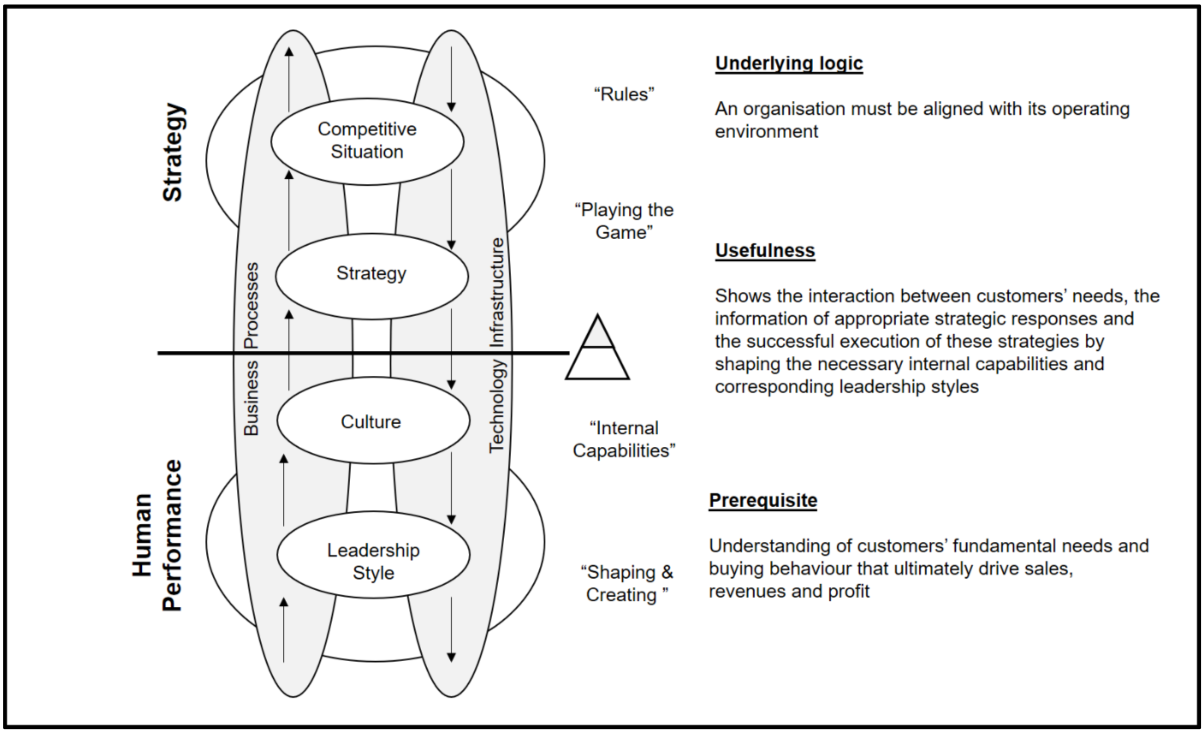


Figure 5.6: Dynamic Alignment Framework
(Source adapted from: Gattorna, 2010:19)

The strategic alignment model was developed first through determining customer purchasing behaviours and then working to develop business strategies, as identified by Figure 5.6. This model frames business processes around human performance, which are outlined within the organisational culture to influence competitive strategy. However, the decision-making paradigm, illustrated in Gattorna's (2010:17) work, still reflects that of section 2.7.3.1, which is further outlined by Figure 2.9.

According to Gattorna (2010:19), this dynamic alignment model incorporates his work on behavioural segmentation as well as research conducted by Chorn (1987), which focused on segmenting leadership styles and personality types. The inclusion of the Adizes and Faust 1985 as cited by (Gattorna 2010:19), presented their "*P-A-E-I*" coding system which defined different management styles for the complete assessment of all persons involved within a given supply chain. This amalgamation of these key concepts leads to the first *multidisciplinary dynamic alignment model*.

This alignment and development of Supply Chain strategies with customer needs and appropriate strategic responses to these needs, as well as instituting adequate internal capacities, outlines the basis for operating this model. Figure 5.7 illustrates the four most commonly observed buying behaviours. These buying behaviours are described to illustrate the connection between the types of buying behaviour and the four generic supply chains that have been identified in Figure 5.7.

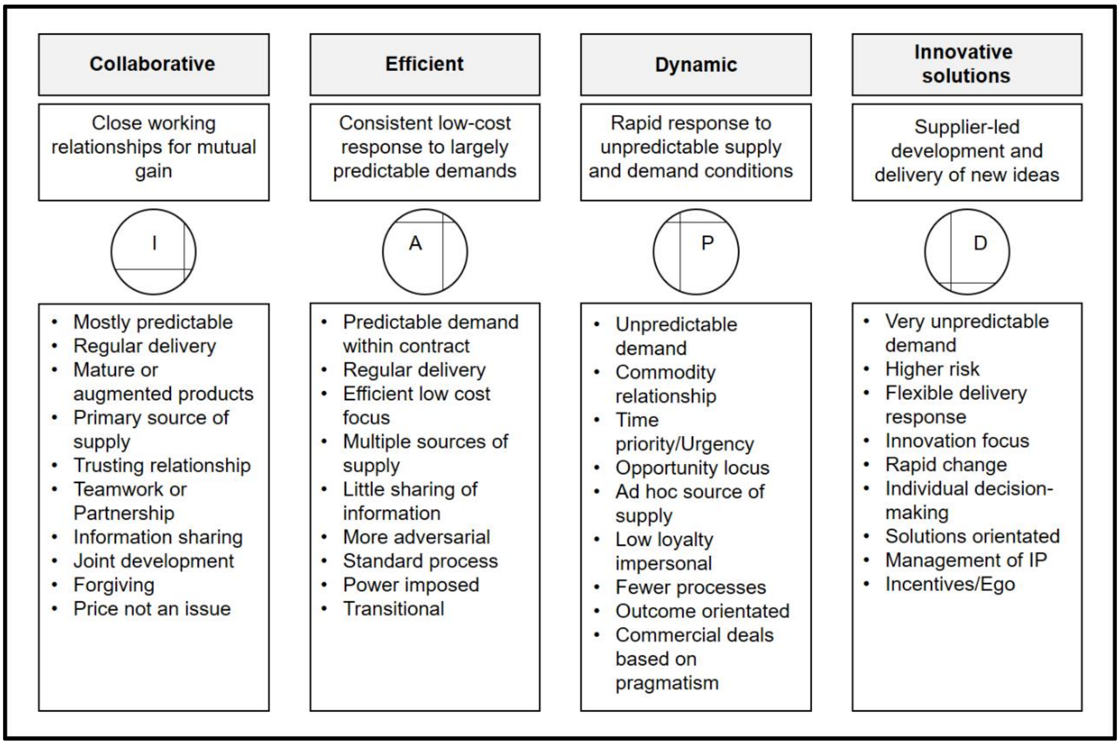


Figure 5.7: The four common dominant buying behaviours
(Source adapted from: Gattorna 2010:48)

According to (Gattorna, 2010:46), customers can be segmented into four behavioural segments. These behavioural segments exist within numerous industries, including both service and goods provision industries. Service industries can derive behavioural buying customer segments from this model despite the fact they sell services instead of physical products.

These four segmentation categories are described below:

Collaborative: Close working relationships for mutual gain.

Efficient: Consistent low-cost response to largely predictable demands.

Dynamic: Rapid response to unpredictable supply and demand.

Innovative**:** Supplier-led development and delivery of new ideas.

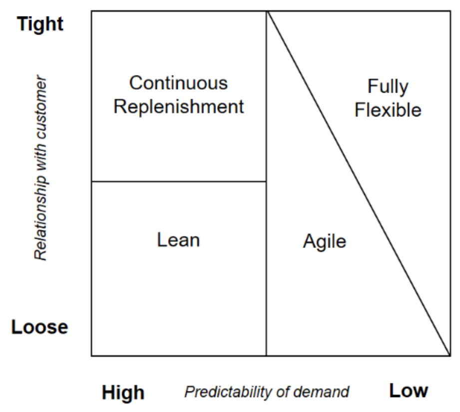
This model integrates, as stated above, with Adizes and Faust's (1985), "P-A-E-I" coding system. This coding system consists of four dominant behavioural forces, each of which is briefly explained below as outlined in Gattorna (2010:21). These categories coincide with the four dominant buying behaviours stated above.

P–Producer**:** The force for action, results, speed, and focus.

A–Administrator**:** The opposing force to D, and represents stability, control, reliability, measurement and logic and efficiency.

D–Developer**:** The force for creativity, change innovation and flexibility.

I–Integrator**:** The opposing force to P, and represents cooperation, cohesion, participation, and harmony.



Supply chain type	Description
Continuous Replenishment	Predictable demand, easily managed through tight collaborative relationships with customers. Focus on retention of customer relationships and maximised OPEX.
Lean	Demand predictable (e.g. from historic off-take), loose customer relationship does not necessitate an extreme service level. Focus efficiency.
Agile	Unplanned or unforeseen demand and a sometime loose relationship with customer–almost always demands agile response at higher cost-to-serve. Focus on the service cost equation.
Fully Flexible	Respond opportunistically & manage yield. Focus on providing solutions for premium price.

Figure 5.8: The four generic Supply Chain types (demand-side)
(Source adapted from: Gattorna 2010:50)

Gattorna also states that customers generally reside in a segment, however, they can and do move between segments depending on purchase decisions. This can be caused by supply-demand variations due to seasonal production or external economic factors that prevail. With regard to the integration of these different fields of supply, Gattorna (2010:50), derived four generic Supply Chain types, that reside in all firms, these Supply Chain types are illustrated in Figure 5.8.

The integration of multiple models and areas of research have led to this point, the *dynamic alignment model*. A supply chain, inherent within an organisation is segmented into one of these four possible outcomes, based on the type of customer it intends to serve. At this point some clarification should be derived. Table 5.2 outlines all the terms used and how each of these fit together, to best describe Figure 5.8.

Table 5.2: Conclusive summary and alignment of all terms used

Adizes and Faust (1985), "P-A-E-I" coding system	**Gattorna (2010:48) Common buying behaviour**	**Gattorna (2010:50) Supply Chain types**
Producer	Collaborative	Continuous replenishment
Administrator	Efficient	Lean
Developer	Dynamic	Agile
Integrator	Innovative	Fully Flexible

These characteristics and their definitions are used to determine which SCOR focus strategies and attributes best describes each of the four supply chains identified above. Table 8.2 was derived from this.

5.7.3. Management for Supply Chain (M4SC) framework

The Management for Supply Chain (M4SC) outlines an actionable framework that enables organisations to implement or develop well-defined and repeatable processes for managing their Supply Chains. The M4SC framework is used to implement SCOR throughout a chosen organisation. M4SC is comprised of four Supply Chain components, *Supply Chain strategy*, *Supply Chain network*, *Supply Chain Process* and *Supply Chain Resources* as identified in Figure 2.10. This model helps organisations outline a process for evaluation and implementation to ensure their Supply Chain strategy is aligned to the business strategy. This framework ensures that the correct drivers are implemented at each stage while feedback is provided to ensure absolute implementation.

5.8. Review of Supply Chain Strategic Frameworks

For the purposes of this review, the M4SC model is presented in Chapter 2 to illustrate how a Supply Chain Strategic Framework can be implemented to achieve organisational alignment. The M4SC framework was developed as a means of using SCOR to achieve continuous improvement. This is done by using SCOR to define Business Strategy. Once complete the M4SC framework is used to translate these strategies into execution plans and policies. Therefore, for the purpose of this research document, the M4SC is presented within the literature review as it is pertinent to understand due to the significance SCOR plays in this research. Despite this, the M4SC model will not be included in the strategy-process performance alignment matrix. In order to be able to demonstrate the possibility of linking other process frameworks with SCOR, a review of the most prominent and available Supply Chain process frameworks was required.

5.9. Supply Chain Process Frameworks

The review of Supply Chain process frameworks as outlined in this section were selected based on each one's prominence within the field of Supply Chain Management as well as the accessibility to these frameworks. The literature review process followed the same methods and steps as outlined in the section 5.7.1. Therefore, the availability of these frameworks was either readily available in literature or accessed through Stellenbosch University databases. The following frameworks were reviewed and selected to be used within Part 6-Phase 2.

5.9.1. The Supply Chain Operations Reference (SCOR) model

The SCOR model is a reference model that describes business activities conducted by an organisation to meet customers' expectations. The model is developed based on six key foundational elements, namely *Plan, Source, Make, Deliver, Return* and *Enable,* as identified by Figure 2.5 (APICS, 2017). The SCOR model is extensive in its explanation as it incorporated all customer interactions throughout the above-mentioned six foundational elements. This model can be used in a myriad of organisations from highly complex to simple single chain organisations.

The Supply Chain operations reference model (SCOR) was developed by APICS as a framework that outlines the business activities that facilitate customer demands. This model incorporates both qualitative and quantitative performance measurements. This is done through an extensive process review as well as outlining specific metrics that can be used to measure these processes. This model requires companies to select a specific Supply Chain strategy once again before performance measurement can take place.

The SCOR model metrics and SCOR mark capability allow companies to benchmark themselves against industry-specific data. This will allow companies to derive a competitive advantage measurement between themselves and their competitors (Ross, 2017). The SCOR process framework combines four techniques into a single methodology for performance review. This methodology is depicted in Figure 5.9.

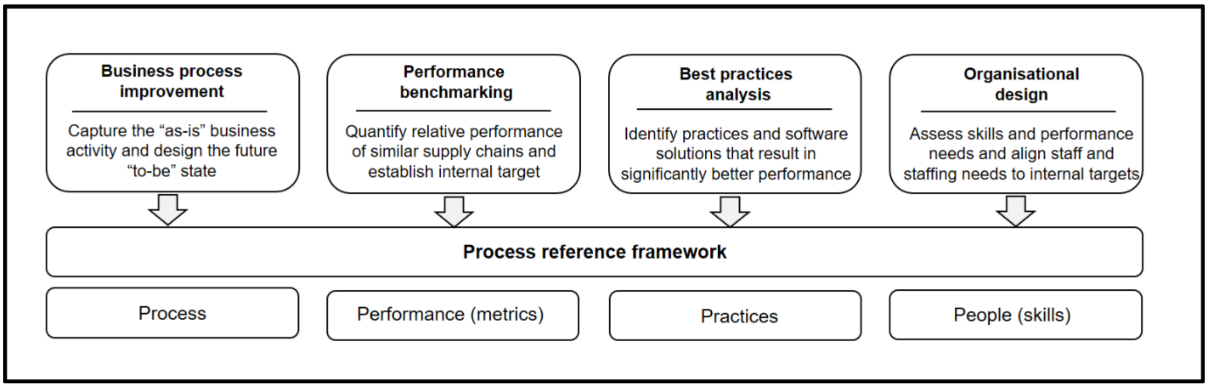


Figure 5.9: Combining four techniques into a single integrated approach
(Source adapted from: Ross, 2017)

This process framework makes use of four techniques, outlined as follows:

Process: This requires companies to understand their current processing procedures while anticipating what will be required in the future.

Performance: This technique quantifies different aspects within similar supply chains and is then used to set internal goals.

Best practices: This is a decision-making technique whereby the previous two techniques are evaluated and decisions must be made on what can be done to improve current process and performance. This is done, either through best practice implementation on processes or introduction of information-sharing software.

People: In order to improve upon the performance, trained staff must be allocated to manage and maintain the specified performance targets and goals.

5.9.1.1. *The SCOR model is the keystone to the strategy-process performance alignment matrix*

The SCOR model uses two focus strategies to identify whether a Supply Chain is to be classified as either *externally* focused or *internally* focused. These two categories have two and three attributes respectively associated to them, that best describe the Supply Chain strategy adopted or developed within an organisation.

Table 5.3 outlines the structure of the SCOR model's measurement concepts, whereby each Supply Chain attribute, either external or internal, has a corresponding level 1 metric. These metrics are used to determine whether the process and its overarching strategy are working.

Table 5.3: SCOR focal strategies and Supply Chain attributes

Focus Strategy	Supply Chain Attribute	Level 1 Metric
External Strategies (customer focus)	Reliability	Perfect Order Fulfilment
	Responsiveness	Order Fulfilment Cycle
	Agility (flexibility)	Supply Chain Flexibility
Internal Strategies	Cost	Cost of Goods Sold
	Assets	Return on Working Capital

Source adapted from: (Bolstrorff & Rosenbaum, 2003:50–53)

In this model, strategy is considered in terms of incorporating business strategy with Supply Chain strategy, while allowing for operational metrics to be used to determine whether what is being measured, needs to be measured. SCOR allows for a clear link to be developed between these level 1 metrics and other measurement repositories.

This connection will allow for a more in-depth evaluation of operational metrics, within a Warehousing context, as well as prioritise these metrics to better reflect and measure the implementation of the business strategy. The following section identifies the four selected Supply Chain frameworks and how each of these frameworks interacts and aligns with the SCOR model's attributes and measures.

5.9.2. American Productivity and Quality Center process classification framework

APQC's Process Classification Framework (PCF) is a framework developed for the objective comparison of business processes used to compare the performance of each process against different organisations. The purpose of the development of this framework was to create a benchmarking initiative among organisations as well as endeavouring to improve performance.

This improvement in performance would take place through a process performance evaluation and benchmarking exercise. The PCF ranks the operating and management processes into 12 strategic level categories (APQC, 2014). All these categories have corresponding processes and performance attributes within them.

5.9.2.1. *The Process Classification Framework (PCF) explained*

The concept of Supply Chain performance is based upon the difficulty of finding available information that is industry-specific. Companies struggle to conduct comparative performance measurements and the APQC framework was developed as an industry-neutral, process measurement framework. At this point it should be stated, that this framework was not derived solely for use in the field of Supply Chain Management. A few of the processes identified below do not pertain to this field. Figure 5.10 identifies 12 processes that have been found as a representative sample of real-world business processes. These processes are themselves divided into two categories. These two categories are *Operational processes* and *Management support services*.

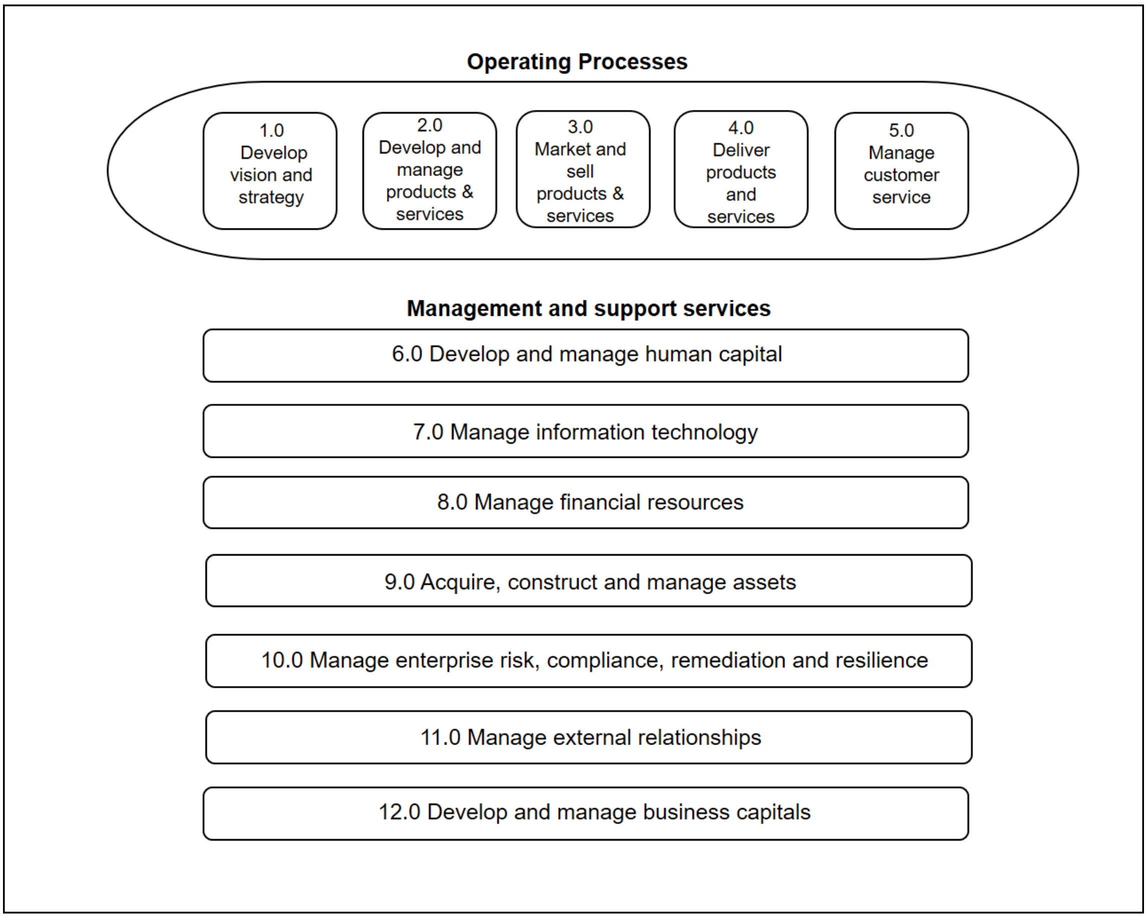


Figure 5.10: APQC process classification framework
(Source: APQC, 2014)

The APQC framework can be used within the marketplace to facilitate the performance measurement and benchmarking exercise. This framework is deemed to be a cross-industry measurement tool. This tool is not a concept directly created for use within the field of Supply Chain Management. However, other vocational societies do exist, that specialise in the formation of a specific Supply Chain measurement tool.

5.9.3. Council of Supply Chain Management Professionals Supply Chain process standards

The council for Supply Chain Management professionals (CSCMP) believes that there is a shortage of standardised cross-industry benchmarking data available in the industry today. They were driven to develop the *CSCMP Supply Chain process standards, second edition* (CSCMP, 2014c). These standards are designed to give Supply Chain managers a reference guide to benchmarking their own supply chains with popular processes. These popular processes are based on CSCMP research and have become commonplace in the SCM field, across a multitude of industries.

According to CSCMP (2014c), these standards are intended to be used across different industries and should be used to assess a company's current processes. This benchmarking tool recommends that companies have a singular selective strategy. This means that companies must select which attributes or processes are most important in operating their supply chain. It is identified by CSCMP that a company should not strive to be best in class in all processes as this will directly result in higher costs. Companies must strive to achieve a best-in-class score for their identified core processes while maintaining their current standards on secondary processes.

These derived standards identified in Figure 5.11 are based on the above-mentioned PCF generated by APQC. This framework was developed through a multitude of research techniques. CSCMP conducted on-site observations in the industry in conjunction with over 50 Small and Medium Enterprises (SMEs) as well as extensive academic research, which were all compiled by *Supply Chain Visions Inc*. The following are the ten processes identified from the study, all of which have been found to be directly related to Supply Chain Management or have processes that impact on the supply chain.

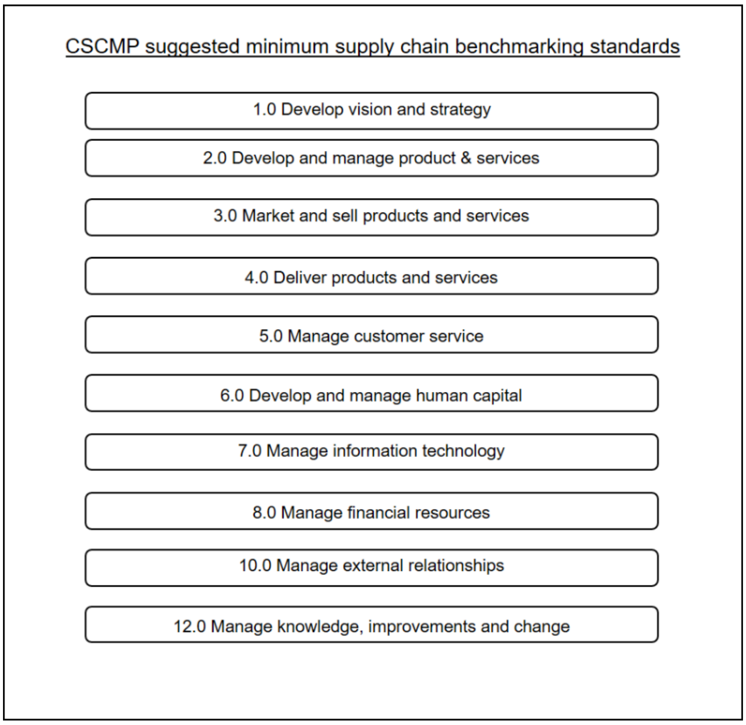


Figure 5.11: CSCMP benchmarking standards derived from APQC process classification framework
(Source Adapted by: CSCMP, 2014)

These standards are aligned with the APQC's PCF framework which allows companies to access quantitative benchmarking metric data. These metrics were built around the APQC's Open Standards Benchmarking Collaboration (OSBC) which invited companies to participate in a global performance survey. The results of this survey are widely accepted as a good yardstick which companies can measure themselves against. Based on this integration, each process identified in Figure 5.11 can be linked to a quantitative data metric identifying the industry's performance in this area. This allows companies to not only measure their own success in Supply Chain Management processes but benchmark themselves against other Supply Chain leaders.

5.9.4. Global Supply Chain Forum model

In the field of Supply Chain Management and its integrating operations, known as *Logistics*, there is still confusion between which definition is most accurate and how each of these concepts integrate into this field today. This argument is predicated on specific issues, such as a lack of defined terminology that is used by all Supply Chain professionals. Furthermore, arguments brought forward from different Supply Chain professionals outline why their field is superior or best describes the field of study. This argumentative approach to Supply Chain Management is further outlined in section 2.3.1 of this report.

Lambert (2008:1), demonstrates that these arguments create a disconnect within the Supply Chain Management field. However, his argument is centred around organisational integration. What better way to demonstrate integration, than to link his model with the SCOR model?

According to Lambert (2008:10), Supply Chain Management needs “Cross-functional integration” with a given organisation and its connected network. This model is structured around a connected network approach to Supply Chain Management. This means that all organisations within a given Supply Chain operate with the best interests of the network at heart, instead of its individual best interests. The same is said for internal functions within the organisation itself. Lambert proposes the use of cross-functional cooperation and the destruction of functional silos. These silos restrict adequate information sharing, which is required for new levels of performance and profitability to be achieved. The Global Supply Chain forum (GSCF) model has developed *eight Supply Chain Management processes*. These processes are outlined in Figure 5.12.

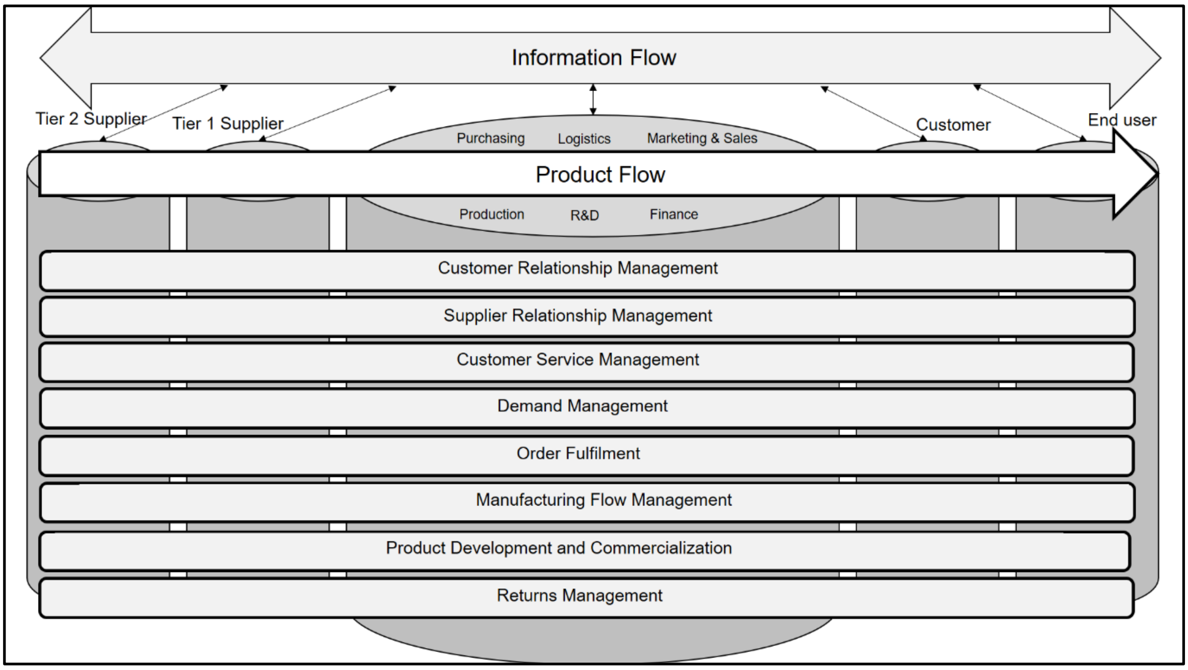
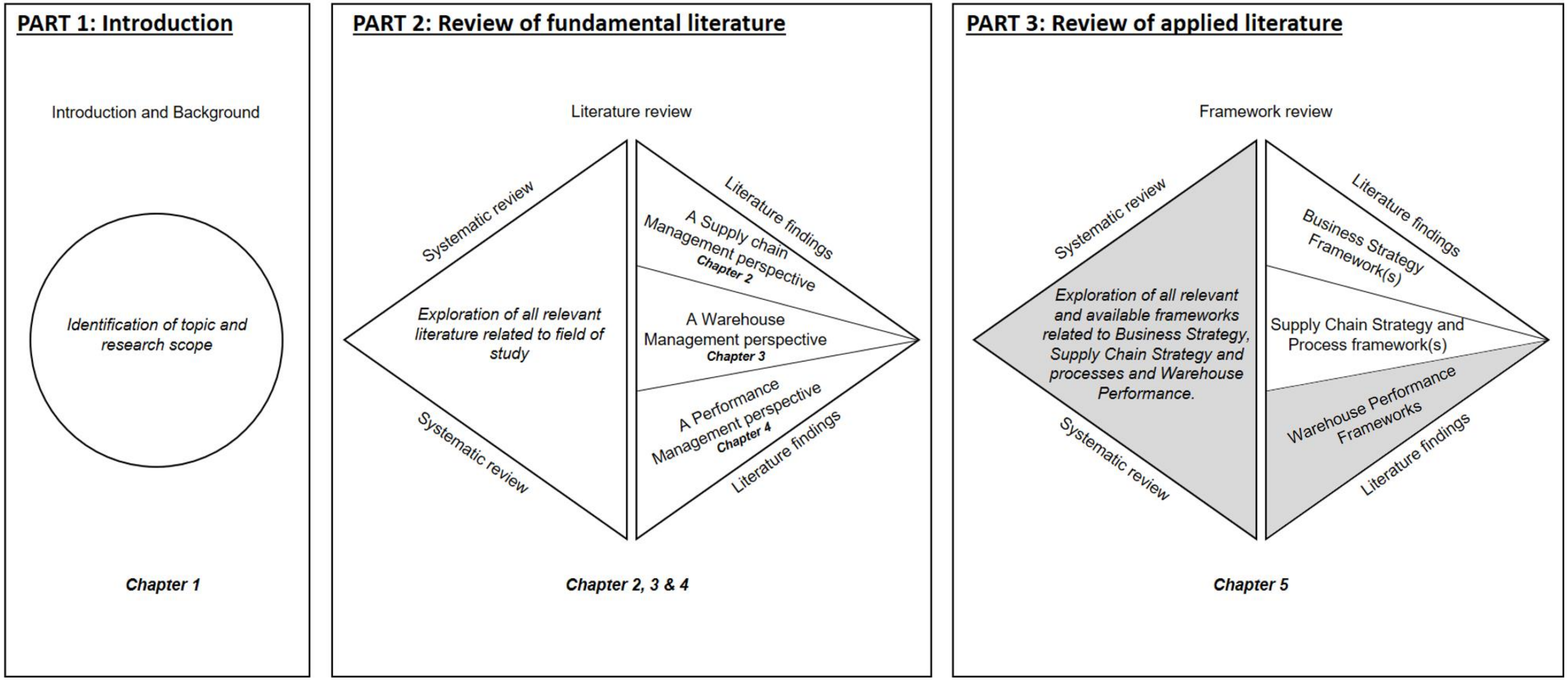


Figure 5.12: GSCF model -Identification of the eight Supply Chain Management processes *(Source adapted from: Lambert 2008:10)*

Derived from these eight Supply Chain Management processes is the need to measure the increased performance from this integrated approach to Supply Chain Management. In order to do this, measurement attributes, from SCOR, need to be assigned to each process. This is done through an analysis of the definition and identified activities that are conducted in each process, that best represents each process.


PART 1: Introduction
Introduction and Background
Identification of topic and research scope
Chapter 1
PART 2: Review of fundamental literature
Literature review
Systematic review
Exploration of all relevant literature related to field of study
Systematic review
Literature findings
A Supply chain Management perspective
Chapter 2
A Warehouse Management perspective
Chapter 3
A Performance Management perspective
Chapter 4
Literature findings
Chapter 2, 3 & 4
PART 3: Review of applied literature
Framework review
Systematic review
Exploration of all relevant and available frameworks related to Business Strategy, Supply Chain Strategy and processes and Warehouse Performance.
Systematic review
Literature findings
Business Strategy Framework(s)
Supply Chain Strategy and Process framework(s)
Warehouse Performance Frameworks
Literature findings
Chapter 5

5.10. Warehousing performance benchmarking framework review

Warehousing performance measures are critical in supporting and interpreting the results of day-to-day operations. It is by the use of KPIs that an organisation can determine if it has been successful in fulfilling its strategy and operational goals. The need to measure is apparent. However, most organisations should not only focus internally, on their own performance, but also focus externally on the performance of the rest of the market.

5.10.1. The literature review process

This literature review was conducted with the intended focus on reviewing the industry's performance benchmarking repositories. This was done to determine which of them reviews the most operational processes as well as has metric categories available for benchmarking to take place. This literature review was unsuccessful due to the lack of research and published knowledge in this area of the field of Warehouse benchmarking.

In order to conduct this section of the literature review. A *pearl growing method* or *Snowball method* was used. This method requires keywords and phrases to be used to search for all metric repositories available. These articles were then reviewed to determine, firstly, whether they published any industry-specific measures related to the field of study. Secondly, a review of the number of citations and peer reviews was considered when evaluating these articles. Despite significant searches and an *extensive snowball being created* no other repositories were found or identified for use in this study.

The WERC performance benchmarking framework was identified through the literature review process as one of the few performance benchmarking frameworks specifically focused on the Warehousing environment. The use of the WERC framework was used within a Stellenbosch context in 2017 by Harvey (2017). This research led to the identification of the framework. In order to get access to the latest version of the WERC watch framework, the Warehouse performance measures derived as part of the case study conducted at DSV were submitted as part of the 2019 survey. In the results of this survey, each participating organisation received a copy of the latest version of the framework. The limitations of accessible information in the field of Warehouse performance benchmarking frameworks meant that this framework was the only one reviewed in this research document.

The following section will thus only review and select one repository for use in the following phases of this research document. Therefore, a full explanation of this repository will be given in section 5.10.2.

5.10.2. WERC watch: A periodic assessment of industry trends

The WERC watch warehousing framework presented by Tillman *et al.* (2019) is based on the results from an industry-wide survey that allows practitioners to answer a set of questions and provide their current Warehouse performance level. This information is then transcribed into a statistical benchmark, allowing the same practitioners to compare their own Warehouse performance to that of other organisations that partook in the survey. For the purposes of this study, the performance results calculated in Chapter 10, section 10.2, were submitted to the 2019 WERC Watch survey conducted by Tillman *et al.* (2019).The original work presented by Tillman *et al.* (2015) outline how each of the measurement categories used within the framework were derived based on the respondents' results. Further discussion on this survey's respondents and their results are presented in section 10.3

5.10.2.1. *Metric Categories of WERC*

Each of the respondents' answers, as discussed in section 5.10.2, were collected and then the entire set of results was divided into five *quintile rankings*. The quintiles outline the metric thresholds within each category. Therefore, each quintile describes a performance level, that best explains the spread of data it encompasses within it. These quintiles, and their accompanying names and thresholds are presented in Table 5.4.

Table 5.4: Metric thresholds established from respondent results in WERC repository

Quintile rankings of WERC performance metrics	
Category Name	Threshold Value
Major opportunity	Lowest 20% of responses
Disadvantage	Responses ranging in the 20-40th percentile
Typical	Responses ranging in the 40-60th percentile
Advantage	Responses ranging in the 60-80th percentile
Best-in-class	Top 20% of all responses
Median	Actual median performance of all respondents

(Source adapted from: Tillman et al., 2015;6)

This quintile ranking allows companies and organisations to categorise themselves into one of the above-mentioned 5 categories: *Major opportunity, Disadvantage, Typical, Advantage* or *Best-in-class.* However, in order to do so a company must first measure themselves in order to be compared. WERC has outlined seven different metric categories, each of which contains the most popular metrics identified through the WERC watch research.

Each of these metrics identified in the following metric group is measured by one of the above-mentioned quintile ranges. These seven Warehouse metric groups are as follows:

1. Customer metrics
2. Operational metrics
    a. Inbound facing metrics
    b. Outbound facing metrics
3. Financial metrics
4. Capacity/Quality metrics
5. Employee metrics
6. Perfect order index
7. Cash-to-cash metrics

Based on the popular metrics, identified by practitioners' responses as well as the calculated quintile thresholds calculated by (Tillman et al., 2015), a Warehouse performance benchmarking evaluation is possible. Therefore, the ability to benchmark performance is an enormous leap forward in the field of performance evaluation. Tillman *et al.* (2015), have also endeavoured to link these metrics with typical Supply Chain strategies.

According to Tillman *et al.* (2015), the following typical strategies were aligned with the metrics outlined in the repository's annual report. Each of these metrics comes from the seven different metric groups (section 5.10.2.1). The different strategies available for selection in the WERC watch repository were identified as follows:

Cost leadership strategy: A strategy defined by an organisation competing on price, the organisation should lower the cost of the goods sold to increase the number of units sold and by so doing, increase their market footprint.

Customer service: The strategic goal is to serve the customers based on their requirements. It therefore outlines the customer service experience whereby a firm does all it can to make the experience memorable while providing the product.

Product or service uniqueness*: This* requires a 'niche' product or service. Customers will be willing to pay a higher price for the goods due to their perceived exclusiveness.

Hybrid strategy*: This* refers to a mixed model, whereby an organisation endeavours to be *all things to all people*.

Due to the implementation of strategies, organisations and practitioners endeavour to align different performance metrics with different strategic approaches.

Table 5.5 illustrates what the respondents determine as the metrics required to measure each strategy. These results demonstrate that practitioners believe that most metrics appeal to all strategies. This is further outlined in the findings of Tillman *et al.* (2015). The outcome of their research asks the question as to why industry practitioners feel that all these metrics best align with a strategy? This realisation outlines the very reason for this research, that is that a specific set of metrics should be aligned with a specific strategy. This does not discount the need to measure all areas, but rather identified metrics that should perform at higher levels in some specific areas than in others. The need for such alignment is further outlined in the research conducted by Harvey, (2017) and Tillman *et al.* (2015)[9], in section 5.10.2.

Table 5.5: Metrics identified by respondents to measure each strategies success

Top 10 Metrics-Performance	Cost leadership strategy	Customer service strategy	Product/Market innovation strategy	Mix: Be all things to all people
On-time shipments	X	X	X	X
Average Warehouse capacity used	X	X	X	X
Dock-to-stock cycle time, in hours	X	X	X	X
Order-picking accuracy (% by order)	X	X	X	X
Internal order cycle time	X	X	X	X
Peak Warehousing capacity used	X	X	X	X
Total order cycle time	X	X	X	X
Fill rate - line	X	X	X	-
Lines received and put-away/hour	-	X	-	X
Lines picked and shipped/hour	-	X	-	X

(Source adapted from: Tillman et al., 2015:6)

In conclusion to this section, the WERC repository has been selected for its extensive market research in Warehousing performance measures. This allows other companies that did not form part of the study to now be measured. This measurement will not only allow for the development and implementation of solutions, but further outlines the need to align metrics with strategy to break through to new levels of performance in both the Warehouse and the supply chain, similar to the thinking of McKinsey 4.0 in section 2.7.

Due to the limited availability of specific benchmarking tools within the industry today, WERC has been identified as the most comprehensive and accurate measurement platform available. Therefore, the selection of the repository to be used for this research has been done through a literature review process, as stated in section 8.3 of this report. In addition, the description of this model is important in order to understand the definition and description of each of these measurement categories, as well as understanding what metrics fall under which descriptions.

[9] *Williams Jr., D.F., Tillman, J. & Manrodt, K. 2015. Disconnected in the DC: The missing link between metrics and strategy. Strategy – CSCMP's Supply Chain (Different to other references)*

The next step is to use these measures to evaluate the performance of a specific Supply Chain strategy and its supporting processes by aligning these operational metrics with specific strategic metrics. The alignment of both the Supply Chain Frameworks and Warehouse frameworks and their metrics is presented as the strategy-process performance alignment matrix in Section 8.3 of this report.

5.11. Summary of Business, Supply Chain and Warehousing framework review

This chapter outlined the different types of frameworks used within industry today. The inclusion of the a top-down approach to this literature review helped to illustrate the connections present between these different frameworks. The purpose of this chapter was to identify and review the different frameworks available within four focal areas namely Business Strategy, Supply Chain strategy, Supply Chain processes and Warehousing performance. The review helped outline the BSC as a good framework for defining Business strategy.

The focus for the Supply Chain strategic frameworks section outlined the Gattorna model as well as the M4SC framework. The M4SC framework was used to demonstrate a process for strategy implementation within the context of SCOR and how the M4SC framework can be used to execute a plan for continues improvement.

The Supply Chain process framework review found three frameworks that could be convincingly linked to SCOR for the development of the strategy-process performance alignment matrix. These four process frameworks were the critical link between strategic level and the Warehousing process level.

The identification and review of a Warehouse performance benchmarking framework was restricted due to the limited number of public resources made available in the public domain. In order to secure a current version of the benchmarking framework, the case study results presented in Part6-Chapter 10 were submitted during the 2019 WERC watch survey, further demonstrating the limitation of access to this type of information.

This chapter focused on the most prominent and readily available frameworks within each field of study for these frameworks to be aligned with the SCOR reference model. The SCOR model is the keystone of the strategy-process performance alignment matrix presented in Part 5-Phase 2: Chapter 8, and the measurement framework used in the case study presented in Part 6-Phase 3 of this report.

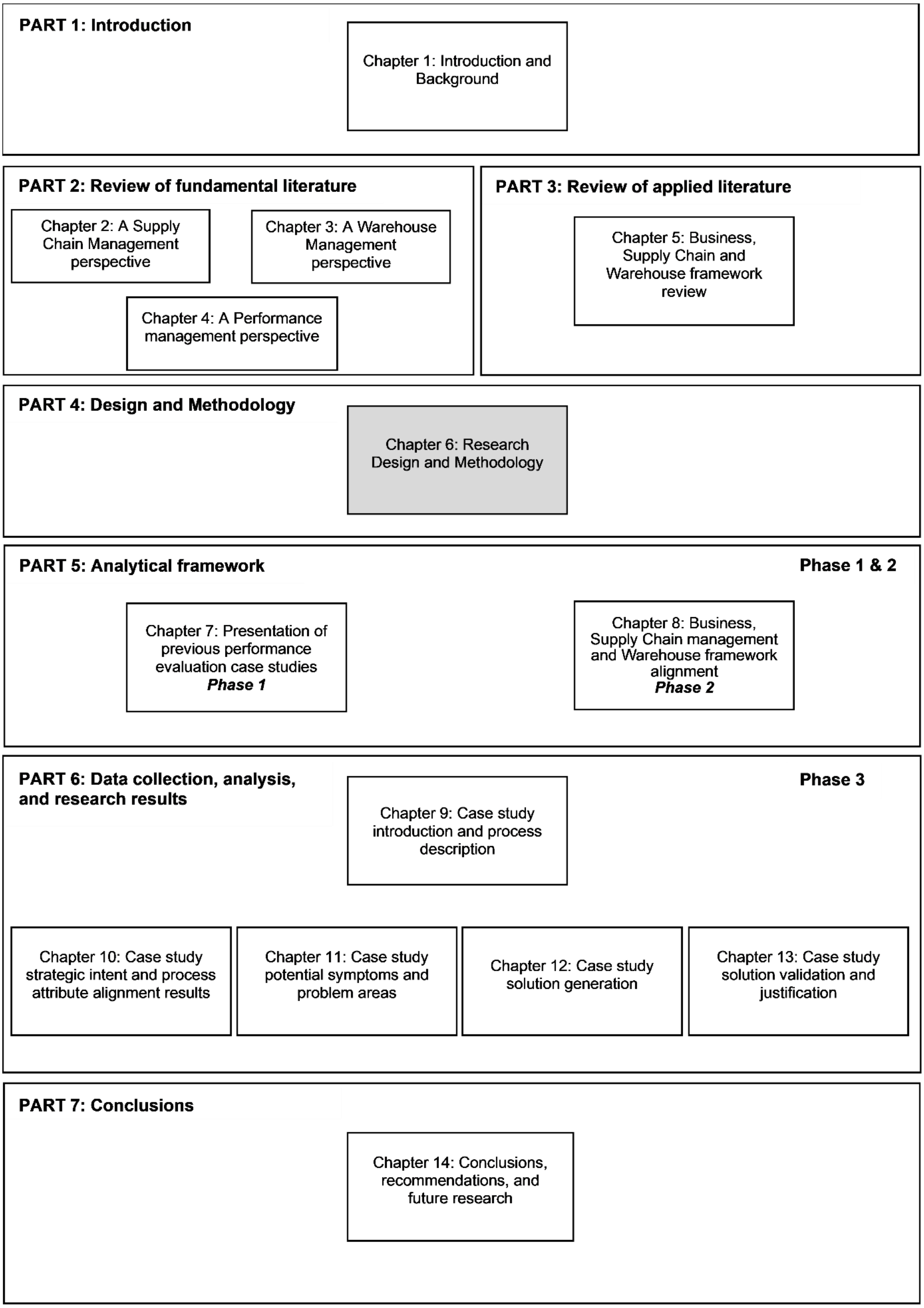
PART 4

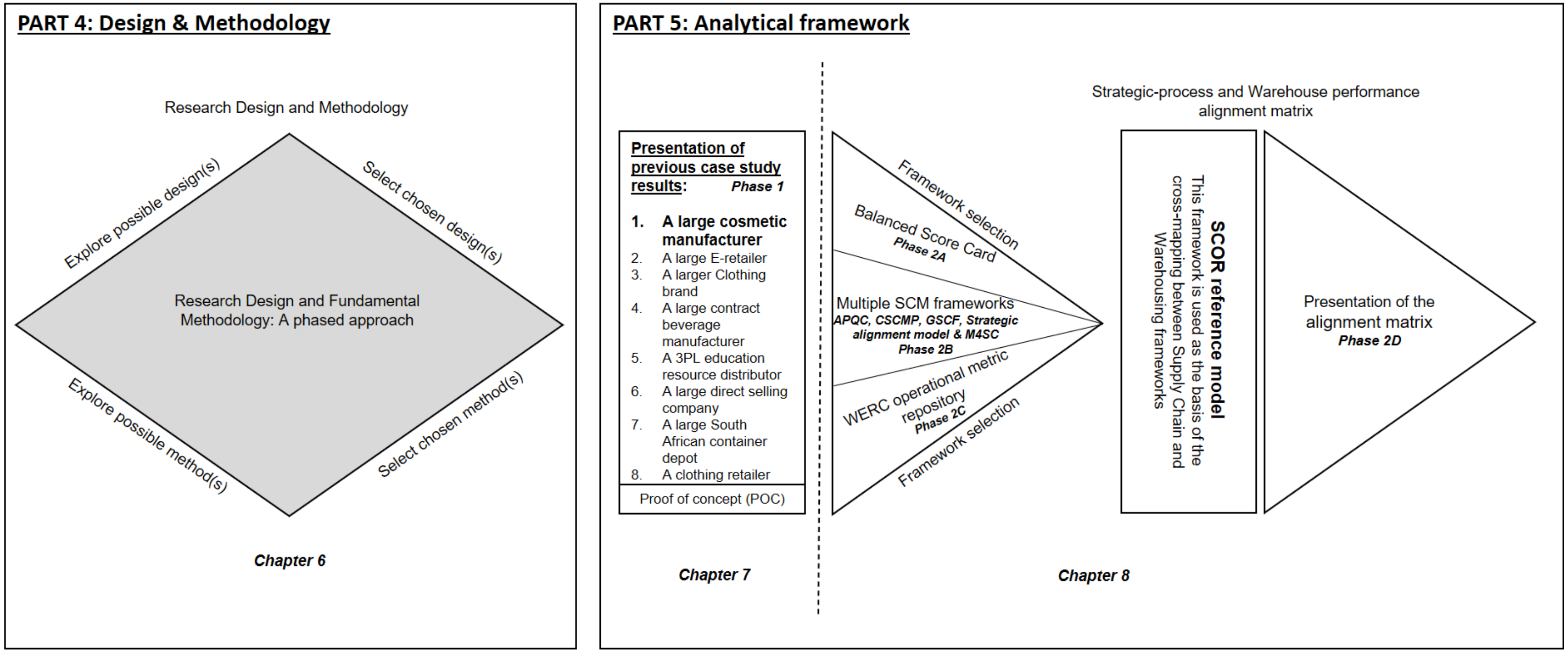
DESIGN AND METHODOLOGY

- Chapter 6: Research Design and Methodology

The section outlines the research design and methodology used throughout the research document. This research document makes use of a phased research approach and design, with each phase conducted using specific data collection techniques to ensure each research objective is met, while at the same time ensuring all the research questions are answered, and in so doing assist in the resolution of the problem statement.

PART 4: CHAPTER 6
RESEARCH DESIGN AND METHODOLOGY




PART 4: Design & Methodology
Research Design and Methodology
Explore possible design(s)
Select chosen design(s)
Research Design and Fundamental Methodology: A phased approach
Explore possible method(s)
Select chosen method(s)
Chapter 6
PART 5: Analytical framework
Presentation of previous case study results: Phase 1
1. A large cosmetic manufacturer
2. A large E-retailer
3. A larger Clothing brand
4. A large contract beverage manufacturer
5. A 3PL education resource distributor
6. A large direct selling company
7. A large South African container depot
8. A clothing retailer
Proof of concept (POC)
Chapter 7
Framework selection
Balanced Score Card
Phase 2A
Multiple SCM frameworks
APQC, CSCMP, GSCF, Strategic alignment model & M4SC
Phase 2B
WERC operational metric repository
Phase 2C
Framework selection
Strategic-process and Warehouse performance alignment matrix
SCOR reference model
This framework is used as the basis of the cross-mapping between Supply Chain and Warehousing frameworks
Presentation of the alignment matrix
Phase 2D
Chapter 8

Chapter 6: Research Design and Methodology

This chapter outlines the applicable research design methodologies and methods used throughout the research process. This ***fundamental research*** design and methodology is outlined in three distinct phases, which from here on are referred to as phases one, two and three. The problem statement has been derived from the review of specific literature pertaining to the field of Supply Chain Management, Warehouse Management and Performance Management, as outlined in *Chapter 2, Chapter 3* and *Chapter 4*. Furthermore, to understand how organisations conduct performance measurement and handle the management of the derived performance levels achieved, a further Literature review was conducted on Performance measurement which is presented in *Part 2 - Chapter 4*. The outcomes of these three literature review sections outlined a need to understand the role frameworks play in measurement in the Business, Supply Chain and Warehousing environments respectively. As a result, *Chapter 5,* conducted a focused literature review on the most prominent and readily available frameworks used in industry today, all of which is presented in the strategy-process performance alignment matrix in *Phase 2 - Chapter 8*.

Due to the intricate nature of this research, two different governing research designs and methods will be presented. The first outlines the design and methods used to conduct phases 1 and 2, this research design and methodology represents the ***fundamental*** portion of the research design and methods used in this phase. *Phase 3*, outlines an ***applied*** research design and methodology that facilitates the exploratory case study requirements of a specific company as presented in *Chapters 9, 10, 11, 12 and 13*.

The literature review conclusions derived from Chapter 2, related to the review of existing Supply Chain theories and major literature findings, are presented as follows:

- The development of the terms Supply Chain Management and Logistics were defined throughout the field’s history.
- The importance of the customer's role within the Supply Chain and how the power shift between the organisations and the customer has changed over the past six decades were outlined and explained.
- The identification of the different Supply Chain drivers and the role and function they play in the development and measurement of a company’s selected strategy was defined.
- An understanding of the decisions required by stakeholders to be efficient or responsive or any combination thereof, outlined the need to understand the Supply Chain process attributes that accompany a Supply Chain design.

- The need for selection of attributes was identified for performance measurement to be conducted to determine the success or failure of the current strategic Supply Chain intent.
- The use of McKinsey 4.0 to unlock new performance potentials in the ever-changing business environment.
- The identification of the need for different levels of management involvement within the Supply Chain strategy selection/identification process and measurement of these processes, particularly if a prioritisation of what needs to be measured is to be created was also identified.
- In order to accurately measure a company's operational processes in line with its strategic intent, several Supply Chain strategic and process frameworks were identified to help outline what should be measured depending on the organisation's selected strategic intent.

The conclusions derived from Chapter 3, following the review of previous Warehousing theories and literature are as follows:

- A brief history of the Warehousing concept was outlined to understand how the need for this Supply Chain node has increased in recent years.
- All the generic processes involved within the Warehousing function were outlined to better understand the types of measures that could be generated for each process.
- The need for a company to identify whether Warehousing should be a core business competency or not as outlined in the distinction between private or public Warehousing decisions.
- Based on the identification of Warehousing processes and the potential for measurement, the different types of metrics were identified to understand what constitutes a good measure as well as what types of measures exist to ensure that accurate measurements are derived.
- Outlining the Warehouse as a component to be a strategic catalyst and break through the *four walls* thinking to unlock improved performance as well as outline the potential benefits through Warehouse automation.
- The need for continuous improvement and benchmarking potential performance is critical to improve and maintain performance levels.

The literature review conclusions derived from Chapter 4, related to the review of existing Performance measurement and management theories and major literature findings, are presented as follows:

- Efficiency and effectiveness are prevalent components at the highest level of performance measurement.
- Seven purposes of performance measurement were also outlined to help define why performance measurement is conducted within organisations.
- The evolution and progression of performance measurements from recommendations, through the development of frameworks and finally the creation management systems outline what organisations need to use to conduct a complete performance review.
- The presentation of performance frameworks further outlined the most prominent performance frameworks available in literature today. These frameworks became the focal point for the identification of a Business strategy framework in Chapter 5.
- Outlining and understanding of the types of measures and how they can be used to conduct performance measurement is critical when attempting to manage performance in an organisation.
- The identification of the different development approaches helps outline how an organisation can go about developing performance management techniques, using specific frameworks, to help define measures from strategy.

The literature review conclusions derived from Chapter 5, related to the review of existing Performance measurement and management theories and major literature findings, are presented as follows:

- There are multiple performance management frameworks available in literature with different perspectives on how measures should be derived. This comparison helped define that there are multiple ways to inform performance measures.
- The balanced scorecard proved to be the most effective framework to integrate with the SCOR reference model and was selected based on its method of deriving measures from strategy.
- A Framework review related to Supply Chain frameworks focusing on both Supply Chain strategies and processes was conducted to outline the most prominent and readily available frameworks in literature today.

Based upon the findings of the identified problem statement the following conclusions were obtained:

- No integrated Supply Chain framework measurement method, which is inclusive of level 1 performance metrics, is currently available within the public domain. This limits the ability of aligning performance evaluations within the Warehousing processes with a selected Supply Chain process strategy. To be able to integrate metric prioritisation of key process metrics within the Warehouse performance environment.
- Warehousing process metrics have yet to be linked to a Supply Chain process analysis, which determines the current and desired levels of performance to quantify the current performance gaps within Warehouse operational processes.

6.1. Problem Statement

Organisations that rely on Supply Chains, both above and below the point at which they operate, rely on performance measurements to determine their performance, whether good or bad. This measurement procedure allows companies to monitor performance issues in the day-to-day execution of their operational tasks. However, there is very little information available that allows performance measures to be aligned with the overarching Supply Chain objectives and strategies (Tillman, Manrodt & Williams, 2019). This problem statement outlined the need for specific research objectives to identify a fundamental research methodology to realise these objectives.

6.2. Research Objectives

- To conduct a Business, Supply Chain and Warehouse measurement *framework evaluation*, to identify the underlying measurement principles that exist in each framework. These frameworks will be aligned with the SCOR reference model attributes which will then be integrated with operational metrics, to assist in prioritising these metrics, to effect improvements in operations that are aligned with selected Supply Chain strategies.

- To develop a Warehouse *metric evaluation tool* that can be utilised to conduct performance measurement within a given case.

- To perform a gap analysis to determine the reality of performance as well as identify the target/goal performance in each case.

- To test this method of Supply Chain/Warehousing evaluation to complete an *exploratory assessment* to determine whether Supply Chain process frameworks and operational metrics can be aligned through gap analysis determination in Warehousing performance on a specific case.

6.3. The conceptual framework

Figure 6.1 was derived in order to outline the intricate nature of all the research components as well as summarise the link between different theories and concepts. This figure outlines which frameworks will be used as well as how they link together. In order to understand the link between different Supply Chain process frameworks and a Warehousing repository, the need to conduct further analysis of the literature surrounding these *frameworks* was apparent. This need was further outlined by the problem statement and research objectives, in order to determine the linking attributes between these concepts and frameworks.

Figure 6.2 further outlines the intricate nature of this phased approach that is discussed in this section of the report. The integration of these concepts outlines a particularly complex ***fundamental research method***, that was conducted through a phased design, to achieve the stated research objectives in section 6.2. Based on these objectives, specific research questions have been derived to further guide the research towards its stated objectives.

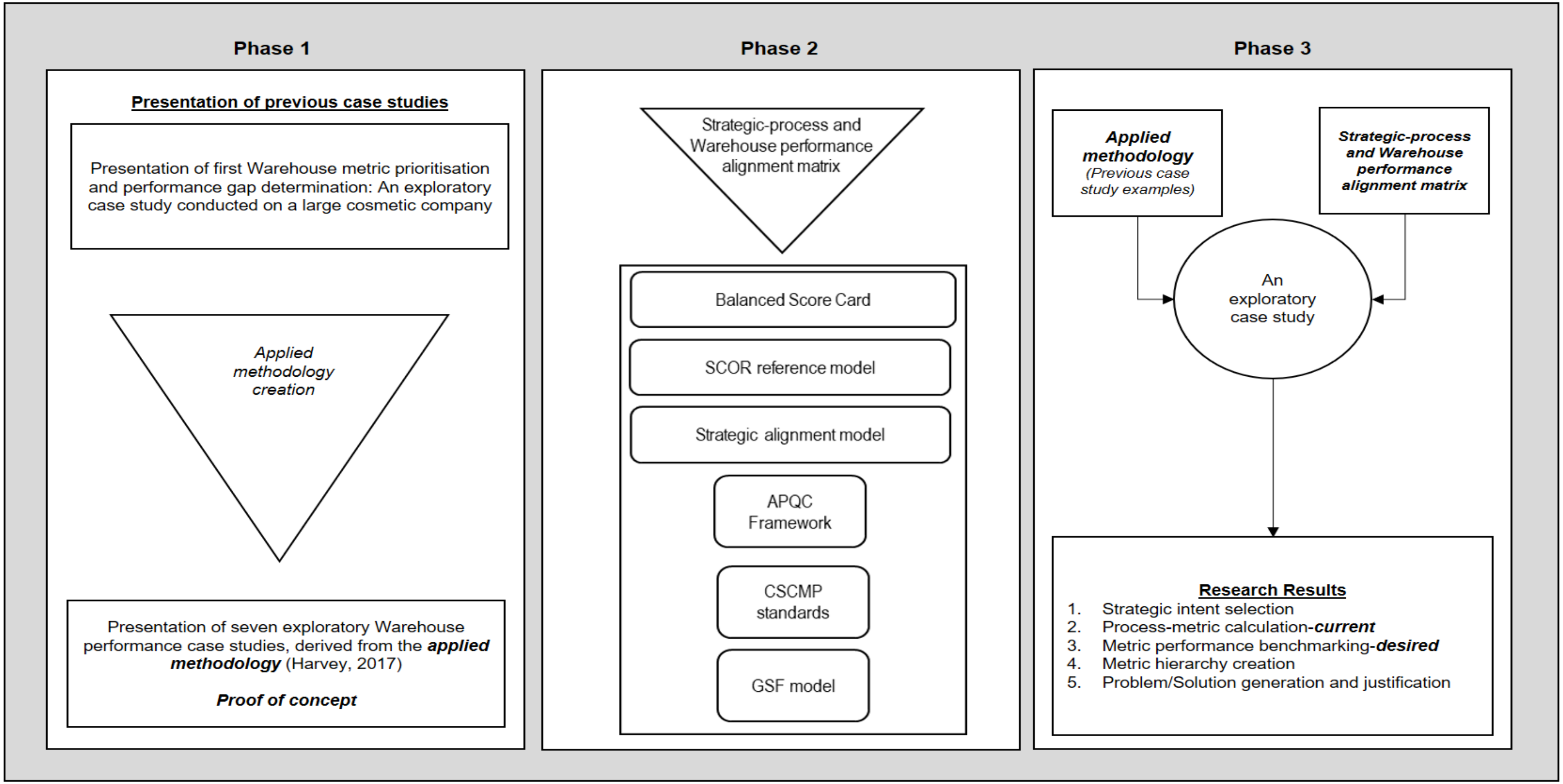


Figure 6.1: Fundamental research method explained – A conceptual framework

6.4. Research Questions

The following research questions were derived from the problem statement in section 6.1. The section below will incorporate research questions pertaining to each of the three phases, aligned by the research objectives in section 6.2.

6.4.1. Phase One questions: Presentation of previous case study results

Q1: What are the performance gaps identified in selecting a specific Supply Chain process strategy?

Q2: How are the identified metrics prioritised within each case's selected Supply Chain strategy to derive beneficial solutions?

6.4.2. Phase Two questions: Framework identification and evaluation

Q3: What are the most popular Performance Management frameworks that facilitate Business Strategy selection present in the literature?

Q4: What are the most popular Supply Chain process frameworks present in the literature??

Q5: What are the most popular Warehouse measurement frameworks present in literature?

Q6: Which of these Business, Supply Chain strategies and processes, identified from the literature reviews, can be aligned with SCOR's five main process attributes?

Q7: Which metrics from SCOR align with benchmarked metrics from the selected Warehousing framework?

6.4.3. Phase Three questions: Exploratory case study example

Q8: To what extent can Supply Chain strategy-process and Warehouse operational metrics be integrated to prioritise improvements to overall performance of the Warehouse, in line with the corporate and Supply Chain objective?

6.5. The fundamental research Design and Methodology

The strategy surrounding this research is developed on a deductive research method, whereby a known theory was investigated and tested for its reliability and validity to the field of study. The conclusions of this research will be based upon the findings derived from all specific data analysed in each section. Due to the nature of this research as outlined in Figure 6.1, this research makes use of three phases:

Phase 1: The presentation of previous case study examples to derive validity as a proof of concept to demonstrate performance gaps, determined through operational metrics. The outcome of these would derive beneficial solutions to impact company performance.

Phase 2: Based on the result of the Framework reviews presented in Part 3, outlined in Chapter 5, a strategy-process performance alignment matrix was developed. This matrix combined Business Strategy with multiple Supply Chain strategy and process frameworks; added to this was the inclusion of a Warehousing process framework to demonstrate that all these concepts could be aligned with the SCOR reference model. This alignment was used to facilitate a cross-mapping of level one metrics, to help facilitate a strategy and metric prioritisation across different level of management, as presented in *phase 2*. This integration between Business Strategy, Supply Chain strategy and processes, with Warehousing metrics is presented in Table 6.1.

Phase 3: To conduct a full Supply Chain strategic-operational performance analysis on a selected case company, through an ***applied research design,*** to derive performance enhancements. The enhancements will be presented in the form of specific solutions, used to close performance gaps, and realign operational level Warehousing processes with the overarching Supply Chain strategy.

The research design will be based on the research objectives; therefore mixed methods and multiple phases will be used within this research. Each of these phases will have different designs and methodologies due to the different data types and data sources being used. This research design and methodology is similar to that identified by Cilliers (2015:5) and uses triangulation through a phased design to corroborate findings and results (Bryman & Bell, 2011:62).

The process of integrating these different phases is based on the Balanced Scorecard (BSC) methodology, whereby four business perspectives namely *Financial, Internal process, Customer and Learning,* and *Growth* are considered throughout the measurement process, in order to facilitate the *generation* and *justification* of all derived solutions through three themed solutions sections.

Firstly, a *computer simulation* was used to test specific solutions in a theoretical environment. Secondly, a *Total Cost of Ownership (TCO)* calculation was used to determine the opportunity cost saving that potentially could be realised if the solutions were implemented. The third and final section saw the development of an *initiative road map,* which could be used as an implementation plan for all initiatives and solutions derived in the final case study, in phase three. Table 6.1 illustrates the summary of this fundamental design and methodology and how the different components connect within phase 2, presented in section 6.7–6.8 of this report.

Table 6.1: Fundamental Methodology and Design

<table>
<tr><th colspan="2">Alignment criteria for different Supply Chain frameworks</th><th colspan="2">Performance gap determination</th><th colspan="2">Metric alignment</th></tr>
<tr><td>Balanced Score Card</td><td>Four perspectives</td><td>Actual level</td><td>Expected level</td><td>SCOR LV1 Metrics</td><td>WERC metrics Categories</td></tr>
<tr><td>Supply Chain Process Frameworks</td><td>SCOR Attributes</td><td>Actual level</td><td>Expected level</td><td>SCOR LV1 Metrics</td><td>WERC metrics Categories</td></tr>
<tr><td rowspan="5"><u>Strategic Models</u>
1. Strategic Alignment Model
<u>Process Frameworks</u>
2. APQC Alignment Framework
3. CSCMP Model
4. Global Supply Chain Forum Model</td><td>Reliability</td><td>S, A, P or D</td><td>S, A, P or D</td><td>Perfect order fulfilment</td><td>Perfect order index</td></tr>
<tr><td>Responsiveness</td><td>S, A, P or D</td><td>S, A, P or D</td><td>Order fulfilment cycle</td><td>Customer-facing metrics</td></tr>
<tr><td>Agility/Flexibility</td><td>S, A, P or D</td><td>S, A, P or D</td><td>Supply Chain flexibility</td><td>Capacity/Quality</td></tr>
<tr><td>Cost</td><td>S, A, P or D</td><td>S, A, P or D</td><td>Cost of goods sold</td><td>Financial metrics & Employee metrics</td></tr>
<tr><td>Assets</td><td>S, A, P or D</td><td>S, A, P or D</td><td>Return on working capital</td><td>Financial metrics</td></tr>
</table>

6.6. Phase 1: Presentation of previous case study results

This phase of research will identify several gap analyses by abstraction through multiple case study interpretations. These cases are empirical studies that were completed to determine the overall performance for a specific case (Yin, 2009:23). The purpose of this phase is to be able to identify gaps in performance through multiple quantitative data collection cases that have been conducted at Stellenbosch University, through student research assignments. For the purpose of this research, only one of these cases has been presented in Chapter 7; the other seven are presented in Annexure H.

According to Bryman and Bell, (2011:39), quantitative data has four specific considerations, making it ideal for this phase of research. These four considerations are *measurable, causality, generalization* and *replication.* Consequently, due to these measurement criteria, both interval and ratio data types will be used in this section of the data analysis (Zikmund *et al.*, 2013:296).

The purpose of these case study examples is to demonstrate the ***applied method*** for data collection based on the results of previous cases. This will help determine the magnitude of the performance discrepancy between expectation and reality in Supply Chain performance and assist in aligning the operational metrics with different Supply Chain level one metrics, as Identified by SCOR (APICS, 2017).

Finally, these metrics were benchmarked against a selected repository identified in phase 2B, (Tillman, Manrodt & Williams, 2017). Each of these cases and their accompanying metrics meets the four considerations outlined by Bryman and Bell (2011:39). The purpose of meeting these four considerations is to ensure a sturdy foundation upon which continuous improvement plans can be implemented to promote performance improvements for the future.

According to Saunders et al. (2016) a longitudinal approach best suits this design as the data collection for all the cases used was done over a period that exceeds a calendar year. These findings were collected from the academic years of 2017 and 2018 and form part of phase 1 of this research.

Each of these cases was conducted as an independent performance assessment through the following ***applied methodology*** which outlines a *five-step process* as presented by Bolstroff and Rosenbaum, (2003). This will allow for independent results to be collected from these cases in different industries. This data was collected from research projects that were conducted at Stellenbosch University by postgraduate students in the department of Logistics in the field of Warehousing. The following five steps outline the ***applied methodological*** approach taken in each case:

The first step will be to identify the case company or distribution centre that will be analysed. Following the identification of the case company, step two is to conduct a process description and evaluation of the major activities conducted within the Warehouse as each case's key processes will differ depending on the industry and products being processed. The third step would be to derive the associated metrics that relate to each process that was identified in step two.

These Key performance indicators (KPIs) will form the base on which the case's performance is measured. Step four refers to KPI data extraction and analysis in order to determine the current and expected performance of each process in each case.

As part, of this data extraction, a Supply Chain prioritisation questionnaire will be filled in by some of the management role players involved in these processes. This semi-structured interview will provide an overview of the current Supply Chain strategy selected by the company, as well as outline the desired performance target they aim to achieve in the future.

Finally, step five was to benchmark the identified KPIs against a repository to determine the case's competitive advantage in its industry as well as outline performance gaps in areas where performance enhancements are required. Once these two phases was completed, phase 3 will follow. Phase 3 outlines the integration of both Phase 1 and Phase 2 concepts into a single ***applied methodical approach,*** presented as an exploratory case study.

6.7. Phase 2: A Literature review of Business, Supply Chain Strategy and processes, and Warehousing frameworks

In order to understand how Business and Supply Chain measurement frameworks link together it is first necessary to identify which frameworks are the most reliable and incorporate a wide variety of measurement criteria. This literature review process outlined in Chapter 5, presents a conceptual scope which helped isolate the most popular and reliable measurement frameworks available across Business performance, Supply Chain Management and Warehousing, respectively. This methodology is presented in Chapter 5 as a single framework review chapter. The literature review outlines the most relevant and available frameworks within each discipline, namely, *Business performance*, *Supply Chain Management* and *Warehouse Management.* This review concludes with an alignment between SCOR's level one metrics and those found within the Warehousing frameworks, thus outlining the presentation of the ***strategy-process performance alignment matrix*** in section 8.3.

6.7.1. Phase 2A: Business Strategy Framework analysis

In this phase, the most popular Business strategy frameworks are summarised and reviewed. The purpose for this framework review focused on the most prominent and available framework available that could link with the SCOR reference model. This review presented different frameworks and methods for conducting performance measurement within the business context. Neely et al. (2002) stated that performance measures should not be based off a business's strategy but rather off stakeholders' needs and wants.

Kaplan and Norton (1996) and European Foundation (1991) believe that performance measures should be based off the business-defined strategy. More so, Kaplan and Norton (1996) defined four perspectives that can be used to help focus performance measurement towards a defined business strategy. This comparison and evaluation was conducted to help outline contrasting methods and processes for business performance measurement and management.

6.7.2. Phase 2B: Supply Chain framework analysis

In this phase, popular Supply Chain frameworks have been evaluated in the form of an in-depth literature review. The purpose of this literature study is firstly to identify the major framework role players within the field of Supply Chain Management. This non-empirical study was used to determine the linking characteristics between the SCOR reference model attributes and each of the selected Supply Chain frameworks' strategies. The SCOR model has been used as the centre point of this alignment due to the extensive research conducted surrounding Supply Chain processes, this allows for a variety of Supply Chain types to be assessed from a process development point of view (APICS, 2017).

This method of data collection and evaluation is described through a literature review and conceptual analysis. The defined concepts are analysed and aligned with other concepts of similar meaning or similar dimensions. Similar to Cilliers (2015:26), a qualitative, deductive approach is used for this phase of the study.

This analysis of secondary qualitative data will provide significant findings on previous knowledge regarding current Supply Chain frameworks and those frameworks used in industry today (Mouton, 2001:175–180). This data will then be analysed to determine if there is any desirable link between the SCOR attributes and each of the selected framework's process strategies, to incorporate these frameworks into a singular strategy-process performance alignment matrix. This alignment will help define all relevant processes that should be measured during a case study investigation.

As a result of the SCOR alignment, level one performance metrics can be identified as the starting point for performance measurement. In order to derive further benefit from this type of alignment, a Warehouse benchmarking repository literature review was also required, to help define the possible performance thresholds/benchmarks that could be achieved once the measurement has taken place.

6.7.3. Phase 2C: Warehousing repository identification

The investigation into the most popular Warehouse benchmarking repositories was also conducted through an extensive literature review process. This non-empirical study was used to identify the different measurement frameworks that exist within the industry today. This analysis of secondary qualitative data provided significant findings on previous knowledge regarding Warehousing performance measurement tools as well as a benchmarking repository that will outline performance gaps within the day-to-day operations (Mouton, 2001:175–180).

According to Saunders et al. (2016), time is a critical variable that should be determined before research is conducted. This research is defined as a cross-sectional design, to draw comparisons between variables within a Supply Chain process context to create an alignment matrix. The choice of these specific design methods allows for correlations between different theories and frameworks to take place, thus allowing for the development of a simplified measurement method, incorporating different measurement frameworks to be created.

6.7.4. Phase 2D: The strategy-process performance alignment matrix

This section is the result of both phase 2A and 2B. The presentation of the strategy-process performance alignment matrix is conducted by linking Supply Chain attributes with SCOR while simultaneously linking Warehousing metrics with the SCOR level one metrics. The result is a unified measurement matrix, allowing for multiple Supply Chain types to be assessed from a strategy and operational level.

The purpose of this is to be able to measure performance no matter the framework, process or strategy used. Only nominal and ordinal data is expected in this phase of research as deductions and connections are being made (Zikmund, Babin, Carr & Griffin, 2013:296). Finally, the identification of the selected Warehouse benchmarking measurement framework as identified in section 5.10, which will be used throughout the evaluations in all case studies, presented in phases 1 *(previous case study)* and 3 *(Exploratory case study)*.

6.8. Phase 3: Exploratory case study: Evaluation and results

This phase of research will be used to determine whether or not the framework analysis, conducted in phase 2, and the metric gap analysis presented through the case studies in phase 1, can be integrated as outlined in Figure 6.1. The purpose of the integration is to determine whether or not the gap analysis assessment conducted on Supply Chain strategies and the corresponding metrics can be prioritised to improve process realignment and performance, as indicated by the ***applied methodology*** outlined in section 6.6.

This alignment can be used as a root cause analysis, once a hierarchy of metrics has been created, while allowing the identification of specific solutions to be derived to improve performance. Aligning the solutions with the selected Supply Chain strategy based on the operational processes outlines the desired intention for this document's research findings.

This method allows for a proof of concept (POC) to be derived. Further understanding and evidence will be created to contribute to the findings that integrating Supply Chain frameworks and Warehousing metrics can benefit each measured case, relative to the business and Supply Chain strategy, as per the initial findings of (Harvey, 2017).

6.8.1. Diagrammatic reasoning of research design and methodology

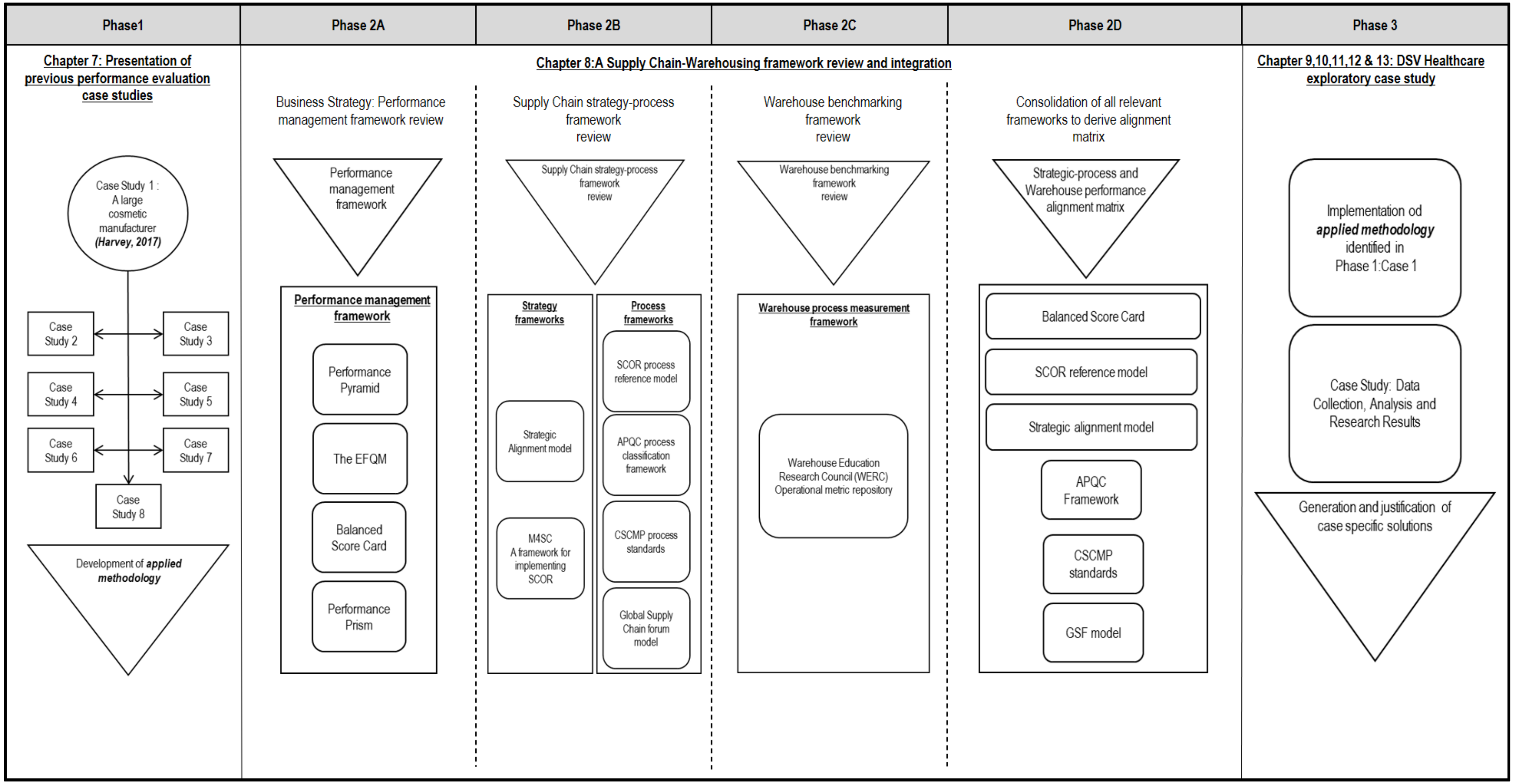


Figure 6.2: Research Design and Methodology flow diagram

6.9. Summary of Research Design and Methodology

This research outlines three phases all with different research designs and methodologies. This mixed methods approach allowed for multiple research findings and data analyses to be conducted. The design helped to gain a greater understanding about the connection between Supply Chain strategy-processes and how they link with Warehouse operational processes.

The first phase outlined a longitudinal research design, incorporating eight Warehousing case study evaluations. The most important of these was identified as case one, which outlined the ***applied methodology*** used in each case, but further outlined the first instance where this method derived a successful performance valuation and benchmarking gap analysis on a specified case company.

The second phase outlined a cross-sectional design outlining a literature review that was conducted in sections, with a third section outlining the integration of the identified frameworks and models discussed in the literature reviews. The integration of these concepts and measures outlines a ***strategy-process performance alignment matrix*** that was used within phase 3.

The third and final phase presented a cross-sectional research design through an exploratory case study. This case study incorporated both the applied methodology identified in phase 1 and the alignment matrix presented in phase 2. This integration lead to the case study findings presented in Part 5. The following chapters outline the data analysis, collection, results and findings of the designs and methods presented in this section of the research document.

PART 5

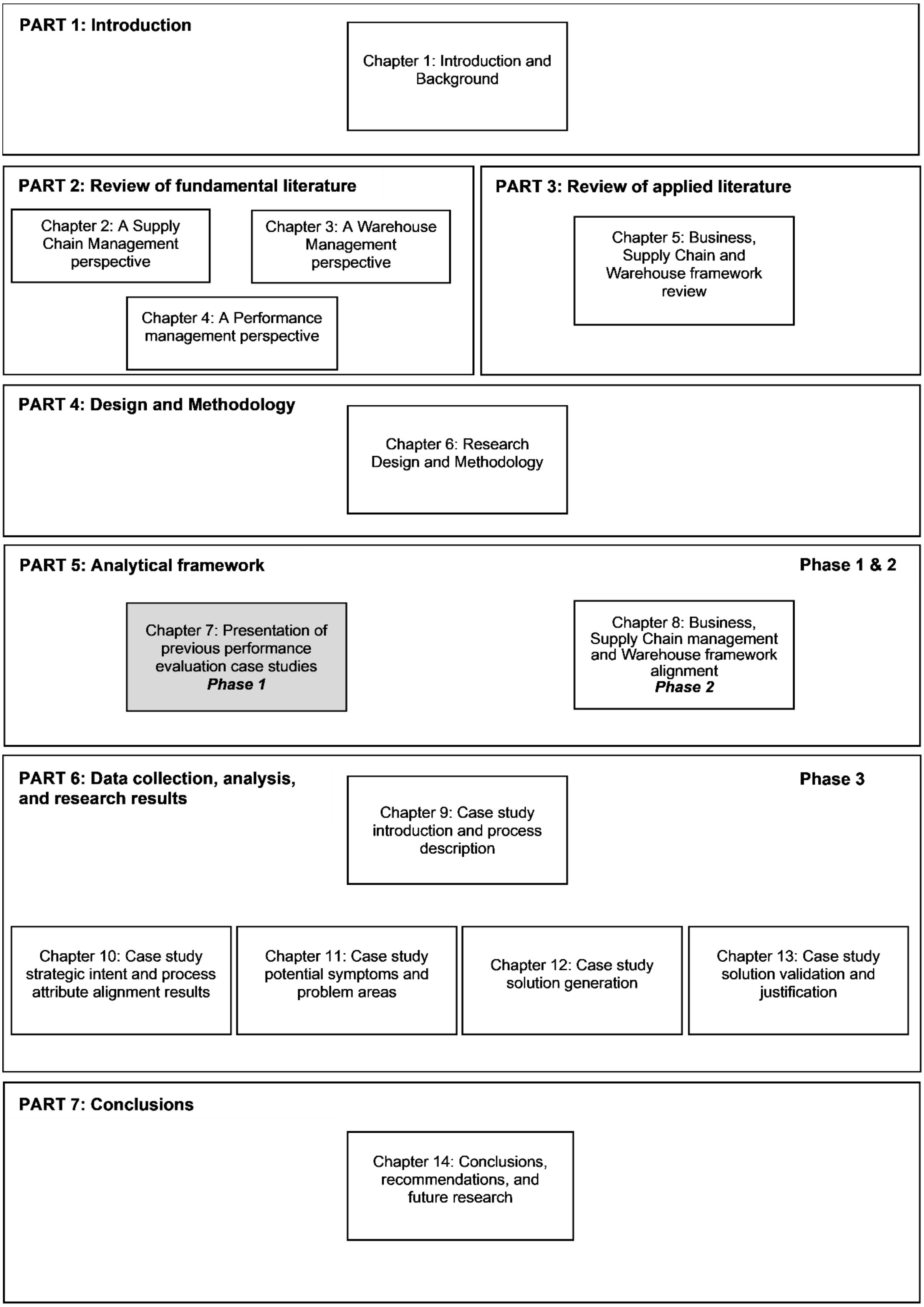
ANALYTICAL FRAMEWORK

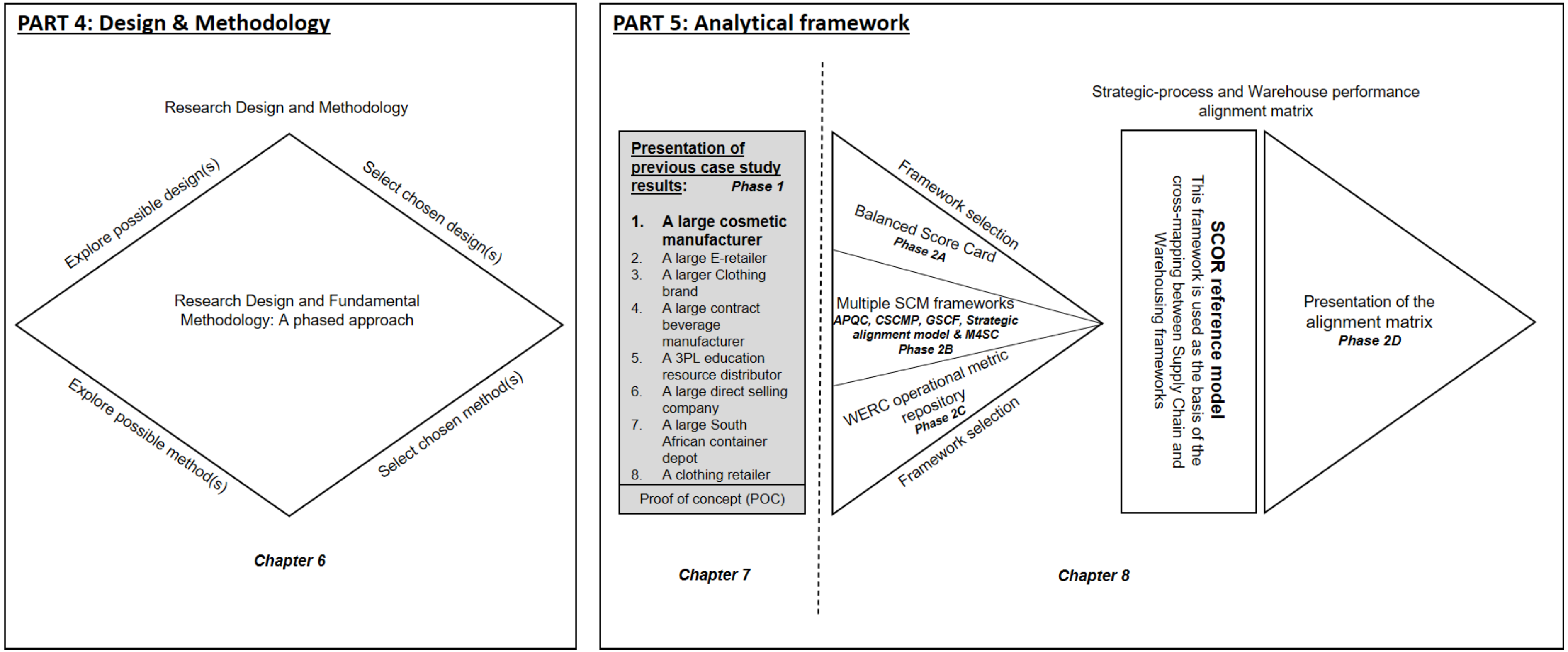
- Chapter 7: Presentation of previous performance evaluation case studies-Phase 1
- Chapter 8: Business strategy, Supply Chain Management and Warehouse performance framework Integration-Phase 2

This section outlines both Phase 1 and Phase 2 of this report. The presentation of this part is critical before the case company analysis is presented in phase 3. Phase 1-Chapter 7, outlines the initial grounding for this specific research by presenting the first case study example that made use of the ***applied methodology*** used in this research document. This analysis laid the foundation for all seven of the remaining case studies presented in Annexure H. For each of these case studies, Warehouse process metrics were calculated and benchmarked against WERC to determine the performance gaps between the current and desired level of performance, relative to Supply Chain processes. Case specific solutions were then developed to close these gaps and improve performance for each case respectively.

Phase 2-Chapter 8 presents the alignment between the selected Business strategy, Supply Chain Management and Warehouse performance frameworks identified in Chapter 5. These three reviews of applied frameworks were then consolidated into a *strategy-process performance alignment matrix* to create and ultimately test Business strategy, Supply Chain strategy and process realignment with operational level Warehouse processes and metrics.

PART 5: CHAPTER 7
PRESENTATION OF PREVIOUS PERFORMANCE EVALUATION CASE STUDIES




PART 4: Design & Methodology
Research Design and Methodology
Explore possible design(s)
Select chosen design(s)
Research Design and Fundamental Methodology: A phased approach
Explore possible method(s)
Select chosen method(s)
Chapter 6
PART 5: Analytical framework
Presentation of previous case study results: Phase 1
1. A large cosmetic manufacturer
2. A large E-retailer
3. A larger Clothing brand
4. A large contract beverage manufacturer
5. A 3PL education resource distributor
6. A large direct selling company
7. A large South African container depot
8. A clothing retailer
Proof of concept (POC)
Chapter 7
Framework selection
Balanced Score Card
Phase 2A
Multiple SCM frameworks
APQC, CSCMP, GSCF, Strategic alignment model & M4SC
Phase 2B
WERC operational metric repository
Phase 2C
Framework selection
Strategic-process and Warehouse performance alignment matrix
SCOR reference model
This framework is used as the basis of the cross-mapping between Supply Chain and Warehousing frameworks
Presentation of the alignment matrix
Phase 2D
Chapter 8

Chapter 7: Presentation of previous performance evaluation case studies – Phase 1

Q1: What are the performance gaps identified in selecting a specific Supply Chain process strategy?

Q2: How are the identified metrics prioritised within each case's selected Supply Chain strategy to derive beneficial solutions?

This chapter will focus on previous case studies that have been collected and compiled with the ***applied methodology*** in mind. A total of eight case studies have been completed at a variety of DCs within the greater Cape town area. Each case study focuses on the metric evaluation and benchmarking techniques outlined by the WERC repository. For the purposes of this research, only one research case study has been presented in this chapter, the rest of them have been placed into *Annexure H: Previous case* . The purpose of this chapter is to outline the performance gap analysis technique as well as the derived solutions presented within each case. It should be noted that the individual company names were omitted to desensitise all sensitive information to ensure the guidelines of ethical research were met.

This measurement and benchmarking research originally outlined by Harvey (2017) is presented in the first case study, whereby this applied methodology was designed and tested on a large cosmetic manufacturer situated in Cape Town. The outcome of this specific case study allowed performance gaps to be determined, a metric hierarchy to be created, which then guided the development of solutions to improve performance gaps. This specific case will be presented within this research for two fundamental reasons: The first is to outline how the ***applied methodology*** will be used within Phase 3 of this research document. The second is to outline the first instance where this specific methodology was used and successfully derived positive results for the cosmetic manufacturer.

As a result, this methodology was then repeated in seven other case studies conducted within the Department of Logistics at Stellenbosch University, to enhance the validity of the ***applied methodology*** used. Several of the supporting cases focus on specific Warehousing operations that the case company management indicated should be a priority for the study. This does not discount the metric evaluations as the narrowed scope allowed for more specific and intrinsic solutions to be derived for each case.

7.1. Case study 1 – A large Cosmetic manufacturer

This case study was conducted for a large cosmetic manufacturer's Warehousing and distribution facility that is situated within the greater Cape Town area. For this case a qualitative data assessment took place in order to identify the business's Supply Chain process strategy through semi-structured interviews using the SCOR assessment model. Following this qualitative review, quantitative performance metric data was also collected for the various operational process that occurred within the DC.

These metrics were benchmarked against the WERC repository. This alignment between the SCOR assessment model and the WERC repository was conducted to determine a metric prioritisation. The cross-mapping between these two frameworks also determined the magnitude of the gaps in performance between the *current* and *desired* state of the DC's performance. For the purposes of this case study only the reliability results will be presented, as this attribute was identified as the superior attribute during the strategic intent selection interviews.

7.1.1. Data analysis and Results

The following sections outline a summarised presentation for the research conducted by Harvey (2017). The purpose of this specific case is to outline and explain the applied methodology generated within this specific case, as this method will be used within the final phase of this research document. This case also sets the grounding for the seven other case studies that were conducted based on the results and findings of this case.

7.1.1.1. *Supply Chain strategic intent identification*

The SCOR assessment determined the *Reliability* attribute to be superior in terms of the overarching Supply Chain strategy identified with the aid of SCOR metrics. For this case specifically, multiple respondents were used to determine the Supply Chain strategy. These respondents operated in different spheres of the business, across different levels of management. The similarity of their responses determines that there was no misalignment between the implementation of the Supply Chain strategy. The results of this semi-structured interview are presented in Figure 7.1. The semi-structured interviews identified the *Reliability* attribute as the superior result, this means that the company's process focus is directed towards the customer, so the POI metric is used as a level one RCA to determine the success or failure of this attribute.

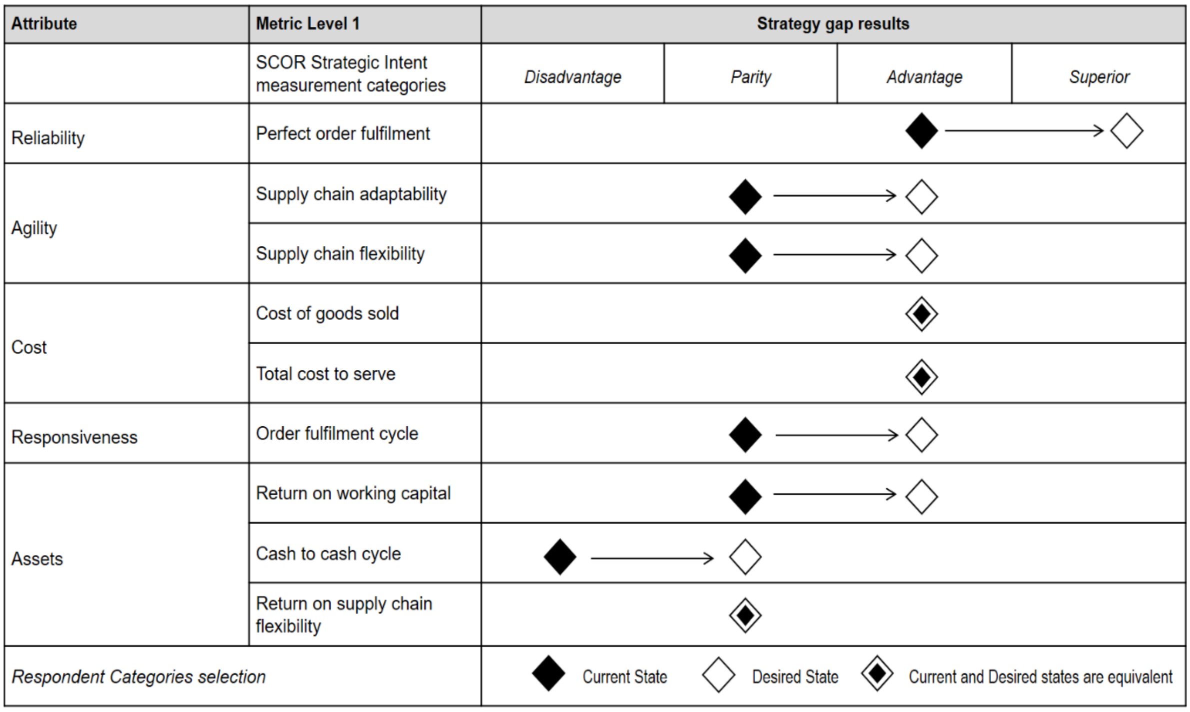


Figure 7.1: GAP results based on SCOR performance attributes – Case study 1

7.1.1.2. *Metric benchmarking results*

Once the SCOR assessment was completed, the metric data was collected to determine the Warehouse's operation performance across all metric categories. The reason for this was to compile a comprehensive benchmarking analysis for the case company's Warehouse and determine how they fared against the international aggregate performance levels. This data is displayed in Table 7.1.

The WERC measurement categories outline thresholds for performance measurement. Each threshold outlines a percentage range for each metric across the seven different groups *(Customer, Operational [inbound, outbound], Financial, Capacity, Employee, Perfect order* and *Cash-to-cash metrics)*. The calculation of the metric results is presented in each line within Table 7.1. The reference key presented at the bottom of the table illustrates the three possible performance results across the five thresholds *(Major opportunity, Disadvantage, Typical, Advantage* and *Best in class)*. In an instance where a solid diamond is presented, this metric value outlines the current percentage results *(as a threshold value, due to aggregations for desensitisation)* achieved for that metric. In an instance where a blank diamond is presented, this illustrates the desired performance level based on the priority set out by the company. Finally, for metrics where both a solid diamond and a blank diamond are overlapping, this illustrates the current performance level with no change desired by the company.

Table 7.1: Metric data and benchmarking score for a large Cosmetic manufacturer

Metric	Unit	Direction	Major opportunity	Disadvantage	Typical	Advantage	Best in class	Median
Customer metrics								
On-time Shipments	%	better >	95%	95%	98%	◈ 99%	100%	99%
Total Order Cycle Time	Hours	< better	◆ 72	72	◇34,96	24	7	24
Internal Order Cycle Time	Hours	< better	◆ 31,2	31,2	◇ 18,8	8	3,8	10
Perfect Order Completion Index	%	better >	86%	◆ 86%	95%	98%	◇ 99%	97%
Operational metrics-Inbound								
Dock-to-Stock Cycle Time, in Hours	Hours	< better	◆ 24	24	◇ 8	4,5	2	6,5
Percent of Supplier Orders Received Damage Free	%	better >	95%	95%	98%	99%	◈ 99%	98%
Lines Received and Put Away per Hour	Lines per Hour	better >	8,4	8,4	◇ 15	25	45,6	20
Operational metrics-Outbound								
Fill Rate – Line	%	better >	91%	◆ 91%	97%	◇ 99%	100%	98%
Order Fill Rate	%	better >	92%	◆ 92%	97%	◇ 99%	100%	98%
Orders Picked and Shipped per Hour	Orders per Hour	better >	2,49	2,49	5	◈ 8,2	24	6
Pallets Picked and Shipped per Hour	Pallets per Hour	better >	5	5	14,94	◈ 23,2	35	20
On-time Ready to Ship	%	better >	95%	◆ 95%	◇ 99%	99%	100%	99%
Capacity/Quality metrics								
Average Warehouse Capacity Used**	%	better >	75%	75%	81%	88%	◈ 93%	85%
Peak Warehouse Capacity Used**	%	better >	88%	88%	94%	◆ 98%	◇ 100%	95%
Inventory Count Accuracy by Location	%	better >	◆ 92%	92%	97%	99%	◇ 100%	98%
Order-picking Accuracy (Percent by Order)	%	better >	98%	98%	99%	◆ 100%	◇ 100%	99%
Material Handling Damage	%	< better	2%	2%	1%	0%	◇ 0%	0%
◆-Current State ◇ -Desired State ◈-Current and Desired State is equivalent								

Table 7.1: Metric data and benchmarking score for a large Cosmetic manufacturer (Continued)

Metric	Unit	Direction	Major opportunity	Disadvantage	Typical	Advantage	Best in class	Median
Perfect Order metrics								
Percent of Orders with On-time Delivery	%	better >	95%	95%	98%	◆ 99%	◇ 100%	99%
Percent of Orders Shipped Complete	%	better >	94%	94%	96%	99%	◇ 100%	98%
Percent of Orders Shipped Damage Free (Outbound)	%	better >	98%	◆ 98%	99%	100%	◇ 100%	99%
Percent of Orders Sent with Correct Documentation	%	better >	99%	99%	99%	100%	◈ 100%	100 %
Cash-to-cash metrics								
Productive Hours to Total Hours	%	better >	◆ 75%	75%	85%	87%	93%	85%
Inventory Days of Supply	Days	< better	90	◈ 90	55,8	30	17	39
Average Days Payable	Days	< better	60	60	45	◈ 31	30	35
Average Days of Sales Outstanding	Days	< better	54	◈ 54	37	30	5	32
◆-Current State ◇ -Desired State ◈-Current and Desired State is equivalent								

7.1.1.3. *Reliability gap analysis*

The results of the SCOR strategic intent analysis outlines the reliability attribute as their superior score. This attribute corresponds to a level one performance metric, which is the perfect order index (POI), as outlined within the SCOR process framework. Integrating the metric benchmarking results presented in Table *7.1* and the semi-structured interviews presented in Figure 7.1 the results of the reliability gap analysis have been illustrated in Figure 7.2. This figure makes use of the current vs desired state measurement criteria, whereby the difference between the current performance level and desired performance level, based on the interview results, identified a performance gap that needed to be addressed. From the results presented in Figure 7.1, the Reliability attribute was selected as the Superior attribute which best describes the process strategy used by the company. Therefore, the associated level one metric identified for the reliability attribute under the SCOR model is the Perfect Order Index (POI).

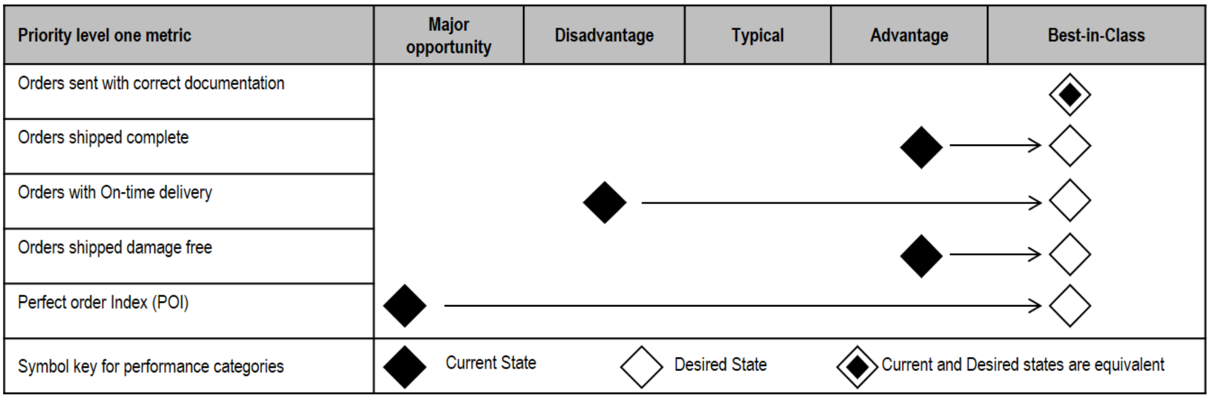


Figure 7.2: Perfect order index gap analysis – A large cosmetic manufacturer

The perfect order index, is calculated with four different components, once multiplied together provides an index for the overall score to be compared. Reliability is measured through the perfect order index, thus for an improvement to take place, this company must focus on these four fundamental measures in order to impact the index value.

There are many factors that can influence these scores, the most prominent of these factors will be the reliance the company has on its distribution service provider. The problem may be created by the distribution company's adherence to the specified service level agreement (SLA) as well as how issues are reported, resulting in further delays down the chain. The reliance the company has on their service providers to ensure customer satisfaction is large, and the focus should be on how to improve communication and performance between these two parties.

This will directly influence the *On-time deliveries*, significantly improving the overall index results. Based on this analysis the case-specific solutions have been generated to improve all identified gaps identified by the POI, as well as management's request to focus on specific operational capacity flow restrictions within the DC, that could further exaggerate the POI performance gap.

7.1.1.4. *Short-term solutions and recommendations*

These case-specific solutions were derived from the metric analysis in Table 7.1. These solutions were developed based on a possible time horizon. Both short-term and long-term solutions were developed. This allowed for low-cost, high-impact solutions to be developed first, while those solutions that require further investigation, planning and financing could be implemented at a later stage.

Scheduling inbound flows: This company receives goods from three sources. These sources are external suppliers, providing goods from the on-site manufacturing facility as well as goods from Work-in-progress (WIP). Inbound flows are not currently scheduled for all three of these procurement sources thus congestion, particularly during higher demand periods, such as the preparation for the Christmas period, is a particular problem.

Implementation of accurate route picking: The pickers operating in the fine picking area do make use of an organised route-picking schedule, allowing the least amount of distance to be travelled, whilst achieving high volumes of order picking. This is not yet implemented in the bulk-picking process and the material handling equipment drivers are responsible for deciding their own pick routes. This may not always reflect the most efficient way to pick orders with more distance being covered per complete order than is necessary, referred to in section 3.7 as the interleaving process.

Labour efficiency measures: In current operations bulk pickers are measured on throughput and average of orders picked. There is no way in telling if the picker is actively picking or just going through the motions. All that matters is if they meet their average quota at the end of the month. This measurement style is measured by several management systems that can be adapted or added onto the company's WMS that is integrated with other systems, such as SAP. An example of a company that offers these measurement statistics is Cranswick, a South African-developed WMS. Since this system can adapt to the current scanners and apparatus that the company already employs, this solution is ranked as a low-cost, short-term solution (Cranswick Computing, 2017).

The above-mentioned suggested solutions' main aim is to quickly and efficiently implement changes that allow for better receiving, throughput and efficient monitoring of employees within the distribution centre. However, these small changes may not be enough to instil long-lasting changes that would ultimately benefit the customer. Therefore, long-term solutions have also been identified to add value to the current short-term suggestions which need to be implemented for greater impact.

7.1.1.5. *Long-term solutions and recommendation*

The following solutions have been recommended which will take much longer to implement. These solutions would in effect have the desired outcome of long-lasting perfect order measurements and improved customer satisfaction.

Service level agreement enhancements: Since the company makes use of a 3PL for all their customer deliveries, a large portion of the perfect order index scores relies on their performance. In order to improve the percentage of orders delivered complete and the percentage of order shipped on time, it is critical to implement more stringent SLA requirements. As contracts generally run for periods of between three and five years and incorporate intense negotiations over costs and transfer of responsibility structures, this solution has been identified as a long term, more costly solution.

Facility layout changes: The layout of the facility that is currently being used in operations is one that was not purpose-built for their specific activities and therefore certain constraints have been identified. The floor-to-ceiling height in several of the Warehouses is not high enough to maximise the capacity of static rack bin locations. Furthermore, the orientation of the racking is also not conducive to the free flow of materials, equipment and people. These constraints further prohibit improvements to the perfect order index that could otherwise be achieved if they were rectified. However, the proposal of changes of this magnitude required an extensive cost/benefit analysis before it could be undertaken. The company has already begun to make facility layout changes in order to influence the process inefficiencies and improve productivity within the Warehousing operations.

Material handling equipment selection: The current material handling equipment employed in the distribution centre is another constraint, due to the facility layout changes. For example, during the process evaluation of this case study, it was noted that during a pick journey, the picker was unable to pick several cases as the equipment he was using at the time could not reach the new, higher bins that had been installed in the cosmetics Warehouse.

In order to complete the order, the picker had to enlist the help of another picker, thus disrupting his picking process in order to successfully pick these cases. The final long-term suggested solutions would be to match the new improved facility layout, that has already been undertaken, with their material handling requirements, in order to achieve higher rates of throughput, an improved perfect order index and greater service levels.

7.1.1.6. *Summary of findings – A large cosmetic manufacturer*

This case identified several critical findings that resulted in further cases being conducted, each of these other cases attempted to repeat and attempt to replicate the success of the results presented in this case. This specific case proved that it was possible to measure a company's Warehousing operations performance results based on strategic processes selection interviews.

This allowed for a gap analysis to be created, between the current performance and the desired performance of each of the SCOR attributes relative to the company's strategic intent as outlined in Figure 7.1. The results of these gaps identified a hierarchy of importance based on the *Superior, Advantage, Parity* and *Disadvantage* measurement categories used. This hierarchy helped outline what was most important to the company in terms of performance management, allowing focus to be directed towards these areas for solutions to be developed to reduce the gaps and improve performance.

This case study identified a research gap outlining the concept of integrating Warehousing operational measures with process frameworks to help improve organisational alignment and operational performance to drive Supply Chain success. It is this outcome that led the focus and drive to conduct further case studies, to determine if these findings could be repeated within other companies. This has been done in seven different projects conducted at Stellenbosch University. Each of these projects has been summarised in Annexure H.

7.2. Summary of previous case studies

The chapter identified a means of determining performance gaps based on Warehouse process metrics related to Supply Chain strategic processes. This required the involvement of company stakeholders to determine the current and desired state prioritisation. This prioritisation was then applied through level one metrics as identified in the SCOR model to determine the performance gaps in terms of Warehousing performance. This integration will allow for each future case to be aligned from a strategic level down to operational level, while conducting a performance gap analysis and developing a metric hierarchy to outline continuous improvement initiatives into the future.

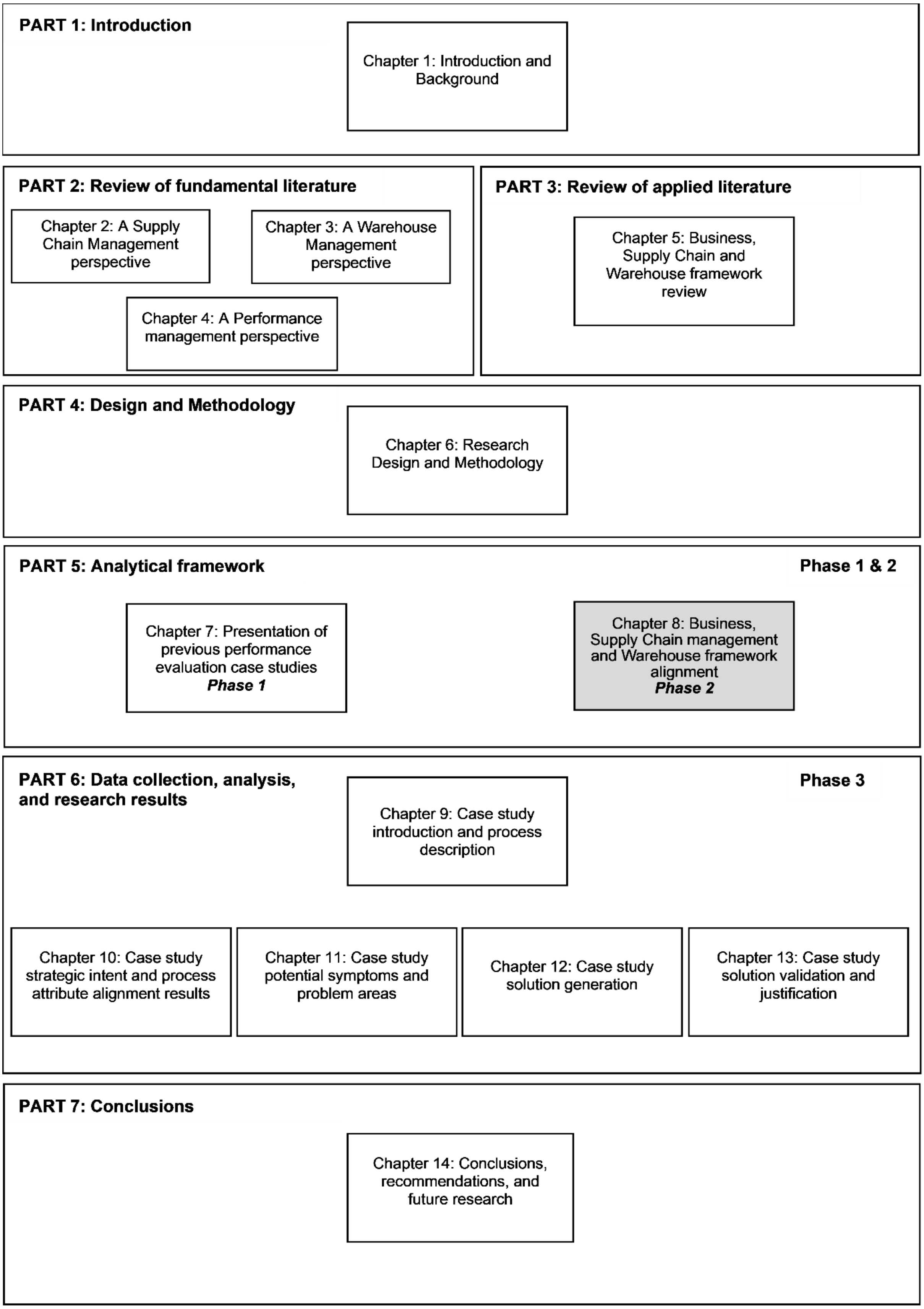
The presentation of these cases outlines the need to measure as well as the potential solutions that can be derived if conducted properly. A complete integration of three crucial elements is required; these are *Supply Chain strategy*, *Supply Chain process frameworks* and *Warehousing operational metrics*, thus drawing to a logical conclusion that answers the first two research questions presented at the beginning of this chapter.

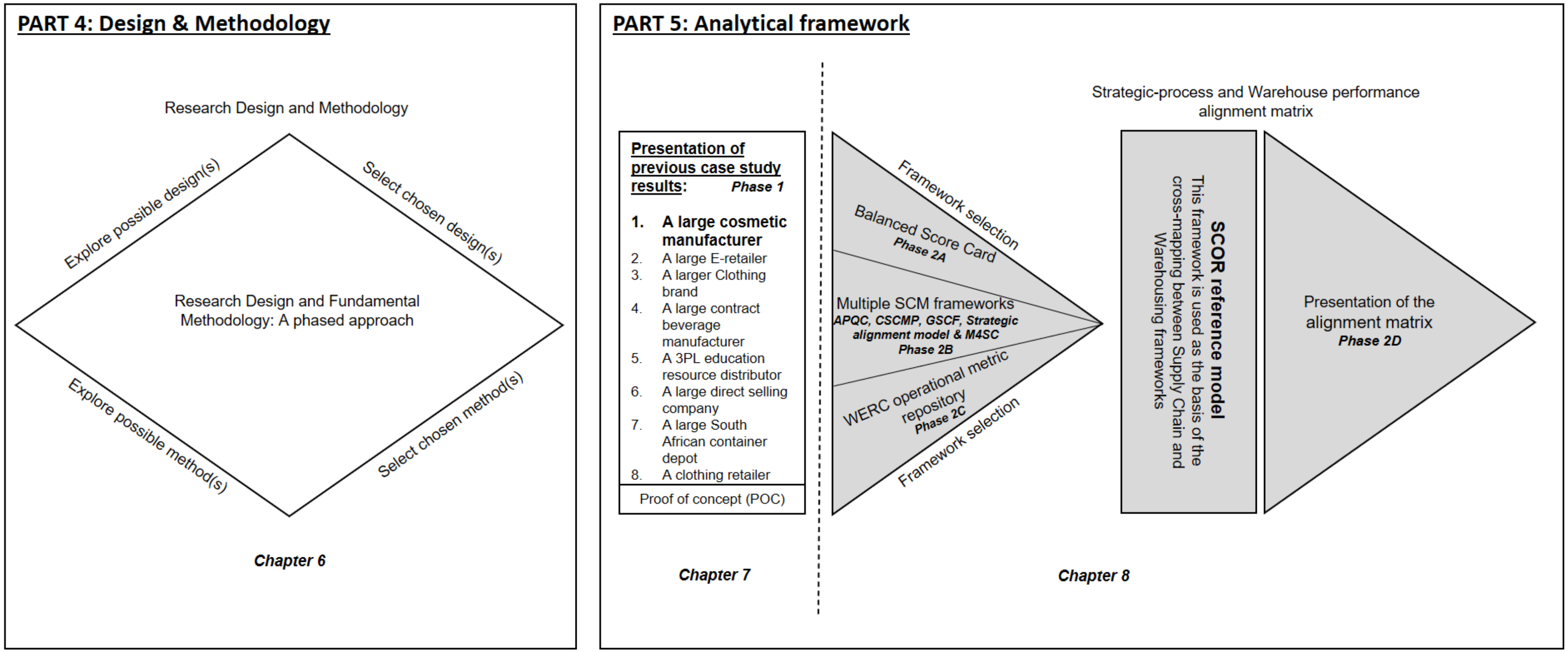
It is apparent that understanding how Warehousing processes interact with one another to fulfil a specific set of strategic process objectives, is critical in the service industry today. However, the processes are meaningless if they cannot be measured in order to determine the success or failure of each process. Being able to measure is important, but being able to benchmark current performance and then set operations performance targets is critical to performance improvements, despite the importance of measurement in accessing the overall business strategy and the positive impact it can have on a company's performance.

The importance of measurement outlines the motivation and purpose of this study. If a company is built around a corporate strategy that translates into a Supply Chain strategy with a strategy objective, facilitated by Supply Chain processes, the implementation and management of this strategy must be able to be measured. Through measurement, a company can determine the success or failure of its chosen strategy. Once measurement has taken place, solutions can then be derived to rectify or improve operations to realign the organisation with its overarching strategy.

Despite this, it is important for all organisations to remember that they cannot be best in all areas. The integration of Supply Chain strategies, operational processes and metrics must be *prioritised;* in order to firstly, determine the gap between expectation and reality and secondly, to facilitate an implementation plan for derived solutions that focuses on the most important aspects first, to bring operational performance in line with strategy goals.

PART 5: CHAPTER 8
SUPPLY CHAIN PROCESS AND WAREHOUSE PERFORMANCE FRAMEWORK ALIGNMENT




PART 4: Design & Methodology
Research Design and Methodology
Explore possible design(s)
Select chosen design(s)
Research Design and Fundamental Methodology: A phased approach
Explore possible method(s)
Select chosen method(s)
Chapter 6
PART 5: Analytical framework
Presentation of previous case study results: Phase 1
1. A large cosmetic manufacturer
2. A large E-retailer
3. A larger Clothing brand
4. A large contract beverage manufacturer
5. A 3PL education resource distributor
6. A large direct selling company
7. A large South African container depot
8. A clothing retailer
Proof of concept (POC)
Chapter 7
Strategic-process and Warehouse performance alignment matrix
Framework selection
Balanced Score Card
Phase 2A
Multiple SCM frameworks
APQC, CSCMP, GSCF, Strategic alignment model & M4SC
Phase 2B
WERC operational metric repository
Phase 2C
Framework selection
SCOR reference model
This framework is used as the basis of the cross-mapping between Supply Chain and Warehousing frameworks
Presentation of the alignment matrix
Phase 2D
Chapter 8

Chapter 8: Business strategy, Supply Chain Management and Warehouse performance framework alignment – Phase 2

Q3: What are the most popular Performance management frameworks that facilitate Business Strategy selection, present in literature?

Q4: What are the most popular Supply Chain process frameworks present in literature??

Q5: What are the most popular Warehouse measurement frameworks present in literature?

Q6: Which of these Business, Supply Chain strategies and processes, identified from the literature reviews, can be aligned with SCOR's five main process attributes?

Q7: Which metrics from SCOR align with benchmarked metrics from the selected Warehousing framework?

An organisation's strategy outlines the focus for performance measurement, as business strategy drives all other strategies within the organisation. The focus of performance management is to identify what should be measured to derive an organisation's strategic success. This chosen business strategy filters down to define Supply Chain strategy, which in turn guides Supply Chain processes to facilitate operational execution. Therefore, this review of different performance measurement frameworks that help define a business's strategy was conducted to understand what are the key concepts used in deriving strategy as well as what frameworks are available to help define an organisation's business strategy. This literature review was conducted in *Part 2-Chapter 4* of this report. A summary of this review will be presented in this chapter as *phase 2A*, in order to answer the research questions defined in *Chapter 6*.

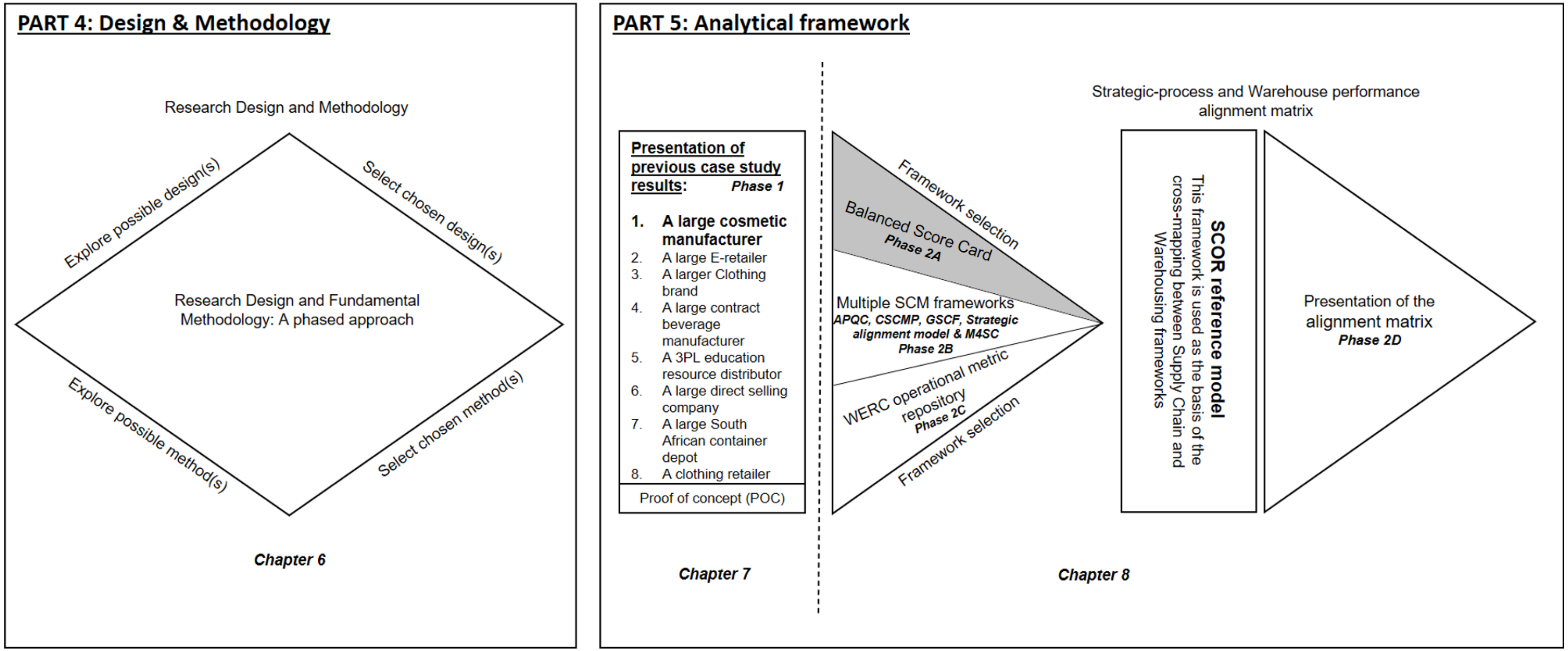
Business Strategy frameworks have been reviewed within a Supply Chain context to help outline how a chosen business strategy can be translated into a Supply Chain strategy. Therefore, the need to review Supply Chain frameworks was also required to be able to draw correlations between business strategy and supply chain strategy in order to translate objectives from business strategy to Supply Chain strategy. The need for this translation is to outline Supply Chain strategic intent that will drive the supporting Supply Chain processes on an operational level. The findings from this literature review will be summarised in *phase 2B*, in this chapter.

Warehouse measurement frameworks have been assessed to determine which of the identified frameworks is most reliable and inclusive of substantial operational metrics used within in a typical Warehouse today. This Warehousing performance framework can be used to perform a metric evaluation and benchmarking exercise on all the inherent activities within a Warehouse. The findings from this literature review will be summarised in *phase 2C*, in this chapter.

At this point, both the Supply Chain strategy metrics and the Warehousing repository metrics will be aligned. The outcome of this alignment, through the above-mentioned steps is one of completeness. The goal is to measure whether Warehousing processes are measured. If they are, are they aligned against a selective Supply Chain process strategy. This will determine whether an organisation is conducting Warehouse activities in accordance with the Supply Chain process strategy. The need to understand how strategy defines operational objectives as well as how they are measured, is one of the main cornerstones of the literary reviews conducted in *Chapters, 2, 3, 4* and *5*.

The alignment between Business strategy, Supply Chain strategy, Supply Chain process frameworks and the selected Warehouse framework will be discussed in *Phase 2D* of this report and presented as a *strategy-process performance alignment matrix*. The use of phases helped identify which sections will answer the identified research questions in section 6.4. Each research question will be presented before each of the results sections. This is done to maintain clear visibility and tracking of the expected results derived from each part and phase within this report.

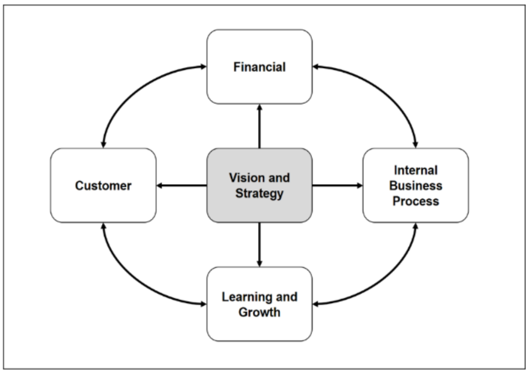
PART4: PHASE 2A
A PERFORMANCE MANAGEMENT REVIEW-A BUSINESS STRATEGY PERSPECTIVE



8.1. Phase 2A: A Performance Management literature review summary

Q3: What are the most popular Performance management frameworks that facilitate Business Strategy selection, present in literature?

The BSC presented by Kaplan and Norton (1996) outlines four perspectives within its framework namely *Financial*, *Internal business processes*, *Customer* and *Learning and Growth*. The measurements required to evaluate the performance of each of these perspectives is presented in Figure 8.1. These measurements, although on an abstract level, focus on business strategy, which provides an excellent starting point for metric alignment with Supply Chain Strategy and processes.



Perspective	Focus	Example KPIs
Financial	Financial performance	ROI & Operating profit margin
Internal Business Processes	Business efficiency	Level of returns & Service rating
Customer	Customer Satisfaction	New Product development
Learning and Growth	Knowledge and Innovation	Employee retention& Flow of NPD ideas

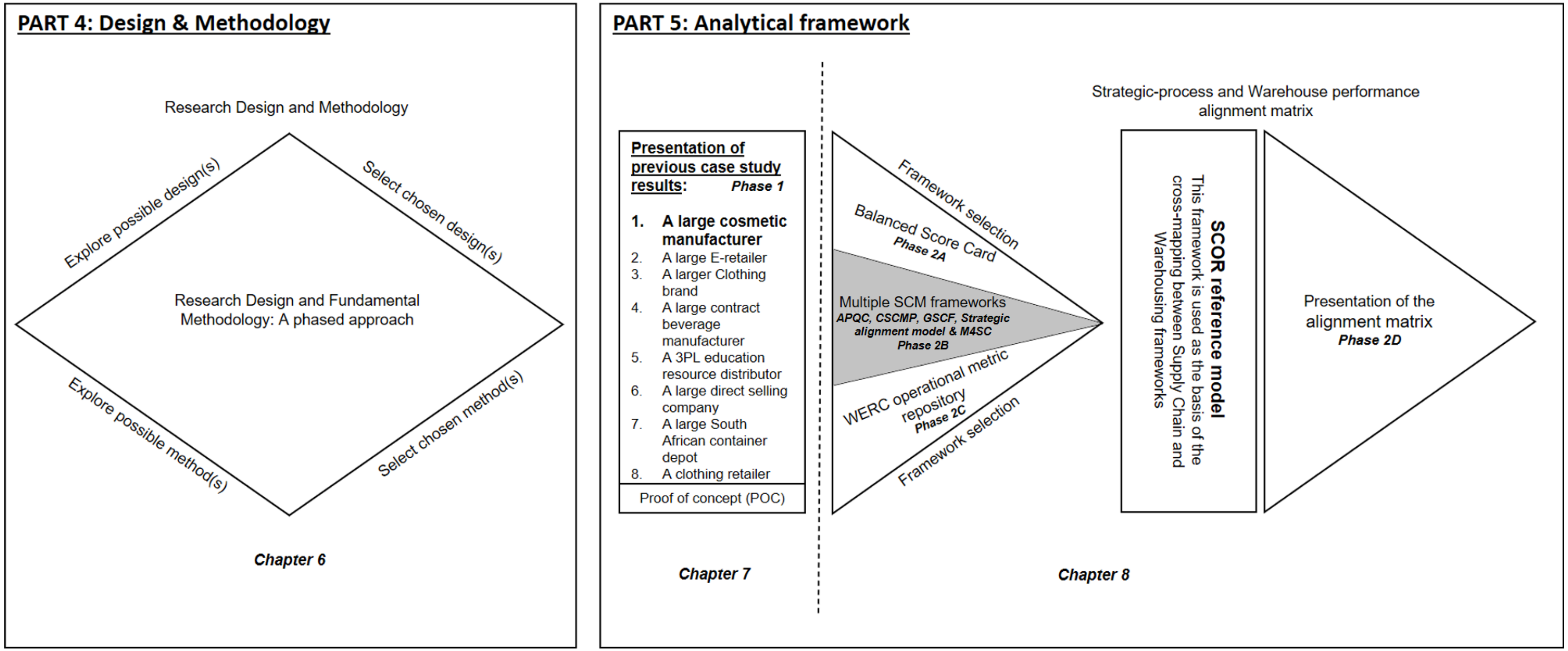
Figure 8.1: The four perspectives of the Balanced Score Card framework
(Source adapted from: Kaplan and Norton, 1996:9-11)

Based on the literature review conducted in Part 2-Chapter four, this framework was compared to three other frameworks, namely The Performance Pyramid, the EFQM model framework and the Performance Prism. Each of these frameworks provided different methodologies for deriving performance measurement within an organisation. Neely *et al.* (2002) even argued that performance measures should not be based on strategy but rather based on stakeholders' needs and wants, thus providing another perspective for the measurement and management for an organisation's business strategy.

The Balanced Score Card (BSC) developed by Kaplan and Norton (1996) has demonstrated over the years that this PM system is under continuous improvement as well, as it includes extensive measurement tools that make this dynamic performance measurement system highly regarded within industry today. Furthermore, of the many performance measurement frameworks that exist, the BSC is one of the few that has any empirical testing to support it.

Despite these conflicting views on performance measurement, The BSC framework was selected as the business strategy framework that was aligned with the SCOR reference model and presented as the strategy-process performance alignment matrix in Phase 2D. To read more about this framework, please review section 5.4.

PART 4: PHASE 2B
A SUPPLY CHAIN STRATEGY AND PROCESS FRAMEWORK REVIEW



8.2. Phase 2B: A Supply Chain Framework Review Summary

Q4: What are the most popular Supply Chain Strategy and processes alignment frameworks present in literature?

The literature review conducted in Chapter 5 outlined an in-depth investigation in to Supply Chain strategic frameworks as well as Process frameworks. The purpose of this review was to identify which frameworks could be linked to the SCOR reference model as well as to help identify the reason for these frameworks being selected. As stated in Chapter 5, these frameworks were selected due to their prominence in literature as well as their availability, as some frameworks were not available in the public domain. Therefore, a brief summary is presented in the following section to present the selected frameworks as well as to answer the research question.

8.2.1. Summation of Supply Chain Strategy and Process Frameworks

The following figure outlines the frameworks selected to be used in the conceptual alignment framework in the following section outlined in Phase 2D of this chapter. Figure 8.2 further outlines the level of decision-making each framework type has in terms of defining or translating business strategy, which was defined in Phase 2A-Section 8.1. For further detail related to the literature review process as well as the reasons for these frameworks being chosen, please review Chapter 5.

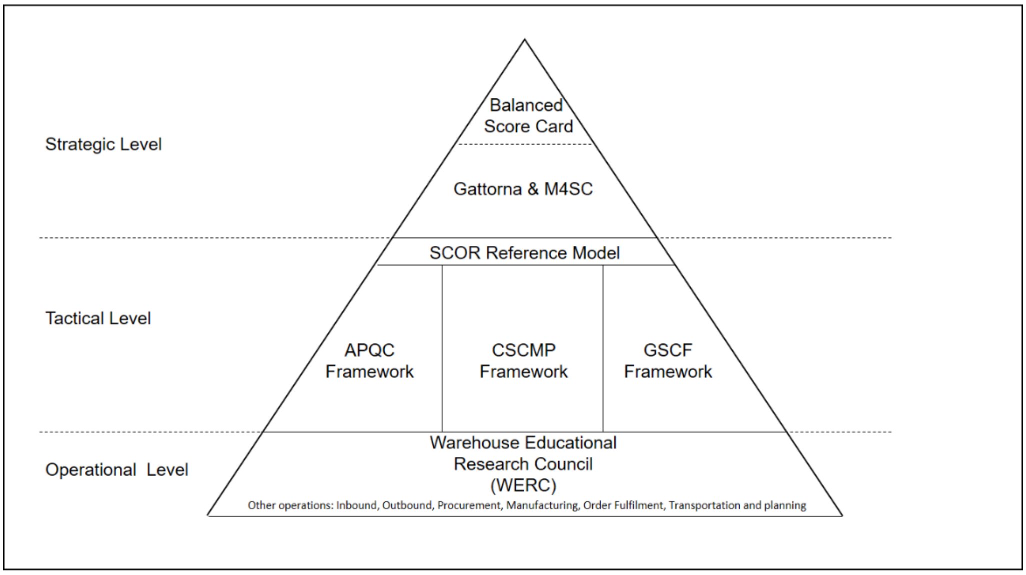
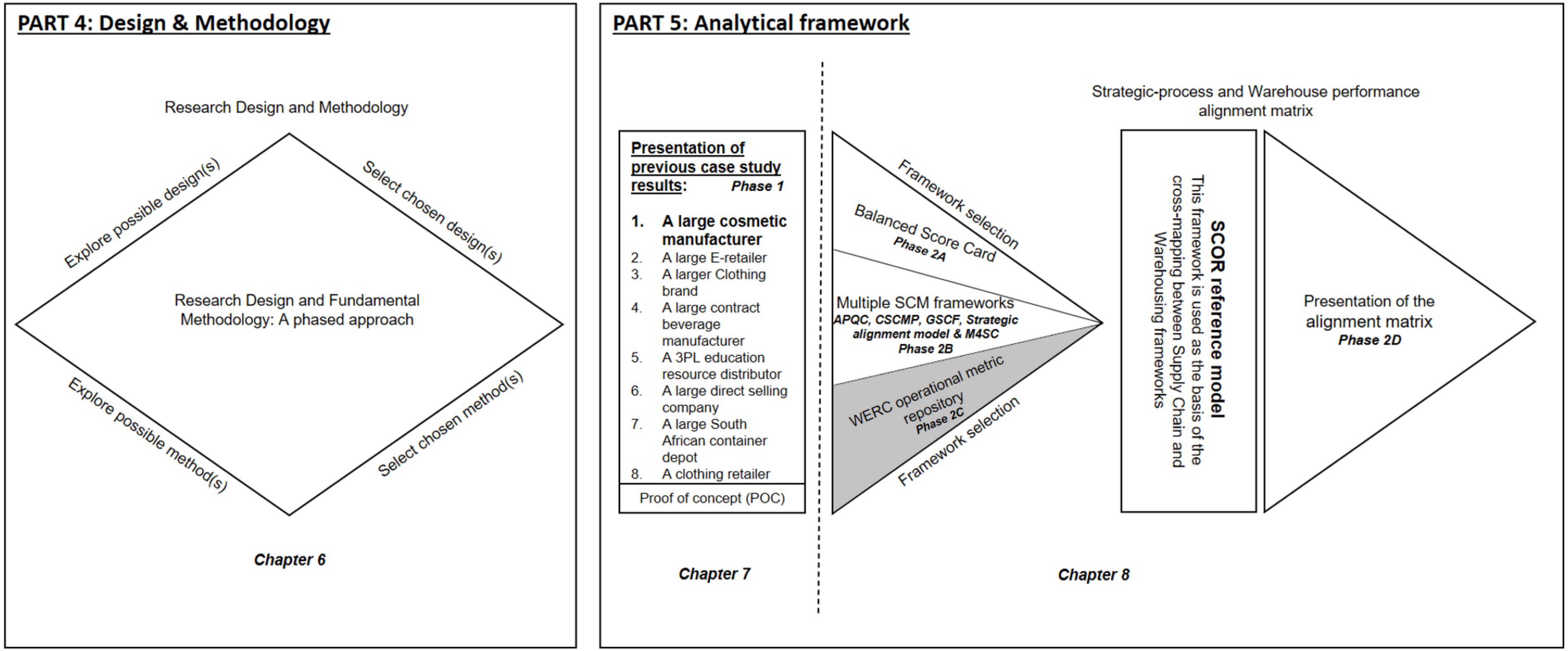


Figure 8.2: Matrix framework alignment review presented in organisational decision-making hierarchy *(Source adapted from: Oliver et al, 2001)*

This summary outlines which Supply Chain Strategy and Process frameworks were identified and reviewed in Chapter 5. Due to the nature of the organisational hierarchy and the identification of the BSC to help define Business Strategy, these additional Supply Chain frameworks have been linked to outline an alignment between Business strategy, Supply Chain strategy and Supply Chain processes. In order to complete this analysis a review of Warehousing performance frameworks was required to help define the benchmarking framework that was used to conduct an exploratory case study with this conceptual alignment. This will be presented in the following section.

PART 4: PHASE 2C
A WAREHOUSE FRAMEWORK REVIEW SUMMARY

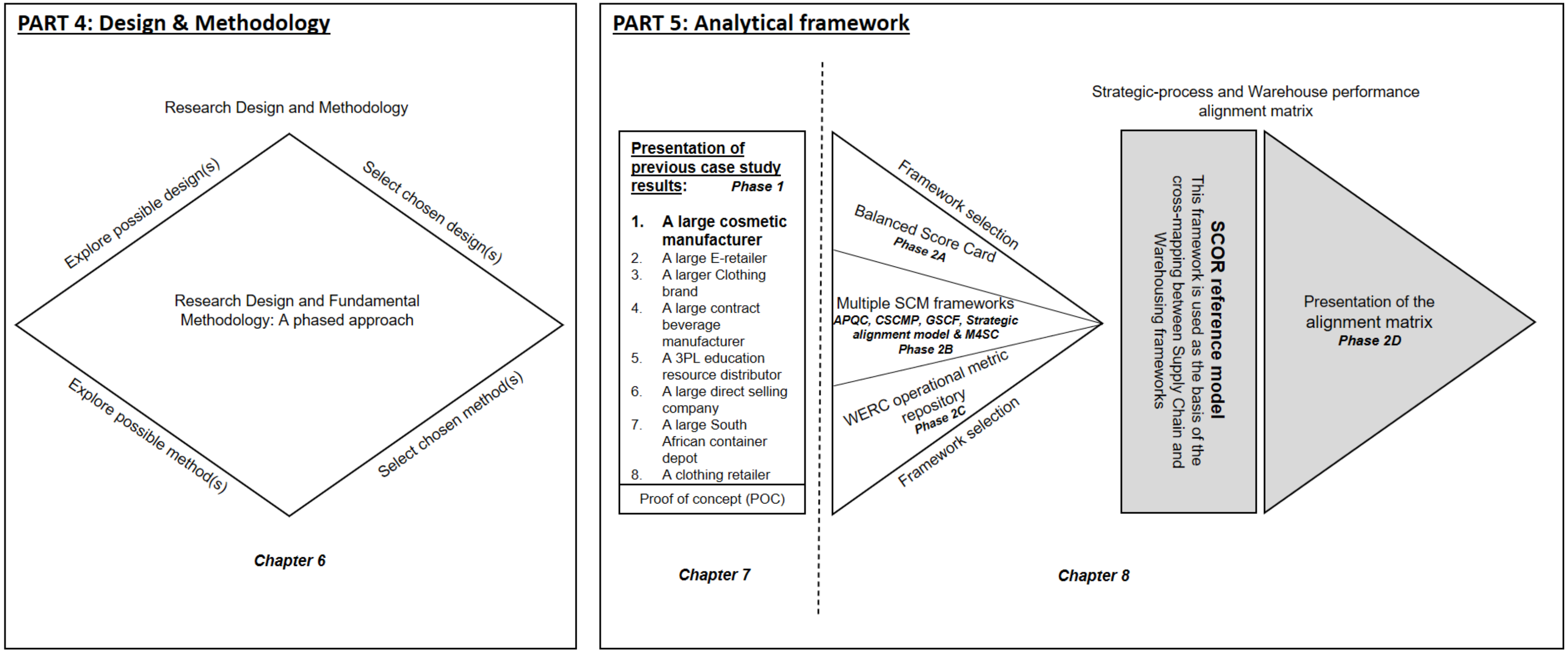


8.3. Phase 2C: A Warehouse Framework review summary

Q5: What are the most popular Warehouse measurement frameworks present in literature?

The review of Warehousing performance frameworks proved to be exceptionally difficult due to their lack of availability in the public domain. However, the literature review process outlined in Chapter 5, did manage to identify previous research conducted by Harvey (2017), which lead to the identification of the Warehouse Educational Research council (WERC). This council conducts an annual survey of organisations from around the world to outline and identify new performance standards each year, which are presented as a benchmarking framework. These respondents' data is reviewed and analysed to outline what the market identifies as critical measures based on popularity and importance. This framework helps organisations to benchmark their current performance with the industry benchmark, providing critical information related to performance management decisions about strategy.

PART 4: PHASE 2D
A STRATEGY-PROCESS PERFORMANCE ALIGNMENT MATRIX



8.4. Phase 2D: Metric alignment with model and strategy

Q6 Which of these Business, Supply Chain strategies and processes, identified from the literature reviews, can be aligned with SCOR's five main process attributes?

Q7: Which metrics from SCOR align with benchmarked metrics from the selected Warehousing framework?

The outcome of the alignment between Business Strategy, Supply Chain Strategy, and processes as well as Warehouse metrics is imperative to bring operations back in line with the company's Supply Chain Strategic intent as well as the overarching Business strategy. To answer the above-mentioned research questions, a *Strategic-process* and *Warehouse performance alignment matrix* was developed to simplify the proposed outline between these different aspects. The results of this alignment are presented in Table 8.2. This table presents each model identified in Chapter 5 in a cross-mapping exercise with SCOR level one metrics as well as WERC operational level metrics, marked by the "X" symbol in the table.

8.4.1. Strategic frameworks within the alignment matrix

The five SCOR attributes have been used as the *keystone* for this alignment matrix. Multiple Supply Chain process models have been aligned with SCOR's five Supply Chain attributes, while WERC has been aligned with the Five level 1 metrics derived within the SCOR process framework. This means that in a case of performance measurement and enhancement, were any one of the four previously presented Supply Chain process models is used, SCOR included, they can be utilised to develop, or design a Supply Chain strategy within an organisation. By using this matrix, a root cause performance analysis and benchmarking exercise can take place. Where this matrix differs from conventional performance measurement processes is that this one allows for strategic Supply Chain goals to be measured on an operational level.

In order to take this alignment one step further, the inclusion of a performance management framework used to define and measure business strategies has also been included. As Identified in Chapter 5 and Phase 2A in this chapter, the BSC framework has been selected for this alignment. The reason for including this framework is to ensure that business strategy is factored into this alignment. This alignment will ensure the Supply Chain can accurately and effectively translate business strategy into supply Chain strategies and processes.

This matrix allows for metrics to be prioritised to follow the basis of RCA thinking; it can be used to measure *what is most important* in relation to the defined business and Supply Chain strategy. However, the final step of this alignment matrix is to include *Strategic process frameworks* that can take operational and process specific measures and align them with a Supply Chain and Business Strategy. This alignment is outlined within Table 8.1.

Table 8.1: Strategic Alignment inclusion in strategic-process and performance matrix

Alignment results between Business and Supply Chain Strategy and processes					
Balanced Score Card	**Internal Process**	**Internal Process**	**Customer**	**Financial**	**Financial**
	Learning and Growth *(applicable across all categories)*				
SCOR attributes	**Reliability**	**Responsiveness**	**Agility**	**Cost**	**Assets**
SCOR Level 1 Metrics	*POI*	*OF*	*SCF*	*COGS*	*RWC*
WERC Metric categories	*CM*	*OM*	*C&Q*	*FM & C2C*	*EM*
Gattorna Strategic Alignment Model					
Continuous Replenishment	**x**				
Lean Supply Chain				**x**	
Agile		**x**			
Fully flexible			**x**		

8.4.1.1. *Alignment results of the Strategic alignment model*

Section 5.7.2, illustrates the alignment of Gattorna's (2010) *Dynamic Alignment Model* with that of Kaplan and Norton's Balanced Score Card (1996) and APICS's (2017) SCOR model which is presented in Table 8.1, following Gattorna's extensive work in identifying customer buying behaviour and its effects on Supply Chain strategy, design and measurement. The extensive integration of a multitude of studies conducted by several professionals in related fields, this model has then been aligned with the previously identified SCOR *focus strategies* and *attributes.*

As a result, the determination of process strategies and performance metrics to prioritise measurements, can now be linked back to an identified and accepted Supply Chain strategy, which will help realign not only the operational process but Supply Chain strategy as well. These findings further the performance measurement method to include and focus metrics from an operational level towards overarching Business and Supply Chain strategy.

The inclusion of the M4SC framework, is outlined in section 2.7.3.2 as a strategic implementation framework that is used to successfully implement SCOR throughout a chosen supply chain. If the framework and its four Supply Chain components are used, and SCOR is successfully implemented, then an organisation can make use of the alignment matrix to align its operational level processes with the WERC metric categories to conduct benchmarking metric actives as well as metric gap analyses to further drive continuous improvement and performance enhancements.

8.4.2. Supply Chain process and Warehouse performance alignment matrix

This concept required the integration of strategic frameworks, with process frameworks while at the same time matching Warehousing metrics with Supply Chain process metrics with the express intent of being able to conduct a top-down performance evaluation. For this integration to take place a *conceptual framework* was used to outline where and how all these concepts would be combined to create the *strategic-process performance matrix*. The matrix presented in Table 8.2, is the same as the table that is outlined in Figure 6.1; however, the focus is on the portion of the conceptual framework that pertains to the alignment matrix.

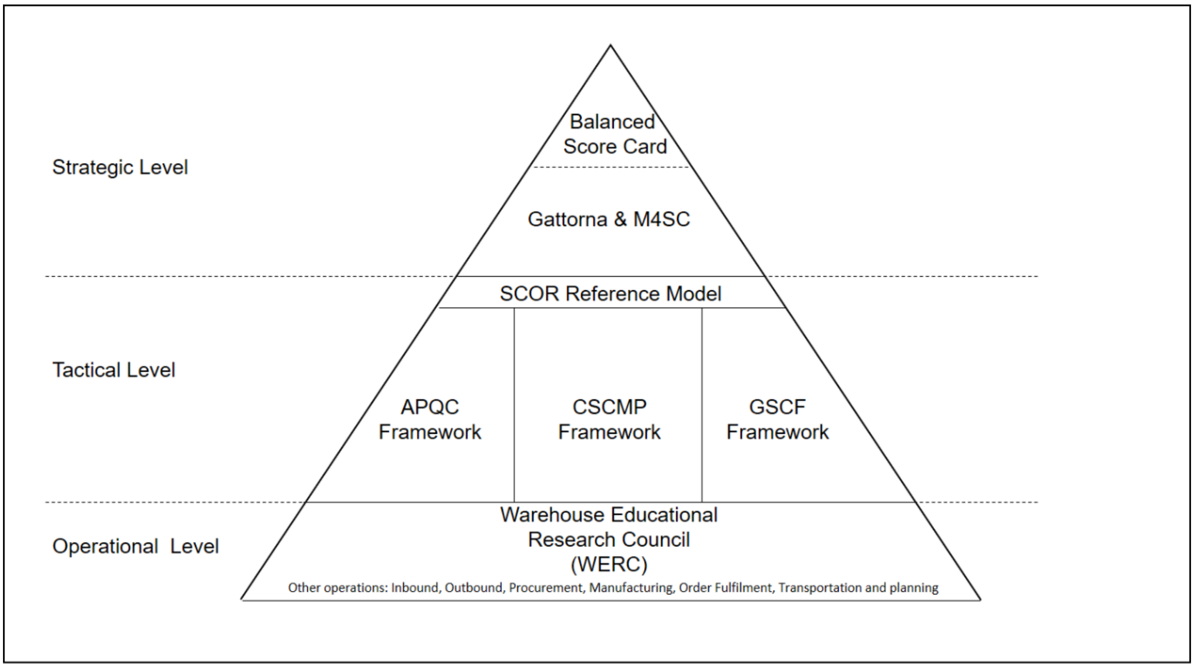


Figure 8.3: Matrix framework alignment review presented in organisational decision-making hierarchy
(Source adapted from: Oliver et al, 2001)

Table 8.2: Matrix derived from the alignment of Supply Chain metric and models

Alignment results between Business and Supply Chain Strategy and processes					
Balanced Score Card	Internal Process	Internal & Customer	Customer	Financial	Financial
	Learning and Growth *(applicable across all categories)*				
SCOR attributes	Reliability	Responsiveness	Agility	Cost	Assets
SCOR Level 1 Metrics	*POI*	*OF*	*SCF*	*COGS*	*RWC*
WERC Metric categories	*CM*	*OM*	*C&Q*	*FM & C2C*	*EM*
APQC Alignment Framework					
Process efficiency	x				
Cycle Times		x			
Cost effectiveness				x	
Staff productivity					x
CSCMP Model *Only operation process presented below*					
Develop Vision and Strategy	x	x	x	x	x
Develop and Manage Product and service				x	x
Market and Sell Products and Services		x			
Deliver products and Service		x			
Manage Customer Service			x		
Global Supply Chain Forum Model					
Customer relationship management	x				
Customer service management	x				
Demand management		x			
Order fulfilment		x			
Manufacturing flow management				x	x
Supplier relationship management			x		
Product development & commercialisation				x	
Returns management	x	x	x	x	x

The results of the strategic-process performance alignment matrix as identified in Table 8.2, outlines the connection between SCOR level one metrics as well as the connection of process attributes, as described in each framework, with the SCOR attributes, level one metrics as well as the metric categories outlined by WERC.

This means that no matter the process framework used within an organisation, the superior attribute, defining the company's operational processes, can be linked back to SCOR as WERC benchmarking categories. This will create a performance gap analysis that will enable an understanding of the discrepancies between the current level of performance and the desired level of performance.

8.4.2.1. *Alignment results for APQC*

Each of these strategic level categories can be grouped into metric categories. This alignment between the SCOR model and APQC's, PCF model, is based on what the respective model is intended to measure. This alignment between the five SCOR attributes and APQCs metric categories is described in Table 8.2.

The APQC metric categories align well with those of the SCOR model. From this point in the analysis, the SCOR level 1 metrics can be used to measure the APQC process success or failure within an organisation. The APQC model does not measure Supply Chain flexibility; however, this attribute could be measured through an amalgamation of level 1 metrics, each of which would be case specific, to best represent the type of business and level of detail for each case's process.

8.4.2.2. *Alignment results for CSCMP*

As identified in section 5.9.3 of this report, CSCMP (2014c) makes use of APQC's PCF model which they present in conjunction with the original framework as the *suggested minimum Supply Chain standards*. This framework isolates specific Supply Chain, defined in Figure 5.11, as Operating processes, to better identify what needs to be measured while determining specific Supply Chain benchmarks base of industry research.

The CSCMP model presents six management and Support services. For the purposes of this alignment matrix, these support services were not included as they are more appropriately linked to the Enablement category of the SCOR reference model. This possible link between these support services and the enablement category of SCOR is presented in section 14.9.3 under Future Research, presented in Chapter 14.

8.4.2.3. *Alignment results for the GSCF model*

Table 8.2: Matrix derived from the alignment of Supply Chain metric and models , represents the alignment of the Lambert model's derived processes and SCOR'S focus strategies and measurement attributes. As identified, the Lambert model's derived Supply Chain types align well with those of the SCOR reference model.

The SCOR level 1 metrics can be used to measure the Lambert model's selected Supply Chain strategy's success or failure within an organisation through performance metrics. This performance would be case specific, which would be derived to best represent the type of business and level of detail for each case Supply Chain selection.

8.4.3. Summary of Phase 2

The following deductions were made from the literature reviews and alignments conducted in Phase 2A,2B and 2C:

- Business Strategy defines the objectives, from which Supply Chain Strategies and process are derived.
- Supply Chain frameworks successfully outline level one operational metrics that are aligned with specific pre-identified Supply Chain strategies.
- The selected Supply Chain strategic and process frameworks used in this report can be linked together through the comprehensive work conducted by the SCOR model (APICS, 2017). This link has led to the creation of an *alignment matrix.*
- There is limited Warehousing benchmarking information available within the public domain today. The sharing of benchmarking repository information is not commonplace within industry and this information is being used behind closed doors within larger organisations.
- There was one metric repository identified for use within the Warehousing literature. The repository was identified as Warehouse Educational Research Council (WERC) as outlined by Tillman, Manrodt and Williams, (2019)
- Due to the lack of benchmarking data available, managers and supervisors set operational efficiency levels and goals in Warehouses without a full understanding of what the selected strategy is or should be.
- In most cases, Warehouses are the centre point for the consolidation and distribution of all goods within a given Supply Chain (Frazelle, 2015:4). It is imperative then, that performance measurement takes place. It is even more important to have these measures aligned with the Supply Chain measurement frameworks, as well as its selected overarching strategy. This will provide a better understanding of which processes in the Warehouse operational performance are critical to the survival and overall performance of the supply chain, not just the individual Warehouse.

The next step in the development and proof of concept for this *strategic-process* and *Warehouse performance alignment matrix* is to conduct a complete exploratory case study on a selected case company to determine once again if the performance gap analysis can be done, as it was presented in *Case study 1*, in section 7.1. However, this research case will be taken further to include the work outlined in *phase 2D* drawing alignments between the BSC, Supply Chain Strategy and processes aligned with SCOR process attributes. This case study will be presented within *Part 6 (Chapters 9,10,11, 12 and 13).*

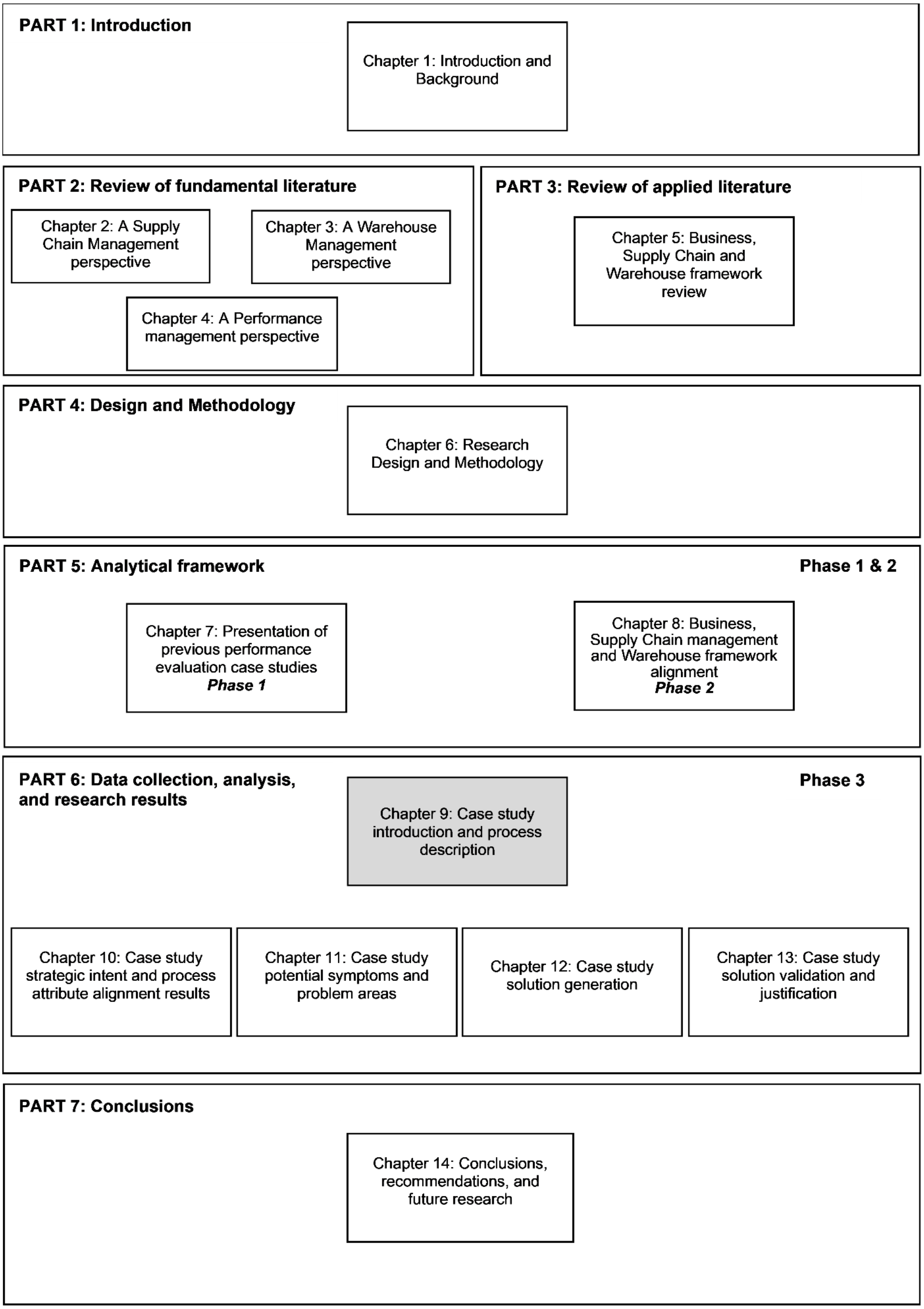
PART 6

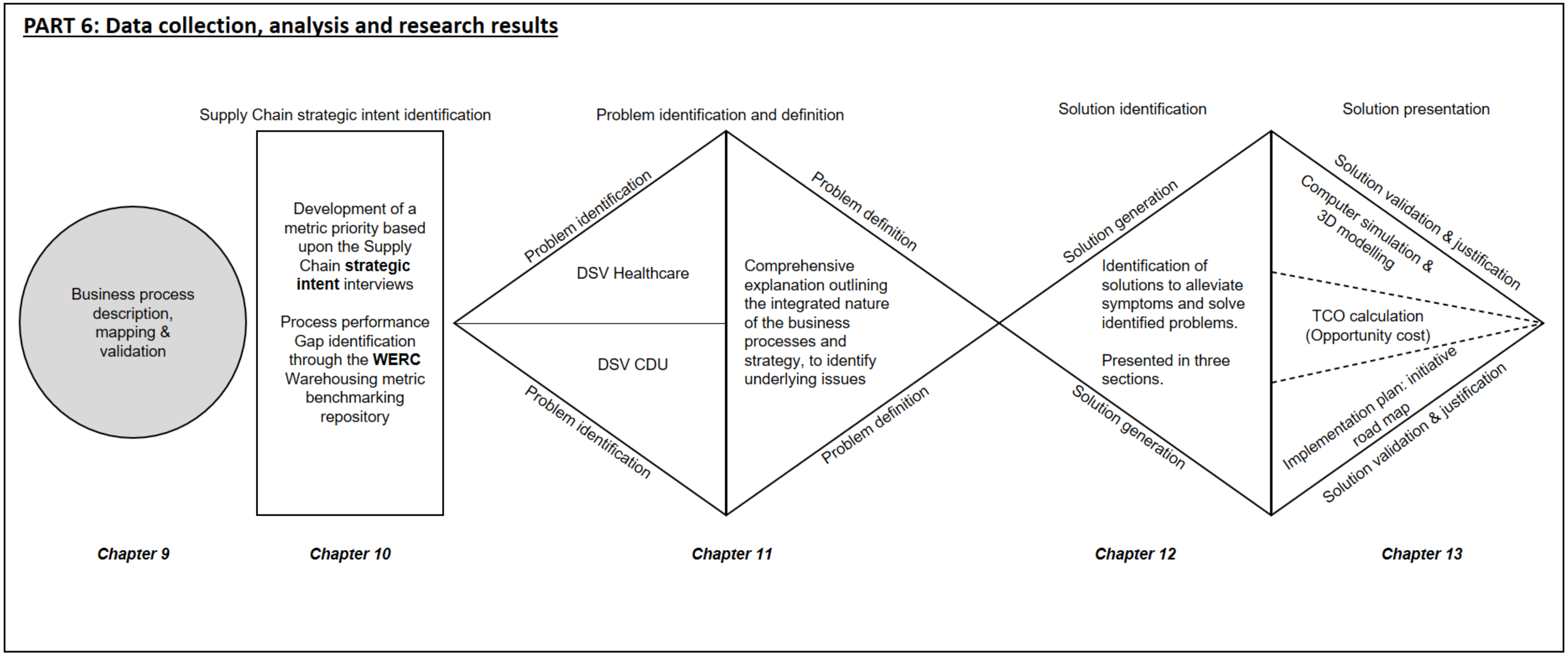
DATA COLLECTION, ANALYSIS AND RESEARCH RESULTS

- Chapter 9: Case study introduction and process description
- Chapter 10: Case study strategic intent and attribute alignment results
- Chapter 11: Case study potential symptoms and problem areas
- Chapter 12: Case study solution generation
- Chapter 13: Case study solution validation and justification

This part of the report outlines the complete Supply Chain and Warehousing performance evaluation of the selected case company. This case company has been identified as DSV Healthcare, situated in Parow Industrial area, in Cape Town, Western Cape, South Africa. This company focuses their operations towards providing medicine parcels to over 1 600 government registered/run facilities within four different provinces across the country. This case study is presented in five separate chapters, each building on the findings of the previous chapter. The results of this case study have been presented in two distinct solutions chapters, outlined by *Chapter 12* and *Chapter 13* respectively.

PART 6: CHAPTER 9
CASE STUDY INTRODUCTION AND PROCESS DESCRIPTION




PART 6: Data collection, analysis and research results
Supply Chain strategic intent identification
Problem identification and definition
Solution identification
Solution presentation
Business process description, mapping & validation
Development of a metric priority based upon the Supply Chain strategic intent interviews
Process performance Gap identification through the WERC Warehousing metric benchmarking repository
Problem identification
DSV Healthcare
DSV CDU
Problem identification
Problem definition
Comprehensive explanation outlining the integrated nature of the business processes and strategy, to identify underlying issues
Problem definition
Solution generation
Identification of solutions to alleviate symptoms and solve identified problems.
Presented in three sections.
Solution generation
Solution validation & justification
Computer simulation & 3D modelling
TCO calculation (Opportunity cost)
Implementation plan: initiative road map
Solution validation & justification
Chapter 9
Chapter 10
Chapter 11
Chapter 12
Chapter 13

Chapter 9: Case study introduction and process description

Q8: To what extent can Supply Chain strategy and operational Warehouse metrics be integrated to prioritise improvements to the overall performance of the Warehouse, in line with the corporate and Supply Chain objective?

The integration of all the theories discussed within the previous chapters, (*Chapters 2,3,4 and 5)* has led to this point, whereby the above-mentioned theory will be **applied** to a single case. This case will follow an ***applied methodology***, in order to derive accurate findings based on the exploratory case studies design, methodology, research objectives, and questions. This is done to ensure a comprehensive performance analysis of the case company's Warehouse as well as the integration of the previous chapter's findings within the applied methodology of this case. In effect, this research document incorporates two methodological frameworks that were used to analysis the concepts and frameworks related to Supply Chain, Warehousing, and performance management. This incorporation outlined how these concepts could fit together to test a comprehensive strategic alignment model concept, namely the ***fundamental method*** and ***applied method*** as stated in *Chapter 6.*

This concept, as presented in *phase 1-Chapter 7* presented the previous results that this integration could derive to benefit a company's overall performance. These eight case studies are identified in *Chapter 7:Presentation of previous performance evaluation case study* of this report. The applied methodology outlines the comprehensive approach used to analyse this report's selected case company, DSV Chronic Dispensing Unit (CDU) and DSV Healthcare. This methodology is written as if it were developed and implemented based on the findings from Part 5 *(Chapters 7 and 8)*. This case study incorporates all the theoretical aspects covered in this report and tests them to understand, analyse, and benchmark strategic KPIs through a strategic intent gap analysis as well as develop a Warehouse operational metric hierarchy. This hierarchy is used to identify case-specific solutions to close the performance gaps and realign the strategic intent of the company with those at the operational level.

9.1. Case company introduction

This research was conducted at a large pharmaceutical dispensary in Cape Town, Western Cape province, South Africa. The data used in this study is derived from internal systems and measurement processes and is not made available to the public, making this research and its findings confidential in nature. For the purposes of this report all sensitive information has been aggregated to eliminate possible distribution of confidential sensitive information. In order to ensure this desensitisation was achieved, approval was gained from both Stellenbosch University and from the managers involved at the case company before any data collection took place. Refer to Annexure G. This section of the research document presents the case study and findings *(both qualitative and quantitative data)*.

The DSV facility is divided into ***two* separate facilities** with three independent overarching silos of operations. These silos all operate under the DSV brand. The Warehousing process operates under DSV Healthcare (Healthcare[10]) while the Chronic Dispensing Unit (CDU) operates as a manufacturing facility attached to the Warehousing process. The distribution services are carried out by DSV distribution, situated on the ground floor of the Healthcare building. This distribution division is utilised by both Healthcare and the CDU for all their transport needs. All the stock required by the CDU is received from the National Department of Health (NDOH) and stored by Healthcare as outlined within Figure 9.1.

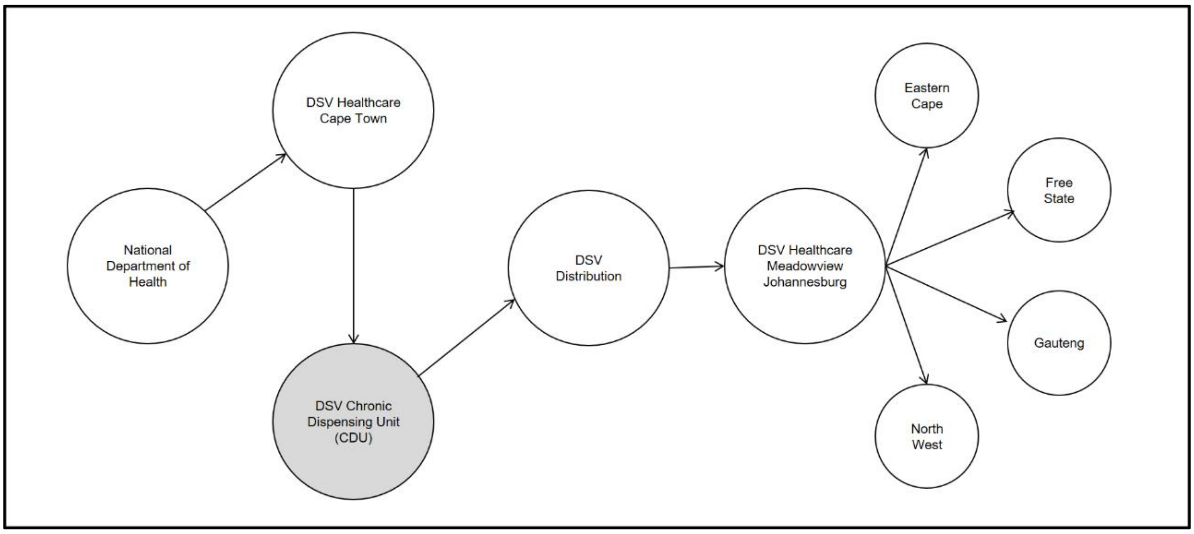


Figure 9.1: Identification of DSV Supply Chain network

[10] *Healthcare: Refers to an organisational nickname used by DSV. It is used to shorten the explanations of each facility.*

For this analysis, these three facilities will be measured as one continuous process as this will provide a more in-depth analysis, not only for the performance of the facility but also the intra-organisational process performance analysis between these three silos. Due to this, the process explanation will be described as one continuous process; however, the management role players will be clearly defined throughout.

9.2. Industry and company background

DSV is a Danish transport and Logistics company offering a wide range of Supply Chain services to its clients. DSV as a brand was established in 1976 by nine Danish hauliers. The company has experienced rapid growth through the acquisition of strategic role players within diversified markets across multiple industries. Due to these strategic acquisitions, DSV prides themselves with excelling in air, sea and road transport as well as in a range of customised Supply Chain solutions. These solutions are broken up into three separate divisions. DSV also has a large footprint across the globe, with offices in over 90 countries and 60 000 staff, ranging from managers, employees, collaborators, partners, and agents (DSV global transport and Logistics, 2019).

DSV Chronic Dispensing Unit (CDU) is the wholly owned Healthcare dispensary of DSV Healthcare. The CDU is South Africa's leading distributor of pharmaceuticals and healthcare products and is responsible for delivering medicine directly to more than 880 000 state patients. This delivery is facilitated through over 1 600 healthcare facilities across the country. Currently, the CDU is responsible for delivering *Patient Medicine Parcels (PMPs)* to four South African provinces. Each of these provinces is identified in Figure 9.2, namely *Eastern Cape, Free State*, *Gauteng* and *North West*, while the CDU facility is situated in Cape Town, Western Cape province, South Africa.

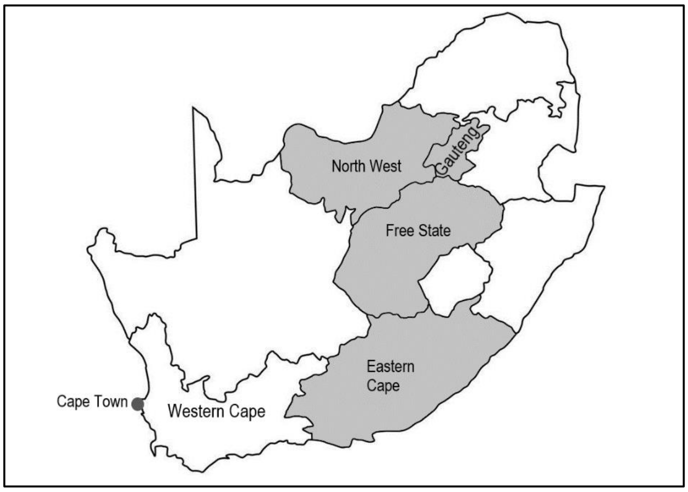


Figure 9.2: Map of South Africa and the provinces served by the CDU
(Source adapted from: Sowman, 2013)

All patients that require medication from government-run facilities normally visit their nearest clinic. They will then be seen by a doctor who will write out a prescription diagnosing the illness as well as listing all the medication required. Patient-specific instructions regarding the appropriate dosage and when to take the medication will also be provided. These scripts are then collected and sent to the CDU for processing. The CDU is then responsible for verifying the mix of medication, ensuring that the dosages and prescriptions are correct and then processing, packaging, and distribution of each individual PMP, for delivery to the clinic for the patient to collect it, on a prearranged date known as a *collection date*.

The aforementioned process is repeated for all scripts sent to the CDU. The performance objectives for this process as well as the underlying operational process are to complete this delivery within the defined SLA outlined at the initial stages of the tender process with National Government. It is important to measure these operational processes to improve on the SLA performance and the service experienced by patients.

9.3. Problem Statement for case

Many companies that provide a service that involves processing and distribution question how they can measure performance, and once measured, how this performance can be maintained or improved upon, to become a more efficient competitor within their industry. This is a critical element within facilities and industries such as this one. This facility makes use of multiple Warehousing and Processing operations to facilitate customers' pharmaceutical needs. In order to do this, managers must identify their core processes and establish a benchmark for their measures. These measures must then be measured against an industry standard, to understand their performance relative to potential competitors. This process provides an in-depth understanding of how well they operate and will help identify those areas that need to be improved on (Richards, 2011:300).

9.4. Case Study Questions

The following case study questions (CSQ) are derived from the problem statement, identified in section 9.3 and follow the same ***applied methods*** used within the eight case studies presented in phase 1 *(Chapter 7)*.

CSQ1. What are the processes that occur within the DSV facility(ies)?

CSQ2. What selective strategic objectives are most prevalent in facility operations?

CSQ3. How can the SCOR model and WERC model metric analysis be combined to effectively measure the businesses alignment and performance?

CSQ4. How does the prioritised metric evaluate the gaps calculated for each process?

CSQ5. What solutions are available that can improve process performance?

9.5. Applied research Design and Methodology

The following section outlines the theoretical components used in performing the *exploratory case study investigation,* the method for which is outlined within the ***applied research design and methodology***. Despite the academic structure of this report, the findings of this analysis have been conducted through a *three-phased methodology*, as outlined in the ***Fundamental research design and methodology.*** This case study represents the third and final phase of this research.

9.5.1. Research design

Qualitative data has been collected through semi-structured interviews with key supervisors in charge of operating processes as well as the business unit manager and the General Manager of the company. This method was conducted to identify the business's selected Supply Chain strategy. Quantitative data was also collected from the company's operating systems, known as Flexgen and DELTA. These systems are used to derive performance measures across a variety of different processes and functions.

The mixed methods design made use of the SCOR reference model framework and the work presented by Bolstroff and Rosenbaum (2003). This was based on what the management of the Chronic Dispensing Unit (CDU), Distribution operations, Processing operations as well as strategic level management identified the company's chosen Supply Chain strategy to be. The purpose of this was to further align operational level metrics and decisions with upper-level management objectives.

The quantitative data was measured against the published repository known as the Warehouse Education Research Council (WERC). This benchmarking process allows DSV Healthcare and the CDU to be measured against an international standard, in order to derive a specific solution to improve upon current operating performance. It enabled them to close the gap between expected performance and actual performance as outlined by the selective Supply Chain strategy.

9.5.2. Applied case study Methodology

This case study followed a five-step process in conducting this in-depth process evaluation for the DSV facility. The first step was to identify the business or company that would be analysed within this research. A brief history and analysis of the facility's key operating functions and processes have been conducted and explained. Step two was to identify the core process of the facility's different activities, encompassing distribution, storage, and parcel manufacturing, to better understand all the components of the facility's functions that are currently undertaken. This facility comprises of three independent facilities operating in conjunction with one another. This is due to the size of the DSV operations for which a multitude of different core competencies exist in order to fulfil day-to-day operations.

The third step required the identification of the key Warehouse operational performance indicators, which corresponded to the processes identified in step two. These KPIs were identified through semi-structured interviews. These interviews identified the Supply Chain strategy adopted by DSV and therefore identified the priority level for the different KPIs. Step four required the data to be extracted and aggregated. These metrics were then benchmarked against the WERC repository to identify potential focal areas that needed attention (Supply-Chain Council (SCC), 2012).

Finally, the evaluation of the findings as well as suggested solutions were recommended to drive specific improvements in the company's performance. These improvements were based on their selected Supply Chain strategy through the corresponding metrics prioritisation. A method of validation was used to demonstrate the effectiveness of the derived solutions. This method encompassed a three-dimensional computer simulation model, total cost of ownership calculations as well as the development of an initiative road map. This allowed for specific solutions and processes to be generated to improve the current performance level. Thereafter, specific changes could be simulated, calculated, or implemented, to derive the potential improvements in performance within the problematic areas or process components. For ease of reference and conceptualisation, the output of this simulation is presented in Annexure K. This gallery of snapshots was taken from the three-dimensional model and is used to illustrate the facility's layout and processes that will be reviewed and explained in this case study.

9.6. Case study data collection and analysis

The following section outlines the data analysis process, evaluations, and findings for this specific case study. All the above research questions will be answered in order to derive a specific case to validate the conceptual analysis developed in this research.

9.6.1. Process descriptions for DSV Healthcare

The following section outlines all the processes inherent within the Healthcare facility. These processes are linked across the healthcare facility to the Chronic Dispensing Unit (CDU) facility process; however, these explanations are kept separate for explanation purposes as presented in Annexure K (Figure K.1.).

Important note: *During the period this analysis took place, DSV Healthcare was moving between tenders. This means that the Western Cape tender was drawing to a close while DSV had just won the new National Government tender. The handover process required DSV healthcare to facilitate the Western Cape government tender for a final six-month period. This transition occurred while a portion of this analysis took place. In order to make the most of the investigation opportunities, the process explanations include specific aspects of both tenders. The primary focus is on the* ***National government tender*** *as these solutions will benefit future operations in this regard.*

9.6.1.1. *DSV Healthcare Information System overview*

DSV Healthcare operates a DC that specialises in the storage and distribution of pharmaceuticals products for both private clients and government tenders. The facility schedules work through order releases that are then picked within the Warehouse. These orders are processed and shipped to customers. For DSV CDU order releases occur three times per week. For orders to be released, the system must run an inquiry to find the availability, quantity, and location of stock within the DC. Each order is identified as a *PIN* on the DELTA system, one “Pin” represents one order. “KCT00A” is a code that refers to National orders that need to be released.

If the order release is delayed or not available it means the scheduling is not yet completed on the FLEXGEN system used by the CDU. Only once the scheduling is complete on this system, is the order released for picking.

This creates an issue with picking as some suppliers supply both Western Cape and National government with the same product with the same product barcodes. When the stock is picked in Western Cape’s designated picking area, it identifies on the system as if it has been picked out of the National picking area. It is critical that the stock be separated to ensure ownership and management of the stock within the DC. Scheduling and picking must take the *Next Collection Date* (NCD) date into account as the National orders must travel a much further distance to the patients and therefore need to be picked much earlier to ensure enough lead times for production and dispatching processes including possible delays.

The Western Cape tender occupies most of the bulk storage and racking within the DC. National stock only occupies one row in bulk storage and several slow racks in *fine pick*[11]. The variety of SKUs required for Western Cape is extensive, while the volume for National is much higher, remembering the National tender is servicing four provinces.

This creates a service delivery issue due to the SLAs agreed upon between each government institution. While the Western Cape Government allows for Short manifesting[12] to occur, National government does not, which means that Zero manifesting occurs[13]. The restriction in space allocation is a cause for more zero manifesting deliveries for National Government scripts. This is an issue as the National Government tender has just been awarded to DSV Chronic Dispensing Unit (CDU), while the Western Cape tender is only valid for the next 6 months, due to repeat scripts being required by patients. The fact that the Western Cape tender has been moved to another distributor is not a concern due to the nature of the tendering process as well as the need to validate the SLA every four or so years. The government will move between providers to ensure a competitive price and service is being offered.

Due to this fact, a process mapping evaluation will be conducted in order to identify any process issues or inefficiencies that may arise in day-to-day operations. For this process mapping to take place, the DSV CDU and the Healthcare distribution facility have been divided into blocks of operations. Each of these blocks outlines significant process flows and operational layouts.

In this chapter, operations have been broken up into the following blocks. Each of these blocks will be explained in the following section, including problems and solutions associated with each process:

1. Receiving
2. Put-away
3. Order release process
4. Physical operations
    a. Fine pick activities
    b. Bulk pick activities

11 Fine Pick- refers to a storage type that allows for individual item picking
[12] *Short manifesting - This is if a patient's script required ten different items but only nine can be picked and shipped, Western Cape government allows for these nine items to be shipped to ensure that the patient gets their medication.*
[13] *Zero Manifesting - This is if a patient's script required ten different items but only nine can be picked and shipped, National government will not allow this patient's script to be sent. Thus, the patient receives no medication.*

5. Manifesting
    - Tote manifesting via conveyor
    - Bulk manifesting via Material handling equipment (MHE)
- CDU activities
- Staging to CDU

9.6.1.2. *Receiving stock*

Orders are placed with the National Government depots; these orders are then shipped to the DSV facilities in order to fulfil the forecasted three-month demand as well as the current script volume. These goods are received via bulk transportation at DSV Healthcare, this facility performing the storage function for the CDU, as presented in Annexure K (Figure K.2.-Figure K.4.). This stock is checked against the order invoice to verify the product type, batch number, expiry date as well as the quantity and condition of the medication. Once this order is approved and accepted into the bulk receiving area within DSV Healthcare, this stock is booked into the DELTA system.

This process requires the operator to verify the batch number, expiry date and quantity of the goods that are being booked in. This process is done to ensure transparency through the put-away, storage and picking process as well as the verification process for stock accuracy, either by *location* or *quantity*. Once these details have been finalised, a put-away instruction is generated. These instructions outline the next step of the storage prices, commonly referred to as put-away.

9.6.1.3. *Put-away Stock*

Due to the integrated nature of the two companies' processes, the CDU has a Material Handling Equipment (MHE) driver that works full time within the Healthcare facility as presented in Annexure K (Figure K.5.).

This is done to ensure the separation of private and commercial stock. Due to the number of provinces being serviced, each province requires their stock to be kept separate from the others to ensure better stock accuracy as well as reduce the mixing of stock between each province. This ensures that a Gauteng product will not be sent to a Free State patient, despite the fact that they are the same items.

The MHE driver is responsible for actioning the put-away. This entails the driver placing the stock into the pre-identified bin and scanning the product barcode and the bin location barcode to allocate this stock to that location. This is crucial to outline the picking accuracy as well as stock count accuracy, particularly leading up to or during NDOH or provincial audits. Once the stock is place in the correct location, the system takes over to outline the following steps to retrieve the relevant stock for a CDU production run.

9.6.1.4. *Order release*

For stock to be picked to fill a client's orders, the orders must first be released from the system. Figure 9.3 outlines the order release process within DSV Healthcare. An order release requires all those orders that form part of that release for the day to be scheduled on Flexgen from the CDU. Once scheduling is complete a DC supervisor from Healthcare must run a query, through DELTA, for the day's orders.

The query runs through the system and identifies all the products required, the stock quantities, location and checks the expiry date. Expiry dates are critical, particularly with medication, as a patient's life and well-being are dependent on accurate stock control and dispensing.

The DC operates off the first-in-first out (FIFO) principle, meaning that the stock that is due to expire first, will be shipped to customers first. This ensures that no stock on hand or customer receipts are out of date. Once the query is finalised on the system, it is released to the voice control picking system, as presented in Annexure K (Figure K.6 and Figure K.7.). All the documents are printed and signed off by the attending supervisor. On the *voice picking system*, the PINS are then prioritised per pick zone as presented in Annexure K. After the prioritisation, the pickers can now commence picking each order, in their respective zones. There are 10 zones in total, 6 on the ground floor of the mezzanine fine pick and 4 on the second level of the mezzanine, where the manifesting activities take place.

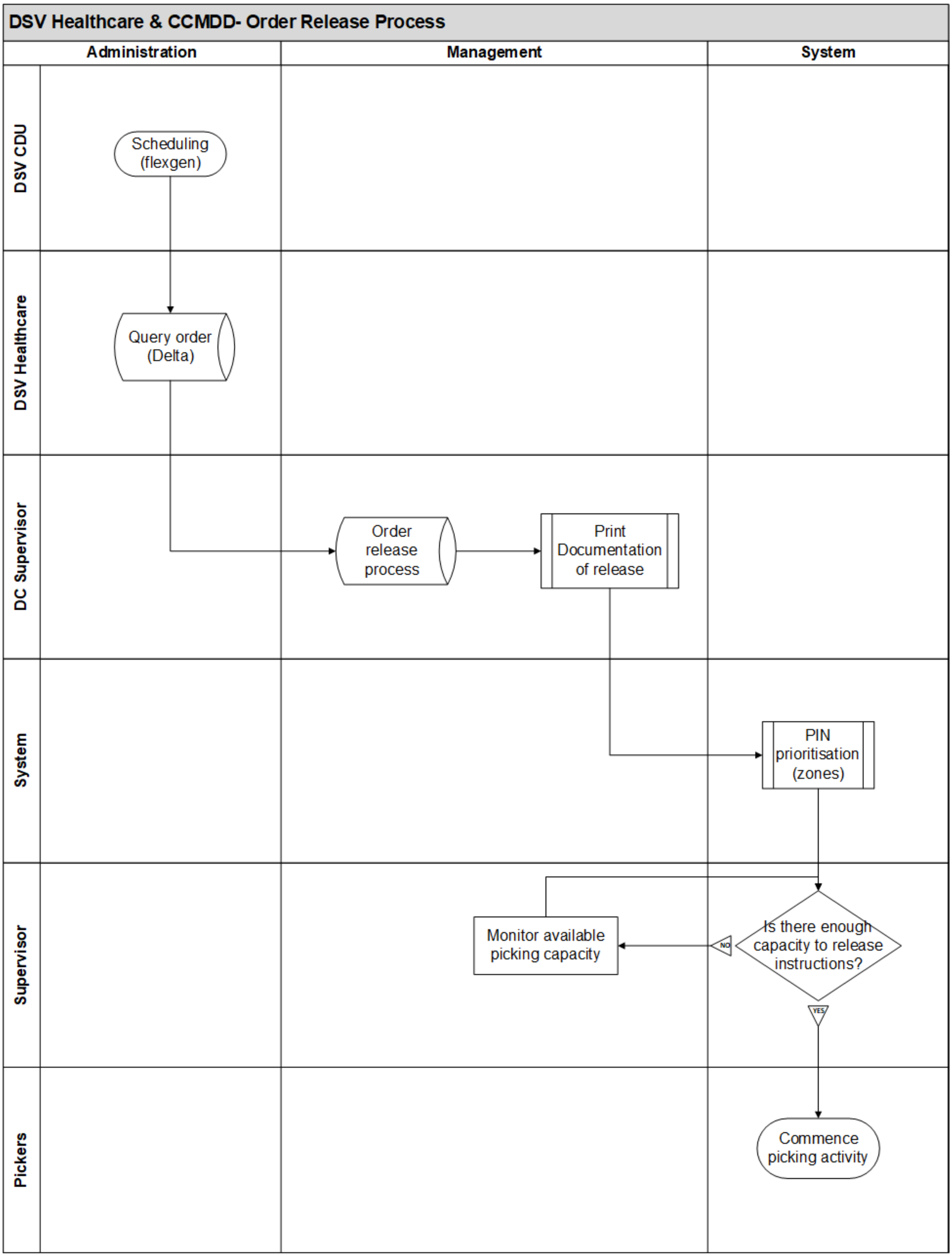


Figure 9.3: Process map for order release

9.6.1.5. *DSV Healthcare: Physical operations overview*

Once the order is released from the administration steps outlined above, the orders then become available for picking through voice-activated systems. Figure 9.4 outlines the process of picking stock within the DSV Healthcare facility. Each picker is required to record their own voice within the system, within the initial set-up of their picking headsets. This is so that the system can register any variation in language or accent between different pickers. Each of the new Bluetooth picking headsets costs in and around R30 000 each. Accountability is given to each picker as they are responsible for their own headset, scanner and Bluetooth receiver. If any loss or damage occurs it is isolated to that one picker, unless external influences are involved (accident). Furthermore, all tote picking conducted within the fine pick area is *picked to conveyor*. This makes order completion much faster and efficient as pickers can then send the order to manifesting the moment it is completed and then complete other orders while the first order is manifested.

Each picker must pick on average 20 PINS per hour, while completing housekeeping[14] activities at the same time. However, each picker can do between 40–60 PINS per hour while still completing housekeeping, based on supervisor experience and expectation. Once a picker starts a pick order, they must accept the order verbally while identifying the correct size tote to be used. There are three different sizes of tote (small, medium and large). Each tote has a barcode on it that will be scanned to associate that order to that tote. The barcodes on the totes are only scanned if it is an electronic pick. The DC makes use of both paper and electronic picking to pick their orders. Therefore, if a paper pick is done, the pick order must be put into the tote before it is put on the conveyer belt, so it can be checked at manifesting.

Once a tote has been selected, the picker must move along their designated pick zone. Each zone has two pickers allocated to it. The voice picker system now instructs the picker to go to a specified bin location to look for the correct bin that holds the required item.

Once the correct bin location is found, the picker is then required to select the correct quantity of stock, for example, 30 items. They then have a choice as to how they confirm the stock that has been selected. For Western Cape, the picker must physically collect 30 items, scan one individual item and verbally confirm that 30 have been picked by saying *OK*.

[14] *Housekeeping - refers to the cleaning and organising of current bin locations that are currently being picked from. Therefore, a picker should correct the alignment and cleanliness of each location upon arrival or departure from each location.*

For National products, the picker must scan each of the 30 items picked from that bin location. This process is repeated until the order is complete. Upon completion of the order, the tote is *pushed back* on to a parallel conveyor belt that senses the arrival of the tote via laser sensors, then the conveyor starts running, moving the tote to manifesting on the second mezzanine level. If a picker's order needs to pick multiple items from different zones, the picker will confirm the items picked in their allocated zone, leave one half of the tote lid open, push the tote back onto the moving conveyor at which point it will be moved to the next zone for completion.

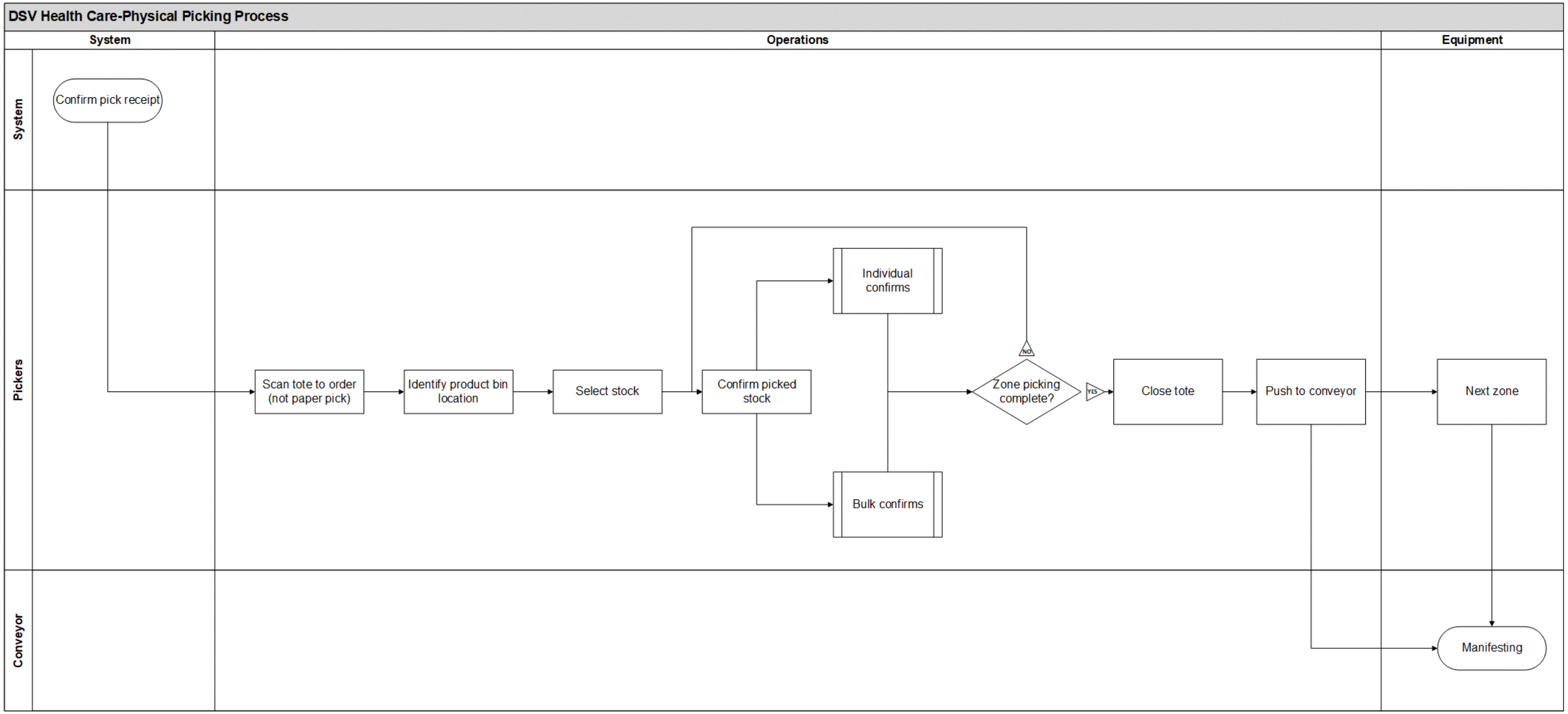


Figure 9.4:Physical picking process map

9.6.1.6. *Process explanation for manifesting*

The products are now received on the manifesting mezzanine via two methods, each of which will be explained below:

Lift truck for bulk goods: *This is when goods from bulk storage arrive in case lots at the manifesting area on pallets.*

Break bulk/Single picks: *Smaller lot sizes are hand-picked by the pickers in the fine pick area. Each of these picks is picked into totes that are moved to the manifesting mezzanine area via conveyor.*

Figure 9.5 and Figure 9.6 outline the processing and movement of goods once they arrive at manifesting. Once the goods arrive on the conveyor belt, as presented in Annexure K (Figure K.8 and Figure K.9), the manifesting operators are set up alongside the conveyor belt to manifest each tote. The tote barcode is scanned to open the system for the items to be confirmed. If the pick order was a paper pick, the operator must open the tote and scan the barcode on the pick order (PO) that was left in the tote by the picker.

Once the pick order barcode has been scanned, the operator must now scan each item within the tote, to confirm that the quantity in the tote and the quantity on the system match. If the operator scans an extra item the system will present a warning notification that they have recorded an extra item. This item will then be removed from the tote. If the tote is short of items *(9 out of 10 items in the tote)* and the operator tries to accept the order, another warning presents on the system. The manifest operator must then identify the picker (from bulk or fine pick) and contact them to collect the additional stock required for the order.

Please Note: *These are situations where a manifesting issue occurs, as not all the pickers write their name down on the paper pick instruction. This is done to identify any repetitive errors from a specific picker. The supervisors need them to identify themselves so disciplinary action can be taken. This wastes time for both the manifesters, and the picker who is then required to fetch the additional stock.*

If an operator successfully scans the tote contents, the items are either placed into a box or into a clear plastic bag. The operator then prints the invoice or manifest. If an invoice is printed, the operator must then scan the invoice barcode to print the *trip*[15] label. The items are then placed randomly into waiting totes that are stacked on pallets for further manifesting.

[15] "Trip"– Organisation jargon that refers to the scanning of a product into a movement status. This product will then be arranged for transport to its destination location.

This next step in manifesting is required to send items either to dispatch or to the CDU for further processing. This process will be discussed in the section below. Referring specifically to CDU stock, this stock is manifested and waits for dispatch to send the stock through *the wall*[16] for transfer to CDU. However, the manifesting supervisor and operators cannot send the stock through to the CDU operations if they are not ready to receive *on the other side* or vice versa on Healthcare's side.

[16] "The wall"–Refers to a physical wall separating the Healthcare facility and the CDU. Goods are moved between facilities through a conveyor belt or bulk receiving bay built into this dividing wall.

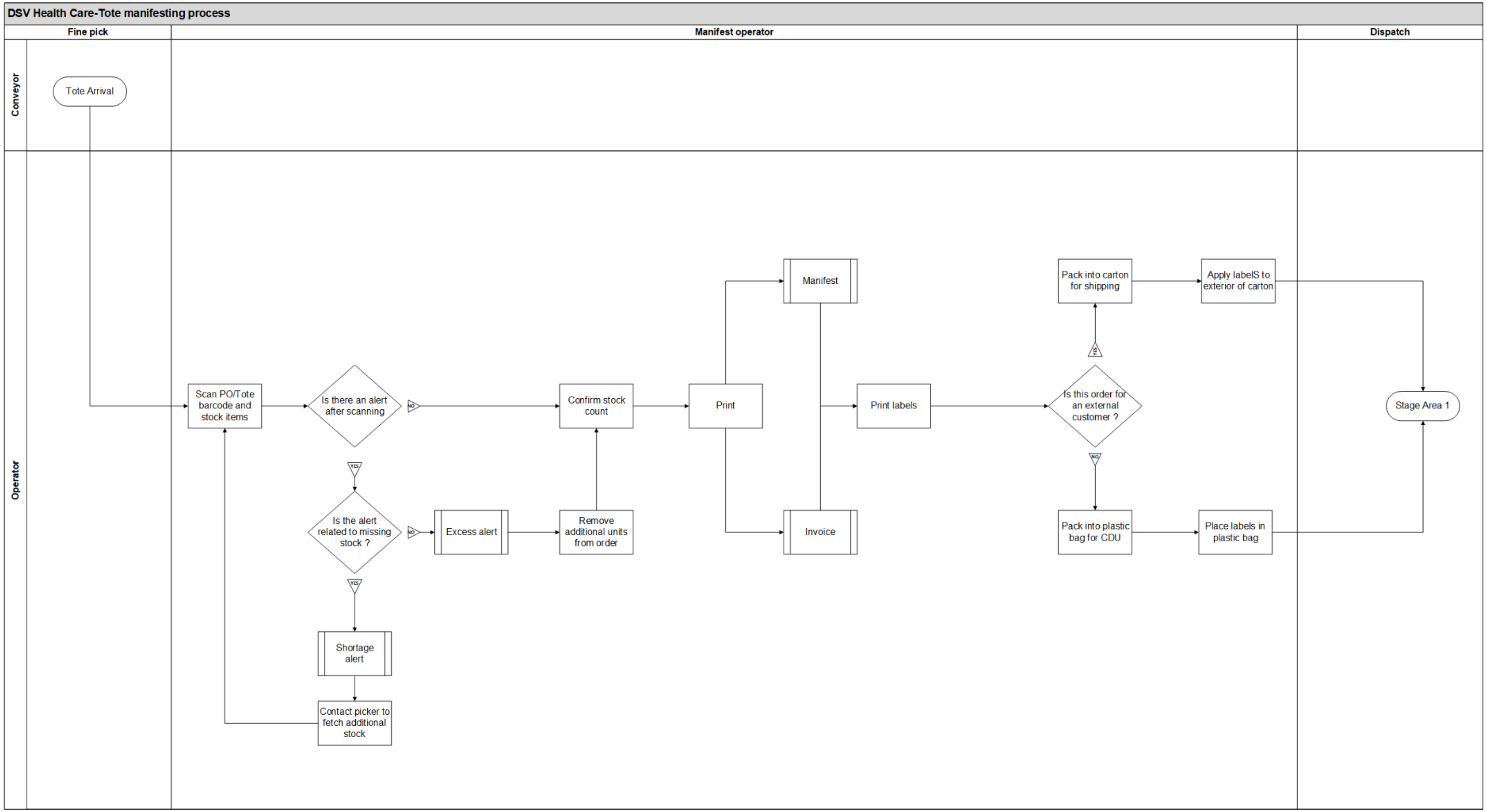


Figure 9.5: Process map for tote manifesting area

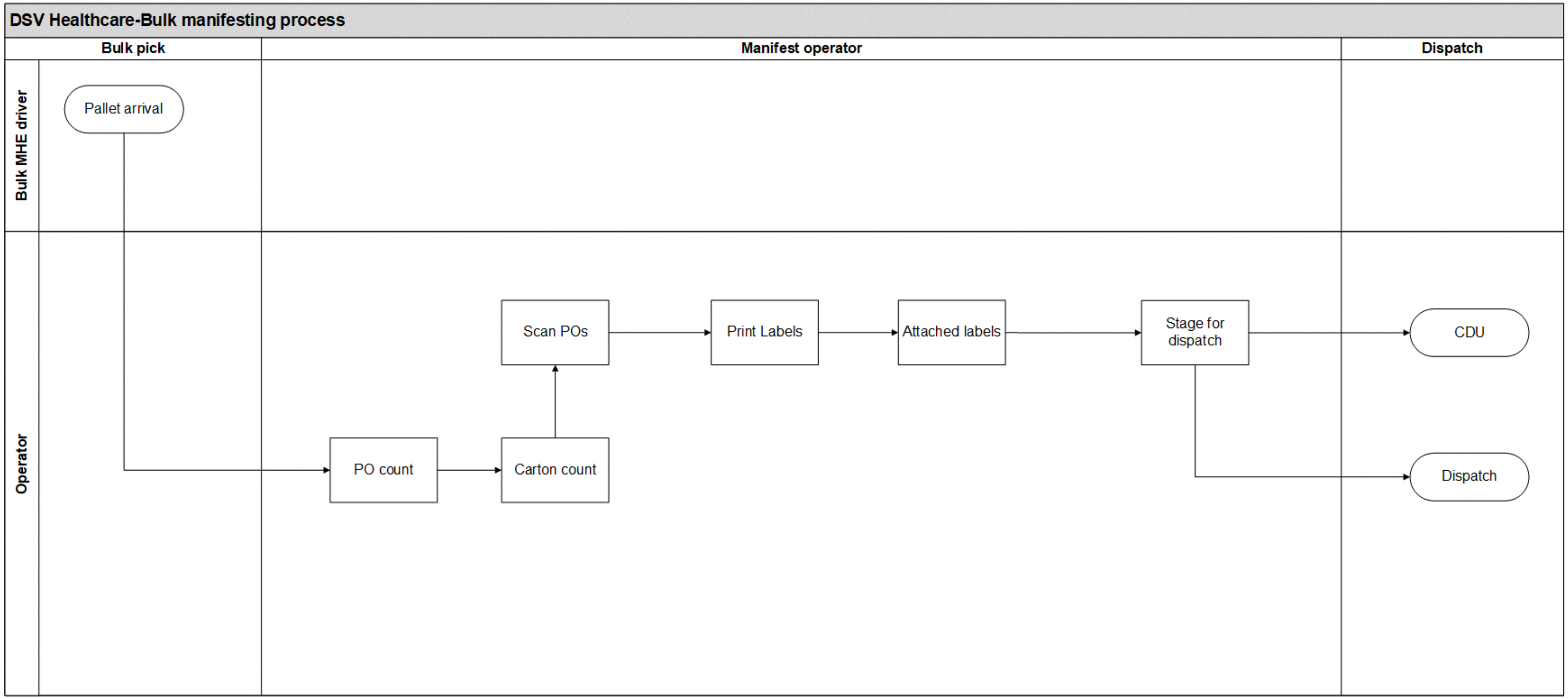


Figure 9.6:Process map for bulk manifesting area

9.6.2. Process description for DSV CDU

When the patient arrives at a hospital, they will be diagnosed by a doctor or nursing sister, who will then write a script for their diagnosed illness. They proceed to the pharmacy where the pharmacist will issue a 1st repeat 1 and 2. National Government scripts work on two-monthly repeats. This means that there is a total of 6 repeats in a six-month period for an individual patient's script. The national clinic will provide the patients with the 1st and 2nd repeats. This script will then be sent to the CDU to then fill the following repeats for the patient. This script will then go through an intricate set of overlapping processes to correctly fill this patient's script. The *administrative and support system* processes are summarised in Figure 9.7 and Figure 9.8 as well as the accompanying explanation:

9.6.2.1. *Script receiving*

Scripts are collected from the numerous facilities that are run and operated by the Department of Health (DOH). These scripts are first transported to hubs within the four provinces. These scripts are then consolidated and transported to the Meadowview DSV facility, in Johannesburg, where they are counted, sorted, and scanned into script envelope bags. These bags are then consolidated into totes with waybills placed on the outside. These totes are then transported to the CDU facility in Cape town.

9.6.2.2. *Mail room*

When the totes containing the scripts arrive, they are received at the CDU administration office, known as *Mail Room,* illustrated by Annexure K (Figure K.10). It is this department's responsibility to begin processing these scripts through an extensive process of checking and verification.

Firstly, the scripts are counted to verify that all scripts collected from the facilities match those that have arrived at the facility. This is done for two major reasons. Firstly, to track the variability of script volumes being sent to the CDU, in order to forecast foreseeable medication volume requirements as well as capacity constraints on the operations floor. The second is to ensure that all possible patients' scripts will be processed within the identified collection date. This means that late delivery of scripts to the mail room will cause the facility to miss the required delivery dates back at the facility in each of the four provinces. Facilities have 10 days to get scripts to the CDU facility in time for script processing.

Once these scripts arrive, they are sorted according to their script date (date the script was written), into script packs. Multiple scripts can have the same collection dates, therefore each of these script packs[17] is stapled together and a barcoded label is printed, one label for each pack. This label provides summary information about each script incorporated in the pack. This label identifies the collection date, the script date as well as an allocated production date. This allocated production date is automatically calculated by the Flexgen system and identifies when these scripts need to be captured by, in order to make production in time for distribution back to the facilities for the patients to collect their medication. After these scripts have been sorted into their various packs based on the physical script date, the scripts are then moved to the capture processes. An example of a perfect script is presented in Annexure C, Figure C.1. This example shows the different types of information and labels used in the following processes.

9.6.2.3. *Patient Capture*

The next step is to verify the incoming script in order to determine whether all these scripts meet the minimum requirements of Good Pharmacy Practice (GPP). The mailroom makes use of a fourteen-point check in *vetting*[18] a script. The outcome of this process is one of three possible outcomes:

Approve: This entails approving the script, checking the script for any discrepancies in types/mixing of medications that could be lethal to a patient.

Rejected: due to incorrect medication combinations and quantity or any other administrative issues that are picked up by the team.

Corrected: This step requires a pharmacist to intervene on potential scripts that could be saved. The *modus operandi*, in this case would require a pharmacist to contact the prescribing doctor directly and inquire about the identified issue. After this, if the phone parties agree with the correction, the script is countersigned and will form part of the approved scripts.

Once the mail room team completes the verification[19] process, the script is then captured, from a hard copy/paper script to an electronic version. This is done only to verify the patient information.

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[17] Refers to the sort of scripts into packs, each pack pertains to the same collection dates.
[18] CDU jargon: it means to verify or validate all relevant information
[19] Verification process-refers to a set 14-point check to identify if the script meets the minimum requirements for capturing.

Once the capturer accepts the final set on the computer the patient profile is then updated. The computer automatically prints out a patient-specific barcode that is stuck directly onto the script. This Script is then moved to the scanning process.

9.6.2.4. *Script scanning*

This requires the scanning operator to verify the script date, collection date and production date from the initial sticker attached to the script pack. Then the scanner removes this stapled label and scans the document into the system, known as the *capture silo*.

9.6.2.5. *Script capture*

Due to the strict guidelines set out by the pharmacy council, the script is then sent to another department, known as *script capture*. It is important to note the difference between the two departments. One is responsible for capturing patient specific information while the other is responsible for capturing the patient's medication requirements. The separation of these two departments is based on the GPP practices which requires at least a post-basic pharmacist to capture the medication requirements.

In some cases, there is an issue with the medication that has been prescribed, for example a conflicting blood pressure medication may have been prescribed in conjunction with other medications that could result in patient fatality. These script capturers are not only responsible for capturing the medications per patient but are also required to check the mixture of medications prescribed, to ascertain that they will not harm the patient in any way. These scripts will then be checked one last time before being *scheduled* into a production batch.

9.6.2.6. *Blind Checking*

Once these scripts have been patient captured as well as script captured, each script is checked one final time, as part of a process known as *blind checking*. These blind checkers verify all patient information, dosages, medications and quantities before the script is scheduled. Again, it is important to note that this person must hold a post-basic or higher qualification.

9.6.2.7. *Scheduling*

Scheduling occurs for the 3rd and 4th repeat scripts. Because the facility is located in one of the four provinces, the facility will provide the patients with the 1st and 2nd repeats of medication in the initial consultation. In scheduling these repeat scripts, the 'Next collection date' (NCD) must be considered, in order to get the medication to the patient on time. The CDU has 56 days to receive, process, pick, package and ship the patient's medication in time for their NCD.

Once the collection dates have been finalised and scheduled, the scripts are assigned a single batch number, whereafter all those scripts will be processed together as a single batch with corresponding collection dates. Once the scheduler aligns and counts all the different types of medication as well as the required volumes, an order is sent to the Healthcare Warehouse.

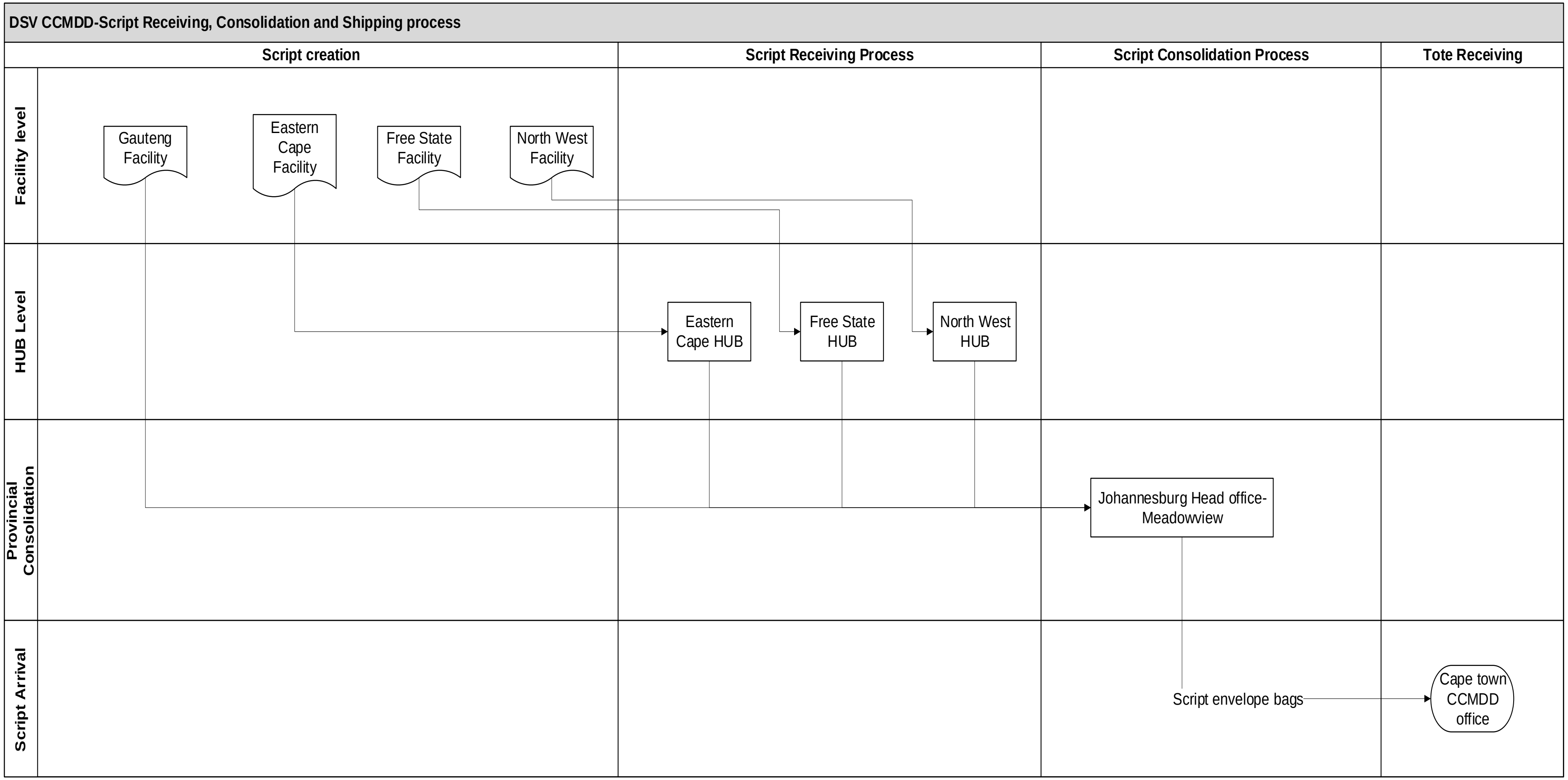


Figure 9.7: Script receiving, consolidation and shipping process

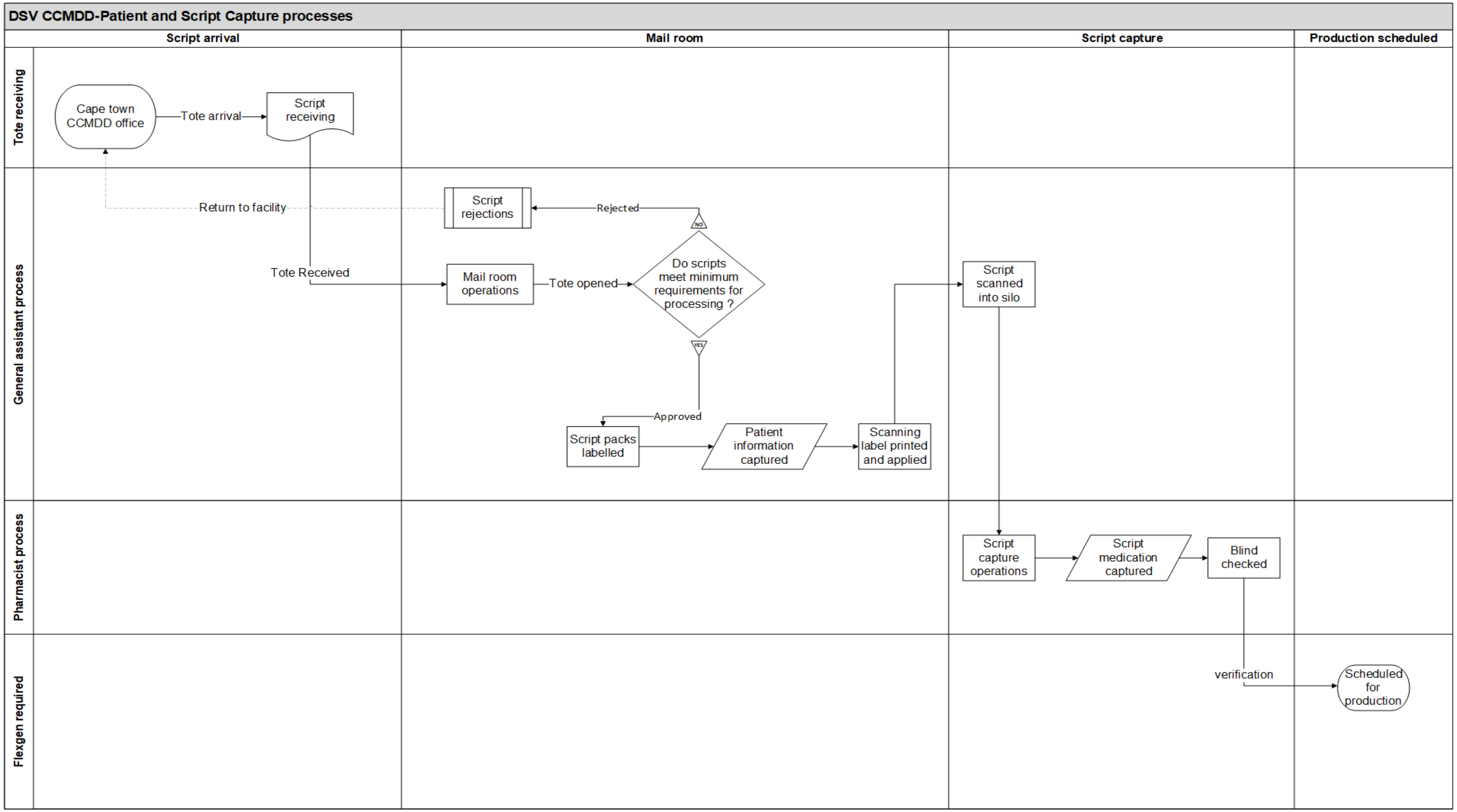


Figure 9.8: Patient and script capture process

9.6.3. Physical Stock movement process

The section outlines the physical picking and moving of stock between the required processes in order to fulfil operational requirements for medication supply, to fulfil the volume of scripts scheduled for a batch. This process falls under the DSV Healthcare facility, therefore all the Warehousing activities conducted to get the required stock for a batch are outlined in Section 9.6.1.4. Once that process has been fulfilled, the stock is then dispatched from Healthcare to the CDU facility. The *Physical stock movement processes* conducted in the CDU is listed and explained as follows:

- Receiving stock (from Healthcare)
    - Too follow stock
- Put-away
- Picking
- Staging and pre-pack
- Labelling
- Sorting (Primary and Secondary)
- Missing items
- Dispensary
- Closing and Dispatch
- Distribution
- Returns Processing

9.6.3.1. *Receiving of stock for CDU*

Product is received and staged into the CDU facility and can be received through two different methods. These are either bulk receiving, which is palletised and arrives via MHE through the Healthcare dispatch dock, or the alternative is tote arrival via conveyor from the Healthcare DC.

In some cases, items are dispatched from Healthcare to CDU in both bulk and fine pick quantities. This means that for a single pick order (PO) from Healthcare, these require both a pallet as well as a few individual items to be picked. This would have been done in two separate areas within the Healthcare facility, as discussed in section 9.6.1.6. When goods are staged between Healthcare and CDU, normally the individual items arrive before the bulk cartons. This is due to the availability of conveyor belts for fine pick totes, while the bulk pallets must be received via MHE through the staging bay door that is situated between receiving and CDU.

The CDU staging operator scans an item that is part of a larger PO, meaning that as this item requires bulk stock that has not yet been dispatched from Healthcare, the operator cannot scan this item into the CDU system. The operator must hold these individual items until the bulk stock arrives. This can be a tricky process as bulk stock may take several hours to arrive and the operator must remember where he stored the stock in the interim, as this storage process is not recorded.

9.6.3.2. Too follow items

In some cases when stock is picked not all the stock is available to fill an order, this is known as a *shortage*[20]. In this case, the balance of the stock will be sent through to the CDU at a later stage. However, on the Healthcare system, an automatic instruction is simultaneously generated, to pick the remaining stock when it becomes available in the Warehouse. When the stock is available, it is then picked as a *too follow order* which forms part of a normal order release in the Healthcare facility. However, in terms of the National Government SLA, zero manifesting is a policy that must be followed if all items are not available. To avoid this, the CDU makes use of their own stocks, to fulfil the missing items to ensure this order is sent out. Despite the order being completed on CDU's side, Healthcare will still pick the stock that the system recorded as *too follow* order. This stock is no longer required by the CDU. Instead of sending the stock back via Return to suppliers (RTS) this stock is then booked in and used to replenish the storage area within the CDU.

9.6.3.3. *Put-away*

Once all the required stock has been received, counted, and scanned into the Flexgen system on the CDU floor it is put-away. This means that all the stock received is either put into bulk block stacking or into fine pick bins waiting to form part of a scheduled batch. If the stock is received after the prescribed delivery time, due to complications with dispatch and receiving processes between Healthcare and the CDU, this stock will move straight to staging or prepack, to limit lead time for the remainder of the processes.

[20] *"Shortage"– This refers to an amount of stock that is received that is less that the total required on the system.*

9.6.3.4. *Picking*

In some cases, Healthcare will have stock constraints, whereby an order is only partially filled, so the stock controller at the CDU floor will make use of the stock on hand at the CDU. This stock is placed into fine pick for one of two reasons. Either this stock was received in excess in a previous batch, therefore, it was staged to be used in the future in case a short supply of medication occurred. The other reason stock is stored in the fine pick area is based on PMP returns, outlined in section 9.6.5.8.

9.6.3.5. *Staging and pre-pack*

Once all these goods are received, they need to be prepared before the labelling process can start. This is important as the labelling and sorting process must differentiate between National and Western Cape stock. The preparation of stock forms part of GPP practices. This requires operators to open items that may be shrink-wrapped together, so that each SKU is separate. These items are then packed in a specific manner, to improve the efficiency of the labelling process. This specific packing requirement varies from product to product, depending on the type of product.

Note: *Pill boxes will be packed with the front of the box facing to the side, to ensure that each patient's label is on the correct side and orientation on the pill box, while smaller bagged products must be packed face up for the label to fit on the product once labelling begins.*

9.6.4. Labelling processes

Each product is labelled in one of four ways: (1) by hand, (2) print and apply, (3) in-line apply and (4) ARV labelling. Once goods are prepared and ready for labelling, the products are distributed to the different labelling stations. Each of these labelling methods will be discussed below and the process is outlined in Figure 9.9.

Manual Labelling**:** The application of this label is done by hand due to the unique product characteristics of the item requiring a label. It is either too big, too small or does not fit into a labelling machine.

Print and apply**:** This application of the label occurs when an operator feeds product onto a small conveyor, which then runs underneath a sensor, triggering the labeller to blow the label (using compressed air) onto the item.

In-line**:** This application process requires pre-printed labels to be fed into the machine. The product is then placed in a small conveyor belt, which moves the product through the machine. A sensor is then triggered which applies the label to the product.

ARV Labelling: This machine is specially designed to handle and label ARV bottles known as *pots* due to their unique shape. This machine spaces the pots evenly in single file order to apply the patient's label as accurately as possible.

The labelling process is very important as this process applies the patient-specific instructions for use and dosage of each medication that must be taken. This process must form part of the GPP protocol and must be completed by a registered Pharmacist, either a fully qualified Pharmacist or a *post-basic pharmacist.* Throughout the labelling process the items must be allocated into different boxes. These boxes are either labelled A or B, which identifies stock for the following sorting processes. This distinction will become apparent in the sorting explanation outlined in section 9.6.5. This labelling process is explained as it takes place during the day-to-day operations at the CDU and is necessary in terms of *Chapters 9* and *10*.

9.6.4.1. *Staging for product arrival at CDU-Stage 1*

The stock arrives at CDU via the two receiving methods discussed in section 9.6.3. These goods are staged to await the request of the next batch to be processed and shipped. Staged goods are scanned and checked to verify all quantities have been received from Healthcare and verify that all pick instructions or PINS have been fulfilled. Once these goods are ready for use, they are moved onto the CDU operations floor.

9.6.4.2. *Movement of goods away from staging area-Stage 2*

This stage only refers to the movement of goods. No value-added activities are added to these products at this stage. The goods are moved via pallet jack to the labelling and prepack areas for further processing.

9.6.4.3. *Prepack and item sortation-Stage 3*

In this stage, goods are collected and carried to the pre-pack operators' desk, whereby a pre-packer will sort and reconfigure the products within each of the boxes to ensure that they are in a suitable condition and orientation for labelling. This means that all units of a single type of product are put into one box. This is done for ease of labelling, as only one type of product can be labelled at a time, per labelling machine. Furthermore, goods are also packed 'right side up' to ensure that the product is labelled correctly with all patient information visible on the front of the product box.

9.6.4.4. *Labelling-Stage 4*

Once the product has been located for labelling, it is moved to the labelling operators' stations. Each of the items is individually labelled and boxed in either an A or B sorting box, denoting which side of the sorter the product will eventually go to. This is a crucial step as the correct medication must be sorted by the correct side of the sorting machine as there are corresponding *system files*, recorded in the Flexgen system that verify the product as it is scanned to allocate it to the correct chute.

9.6.4.5. *Hand-labelling process*

Due to the fact that patient scripts have multiple *lines*[21] that are required for patient scripts it is expected that some of these items have a unique shape, size and weight. For these product types, the labelling process creates some difficulty as these products cannot be passed through a labelling machine. These items will need to be labelled by hand, thus creating a major time constraint in the completion of a batch as hand-labelling 18 000 units is an exceptionally long and labour-intensive process.

If the automated labelling machines are operating at high capacity, more qualified staff, such as post-basic pharmacists, can be allocated to the hand-labelling process. Therefore, cross-training between different departments is also necessity to ensure that all work, no matter which process, is being done as fast and as accurately as possible. Once these goods have finished been labelled, they are then packed on to rolltainers which are then staged for sorting.

9.6.4.6. *Rolltainers staging- Stage 5*

All products that have finished being labelled are staged in the same area to then be taken to the sorter for further processing. The sorting process is explained in section 9.6.5.

[21] *Product lines- refer to different types of products.*

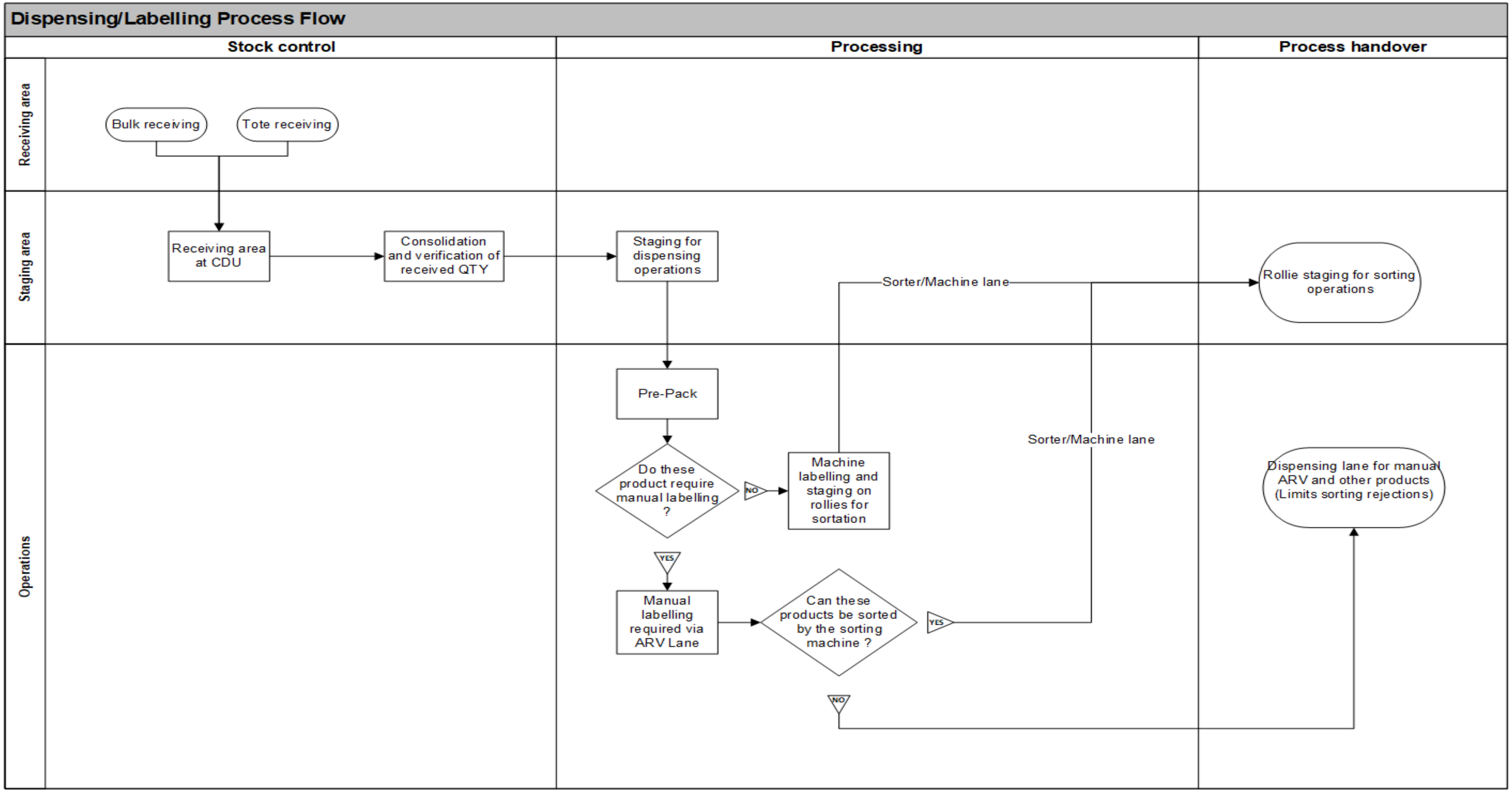


Figure 9.9: Dispensing and labelling process flow

9.6.5. Sorting Process explanation

Once all products are labelled and the batch has been finalised for sorting, the induction operators move the rolltainers to the designated loading area. The contents of these rolltainers are then loaded onto the corresponding side of the sorter, illustrated by Annexure K, Figure K.11 and Figure K.12). The description of A and B identifies which side of the sorter these goods will go to. This sorting machine is a European mail sorter which has been adapted for CDU operations. It is oval, making it ideal for two separate sorting processes to be completed at the same time. This process is outlined in Figure 9.10. This machine identifies each product by its patient-identifying barcode and sorts these goods into two categories. The sorting machine is split into two sorting runs, namely Side A and Side B and can do 420 Patient Medicine Parcels (PMPs) per drop, 210 on each side.

9.6.5.1. *Primary and Secondary sortation*

The first is known as primary sort while the second is known as secondary sort. Primary sortation sorts the stock per facility. The secondary sort allows for each patient's medications to be separated by facility for ease of distribution.

This activity entails that each primary sortation is categorised into alphabetical order per patient by facility. The secondary sort allocates each patient's medication per facility in alphabetical order, which is then bagged and packed to be distributed to their destination facilities across the country. The result is a PMP generated for each patient with their specific script details on it.

9.6.5.2. *Quality Assurance*

Quality assurance (QA) confirms that every product is in the correct bag for the correct customer as per their prescribed script. Any problems detected would go through to the missing items dispensary. If no problems are detected the products move forward to the bagging machine.

9.6.5.3. *The Bagging machines*

Each patient order is placed onto a conveyor for bagging whilst the products move along the conveyor. An operator scans each item in order to indicate the order's completeness, illustrated by Annexure K (Figure K.13). If the order is complete, then it goes off the conveyor and is dropped into a bag, a sticker is applied onto the bag for patient identification whereafter it is sealed. However, if the order is rejected then it is removed off the conveyor and placed into the *missing item box*, this box then goes to the dispensary for resolution. However, if it is complete and sealed it moves onto the bagger despatch.

9.6.5.4. *Missing items processing*

Missing items refers to a process whereby any items that fall off the belt or are found during the sorting process must be booked-in on the Flexgen system for them to be stored at an allocated rack within the dispensary for rectification. These items must be recorded on the Flexgen system in order to be reallocated to a PMP at the dispensing area. It is important for the missing items operator to be proactive in scanning all possible missing items to ensure that the dispensary does not have to reissue and relabel the stock to correct the PMP, illustrated by Annexure K (Figure K.14 and Figure K.15).

9.6.5.5. *The Dispensary*

This activity is derived from the QA bagging, closing, missing item and verification[22] activities. If an item is identified as an issue it will be sent from QA to the missing item rack. Damages may occur due to the bagger machine going too quickly and as a result damaging the product during the sealing of each PMP. These items and parcel will have to go to the missing item dispensary to be replaced and resolved as well.

The QA operators have goods known as *uglies*[23] that must be sorted and manually dispatched. Once the items arrive at the missing item dispensary, the *pharmacist or post-basic* will assess and take corrective measures on each PMP. For all actions undertaken on the floor regarding medicine, the responsible pharmacist (RP) must sign off on all operations with regard to packaging and labelling of medication. This ensures that GPP protocol is followed as well as limiting the possibility for mistakes. Once the mistakes have been rectified, the products are moved into an area known as *manual dispatch*. At manual dispatch the PMP is checked again and then proceeds to dispatch and closing.

9.6.5.6. *The Closing and Dispatch process*

This process refers to two processes that form part of a single operation. Dispatch refers to the allocation of PMP's to a *container*. A container is a box used as secondary level packaging for ease of transport. This box will have an inner label to which the allocated PMPs will be scanned into, it via the Flexgen system. This container then moves to a closing station, along an assembly line type process layout.

[22] *Verification – this refers to a process whereby a specific percentage of PMPs is checked for quality assurance purposes.*
[23] *These items cannot be inducted onto the sorter due to the size, shape, and fragility.*

Closing stations are responsible for printing a manifest containing all the delivery information as well as the contents of the box with its destination and collection date whereafter a *waybill* is printed. This is the sticker that is presented on the outside of the box and will be used for the remainder of the container's journey. The box is then sealed with the manifest inside and placed on a conveyor belt that carries the containers down a level to the distribution operation.

9.6.5.7. *Distribution*

Once the boxes are dispatched to distribution, the outer waybill is scanned and the box is allocated to a pallet. These pallets are staged in allocated areas, depending on the parcel's destination. Once the entire batch has been received, the containers are loaded into vehicles for transport to the Johannesburg facility, known as *Meadowview*. Transport from the DC takes place only twice a week, on Wednesdays and Fridays. Therefore, it is imperative that all operations are synchronised and operate with the same deadline in mind, as illustrated by Annexure K (Figure K.16. and Figure K.17.).

9.6.5.8. *Returns Processing*

Once a parcel has been dispatched, there are instances whereby patients either miss their collections, the delivery misses the delivery date or patients just neglect to pick up their PMPs from their assigned pick-up-points (PUP). These parcels then become returns, as illustrated in Annexure K (Figure K.18). These returns are brought back to the CDU facility. Each parcel is scanned to verify the patient information to determine which of them missed their medication. Once these parcels have been captured to the Flexgen system, the parcel is opened and the medication is sorted, de-labelled and placed into the CDU fine pick to be used as needed.

9.6.6. DSV operational process summary

Understanding the integrated nature of these facilities and how the operational processes interlink is the first step to being able to conduct performance measurement and therefore answering the *first applied research case study question*. Outlining the processes and how they interface and overlap not only outlines what to measure but also identifies areas with issues for which operational solutions were found to improve the strategic performance. This understanding outlines the very context for performance measurement.

First, we need to understand *what needs to be done*, then *how it is done* and finally, *how well it is done*. From this a company can focus on its overall performance, isolating the real issues instead of the symptoms. This explanation outlines what the company does and how the company does it. The next step is to understand how well they do it. In order to gain this understanding, the company's Supply Chain strategy must first be identified. This was presented in Chapter 10.

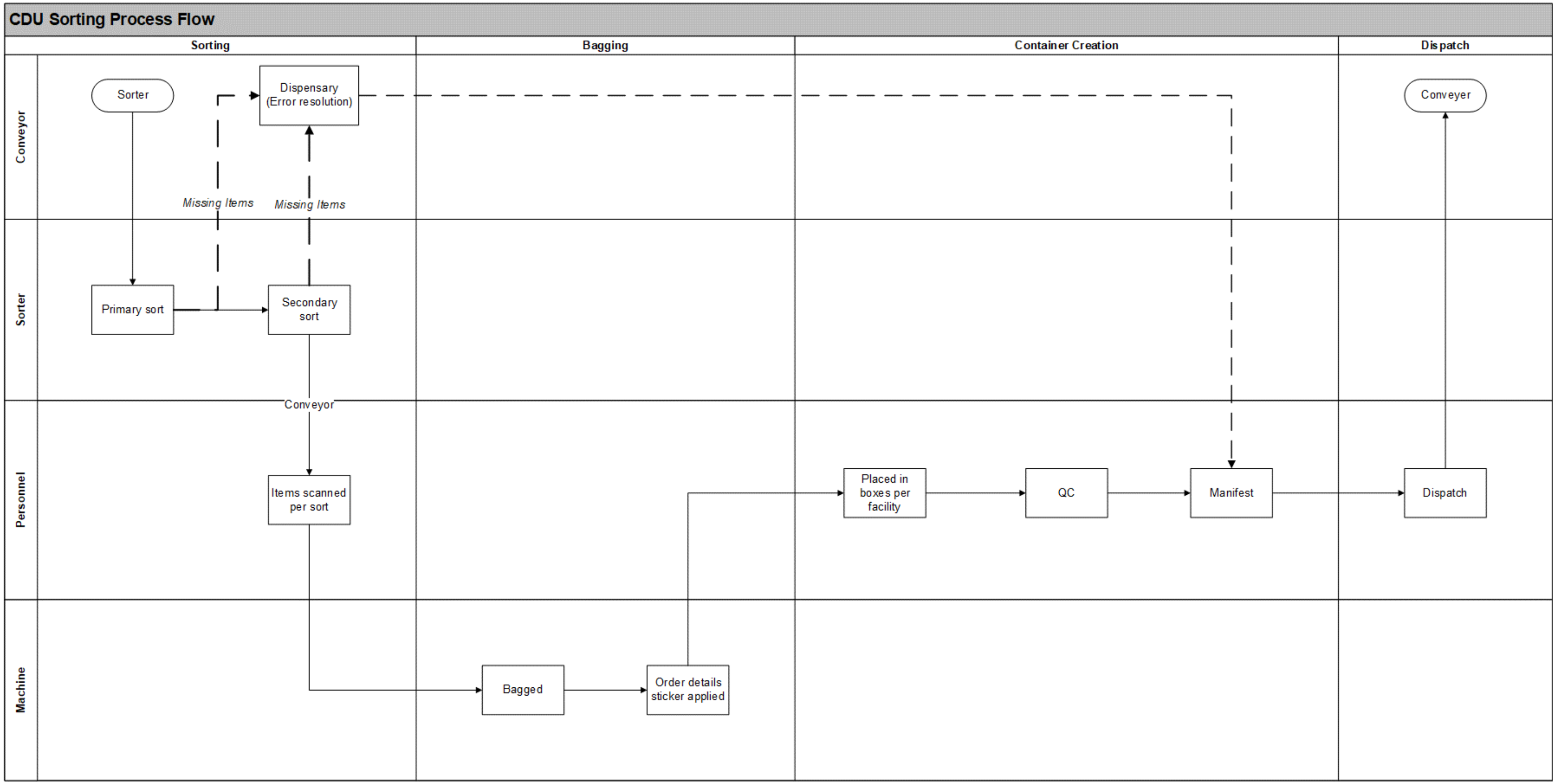
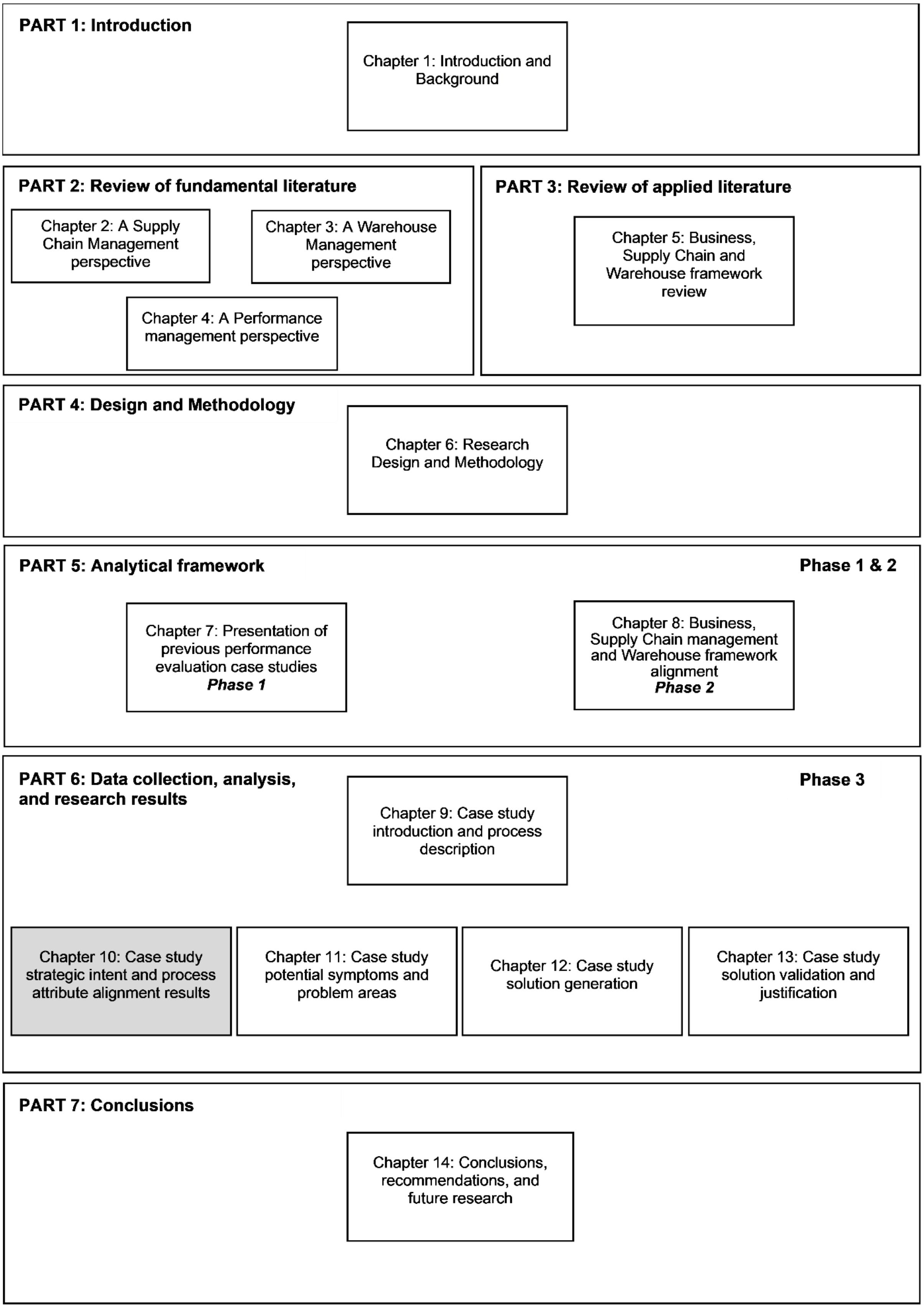
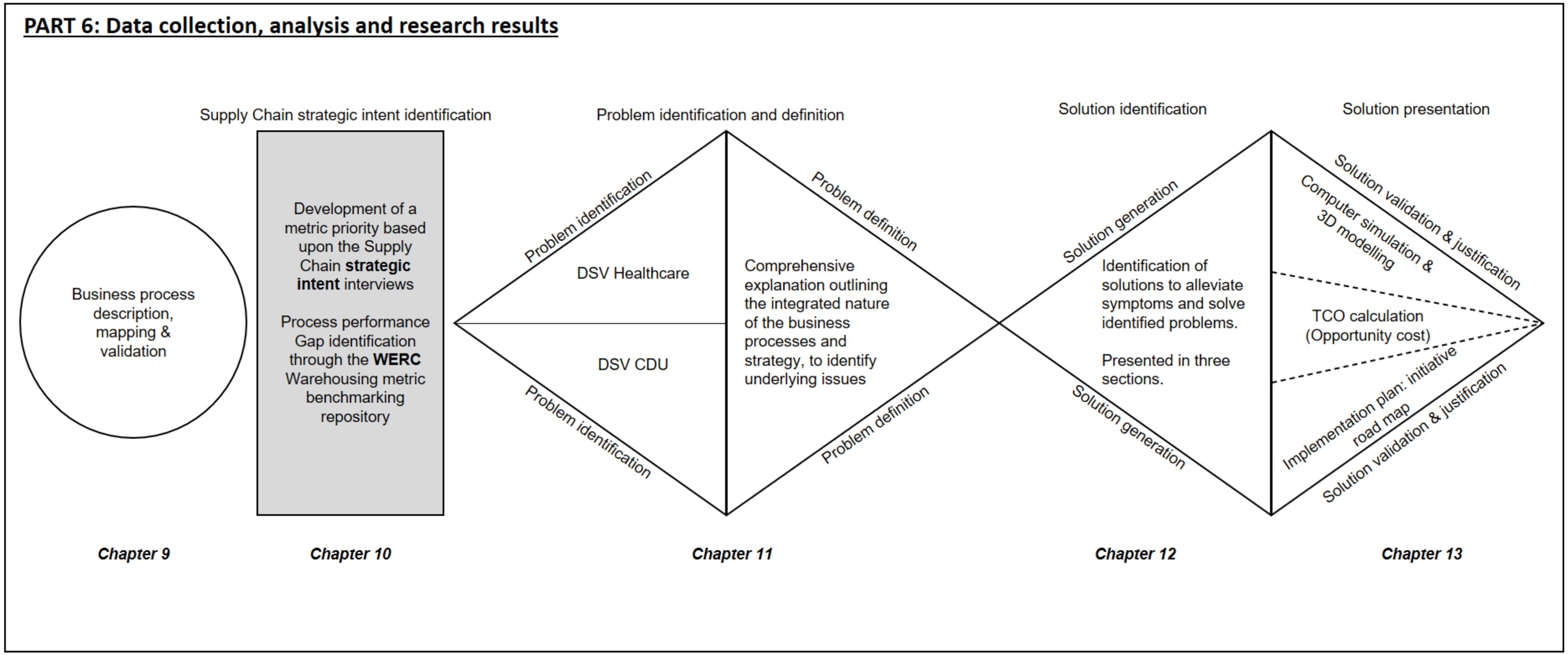


Figure 9.10: Sorting process and missing items flow

PART 6: CHAPTER 10
CASE STUDY STRATEGIC INTENT AND PROCESS ATTRIBUTE ALIGNMENT RESULTS




PART 6: Data collection, analysis and research results
Supply Chain strategic intent identification
Problem identification and definition
Solution identification
Solution presentation
Business process description, mapping & validation
Development of a metric priority based upon the Supply Chain strategic intent interviews
Process performance Gap identification through the WERC Warehousing metric benchmarking repository
Problem identification
DSV Healthcare
DSV CDU
Problem identification
Problem definition
Comprehensive explanation outlining the integrated nature of the business processes and strategy, to identify underlying issues
Problem definition
Solution generation
Identification of solutions to alleviate symptoms and solve identified problems.
Presented in three sections.
Solution generation
Solution validation & justification
Computer simulation & 3D modelling
TCO calculation (Opportunity cost)
Implementation plan: initiative road map
Solution validation & justification
Chapter 9
Chapter 10
Chapter 11
Chapter 12
Chapter 13

Chapter 10: Case study strategic intent and attribute alignment results

The company has a very complex but well-integrated set of processes that allow for a multitude of functions and activities to take place. It is critical to understand the overall intent of these functions and activities to provide context for the driving forces that outline the purpose of the day-to-day business. In order to achieve this understanding, a Supply Chain strategic intent analysis was conducted. This analysis involved nine respondents from different management levels and strategic functions within the organisation.

10.1. Supply Chain strategic intent selection

The SCOR process alignment model was used to determine the company's overarching Supply Chain process strategy, which outlines *strategic intent* as outlined in the previously presented *case study one, a large cosmetic manufacturer,* in Chapter 7. This Supply Chain intent identifies the company's desired Supply Chain performance focus that further assists in the identification of an overarching Supply Chain strategy. This chapter focuses on answering the *second applied research case study research question*, outlined in section 9.4. A total of nine respondents were interviewed through a qualitative data collection process and were asked to rank each of SCOR's five Supply Chain process attributes, based upon their personal understanding of the company's Supply Chain strategic intent.

10.1.1. Data analysis and results-Strategic intent identification interviews

Each respondent was given a choice of four performance levels, either: *Superior, Advantage, Parity or Disadvantage,* related to the SCOR level 1 metrics. These results had to be allocated to a *current performance* and a *desired performance* state, thus outlining the potential process gaps within a performance context. Respondents were faced with a single rule, only one *Superior* score could be allocated to a Supply Chain performance attribute. They could give a superior score to both the current and desired state but could only choose one superior attribute overall. The SCOR attributes and their accompanying metrics are presented in Table 10.1 below. The complete version of the interview document used can be found in Annexure D.

Table 10.1: SCOR model strategy description and association

Focus Strategy	Supply Chain Attribute	Level 1 Metric
External Strategies (customer Facing)	Reliability	Perfect Order Fulfilment (POF)
	Responsiveness	Order Fulfilment Cycle Time
	Agility	Supply Chain Flexibility
		Supply Chain Adaptability
Internal Strategies	Cost	Total Cost to Serve
		Cost of Goods Sold
	Assets	Cash to Cash Cycle
		Return on Supply Chain Fixed Assets
		Return on Working Capital

(Source Adapted from: APICS, 2017)

This assessment was conducted with nine DSV employees all with varying roles and responsibilities, and each with a different level of management focus. The variety of management involvement is critical for an initial corporate strategy alignment to be conducted. In a case where respondents selected different Supply Chain attributes, the organisation would have a serious problem with corporate alignment. The implementation of this strategy would have opposing focus strategies, each using different drivers, resulting in a complete breakdown of the organisational strategy, goals and performance. The objective, therefore, is for all respondents to choose the same focal strategy so a consensus can be reached regarding the metric prioritisation.

The results derived from this interview process outlines an indication of the alignment between the *strategic* management roles as well as the *tactical* and *operational* level management, as outlined in section 2.7.3. The consolidated comments from these semi-structure interviews are also presented in Annexure J, to help aggregate and desensitize the findings used in this section. Table 10.2 below outlines the business functional roles each respondent performs as well as the level of management decisions that they make. It illustrates the level of management that exists within the organisation. This table indirectly outlines the filtration of strategy from strategic level management to operational execution.

Table 10.2: Hierarchy of management involvement for respondents

Job Title/Functional Role	Level of Management decision making
Business Unit Manager	Strategic level
Production manager	Tactical level
Distribution manager	Tactical level
Logistics Coordinator	Tactical level
Responsible Pharmacist CDU	Tactical level
Script processing Head of Department (HOD)	Tactical level
Business Analyst	Tactical/Operational level
Senior Operations	Operational level
Prescription handling Supervisor	Operational level

All respondents that partook in the interview process outlined their strategy selections based on their understanding of their personal roles and responsibilities within the organisation's management hierarchy. Different perspectives were thus outlined on how management decisions and strategic intent could influence the possible performance gaps. These performance gaps outlined areas of focus as well as metrics that could be used to affect performance enhancements. The aggregated results of the SCOR strategic intent selection are outlined in Figure 10.1.

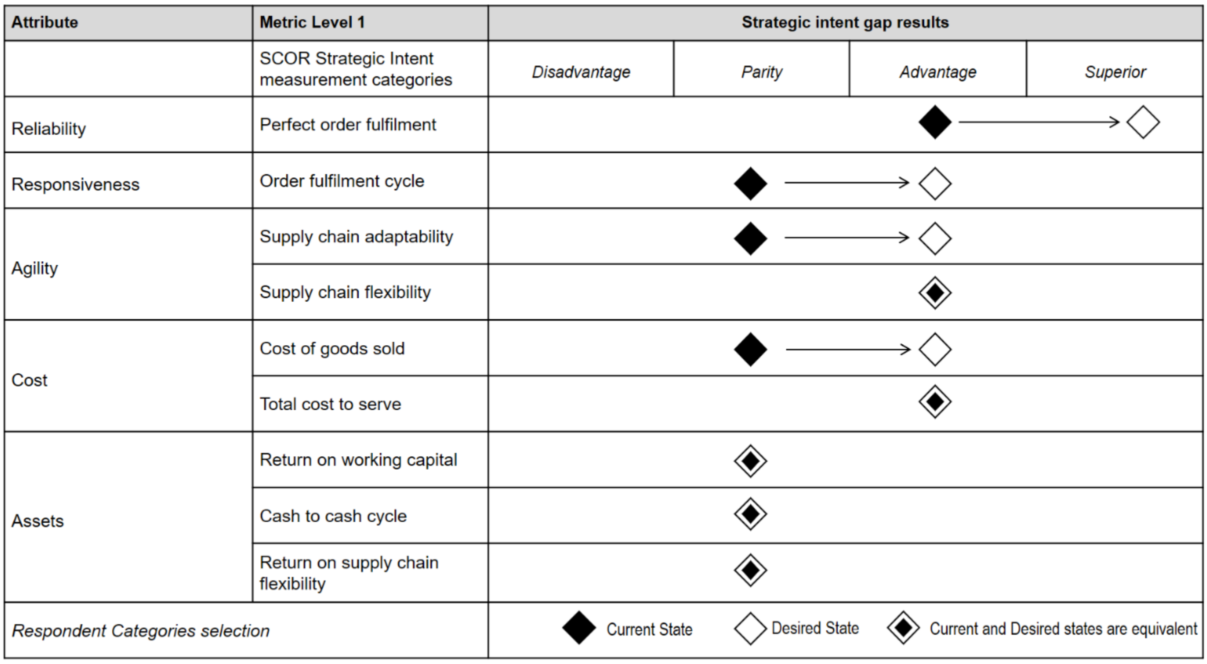


Figure 10.1: Results of strategic intent interviews based on SCOR's strategy model

The results of the strategic intent interviews outlined in Figure 10.1 are aggregated to determine the overall performance gaps identified by the nine respondents that partook in the interview processes. The collective responses identified the reliability attribute as the main superior strategy that the organisation has adopted.

The reliability attribute as well as its accompanying metric form the apex of the metric priority. Perfect order fulfilment (POF) is the priority one metric for performance management to initiate a performance measurement RCA. The remaining attributes and metrics will then become supporting attributes and measures for the company to focus on once the POF reaches its desired state. The creation of a metric priority is first and foremost to identify what should be measured, but also to identify what the company should spend time and money on, in order to derive better performance. In this case the focus should be on customer service.

DSV has an interesting situation due to the nature of the business that identifies the patients they serve as their customers. This is an important development as the POF metric is calculated through the measurement of four separate metrics. These metrics attempt to measure correctness, which is critical when dispensing medication. If the incorrect medication was dispensed with the wrong dosages, instructions or mixture of products a patient's life could be endangered.

10.1.2. Text analysis of interview responses

As part of the interview process, all the respondents' comments, stories, and motivations behind each of their decisions were recorded and analysed in order to better understand the focal points surrounding their choices. A summary of all these responses has been collated into supporting documentation outlined in Annexure J.

10.1.2.1. *Reliability attribute analysis*

The reliability aspect will be analysed in detail to determine why, each of the respondents made the selection they did and how this selection impacted their roles and functions. Overall, the collated comments for all nine respondents derived a 95,7% positive sentiment/confidence result. This is very important for the business as it outlines the confidence that each respondent has for the current Supply Chain strategy for the organisation. Based on this positive sentiment analysis, a deeper text analysis was conducted to outline some of the main topics, words, phrases and themes the group collectively considered when making their decisions. Table 10.3 outlines the top ten words used by respondents across all nine responses.

Table 10.3: Reliability Attribute – Top-ranked words

Word	Occurrences	Frequency (% of total)	Rank
SLA	14	2,4%	1
Patients	13	2,2%	2
Business	9	1,5%	4
Critical	9	1,5%	4
Issues	8	1,3%	5
Current	8	1,3%	5
Service	7	1,2%	6
New	6	1,0%	7
Time	6	1,0%	7

This analysis outlines individual words that had the highest occurrence, or usage, across all nine respondents. A frequency percentage is also included, this indicates how often each word was used as a percentage of total written word count of respondents replies to questions. The most important word used was SLA known as *Service level agreement*. Most respondents felt it was critical to maintain the service level agreement the company has with the South African National Government. The current tender and SLA were critically important to the survival of the business. Following on from this, is *Patient/Patients*, which outlines to whom the business is directly providing a service.

This priority is outlined in the SLA document. Therefore, these two concepts go hand in hand when considering the four metric components of POF. Finally, most respondents focused on specific issues they felt needed to be improved upon to increase the overall company performance from an *Advantage* category to a *Superior* category. This gap is outlined in Figure 10.1. This text analysis also outlines specific two-word phrases in Table 10.4, that identified words, phrases and themes that motivate *why* the reliability attribute was selected as the main Supply Chain strategy for DSV CDU and Healthcare.

Table 10.4: Reliability Attribute – Two-word phrases

Rank	Expression	Focus	Expression count	Frequency (% of total)	Prominence
1	SLA achievement	Service level	5	0,5%	51,9
2	Service delivery	Service level	4	0,4%	38,3
3	The business	Business	4	0,4%	73,2
4	For SLA	Service level	3	0,3%	35,6
5	The patients	Patient	3	0,3%	37,2
6	Patients are	Patient	2	0,2%	30,8
7	Better late	Service level	2	0,2%	34,2
8	Medication errors	Correctness	2	0,2%	34,3
9	of medication	Correctness	2	0,2%	34,4
10	The SLA	Service level	2	0,2%	37,6
11	On time	Service level	2	0,2%	45,0
12	Supply chain	Business	2	0,2%	49,2
13	or death	Patient	2	0,2%	55,1
14	Life or	Patient	2	0,2%	55,2
15	The tender	Business	2	0,2%	60,5

This text analysis further outlines the integration of silos across corporate supply chains structure. All respondents may have different responsibilities and levels of decision-making; however, they all made use of the same phrases, words and sentiment in their responses. This cohesion between different groups and roles further outlines how well the organisation integrates its strategic intent in its organisational culture. Furthermore, the repetitive use of specific words relates back to the attribute's definition.

It is critically important in outlining the motivation and decision-making concepts used to select the *Reliability* attribute as the most relevant attribute for the company's current strategic intent. This attribute is considered to be a priority one in terms of the metric hierarchy, outlined in section 10.1.3. Following on from this, the other attributes that are now identified as supporting drivers to a reliable Supply Chain will be discussed. These strategic gaps should also be analysed to understand what more can be done to improve and support the reliability of the organisation's chain.

10.1.2.2. *Responsiveness attribute analysis*

The responsiveness attribute received an average result across all respondents within the *parity* result with the desired state being in the *advantage* category. The rules of the interview process are critical to remember at this point. Respondents were only allowed to allocate a superior score to one attribute. This process thus allows for all other attributes, based on their priority level chosen by the respondents, to become supporting attributes.

The responsiveness attribute derived a 57,9% positive sentiment. This result helps influence and outline why the reliability attribute was selected as the most accurate choice for the company's strategy. This sentiment result does not determine the level of performance but rather the level of importance this attribute has in the eyes of the respondents. Following on from this sentiment score, this attribute score, as well as its comments, were analysed to outline the most important themes and concepts discussed during the interviews. The top ranked words used during the interviews were analysed and are presented in Table 10.5.

Table 10.5: Responsiveness Attribute – Top ranked words

Word	**Occurrences**	**Frequency** (% of total)	**Rank**
Stock	10	2,5%	1
Responsiveness	9	2,3%	2
Issues	8	2,0%	3
Management	6	1,5%	4
Changes	6	1,5%	4
Currently	6	1,5%	4
Order	6	1,5%	4
SLA	5	1,3%	5
Lead	5	1,3%	5
Current	5	1,3%	5

Almost all respondents discussed the current *stock issues* that the marketplace as a whole is experiencing and how these issues impacted DSV's ability to respond to these constraints. These stock issues are discussed later in the problem identification and solutions section of this report, presented in Chapter 12.

Despite the current issues of stock, respondents felt that the company and its operations were doing a very good job in reprocessing stock to facilitate as many PMPs as possible. The frequency with which this concept was mentioned and discussed identifies a significant focal area for the company to improve upon to facilitate a reduction in the current gap that has been identified in Figure 10.1.

As shown in the results presented in Table 10.5, respondents felt that the current stock issued not only impacted the level of responsiveness the company achieved but also outlines how it would impact upon the SLA and therefore customer delivery. These issues then directly impact the reliability gap. These two attributes and their accompanying metrics are connected through service delivery. It is these links that will influence why a metric prioritisation is so important as well as how well it will impact the performance achieved in the future.

A two-word phrase analysis was also conducted on this attribute's response to determine other concepts or themes that respondents found relevant when considering their selection. These concepts and themes outline the respondents' thoughts and beliefs in their strategy selection. These comments also outline areas that need to be focused on when deriving case-specific solutions. This analysis is outlined in Table 10.6.

Table 10.6: Responsiveness Attribute – Two-word phrases

Rank	Expression	Focus	Expression count	Frequency (% of total)	Prominence
1	Data accuracy	System	1	0,20%	97,1
2	Communication barriers	Business	1	0,20%	93,2
3	GPP OTIF	Patient/Service level	1	0,20%	80,2
4	Causes delays	Service level	1	0,20%	75,6
5	JHB overflows	Business	1	0,20%	68,9
6	Cost management	Business	2	0,30%	62,3
7	Massive delays	Business/System	1	0,20%	57,9
8	Priority shipping	Patient	1	0,20%	57,6
9	Stock replenishment	Business	2	0,30%	56,6
10	Management availability	Business	1	0,20%	48,4
11	Availability of	Business	1	0,20%	48,3
12	SLA dictates	Service level	1	0,20%	43
13	Strategic management	Business	1	0,20%	41,1
14	Optional level	Business	1	0,20%	40,3
15	Terminology discrepancy	System/Business	1	0,20%	38,1

The results focus on a variety of topics that outline repetitive issues within the company. Data accuracy outlines stock-keeping, order quantities as well as the communication between the different role players responsible for stock provision. This communication between the different Supply Chain partners outlines a slight misalignment between the different organisations. Further information about the current stock issues is outlined in section 11.2.2.

Added to these communication issues are further constraints such as cost management initiatives from strategic level management that limits possible performance achievements. These cost-saving initiatives limit operational level managers and their activities, further restricting the ability to counter the current delays created by stock availability. An example of this cost management is reflected in the approval of overtime to meet specific deadlines. All challenges identified through this report will be discussed in sections 11.1 and 11.2 of this report.

The responsiveness attribute has been given a priority two level of importance in terms of the metric hierarchy outlined in section 10.1.3. As a result of this textual analysis of the responsiveness attribute, a better understanding is reached of why respondents have chosen a parity score for the company's current *responsiveness* capabilities. Respondents also outlined focus areas that could derive possible solutions to help close the performance gap and improve not only the responsiveness score but the company's reliability as well.

10.1.2.3. *Agility attribute analysis.*

The agility attribute derived a 55,6% negative sentiment based on the respondents' comments. This result outlines the current parity ranking this attribute received from the respondents. This attribute has two level one metrics. Respondents felt that Supply Chain adaptability had a lower level of performance than Supply Chain flexibility. One of the main reasons for this ranking is due to the current plan to implement an e-scripting programme into the current operational processes outlined in the section 9.6.2. This process was not part of the original government tender but is now becoming a service delivery requirement for the company to improve their customer relations with the government and indirectly serve more patients. This attribute and its accompanying metric also link directly to customer service as well as the requirements set out in terms of the SLA. These concepts are further outlined in Table 10.7.

Table 10.7: Agility Attribute – Top ranked words

Word	**Occurrences**	**Frequency** (% of total)	**Rank**
Scripting	9	2%	1
Flexible	7	2%	2
Delivery	6	1%	3
Revenue	5	1%	4
Tender	5	1%	4
Possible	5	1%	4
Patients	5	1%	4
Process	4	1%	5

A two-word phrase analysis was also used to outline what concepts respondents identified that made the company more flexible and less adaptable in terms of the results presented in Figure 10.1. These phrases also outline possible areas of focus in terms of deriving solutions to improve performance and to close the gaps. This action would directly impact the reliability attributes performance. This phrase analysis is outlined in Table 10.8.

Table 10.8: Agility Attribute – Two-word phrases

Rank	Expression	Focus	Expression count	Frequency (% of total)	Prominence
1	e-scripting	System/Business	8	1%	64,2
2	Be flexible	System	5	0,60%	33,8
3	Service delivery	Business/Correct	3	0,40%	25,9
4	Benefit the	Service level/Business	3	0,40%	57,9
5	This process	Business	2	0,20%	6,9
6	Flexible enough	Service level	2	0,20%	22
7	Sla and	Service level	2	0,20%	26,6
8	Medication errors	Correctness	2	0,20%	43,2
9	Master data	System	2	0,20%	55,7
10	The GPP	Patient	2	0,20%	66,6
11	The government	Service level	2	0,20%	67,7
12	On time	Patient/Service level	2	0,20%	69,7
13	Result in	Profit	2	0,20%	71,3
14	To current	Service level	2	0,20%	75,2
15	Implementation of	System	2	0,20%	95,6

A further concern regarding the company's agility capabilities is based on the new e-scripting process and the high risk of medication errors. These medication errors could result from incorrectly transcribed scripts from the electronic system. This component will impact DSV significantly, as incorrect medication could result in patient deaths if the wrong medication is taken by a patient. This directly contravenes the SLA and intention of the government tender. Any loss of life due to these types of errors is unacceptable. Therefore, this risk is significantly higher for all those involved in the company and tender.

Despite this programme being driven by the government, DSV would be held liable for any prescription error, resulting in the respondents' hesitation as well as outlining the reason for the strategy gap. The second outlines an increased risk in the reliability attribute, which further limits the level of achieved performance. If an increase in script errors occurred, then less patients would be served, resulting in a lower POF score.

All these aspects need to be considered before implementable solutions can be developed to improve the current level of performance. The agility attribute has been given a priority of importance in terms of the metric hierarchy outlined in section 10.1.3. along with the responsiveness attribute. The final aspects that need to be considered as supporting aspects for DSV are the Cost attribute and the Asset attribute.

10.1.2.4. *Cost attribute analysis*

The cost attribute derived a neutral score of 77,4% sentiment. This score outlines a lower priority than the other three components discussed above, due to the level of sentiment respondents had towards the definition and metrics. Due to this result, the Cost attribute as well as the *Assets* attribute will form the base metric hierarchy. Despite this the text analysis outlined cost of goods sold as a metric they could increase in terms of its importance to the company and its role players. The top-ranked words used by respondents are presented in Table 10.9.

Table 10.9: Cost Attribute – Top-ranked words

Word	**Occurrences**	**Frequency** (% of total)	**Rank**
cost	23	5,30%	1
costs	13	3,00%	2
management	7	1,60%	3
focus	6	1,40%	4
saving	6	1,40%	4
current	6	1,40%	4
impact	5	1,20%	5
business	5	1,20%	5
point	5	1,20%	5
revenue	5	1,20%	5

Table 10.10 outlines a cost-saving environment at DSV. This was explicitly mentioned by all respondents. All respondents felt that the focus on cost was significant from a strategic management level but it had an overall negative impact on the respondents' sentiments. Based on the interviews, the respondents felt that the focus of cost management should be important but were more concerned about the impact these cost-saving initiatives would have on the service delivery to the patients. It was reiterated time and again that the patient was and should remain the sole focus of the business.

Table 10.10: Cost Attribute – Two-word phrases

Rank	Expression	Focus	Expression count	Frequency (% of total)	Prominence
1	Cost saving	Profit	6	0,80%	49,4
2	Is critical	Business/Profit	4	0,50%	36,2
3	Cost cutting	Business/Profit	3	0,40%	19,9
4	To manage	Business/Profit	3	0,40%	22,8
5	Service delivery	Service level	3	0,40%	23,7
6	Cost management	Business/Profit	3	0,40%	32,3
7	SLA and	Service level	3	0,40%	38,5
8	Costs are	Business/Profit	3	0,40%	45,6
9	The company	Business	3	0,40%	53,1
10	Saving initiatives	Profit	3	0,40%	65,2
11	Management of	Business/Profit	2	0,30%	35,2
12	The management	Business/Profit	2	0,30%	35,4
13	Resulting in	Profit	2	0,30%	35,7
14	and patient	Service level/Patient	2	0,30%	41,6
15	Variable costs	Business	2	0,30%	60

The total cost-to-serve remained unchanged in both the current and desired state, due to the tender process as well as government involvement. All costs involved in the cost to serve were fixed during the tendering process. The cost attribute has been given a priority three level of importance in terms of the metric hierarchy outlined in section 10.1.3. Therefore, this metric fell into an advantageous category, outlining its importance but also identifying that no more could possibly be done to improve on its results.

10.1.2.5. *Assets attribute analysis*

All asset categories, both current and desired, remained unchanged by respondents. The text analysis derived a 92,6% positive score; however, respondents felt that the level of importance did not need to be changed. Table 10.11 outlines the text analysis for the asset attribute.

Table 10.11: Asset Attribute – Top-ranked words

Word	**Occurrences**	**Frequency** (% of total)	**Rank**
Assets	10	3%	1
Capital	9	2,70%	2
Cash	8	2,40%	3
Working	7	2,10%	4
Management	6	1,80%	5
Current	6	1,80%	5
Business	6	1,80%	5
Service	5	1,50%	6
Process	5	1,50%	6
Fixed	5	1,50%	6

Based on this analysis, the lack of gap identification based on the respondents' collective choice, this attribute and its accompanying metric derived a priority level four in terms of importance on the metric hierarchy. Thus, no change is required and therefore no specific solutions are required for this attribute to improve performance. The company will need to maintain their current level of performance. One concept to help validate this decision can be found in Table 10.12.

DSV CDU and Healthcare own a very small quantity of fixed assets, therefore the need to monitor and measure their return on assets and Working capital is *marginal*. This does not mean that they should not be measure but rather their cost to the operation should be measured.

The asset attribute has been given a priority level four in terms of importance on the metric hierarchy outlined in section 10.1.3, showing its influence on the cost of goods sold as well as the total cost of ownership rather than on generating returns. Cost factors involved in the usage of the assets are probably more important than sweating the asset. However, the asset is still required in operations but the current level of concern is justified based on the amount of assets involved in the company.

Table 10.12: Asset Attribute – Two-word phrases

Rank	Expression	Focus	Expression count	Frequency (% of total)	Prominence
1	working capital	Business	6	1,10%	35,9
2	fixed assets	Business	5	0,90%	54,3
3	to cash	Business	4	0,70%	51,3
4	cash to	Business	4	0,70%	51,5
5	the company	Business	3	0,50%	7,8
6	service delivery	Patient/Service level	3	0,50%	32,1
7	preventative maintenance	Profit	3	0,50%	50,9
8	is essential	Business	2	0,40%	52,3
9	generate returns	Profit	2	0,40%	57
10	asset light	Business	2	0,40%	58,1
11	business model	Business	2	0,40%	59,4
12	cost saving	Business/Profit	2	0,40%	63,9
13	current operations	Service level/Correctness	2	0,40%	75
14	tendering process	Business/Profit	2	0,40%	86,9
15	business success	Profit	2	0,40%	89,9

As a result of the strategic intent interviews, the respondents felt that overall “reliability” was the most important attribute and should define the company’s strategic intent. From this they outlined very specific and detailed concerns around the supporting attributes of *Responsiveness*, *Agility*, *Cost* and *Assets*.

These concerns identify areas in which case-specific solutions can be derived in order to improve upon the current level of performance. However, in order to derive solutions, the actual level of performance for the internal operational processes at DSV need to be calculated. These results are presented in section 10.2.1 and section 10.2.2 of this report. In order to extrapolate the importance each of these metrics should have in terms of the intensity of focus, a metric hierarchy was created that would be applied to these performance metrics outlined in section 10.1.3.

10.1.3. Metric hierarchy creation based on strategic intent interviews

Based on the strategic intent interviews outlined in section 10.1, the following metric priority outlines the level of importance each attribute and its companying metric should have. This hierarchy is applied to the company’s actual performance metrics that have been measured for both DSV CDU and DSV Healthcare.

Figure 10.2 outlines DSV CDU and Healthcare's metric hierarchy based upon the consolidated responses of those managers involved in the strategic intent interviews. This hierarchy outlines the reliability attribute as a priority level one.

The Perfect Order Fulfilment (POF) metric should be considered as the initial starting point when conducting a performance RCA. This metric incorporates four supporting metrics in order to calculate the index value. These metrics have been outlined in section 3.10.1.

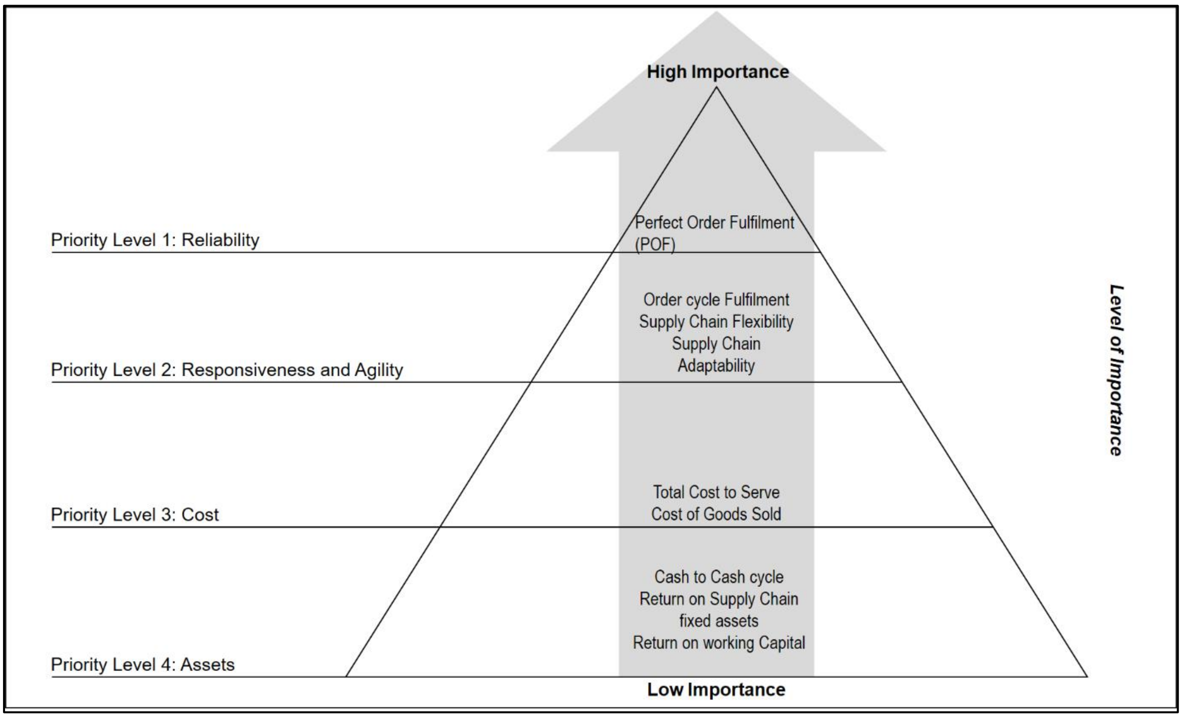


Figure 10.2: DSV metric prioritisation

In support of these metrics, those outlined under the *Responsiveness* and *Agility* attributes, namely, *Order fulfilment cycle time*, *Supply Chain flexibility* and *Supply Chain Adaptability* form the basis for priority level two. Therefore, after the POF metric is calculated and monitored, the company should direct its attention to these metrics to help improve upon the progress already made from level one. This is how a company can influence and allocate appropriate, limited resources to improve upon what is critical, what is necessary and avoid improving upon what is not.

The level three priority attribute, *Cost* and its accompanying metrics need to be maintained and driven, up to a certain point. However, this metric will not directly impact upon the company's ability to service their customers, it will influence the survival and longevity of the company. Monitoring and maintaining its level of importance should also be factored in when allocating resources.

Finally, the *asset* attribute requires no changes in performance; these performance levels can be maintained if no resources are used elsewhere to affect change. This attribute and its metrics derived very little importance from the respondents. These metrics should be measured to determine whether there is a positive contribution to overall performance but not at the expense of the others. Therefore, this metric ranks fourth on the metric prioritisation.

The creation of a metric hierarchy has been achieved. This hierarchy must now be applied to physical operational metrics in order to determine what should be measured as well as what level of performance each metric is required to achieve. This hierarchy will be used to set performance targets for the company to strive towards, after which case-specific solutions will be derived and tested to demonstrate the actual and theoretical effectiveness of the hierarchy.

10.2. WERC metric analysis and results

The Warehouse's performance metrics related to the multitude of interlocking operational processes have been measured in order to determine three very important outcomes. The first is understanding what the company measures. This is critical to understand before any alignment between strategy and performance measurement takes place. This understanding outlines the priority the organisation puts on metrics they believe to be important. The second critical outcome is understanding how well the company is performing in the metrics that they currently measure. The third and final aspect is linking the current performance to a performance target. This will help determine if any progress has been made as well as to outline if any initiatives have been implemented. The performance measure will indicate whether or not there is an improvement.

The operational performance metrics for DSV have been split between the two sister facilities. The reason for this is they are run as two separate cost centres but have interlocking operational processes. The Healthcare facility acts as the storage and distribution hub for all the CDU's stock being received and PMPs sent to the various facilities within the four different provinces. *For more information regarding these two companies and their processes please review sections 9.6.1 and 9.6.2*. The results of the performance evaluation are illustrated in Table 10.13 and Table 10.14 respectively.

10.2.1. DSV Healthcare WERC metric evaluation

The following table illustrates the performance results calculated for a period of three months at DSV Healthcare. These results have been aggregated to exclude sensitive performance results as well as to mitigate any exposure of strategic information to outside parties. This metric evaluation makes use of three different states, displayed by the shapes used in Table 10.13 and Table 10.14. These states help outline the current and desired state for each metric based on the company's current performance as well as the integration of the metric priority outlined in section 10.1.

The scope and purpose of this study is to measure and analyse the operational performance of DSV CDU and all its processes. However, in order to complete this measure, the inclusion of DSV Healthcare metrics and performance was required. Therefore, only the metrics relating to or linked with the CDU have been measured. DSV Healthcare boasts impressive performance in terms of its private clientele but may be limited in other areas, in terms of CDU service delivery. This in no way reflects upon the good work and impressive track record that DSV Healthcare has achieved over its many years of operations, but rather outlines specific areas in terms of inter-company cooperation and performance gaps that need to be addressed to improve performance further.

As outlined in section 10.1 as well as Figure 10.2, DSV outlines an overall priority level one for perfect order fulfilment (POF). The corresponding metrics in terms of the WERC repository is the Perfect order Index (POI). Both these metrics measure the same components in order to determine the index value. These four components are as follows:

- Percent of orders with on-time delivery
- Percent of orders shipped complete
- Percent of orders shipped damage free (Outbound)
- Percent of orders sent with correct documentation

Once each of these metrics has been determined, the POI index can be calculated by multiplying each of the four metrics to determine the POI. The current POI calculated for the measurement period, in terms of the process surrounding the CDU, is Typical in nature. This level of performance was determined based on the level of service the CDU derives from Healthcare. This metric was determined in consultation with the CDU production manager. Despite this low performance, DSV Healthcare has a *Best-in-Class* POI for their private clients.

Table 10.13: DSV Healthcare WERC evaluation metrics

Metric	Unit	Direction	Major Opportunity	Disadvantage	Typical	Advantage	Best in Class	Median
Customer metrics								
Total Order Cycle Time	Hours	< better	72	72	◆ 34,9	24	◇ 7	24
Internal Order Cycle Time	Hours	< better	31,2	31,2	◆ 18,8	8	◇ 3,8	10
Perfect Order Completion Index	Lines per Hour	better >	8,4	8,4	15	25	◈ 45,6	20
Operational metrics-Inbound								
Percent of Supplier Orders Received with Correct Documents	%	better >	86%	86%	95%	98%	◈ 99%	96%
Percent of Supplier Orders Received Damage Free	%	better >	95%	95%	98%	99%	◈ 99%	98%
On-time Receipts from Supplier	%	better >	80%	80%	90%	95%	◈ 99%	93%
Operational metrics-Outbound								
Fill Rate – Line	%	better >	91%	91%	97%	99%	◈ 100%	98%
Order Fill Rate	%	better >	92%	92%	◆ 97%	99%	◇ 100%	98%
Orders Picked and Shipped per Hour	Orders per Hour	better >	2,49	2,49	5	◆ 8,2	◇ 24	6
On-time ready to Ship	%	better >	95%	95%	◆ 98%	99%	100%	99%
On-time Ready to Ship	%	better >	95%	95%	◆ 99%	99%	◇ 100%	99%
Perfect order metrics								
Percent of Orders with On-time Delivery	%	better >	95%	95%	◆ 98%	99%	◇ 100%	99%
Percent of Orders Shipped Complete	%	better >	◆ 94%	94%	96%	99%	◇ 100%	98%
Percent of Orders Shipped Damage Free (Outbound)	%	better >	98%	98%	99%	100%	◈ 100%	99%
Percent of Orders Sent with Correct Documentation	%	better >	99%	99%	99%	100%	◈ 100%	100%

◆-Current State ◇ -Desired State ◈-Current and Desired State is equivalent

Table 10.14: DSV Healthcare WERC evaluation metrics (Continued)

Metric	Unit	Direction	Major Opportunity	Disadvantage	Typical	Advantage	Best in Class	Median
Capacity/Quality metrics								
Average Warehouse Capacity Used**	%	better >	◈ 75%	75%	81%	88%	93%	85%
Inventory Count Accuracy by Location	%	better >	92%	92%	97%	◆ 99%	◇ 100%	98%
Order-picking Accuracy (Percent by Order)	%	better >	98%	◆ 98%	99%	100%	◇ 100%	99%
Material Handling Damage	%	< better	2%	2%	1%	0%	0%	0%
Employee metrics								
Overtime Hours to Total Hours	%	< better	◆ 15%	11,98%	7,13%	3,7	2,1	7,3
Cash-to-cash metrics								
Inventory Days of Supply	Days	< better	90	90	55,8	◆ 30	17	39
Average Days Payable	Days	< better	60	60	45	31	◈ 30	35
◆-Current State ◇ -Desired State ◈-Current and Desired State is equivalent								

The focus for this performance discrepancy is based on the *percentage of orders shipped complete*. The production managers have found on numerous occasions that an RTS is required in order to get the complete order filled, due to the errors inherent in the handover process between Healthcare and CDU. This restriction in orders shipped complete has resulted in the variance in performance. Due to the nature of the business, the organisation has implemented specific solutions to combat these issues. These solutions will be discussed in *Chapter 11*.

For DSV to make headway in terms of its Warehouse operational performance, the company must have a major focus on the POI metrics to derive significant performance enhancements. Therefore, the allocation of company resources should be focused towards the POI metrics. The reasoning behind this is outlined in section 10.1. The employees of the company have determined the main Supply Chain attribute that defines their strategic intent is the *Reliability* attribute. The level one metric for measuring this strategy is the POF/POI. As a result, the company has a significant variance in actual performance versus the desired level to contribute to their intended overall Supply Chain performance.

It is critical to understand the way these processes and metrics interlink between the two facilities. The intention of this report is to measure the performance of the CDU and all its processes. Therefore, the inclusion of DSV Healthcare is done to improve the overall performance of the CDU. The reasoning behind this inclusion is based on the need to improve stock receiving accuracy and eliminate delays in backorders between the two companies to improve the CDU's operational performance.

10.2.2. DSV CDU WERC metric evaluation

The nature and scope of this analysis was to measure the performance of all operational processes that pertain to the CDU operations. The incorporation of the performance metrics calculated for DSV Healthcare outlines the stock receiving and distribution for the CDU operations. The integration of these processes and their supporting metrics results in a very complex set of operations. Due to this, the metrics for each cost centre have been split into the two sets of metrics outlined in this section. Therefore, the operational metrics calculated for DSV's CDU are presented in Table 10.15 and Table 10.16 respectively.

The strategic intent interviews outline an overall Supply Chain strategy where it is intended that all the respondents in the company could identify a major theme and strategy the company is modelled around. This strategy selection was identified by respondents of different areas of expertise as well as across different functions within the CDU process. This selected Supply Chain strategy outlines a pre-existing alignment within the SCOR model which identifies a level one metric known as the POF.

The alignment matrix outlined in by Table 8.2 in section 8.4 identifies linking attributes from multiple models as well as outlining metrics that attempt to measure the same concepts and process types within an organisation. Therefore, the identified link between the POF and the POI are important. Based on this operation metric and the alignment of all these frameworks with the SCOR model, the following metric gap analysis was performed to determine where the possible gaps exist, based on the calculated metrics.

Table 10.15: CDU WERC evaluation metric

Metric	Unit	Direction	Major Opportunity	Disadvantage	Typical	Advantage	Best in Class	Median
Customer metrics								
On-time Shipments	%	better >	95%	95%	98%	◆ 99%	◇ 100%	99%
Total Order Cycle Time	Hours	< better	72	72	◆34,96	◇ 24	7	24
Internal Order Cycle Time	Hours	< better	31,2	31,2	18,8	◆ 8	◇ 3,8	10
Perfect Order Completion Index	%	better >	86%	86%	◆ 95%	98%	◇ 99%	97%
Operational metrics-Inbound								
Dock-to-Stock Cycle Time, in Hours	Hours	< better	24	24	8	4,5	◈ 2	6,5
Suppliers Orders Received per Hour	Orders per Hour	better >	1	1	2,92	6,2	◈ 14,6	5
Lines Received and Put Away per Hour	Lines per Hour	better >	8,4	8,4	15	25	◈ 45,6	20
Percent of Supplier Orders Received with Correct Documents	%	better >	86%	86%	◆ 95%	98%	◇ 99%	96%
Percent of Supplier Orders Received Damage Free	%	better >	95%	95%	98%	99%	◈ 99%	98%
On-time Receipts from Supplier	%	better >	80%	80%	90%	95%	◈ 99%	93%
Operational metrics-Outbound								
Fill Rate – Line	%	better >	91%	91%	97%	◈ 98,6%	100%	98%
Order Fill Rate	%	better >	92%	92%	◆ 97%	◇ 99%	100%	98%
Orders Picked and Shipped per Hour	Orders per Hour	better >	2,49	2,49	5	8,2	◈ 24	6
On-time Ready to Ship	%	better >	95%	95%	◆ 99%	◇ 99%	100%	99%
Financial metrics								
Days on Hand Finished Goods Inventory	Days	< better	83,8	83,8	◈ 45	30	15	40
Perfect order metrics								
Percent of Orders with On-time Delivery	%	better >	95%	◆ 95%	98%	99%	◇ 100%	99%
Percent of Orders Shipped Complete	%	better >	94%	94%	96%	99%	◈ 100%	98%
Percent of Orders Shipped Damage Free (Outbound)	%	better >	98%	98%	99%	100%	◈ 100%	99%
Percent of Orders Sent with Correct Documentation	%	better >	99%	99%	99%	◆ 100%	◇ 100%	100%

◆-Current State ◇ -Desired State ◈-Current and Desired State is equivalent

Table 10.16: CDU WERC evaluation metric (Continued)

Metric	Unit	Direction	Major Opportunity	Disadvantage	Typical	Advantage	Best in Class	Median
Capacity/Quality metrics								
Average Warehouse Capacity Used**	%	better >	75%	◆ 75%	81%	◇ 88%	93%	85%
Peak Warehouse Capacity Used**	%	better >	88%	◆ 88%	94%	◇ 98%	100%	95%
Inventory Count Accuracy by Location	%	better >	92%	◆ 92%	97%	◇ 99%	100%	98%
Order-picking Accuracy (Percent by Order)	%	better >	◆ 98%	98%	99%	◇ 100%	100%	99%
Material Handling Damage	%	< better	2%	2%	1%	0%	◈ 0%	0%
Employee metrics								
Annual Workforce Turnover	%	< better	20%	20%	◈ 10%	4%	1%	5%
Overtime Hours to Total Hours	%	< better	◆ 15%	11,98%	◇ 7,13%	3,7	2,1	7,3
Part-time Workforce to Total Workforce	%	< better	◆ 16%	9,30%	◇ 1,30%	0%	0%	0,20%
Unplanned Absence Percentage	%	< better	10%	7,70%	4,75%	3,05%	2,00%	5%
Cross Trained Percentage	%	better >	◆ 25%	37,50%	◇62,50%	82,50%	90%	70%
Productive Hours to Total Hours	%	better >	75%	75%	85%	◈ 87%	93%	85%
Cash-to-cash metrics								
Inventory Days of Supply	Days	< better	90	90	◆ 55,8	◇ 30	17	39
Average Days Payable	Days	< better	60	60	◆ 45	◇ 31	30	35
◆-Current State ◇ -Desired State ◈-Current and Desired State is equivalent								

10.2.2.1. *The reliability realignment, gap analysis and Gap closing solutions*

The perfect order metric has been identified as the single most important level one metric in terms of DSV CDU's strategic intent selection interviews. The performance metrics have been calculated and benchmarked against the WERC repository. These metrics currently display the performance gaps that exist within the CDU. Remembering that all processes are linked despite their individualised functions, the first process is linked to the last process. Therefore, any discrepancy in high-level performance (priority level one) will filter down into lower priority processes and metrics. The organisation should focus on the most important first, these metrics are often referred to as the *low hanging fruit,* thus, easily accessible with extremely beneficial results. This POI gap analysis is outlined in Figure 10.3.

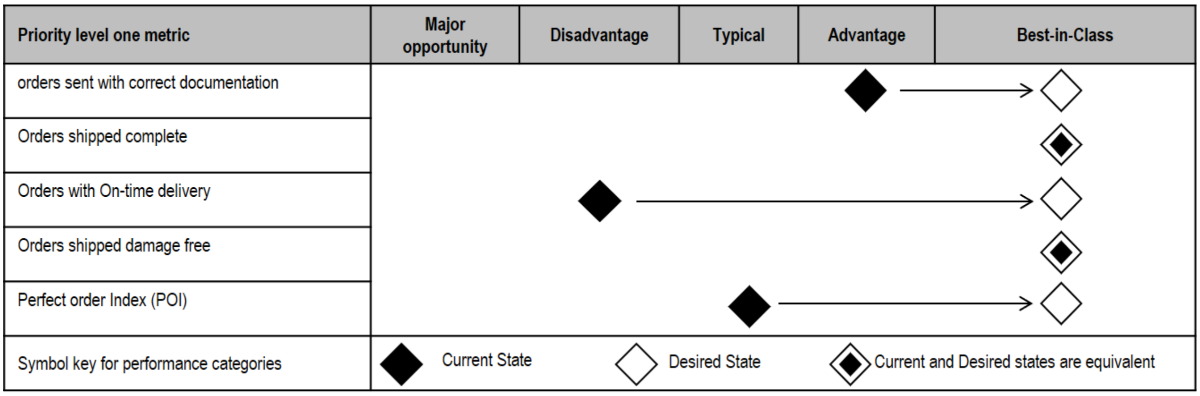


Figure 10.3: Reliability attribute gap analysis

The POI results outline two distinct metrics that need close attention. These are identified in Figure 10.3 as *Percentage of orders sent with correct documentation* and *percentage of orders with On-time delivery*. Based upon the measurement categories outlined in the WERC repository, the largest gap can be addressed by the findings.

Percentage of orders with On-time delivery: Due to the nature of the National tender, as well as the requirement to service four provinces in a varying environment with significant differences in communication, infrastructure, and financial situations there has been a significant fluctuation in the overall performance of on-time deliveries. This performance level was further exaggerated by the several changes made to the manner and method in which CDU batches were put into production. In conjunction with these production changes, the number of public holidays that occurred around the time of the implementation of new processes created an exaggerated effect to *On-time delivery*. This initiative/change will be discussed in further detail under the problem and solution sections of this report, outlined in *Chapter 11, 12 13 and 14.*

Orders sent with correct documentation: This gap outlines the need for script copies to be sent back to the facilities as a record of the PMPs supplied. It is also critical for pharmacists at the facilities to be able to verify the medication inside a patients PMP upon collection, if necessary. The reason for the script copy is because the original script is sent to the CDU.

Production operations are responsible for the printing and dispatching of script copies inside the PMP containers so that the PMP and the script copies for a particular batch arrive at the same time. Due to the variability of the communication between facilities, provincial account managers and the CDU as well as the decision made by facilities whether they want script copies has complicated the process. Added to this, is a modification of the script printing process to synchronise the closing of containers with the printing of script copies, has limited the performance in this area.

The result outlined in Figure 10.3 is the final performance gap in the index value. This is due to the above-mentioned gaps that have determined that the current level of POI is in the advantage category. Comparatively speaking, this is still a substantial score for perfect order, considering the fact that the WERC repository is based on the industry leaders from the USA. Despite this, DSV is currently undertaking measures to improve on the above-mentioned metrics and others to ensure superior service to their patients. The work currently being done at DSV goes further than the superior Supply Chain attribute, by incorporating those metrics outlined in the *Responsiveness* Supply Chain attribute as well. While these metrics are currently being focused on, it is important to reiterate that these metrics form the basis of the second level of priority for the company and therefore play a supporting role in the overall performance of the business.

10.2.2.2. *Responsiveness realignment and gap analysis*

Due to the nature of this attribute as well as the alignment between a Strategic intent model and an Operational Warehousing metric repository, the following metric selection outlined in Table 10.15 is based upon several factors that should be discussed before the analysis can continue. Firstly, the pharmaceutical industry is currently facing several issues regarding short supply of specific medications. This, coupled with the limited stock kept on hand by the facility as well as those stock levels kept at the provincial depots has resulted in stocking issues, not only for DSV but the industry as a whole. This could also have to do with the timing of the tender launched by the National Government of South Africa. These economic factors must be considered when outlining the reason and level of importance these metrics have been given.

Secondly, the influence limited stock has on the number of PMPs that could possibly be sent to patients versus the number of scripts sent to the CDU, creates a further issue. The National Government has outlined in the initial SLA that no PMPs can be sent if they are no one hundred percent complete.

If a single item of Aspirin is out of stock, all PMPs that require this stock item cannot be sent. Based on the prescription mixes that come to the facility as well as the trend of Aspirin prescription accompanied with other chronic medication, results in a lot of parcels that cannot be completed and distributed due to *zero manifesting*, as outlined in section 11.2.4.5.

Finally, due to the nature of the two companies and their interlinking processes, the CDU does not, at the time of measurement, hold enough stock to fulfil its own batches independently from Healthcare. This means that for every production batch, stock was picked in pallet or case lots, depending on the type of product and sent to the CDU for staging before production. It was this dependency, accompanied with internal corporate rulings that hindered the whole operation.

It is these factors that cause significant gaps, not only in the responsiveness attribute but in the reliability attribute as well. The need to rectify these issues is critical in order to enhance performance. The severity of the stocking issues impacts on not only the *Responsiveness* attribute but on the reliability attribute as well.

Due to the level of priority identified in the strategic intent interviews, these metrics were given a desired state within the advantageous category. This was based on the present gaps identified in the reliability attribute. The company should focus on closing priority level one gaps before focusing on priority level two. However, due to the nature of the current operational environment and the relevant metrics, the importance warrants further analysis. The following metric gaps were derived and are outlined in Figure 10.4.

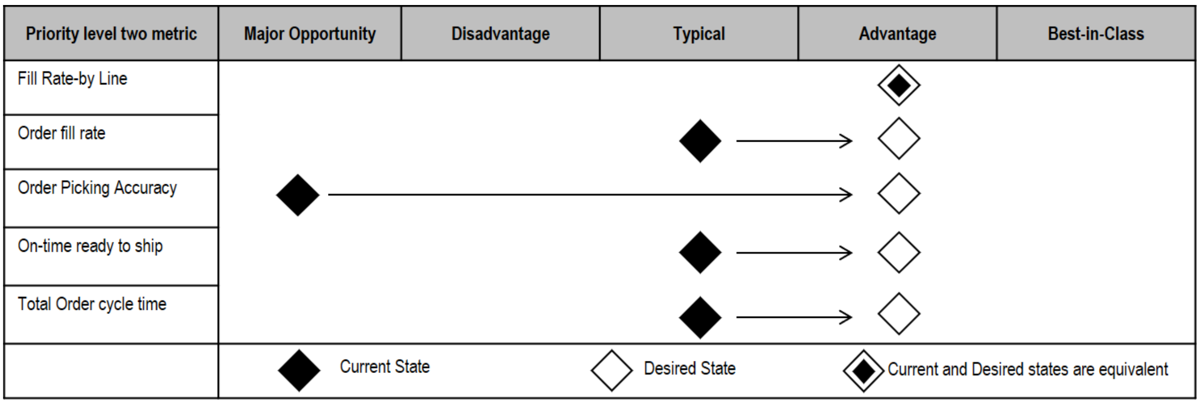


Figure 10.4: Responsiveness attribute gap analysis

Based upon the above explanation the need to drive improvements in these metrics stems from the need for stock as well as the need to prevent this issue arising again. It needs to be made quite plain however, that these stock issues are a result of the marketplace, therefore the majority of these issues and delays are out of the DSV’s control. Even if stock levels were increased prior to this short supply of key medications, it would be limited by two factors. Firstly, the current delay with stock that would have been kept would have been used up before replenishments were received. The second factor is that excessive stock holding would have driven the total cost of ownership of a PMP well above the current tender rates, thus eroding any profit margins.

The result of these issues and their impact on potential service delivery was alleviated somewhat by the returns processing. This department is responsible for managing the reverse flow of PMPs that remain uncollected by patients from each and every facility. These returns detracted from the ability of the company to fulfil all the deliveries as planned. This initiative and others like it will be discussed in the challenges and solutions section of this report, outlined in *Chapter 11 and 12*, of this report.

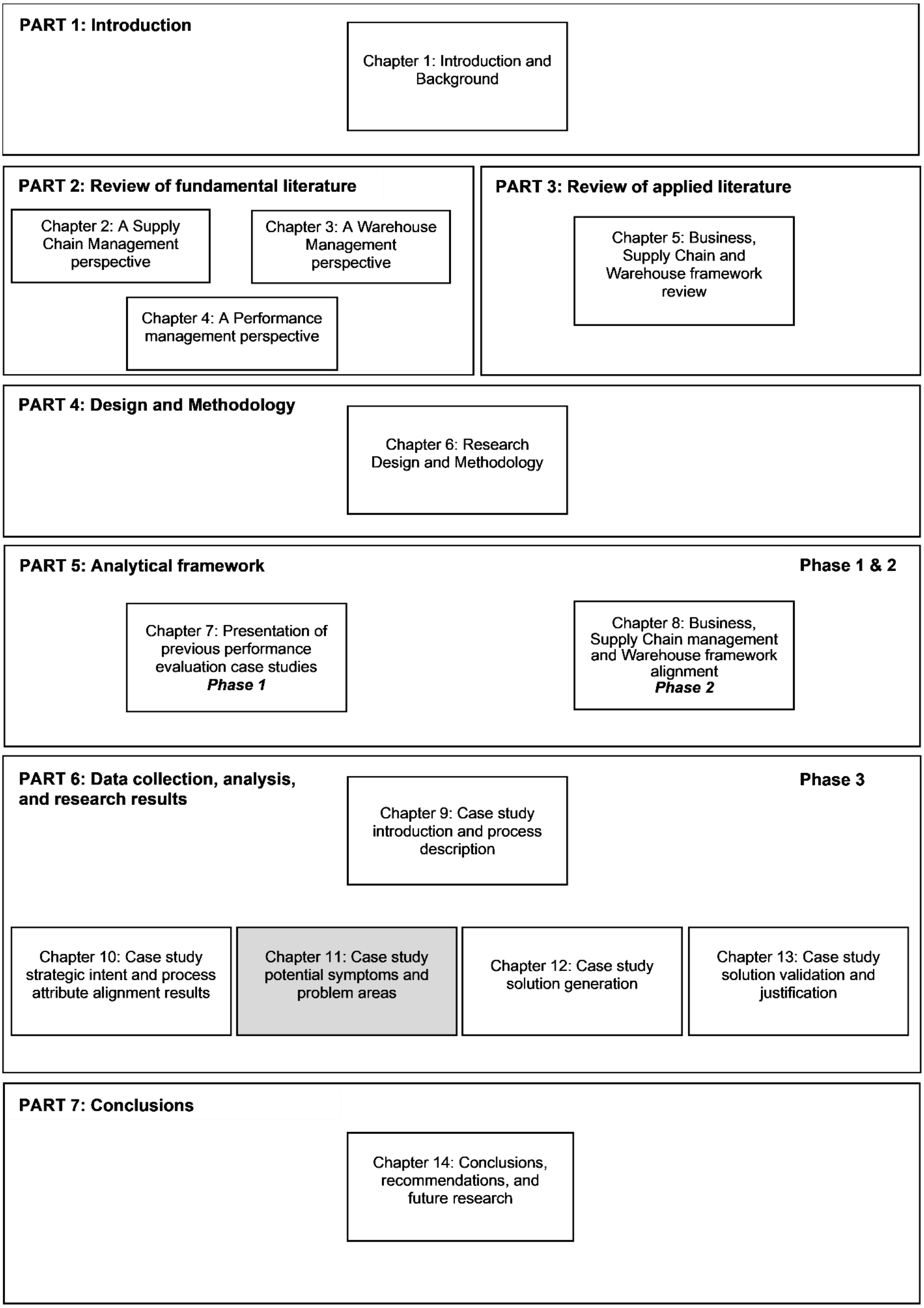
10.3. Summary of strategic intent and attribute identification

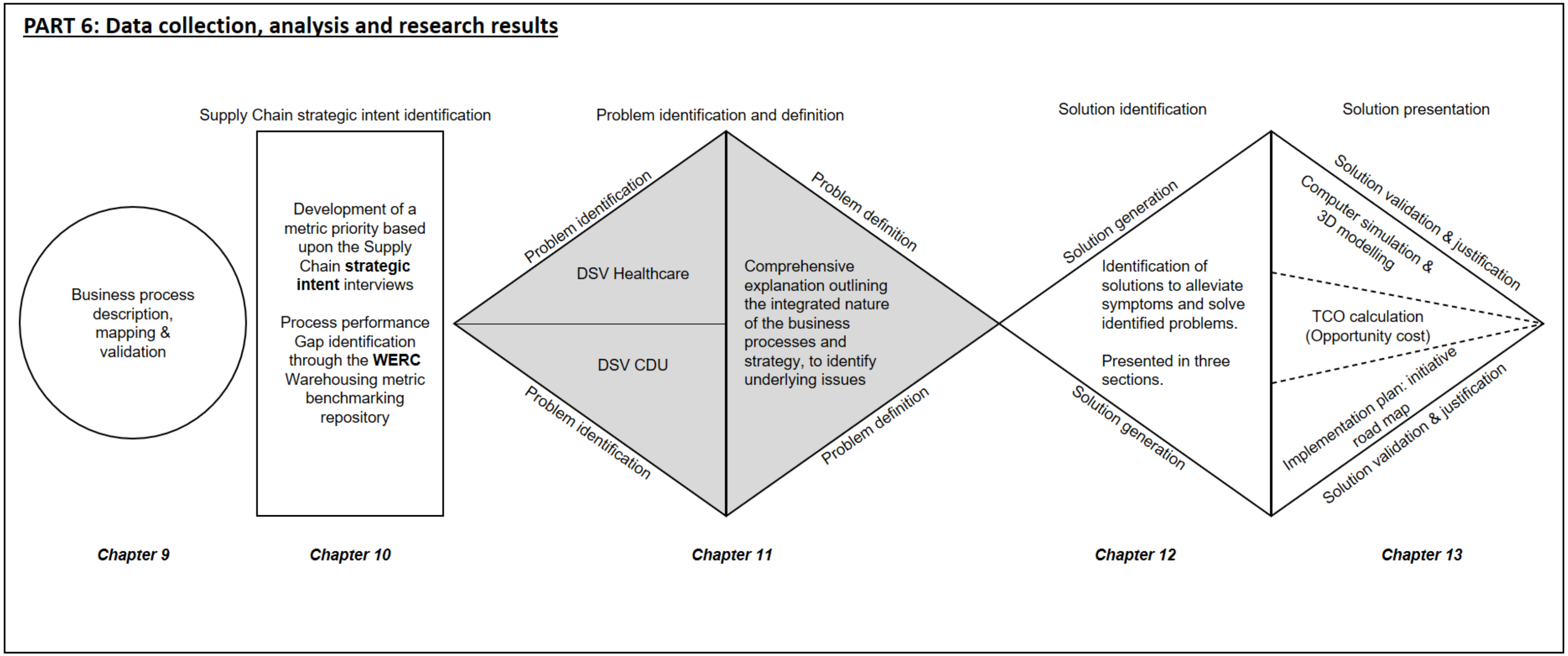
The metric prioritisation structure based upon the strategic intent interviews, its involvement with the metric cross-mapping between SCOR's level 1 metrics and the WERC metric repository, shows that such integrations are possible. The involvement of key stakeholders across the business is crucial to focus the Supply Chain scope of operation within the definition one of the five SCOR attributes. It is this ability to link the current strategic environment to the SCOR model that allows for this cross-mapping investigation to succeed. The use of SCOR as a base for integration played a vital role in the success of the *strategic-process and Warehouse performance alignment matrix*.

The integration of these frameworks, both Supply Chain- and Warehouse-related, allowed for a Warehouse gap analysis to be created in conjunction with a metric prioritisation based on the aforementioned Supply Chain strategic intent interviews. This performance gap determination further focused the investigation into the related processes related to POI and fill rate, as outlined by Figure 10.3 and Figure 10.4, respectively.

From this, specific solutions have been generated to endeavour to improve upon the current performance levels and increase operational alignment with the companies overarching strategic objective, customer service. However, before solutions can be implemented, further analysis of the current challenges being faced at the CDU is necessary. The identification of other operational challenges will determine which solutions are chosen and why.

PART 6: CHAPTER 11
CASE STUDY POTENTIAL SYMPTOMS AND PROBLEM AREAS




PART 6: Data collection, analysis and research results
Supply Chain strategic intent identification
Problem identification and definition
Solution identification
Solution presentation
Business process description, mapping & validation
Development of a metric priority based upon the Supply Chain strategic intent interviews
Process performance Gap identification through the WERC Warehousing metric benchmarking repository
Problem identification
Problem definition
DSV Healthcare
DSV CDU
Comprehensive explanation outlining the integrated nature of the business processes and strategy, to identify underlying issues
Problem identification
Problem definition
Solution generation
Identification of solutions to alleviate symptoms and solve identified problems.
Presented in three sections.
Solution generation
Solution validation & justification
Computer simulation & 3D modelling
TCO calculation (Opportunity cost)
Implementation plan: initiative road map
Solution validation & justification
Chapter 9
Chapter 10
Chapter 11
Chapter 12
Chapter 13

Chapter 11: Case study potential symptoms and problem areas

This chapter outlines the potential symptoms and problems area's in two distinct sections. The first outlines all the symptoms and problems identified within the Healthcare facility. The second section outlines the symptoms and problems within the CDU. It is important to separate these explanations as each facility is run by different management structures, despite the integration of their processes as described in *Chapter 9*.

11.1. Challenges identified at DSV Healthcare

This section outlines some of the process flow constraints that occur at the Healthcare facility. These constraints are solely focused on the processes that directly impact the CDU but are managed within the Healthcare facility. This is due to the scope of the study whereby the performance of the CDU is the primary focus. All measurements pertaining to this research are focused on the CDU's challenges and its performance enhancement. Please note that the majority of these issues pertain to the process description for both companies, outlined in sections 9.6.1 and 9.6.2.The flow constraints identified across the processes involved are discussed in the sections that follow.

11.1.1. Picking process flow issues

Certain issues arose within the picking activities. These issues can either be human error, system errors or due to a communication break-down between the two facilities.

11.1.1.1. *System errors*

This occurs when a barcode is scanned and picked from Western Cape but the system identified it as National stock. In the past the picker would then need to go and count each area's stock to confirm that the system's quantities match the physical quantities on the shelf. However, now that the Western Cape tender is coming to an end, this procedure is bypassed and the stock is moved as per the SOP set out for the National Tender.

11.1.1.2. *Product batch numbers*

This error causes confusion between the different batch numbers for each line of medication, based on the supplier's production runs. If the replenisher picked the correct stock but with the incorrect product batch number, this product can be rejected by a customer due to the difference in batch numbers on the accompanying documentation.

This type of rejection results in lost sales and product returns. On the DELTA system the batch number and the expiry date are critically important when picking, any confusion here can result in major delays for all operations.

11.1.1.3. *Human errors*

This challenge focuses on certain labour-intensive processes that Healthcare has implemented in their operations. These challenges are as a result of quality standards across different Warehouse operators as well as the completeness level to which an employee will complete a task. These errors are outlined as follows:

Replenishment: Confusion can occur between the racking bin location barcode and the physical bin itself. For example: The replenishment needs to be done in *26E02D* however, the replenishment is completed in bin location *26E20D*. As a result of this, the stock is now in the wrong location. When a picker then receives an instruction to pick from *26E02D* the product is not there or the incorrect product is in the identified pick bin. The supervisors are aware of these types of errors and do their best to rectify these issues as soon as they are identified.
Incorrect replenishment details: Each replenishment operator is responsible for filling in their details on the replenishment ticket upon completion of a replenishment into a correct bin location. This allows the supervisors to identify which operator is incorrectly performing put-away activities. However, although personnel are instructed to write their credentials down for each put-away, this is not always done. As a result, the wrong person is disciplined or the problem perpetuates due to no name being identified for disciplinary action to take place.

Bin location confusion: Each bin location is made from a cardboard cut-out, which if necessary, can be taken off the rack by the picker for easier access and use. However, because multiple pickers work near one another, sometimes bin locations can be mixed up and the bin is incorrectly placed into a different position on the shelf, this then becomes an issue for the next picker. The issue arises when the operator places the bin back into the rack but not in the correct bin location. To mitigate this issue Healthcare applies bin location labels to the box within a specific bin location. This means that each bin has a barcode corresponding to that of the racking location.
This method is only applied to Healthcare's private stock and is not used within the Western Cape or National picking racks. This is a system that could be implemented throughout the *fine pick area*, within both facilities *Healthcare* and *CDU* to avoid storage errors such as this one.

Housekeeping: Should always be conducted. However, some pickers either decide not to do it at certain times or neglect to do it entirely. This makes physical picking and stocking counting much slower than it should be if the process was always followed.

Employee performance/moral: Employee overall performance is a further issue. The supervisor can check how many PINS/Orders have been completed through the order release that is done every day. Continuous management is required for those employees that pick slower than others. *For example: Half-way through an order release, one picker had picked 20 pins while another had completed 15, the third had only completed 2. The supervisor is aware that these discrepancies in performance exist and they are being managed closely.* It has been raised that continuous housekeeping should not hinder a picker's performance, and therefore it is not a valid reason for poor picking performance.

11.1.2. Staging process flow constraints

These issues were all identified by the staging and missing items supervisor, as well as observations during the evaluation process. Each of the issues identified below will be described in detail as well as have examples for ease of understanding.

11.1.2.1. *Waiting for stock*

During the evaluation of the manifesting area, run by DSV Healthcare, it was identified that stock was waiting to be dispatched to the CDU facility. The staging operator has identified that they can see the stock waiting at manifesting but it has not yet been sent, thus outlining a fundamental communication gap.

This waiting for stock frustrates both parties involved. If manifesting doesn't send the stock, their mezzanine floor gets congested with waiting stock ready for dispatch to CDU. At the same time, workflow stops at the CDU as there is no more stock for staging and labelling, which then further delays the sorting machine teams as well as dispatch.

11.1.2.2. *"to follow" stock*

As identified in section 9.6.3.2, stock that is unavailable in the Healthcare facility is sent to CDU at a later date, when it becomes available. At the same time the DELTA system registers the short pick and automatically generates a to follow order which will be released the moment there is stock available in the Warehouse. The CDU also carries small quantities of certain stocks within their own fine pick racking, they then find the missing stock and fulfil the order, which is then dispatched.

In the DSV Healthcare DELTA system the *to follow* order is then released and is picked and staged for CDU even though this stock is no longer required. This outlines an inefficiency as this work adds no value to the business or its customers. This time and effort could be spent elsewhere to complete more important tasks.

11.1.2.3. *Healthcare sticker waste*

Since Healthcare and CDU are deemed to be two different entities of DSV, upon completion of manifesting activities each order has an invoice and a set of two labels attached to it. These goods are then dispatched to CDU where the stickers are thrown away and form no part in the subsequent processes or activities. This invoice is the only documentation required by CDU to confirm the receipt of stock at the receiving area on the CDU side. Due to the amount of stock that is being received from Healthcare to CDU, the need to understand the costs involved in this seemingly redundant process is critical. Understanding how much is spent in this activity could reduce the cost of operations as well as wastage and environmental impact. This costing analysis will be outlined in the *Chapter 13,* in section *13.2* of this report.

11.2. Challenges identified at DSV CDU

This section outlines the operational process flow challenges the CDU currently experiences on a day-to-day basis. All these challenges restrict productivity and therefore limit the ability to service the customer.

11.2.1. Script receiving and processing challenges

Script receiving and script processing challenges present a significant issue for the CDU. Scripts can be seen in ordinary Supply Chain terms as an order. Each script represents a single patient and their specific *order* of products or medications. Due to the nature of medications and their tendency to be deadly if prescribed incorrectly, it can be understood why this process generates such concern. Please review the Mail room and Script capture process descriptions to better understand how these issues interlink as outlined in section 9.6.2.2 and section 9.6.2.5 respectively. The following section outlines the type of error experienced in each of these processes.

11.2.1.1. *Scripting rejection*

The mail room process is responsible for creating a system profile for a patient. This profile is an electronic version of the physical script that is received from the government facilities. It is imperative that all issues in the process be corrected or managed on a day-to-day and week-to-week basis. It is also important to get the facilities, account managers and prescribers involved in mitigating these issues, to actively decrease the number of scripts being rejected. Script rejections can occur at two different stages, a script can either be rejected as a First line or Second line rejection. A First line rejection means that the script did not pass the initial fourteen-point check upon its arrival at the CDU. A Second line rejection is a rejection predominantly found in the script capture process and deals with script rejections based on medication errors. The following rejection reasons have been identified as the CDU's top five rejection reasons on a month-to-month basis.

Prescriber details query: This rejection reason is based on the lack of prescriber confirmation on the script. Either, the prescriber neglected to sign the script or an invalid prescriber[24] wrote up the prescription.

Patient detail query: This means that a patient's details are not present on the script. The patient details were given to the prescriber incorrectly or they do not match the current profile of the patient on the Flexgen system. Predominantly, the most frequent issue in this category is incorrect personal identification numbers (IDs)**.**

Dosage/Direction query: This error is predominantly identified in script capture as a second line rejection. This rejection means that the prescriber has prescribed an incorrect mixture of medications that could be lethal to a patient if taken. The other error in this category is directions for use which are contradictory to the strength of the medication that was prescribed. This could also be lethal if consumed by a patient.

Department of Health policy rejection: This rejection is specific to the product code list outlined by the DOH. This means that a prescriber has prescribed a medication that does not form part of the approved list of medications the government is willing to supply.

Post-dated Scripts: This rejection focuses on the 56-day production cycle the CDU uses to ensure on-time delivery to patients. In certain cases, prescribers will incorrectly indicate the next collection day (NCD) that is outside the collection period for the script. This means that a patient will arrive to collect their PMP on the wrong date.

[24] Invalid prescriber: this is a person who is not qualified or does not possess the necessary credentials to write out a prescription.

Script rejections cause major issues in terms of service delivery and SLA measurements due to the number of script rejections and delays surrounding a script error that is received. It is critically important for these errors to be measured and managed in terms of training and feedback to eliminate or reduce the number of errors being received.

This is due to the immense issue of script rejections. If a script is rejected, the current lead times to return that script to the facility for it to be corrected and sent back in time for production is unlikely. As a result, that PMP will not be sent out by the CDU. The patient will have to get their PMP directly from the facility. Following the current script rejection issues are the current stock-out and replenishment issues being experienced at the CDU.

11.2.2. Stock receiving delays and RTSs

Due to the nature of the stock handover processes, two stock movement methods were outlined in section 9.6.3.1. The first stock receiving process is via a conveyor belt; the second is via a bulk receiving door which Healthcare's MHE makes use of from the adjacent receiving floor. In some cases, this stock is received at different times.

This requires fine picked stock to be stored to await arrival of the bulk items before this stock can be booked in Flexgen. The inefficiency lies with the staging operator to remember where they placed the fine pick stock when the bulk items arrive. There could be a 2–3 hour wait between fine pick stock and bulk stock arriving. The operator must then go and search the rolltainers to find the stock before it can be confirmed and booked into Flexgen.

Due to the picking accuracy of DSV Healthcare and the complexity of the system integration between Flexgen and Delta, some lines are neglected and are not picked or manifested by Healthcare to the CDU. As a result, the CDU operations manager will have to complete an RTS. This RTS is seen as a CDU order and is placed as the lowest priority on the Healthcare picking priority. This causes a delay in the production run of a batch and therefore delays the ability to meet the *production date*, *date to courier*, *delivery date* and finally the *date of collection* by the patient. The process of completing an RTS delays the production process by two to three days.

11.2.3. Sorting and dispensing process constraints

All the activities below are a result of both the *Primary* and *Secondary* sorting. These issues occur at random during everyday operation. Each of these discrepancies is handled by dispensing. Dispensing must assess each issue and correct these by hand, then return them to dispatch for distribution.

11.2.3.1. *Products falling off the sorting machine*

When goods are inducted into the sorting machine, some items tend to repeatedly fall off or go missing during the sorting machines runs. This requires staff to constantly walk around the sorter to ensure that all items that do fall off are booked back into the correct patient drops.

An example of this, would be *Hydrochlorothiazide (HCTZ),* which are water tablets used to reduce blood pressure. They are generally prescribed in conjunction with other medications and are used with most scripts requiring blood pressure medication, meaning that it is a popular, high-volume product.

11.2.3.2. *Shift changeover inefficiencies*

With DSV CDU running three shifts within 24 hours there is a lot of work that is being done. This work may not always be completed before the next shift change, which is understandable. However, the communication between each shift is causing further operational issues. At the end of every shift there is a missing items collection box for items that are misplaced or fell off the sorter during the sorting process.

The ownership of this missing items collection box is lost in ‘translation’ across the different shifts. The box gets lost on the floor and these items are not booked into the missing items racking. Therefore, when a deviation is sent to the dispensary due to a missing item, each item must be manually redispensed instead of just picked and placed in the PMP.

11.2.3.3. *Damages from bagging machine*

When products have finished the secondary sorting process and have been QC’d they are then bagged. In some cases there are multiple items required for a single patient (over 10 items). These larger orders create a timing issue for the bagger clutch because when the products are bagged some items are damaged in the bagging machine as the guillotine cuts off the top of the bags keeping them from being sealed correctly causing clutch timing delays. Products may be half-in and half-out of the bag, and when this occurs both the bag and medication can be irreparably damaged. This order must be sent to dispensing for product replacement.

11.2.3.4. *No labelled bags*

In some cases, items are dropped into the bagger, the bag is sealed and should then be labelled. These bags are sometimes not labelled due to an issue with the label reel being jammed or out of labelling material that then requires refills. All these bags that are then not labelled must go to dispensing to be checked and verified before they can be dispatched.

11.2.3.5. *Large stock items breaking bags*

When a large patient order is dropped into the bagging machine, the combined weight of all the products can damage the bag, resulting in all the items lying loose on the conveyor. These items must be collected and sent to dispensing to be confirmed and checked before being re-bagged.

11.2.3.6. *Empty bags*

This occurs when products are dropped into the bagger and are either lost or blocked from entering the bag. However, the bagger machine still seals the bag with a patient label attached. These bags must then be removed and sent to dispatch in order to be checked and corrected if necessary. This can be quite tricky if a single item is required, like HCTZ. The bag itself feels empty, only when checked is it discovered that there is an item inside. If the bagger operator had opened the bag to check it and it was incorrect it would be sent as a deviation to the dispensary. This added to the TCO of the PMP as extra materials are required to finish that PMP. Incorrect identification of errored PMPs results in significant increases in TCO, as outlined later in *Chapter 13*.

11.2.4. Operational capacity constraints

This section outlines the physical flow restriction between the different departments within the CDU sorting facility. All of the following restrictions and issues impact the total productivity and on-time dispatch as well as the accuracy of products being delivered to customers, as outlined by the *Reliability* attribute in section 10.1.1.

11.2.4.1. *Staging and Labelling operations*

Since staging and labelling must be completed before products can be sorted this limits the amount of stock that can be sorted on a given day. The staging and labelling machines used within the labelling process are very labour intensive, while the sorting machines are automated. The capacity discrepancy between the number of products sorted vs the number of products labelled per hour is large, resulting in extensive downtime for the sorting machine, due to waiting for the labelling process to finalise.

11.2.4.2. *Workforce absenteeism*

Due to absenteeism in key processes within the CDU, operational delays can occur that impact the entire production run. The labelling process, for example, had two labellers absent during a single night shift. These labelling machines were thus left unmanned for the entire shift.

This drastically reduced the amount of stock per hour that the labelling teams could get through. Although cross-training and level qualifications have a significant negative effect on downtime, the management of headcounts and costs due to the hiring of more post-basic pharmacists is not warranted for the amount of work available vs their hourly wage.

11.2.4.3. *Communication*

Communication between all members of the team involved in the operations as well as the handover between the dispensary and the sorting departments is critical to get operational plans in place daily. There have been certain instances in the past where delays were not communicated between departments, resulting in high levels of downtime for both machines and personnel.

11.2.4.4. *Dispensing*

Due to the volume of errors that dispensing must deal with on a day-to-day basis, it is understandable to expect a longer turnaround time within this department. It is however, imperative that this department receives significant support during times of high volume, as any delay in this department restricts the dispatch and distribution of PMPs to patients.

11.2.4.5. *Zero manifesting*

Due to the SLA agreements with the National government, it is outlined within the agreement that stock will not be distributed unless all the stock is accounted for. When an order is realised but the total amount of stock is unavailable, the order will not be dispatched for distribution. Despite this, all the products are still picked, staged, labelled and sorted, only then to be identified as *Zero Manifesting,* whereby they need to have all the labels removed and are then entered back into the system as cycle stock for the next order. This process from start to finish equates to an entire shift of the CDU personnel that is wasted, as no income was generated from this activity.

11.2.4.6. *ARV sorting and dispatching process*

ARVs require hand labelling due to the shape and weight of the product. These items require very labour-intensive processes in terms of labelling, bagging and despatching in order to complete a PMP. All these manual PMPs must then be sorted according to collection date as well as by alphabetical order. This is done to get appropriate numbers of PMPs into one container, ready for distribution. This is a very time-consuming process, despite the planned changes to automate the labelling and packaging process.

11.2.5. Physical Flow Constraints

The CDU facility is restricted by operational floor space and storage capacity within their current set-up. It can be expected that certain areas requiring high volumes of stock handling and movement will cause bottlenecks and flow restriction within their specific process. However, these restrictions in the physical flow of goods from one activity to another are causing a delay in processing, volume of throughput and time.

11.2.5.1. *Dispensary physical flow constraints*

The area that will be focused on in the following section will be the specific flow movements and scheduling of a single batch as it would *move* through the staging, preparation and labelling, finalisation processes. Please remember this is an evaluation of a single batch. Batches vary in size and number of products as well as complexity regarding handling requirements. Complexity increases when more stock requires manual labelling or has a high percentage of missing items that requires the dispensary to process and correct these errors. Taking the above information into account, Annexure E, Figure E.2, illustrates all the pallets and rolltainers across the entire floor. All these storage items have been colour-coded to outline which activity or stage of processing they fell under. See Figure E.1., for the map legend.

Figure E.2 illustrates just how much bulk stock, either palletised or stored in rolltainers, is scattered across the CDU floor. This space can at sometimes be excessively cramped when navigating through the different areas. However, due to the limited space, in some cases the stock positioning within the CDU is necessary for replenishments and storage. The following section will focus solely on the movement of a single production batch through the staging, preparation, and labelling processes, outlined by Figure E.3. The reason for this is to outline the capacity difference between the labelling area and the capacity of the sorting machine. This analysis will outline the reason for the sorters' downtime as well as identify process inefficiencies, remembering that the sorters downtime is not solely caused by the labelling process.

11.2.5.2. *Labelling flow constraints*

This process has been summarised in six movements, each of which, as well as the accompanying activities, will be explained. At the same time, inefficiencies will be identified. The result of this workflow study is to identify the best alternative method to the current process to eliminate double/triple handling and reduce the need for movement as much as possible.

The following stage explanation outlines observed movements of goods during a normal day of processing within the CDU facility. The graphical portion of this analysis is presented in Figure E.3.

Stage 1: Staging for product arrival at CDU

Stage 1, (marked in red) represents the stock arrival at CDU via the two receiving methods discussed in section 4.1. These goods are then staged to await the request of the next batch to be processed and shipped. In this stage goods are scanned and checked to verify that all quantities have been received from Healthcare.

During the process of staging, prepackers will take goods from pallets in Area 1 to start processing. Therefore, goods move around the prepacking stations and labelling machines to area 2. When this batch order is processed the goods are then moved via pallet jack to an area 2 (marked in blue), where operators can get to the stock as well. However, the processing of stock should move from the top down and not bottom up. Despite this the goods are ready for prepack in stage 2.

Stage 2: Movement of goods away from staging area

This stage or activity only refers to the movement of goods. No value-added activities are added to these products in this stage. The goods are moved from area 1 via pallet jack to area 2 (marked in blue).

Stage 3: Prepack and item sortation

In this stage, goods are collected from area 2 (marked in blue) and carried to the prepack operators desk marked as area 3 (marked in yellow). Prepack and sorting refer to the activities whereby goods are sorted into product specific categories. This means that all units of a single type of product are put into one box. This is done for ease of labelling, as only one type of product can be labelled at a time, per labelling machine. Furthermore, goods are also packed "right side up" to ensure that the product is labelled correctly with all patient details visible.

It is at this point that double handling takes place again. Once a product has been sorted and packed correctly, it is then carried back to the same staging area it was collected from in the beginning of stage 3, to await labelling in stage 4 (marked in green). In some instances, goods need to be searched for in order to be prepacked as there is no clear division between stages of work that have been completed.

Stage 4: Labelling

It is at this point that goods are handled again; these goods are sometimes stored on the same pallets or rolltainers as stage 2 products. This means that goods that have not yet been prepacked and goods that have, are mixed on one pallet. This then requires both labelling and prepack operators to search for products they need to work on. Once the product has been located for labelling, the product is moved once again to the labelling operators' stations. Here each of the items is individually labelled and boxed in either A or B describing which side of the sorter the product will eventually go to. Once goods have finished being labelled, they are then moved by hand to area 5 (marked in pink) and placed on rolltainers.

Stage 5: Rolltainers staging

In area five, products that are finished being labelled are staged in this area to then be taken to the sorter for further processing. The sorting process has been explained within section 9.6.5. As it is evident within the explanation in section 9.6.4.6, there is a lot of repetitive movement and handling of products between the various stages of prepack and labelling processes. This repetitive work flow limits potential output of the facility as well as increases the amount of time required to complete a batch. Therefore, in the Solutions section of this report, an organised process flow map has been generated in order to reduce the amount of double handling and repetitive tasks that have been outlined above. This process flow map will endeavour to limit the distance travelled by operators to *fetch* work.

11.2.5.3. *The Missing items conundrum*

The missing items dispensary forms part of the dispensing unit. This part of the organisation can only be performed by a post-basic or fully qualified pharmacists. Products for this specific part of the organisation are obtained from three sections namely; QA, bagging and closing.

Additionally, missing items occur when products are dropped from the sorter and miss their designated container during a primary sort, or fall off the sorter during the secondary sort. Items that fall into the rejection box are scanned by an operator that walks around the European Mail Sorter searching for these items. Once at the dispensary, the entire PMP will be verified, and the appropriate corrective action taken to complete it.

After the secondary sortation process is completed, a QC check is done. Operators scan the items as they move off the sorter. Once QC is complete these items are run through a bagging machine whereby the items are bagged into individual PMPs. A quality checker selects, opens and scans bags at random and if there is an item missing from the bundle this bag will then be moved to the missing item dispensary.

The last area from which items are moved to the dispensary area is from container closing. The reason being that if the dispatch details have been changed, the dispensary then needs to change the details in order to rectify the mistake to ensure that the PMP is sent to the correct site and patient.

Once items arrive into the missing item dispensary from the three areas mentioned above, the items are handled in the dispensing area to fix any discrepancies. This entails an individual scanning of the bag and emptying the contents of the bag. The post-basic needs to then go to the corresponding sites missing items bin and search for the item by facility and patient name. The post-basic then needs to retrieve the missing item and scan the item to place it into the PMP and seal the bag. From there all the corrected PMPs are moved back, dispatched and treated as a manual PMP, as outlined in section 9.6.5.4.

If the products only need to be verified, the post-basic receives the bag, scans the bag and removes the label. They then empty the contents of the bag, scan all the items individually and then throw away the old bag and retrieve a new bag and place the items into the new bag which is sealed and relabelled. This bag is also sent to despatch as a manual.

11.2.5.4. *Primary sortation issues*

As outlined in section 9.6.5 the sorting process involves two sorting methods. The first, known as primary, is sorted by facility. The second is known as secondary which is done by patient by facility. The following issues have been identified during the sorting process.

The Speed of sorter belt moving around the track: Due to the total net weight of some products, they tend to *fly off* when the belt goes around the corner at high speed. This means that all these items are *missing*, requiring these scripts to go to missing items. The volume of these issues is extraordinary, hundreds if not thousands of scripts are sent to missing items for this specific problem.

***Item drops in incorrect bin*:** The sorting machine releases items per drop at the correct time; however, the item does not fall into the correct bin due to its diminished net weight. Therefore, this item falls into the incorrect patient's order. This causes two ripple effects, firstly the item is missing from a script, therefore that script must go to missing items dispensing for resolution. The second is that the script that now has the extra item must also go to missing items dispensing to determine whether it is correct.

Duplications: This refers to the sorter camera, whereby an item has been labelled twice. This creates a sorter issue as these items are then dropped into the rejection bin which then goes to missing items to be verified.

Shortages on file: This means that during a primary or secondary sort, the total batch quantity is short of stock. This means that if 200 items of a specific product are not in stock, this means that 200 scripts will be held back due to the *zero manifesting* SLA outlined by National. If a batch is sorted and is dropped with short supply of products these scripts will go to missing items dispensary, for correction and will ultimately be removed from the batch.

No labels**:** This refers to an incorrectly labelled item from the staging and labelling process. The issues are placed into the reject bin on the sorter and must go to missing items to verify if a script is missing that particular medication.

Bad labels**:** This means that during the labelling process, a label was placed with the product barcode only partially visible. Therefore, when the sorter scans the patient specific barcode, it registers as a no scan and is dumped in the reject bin. These items are correctly labelled for a patient specific order but cannot be scanned by the sorter. When these patient scripts go along the belt to be verified before bagging the operator scans all items and identifies a missing item, these scripts are then moved to missing items for verification and correction.

Mixed batch: Since the sorting machine can only sort through one batch at a time, when stock from two different batches is mixed, it generates a no-scan on the sorter. These items are then rejected and moved to missing items for correction.

11.2.5.5. *Secondary sorting issues*

This section refers to the issues that occur after the primary sort has already taken place. This means that the above-mentioned items continue being processed until the order is dropped and sent to verification and bagging. Therefore, repeatable issues such as *miss drops, fly offs* and *non-scans* are still an issue within this section. Despite this, the following issues have also been noted.

Items bounce into incorrect bins: Due to the dropping processes involved in the sorting machine, items are collected at the top of a shoot during the sorting process. Once the sorter has finished dispensing all the patient-specific items into each shoot, these scripts are then dropped onto a belt at the bottom of the sorter. During this dropping stage, items bounce as they hit the belt and bounce into a neighbouring patient bin. Both these scripts; with the extra item and the missing item; are sent to missing items dispensary for correction.

Mix trays: This refers to an instance whereby, goods that are mixed on the belts are verified by two different controllers. For example, if two controllers are scanning items and they both attempt to scan an item for the same patient, the system blocks it. Therefore, when these items are found to be in the incorrect bins both scripts are removed and sent to missing items dispensary for correction.

Script issues: This refers to where information presented on the script creates a system error. For example, Ibuprofen is sent with every second script a patient receives, however, on the alternating scripts the system registers that Ibuprofen is *missing* from the script. When the dispatching controller scans the item to be packed into cartons for shipping, the system flags it and says it cannot be sent due to the agreed national SLA. However, this script does not need Ibuprofen as the patient has already received this month's supply with the last parcel sent. In this case, these PMPs are sent directly to the operations manager to be resolved so they can be despatched on time.

Verifications and Uglies: This refers to items that cannot be put through the sorter for various reasons, either they are too heavy or too fragile. However, the rest of the patient's items can be put through the sorter. The rest of the items are sorted and dropped. They are then collected by hand and bagged. These bags are then taken to missing items dispensary whereby the *Uglies* are added to then complete the order.

Camera quality B-side: Due to the lower resolution of the scanning camera on the B-side of the sorter, more missing queries occur on average from this side of the sorter than on the A-side. The delay also outlines efficiency differences of processing volumes between the two sides of the sorter. Therefore, A-side can do two to three times the number of drops that B-side can.

11.2.5.6. *Missing Items Root Cause Analysis*

In order to conduct an RCA for the missing items dispensary an *Ishikawa diagram* was created to illustrate all the causes that could contribute to the missing item dispensary volumes. This diagram is depicted below in Annexure F and illustrates all of the above-mentioned issues that are outlined in section 11.2.5.3, Missing items dispensary of this report. This approach is used in conjunction with the 5 Whys as well as the problem-solving process. This will then outline why these problems occur as well as how they can be rectified. In order to rectify these issues, the problem must first be stated as simply as possible.

Each problem must be prevented on three levels to ensure that the issue is completely solved, not just to rectified at the inception point. Based on the problem-solving technique, processes must be analysed and adjusted to accommodate these new solutions.

11.3. Outcomes of Problem Identification

This section goes hand in hand with the process description of both the DSV Healthcare and DSV CDU facilities as all these issues were highlighted within the *physical operational processes* or the *supporting and administrative systems*. All these issues outline the need for operational performance benchmarking and gap analyses to take place.

These issues illustrate how interconnected these two facilities are, which outlines the main concept and theme of Supply Chain Management. This section outlines an understanding that if there is a single, backlog or flow restriction the entire process suffers. It was imperative to outline these issues to assist in the problem definition.

11.4. Outcomes of Problem Definition

The identification of problems, as outlined in section 11.2, outlines all the issues related to the internal operational processes. These problems must then be elevated to identify their impact related to the identified Supply Chain process attribute, through an RCA. The focus here is to ensure the company focuses on the most important problems first, in order to influence their operational performance, related to their Supply Chain processes.

In order to outline which of these problems will need to be addressed through the generation of specific solutions, the following three perspectives were considered: *Warehouse operational management processes, practices,* and *enablement* (in line with APICS, 2017). Therefore, each of these perspectives will highlight a problem that will be addressed in Chapter 13.

The need to identify issues with Warehousing processes is critical in performance management. However, the prioritisation of operational metrics, related to Supply Chain strategic intent not only allows for performance metrics to be prioritised but allows for identified problems to be defined and addressed in order to impact the derived performance.

11.4.1. Warehouse operations management processes

The process-specific problem identified during the case study analysis outlines distribution management as a significant issue. The distribution between DSV Healthcare and DSV CDU outlines a process-related constraint that directly impacts the reliability attribute on two levels, internal reliability, and external reliability. The internal stock handover process between the bulk DC (DSV Healthcare) and the CDU outlines a significant impact on the reliability attribute as the delay in this process impacts the level 1 metrics outlined by the SCOR model. Therefore, any delay within this process handover, will result in poor internal POI performance.

This delay in the internal handover process between the two facilities further drives a delay in the external POI performance to the government facilities, thus impacting the overall Supply Chain process attribute performance level achieved. In order to address this Warehouse operational process issue, the management of internal processes related to distribution management needs to be addressed. This will impact both the internal and external POI performance level, presented in section 10.2 .

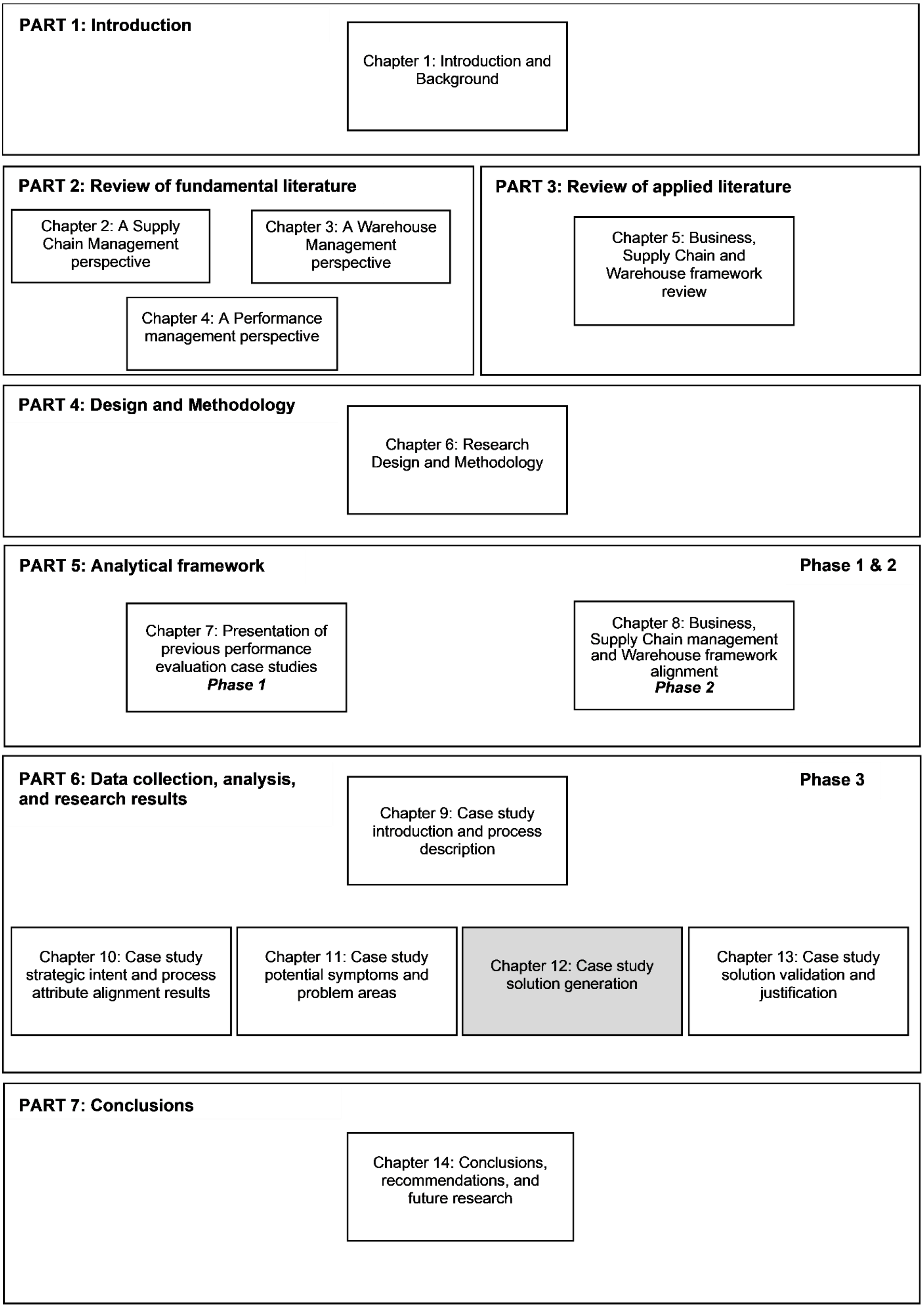
11.4.2. Warehouse operational practices

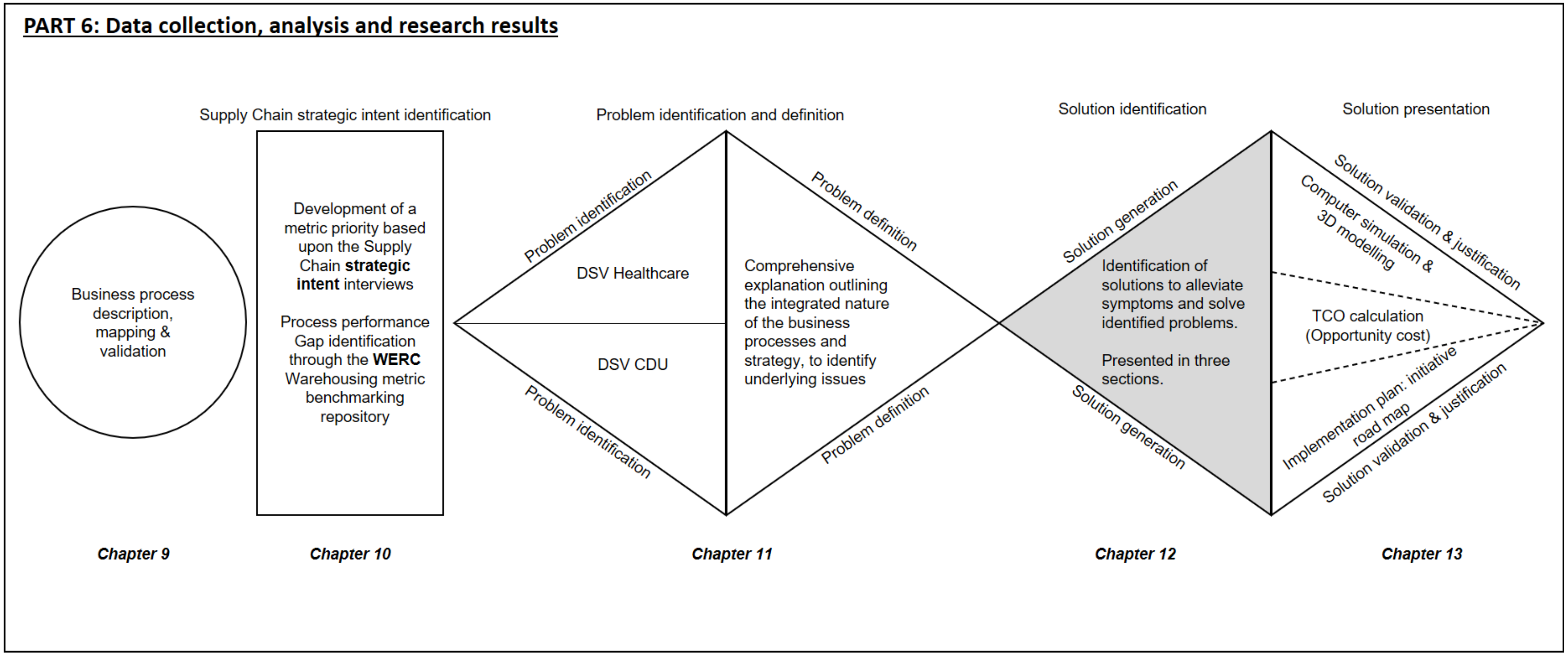
In order to impact the Warehousing issues related to operational practices, the most prominent process delay related to process practices, is defined by the missing items problem, indicated in section 11.2.5.3. This outlines continuous, repeatable errors that need to be addressed, like the implementation of good handling/sorting practices related to an in-house conversion process. Therefore, the need to identify and generate solutions surrounding a recurring issue such as this, will greatly impact the reliability attributes related to POI performance. The solutions related to this problem definition are further covered in section 12.4.

11.4.3. Warehouse operations enablement

The enablement aspect of this problem RCA outlined the Delivery vs Collection problem as its main finding. The need to fulfil operational requirements to derive performance related to a service level agreement is critical for the fulfilment of reliability, in terms of Supply Chain performance. The focus should be on the implementation of specific solutions to increase the reliability attributes' performance in relation to the defined agreement between DSV and the National Government. These improvement initiatives are outlined in Chapter 13, section 13.3.

PART 6: CHAPTER 12
CASE STUDY SOLUTION GENERATION




PART 6: Data collection, analysis and research results
Supply Chain strategic intent identification
Problem identification and definition
Solution identification
Solution presentation
Business process description, mapping & validation
Development of a metric priority based upon the Supply Chain strategic intent interviews
Process performance Gap identification through the WERC Warehousing metric benchmarking repository
Problem identification
DSV Healthcare
DSV CDU
Problem identification
Problem definition
Comprehensive explanation outlining the integrated nature of the business processes and strategy, to identify underlying issues
Problem definition
Solution generation
Identification of solutions to alleviate symptoms and solve identified problems.
Presented in three sections.
Solution generation
Solution validation & justification
Computer simulation & 3D modelling
TCO calculation (Opportunity cost)
Implementation plan: initiative road map
Solution validation & justification
Chapter 9
Chapter 10
Chapter 11
Chapter 12
Chapter 13

Chapter 12: Case study solution generation

DSV Healthcare is responsible for most of all the CDU's bulk and case lot storage. As a result, the CDU is reliant on the Healthcare facility to pick and dispatch these products as quickly and efficiently as possible. This section will help outline some of the possible areas where process enhancements could be derived. It outlines the area and description along with the proposed solution explained. This chapter is split into two focal areas, the first focuses on the possible solutions for Healthcare, the second focusing on the possible solutions for the CDU.

12.1. Operational standards between Healthcare and CDU

The main issue outlined by the production management at CDU in terms of receiving of stock, is the delay and error rate of the batches that are ordered for a production run from DSV Healthcare. This error rate has been outlined in the performance metrics results presented in section 10.2.1 and 10.2.2. The recommendation is to improve communication based upon a significant difference in the two organisations' *modus operandi*.

DSV Healthcare has been given an explicit instruction from their strategic level management, to facilitate the orders of its private clientele before attending to the CDU's needs. This decision to institute such a blanket operational standard limits the available impact any other solutions could have on the current operational delays experienced by the CDU. This outlines the discrepancy identified in the metric evaluation section, of the difference in the POI calculation for Healthcare's private clients versus the POI experience by the CDU.

If this operational standard is removed and the CDU is given the same level of customer service as Healthcare's private clients, the POI for both facilities could increase drastically. To prove this concept, a computer simulation was developed to outline the impact these improvements could have if implemented to the stock handover process between Healthcare and the CDU.

Due to the current operational standard set out by Healthcare's management, as well as the scope and focus of this research being directed towards the CDU, this is the only operational solution being suggested for DSV Healthcare. In order to derive better performance, the same level of attention that has been given to the CDU will need to be given to the Healthcare processes.

12.2. Solutions section for CDU operations

This section of the report outlines all possible solutions to improve the productivity, capacity and performance of CDU operations, some of which have already been implemented. This section will be broken up into two distinct sections. The first will focus on physical changes, which are: (1) Reorganisation of specific operational layouts and their accompanying processes; (2) Cost-saving initiatives that will improve the cost structure; (3) Total Cost of Ownership (TCO) to improve the overall bottom line of the CDU. The second section will discuss possible system changes, this outlines processes within the facility that depend on information technology and the underlying systems that support operations.

Many of these solutions were derived based on the findings from the computer simulation, TCO calculations as well as the initiative road map that was also conducted during this evaluation. The simulation results allow for specific changes to be made or tested in order to determine the potential success or failure of each solution. However, the overall focus of performance improvement is driven by the identified Supply Chain strategy. It is this strategy identification that drives the priority and focus of these solutions and findings towards a more reliable performance management environment.

12.3. System specific solutions

The following solutions outline several solutions identified to improve upon the current processes. These solutions are based on system processing solutions to drive improvements and increase performance. The focus on the system allows for low-cost, high-impact solutions to be implemented through the current system infrastructure.

12.3.1. Collective operational weekly meeting – Communication solution

Due to the necessity for communication between all operational supervisors and strategic management personnel, a weekly meeting is periodically diarised. This is done to ensure that all plans, issues and concerns are tabled with all the parties concerned, notwithstanding the fact that the meeting environment is good for planning and forecasting the week's production runs as well as ensuring alignment and cross-functional involvement from all department supervisors. These meetings also build morale across the management structure as progress is shared and celebrated by all.

12.3.2. Production date solutions

In order to generate better script adherence and improved volume of scripts with on-time delivery, to directly impact the POI and customer service levels outlined within the government SLA, the production date programme was implemented. This programme was designed to change the way scripts were allocated to production runs.

This solution was implemented to mitigate: *script rejections, stock supply issues, zero manifesting* and *increase POI* in terms of the SLA. The process implemented a fixed calculation based upon several criteria that outlined what production date a script was allocated too. The production date refers to a real-time date range when a script begins its journey to becoming a PMP, through the implementation of specific system calculations.

These calculations used the prescriber date, plus specific SLA lead times to calculate the production date. Once the production date was calculated, the operational lead times were added to identify the target *Date to courier*. After the date to courier each province's transportation lead times where calculated to determine the delivery date. The SLA defines the *delivery dates* as three days prior to the *date of collection*. These calculations have been set and implemented to increase the number of on-time deliveries to patients, in four different provinces. As a result, any script that is allocated a production date will, in effect, be delivered within the agreed SLA. The outcome of this solution after implementation, has increased the OTIF and POI performance for DSV deliveries significantly.

12.3.3. Stock ordering minimum quantities

In order to isolate the stock handover between Healthcare and the CDU a new stock-ordering SOP has been initiated. This stock-ordering SOP identifies the minimum case quantities for each medication type. The reason for this is the decision to hold more stock on the CDU floor in the event of an order delay from Healthcare or the need to perform an RTS. The excess stock will be stored within the four provincial racks that have been provided, see section 12.4.3. In the event of enough stock being carried by the CDU to fulfil a production batch, no order will be sent to the Healthcare facility. All stock required for that production batch will rather be picked from the CDU racking. This is done to ensure that the medication used is within the manufacturer's identified expiry date.

12.3.4. Zero Manifesting solutions-system focus

In order to mitigate the amount of stock that is processed and sorted yet still ends up at the dispensary because that item in that parcel is out of stock, the company instituted a zero-manifesting solution. This solution allows for a stock report to be run to determine which products are either out of stock or have insufficient stock to fulfil a complete batch.

The production manager now has the capability of selecting, on the Flexgen system, those out-of-stock items. This identifies the affected scripts and removes them from the production batch. As a result, each patient affected will be sent an SMS to notify them that they will have to go to the facility to pick up their medication, rather than the agreed upon PUP.

12.4. Process specific solutions

These solutions outline improvements made on physical flow processes or those processes that require any real involvement from personnel, either in an administrative role or operational capacity. These solutions are based upon the operational needs of the supervisors and personnel working in operations as well as the shift in tender requirements between the Western Cape government and the National government. The solutions are discussed in the following sections.

12.4.1. Delivery vs Collection management

The *delivery vs collection analysis* defines a report that has been created to determine how many of the National government facilities have had parcels delivered to them in the past week and matches these facilities with the number of scripts received from the same set of facilities. This measurement outlines inefficiencies in parcel delivery and script collections. Since a vehicle is going to complete a delivery, they should collect the week's scripts at the same time. This will generate a return for the return leg of the transport journey. This is a critical element in road transport known as *Back-Hauling*. In most cases a return journey generates no return for the transporter. Being able to generate a return as well as decreasing the time it takes a script to get to the CDU, increases the ability of the CDU to fulfil as many PMPs as possible and reduce the potential for rejections. This analysis outlines those facilities and transporters that did not perform a delivery and collection. These transporters and facilities are then identified and contacted to drive the consolidation of the two processes.

12.4.2. Increase in script receiving/rejection delays

As a result of the delivery vs collection analysis, the involvement of distribution and the implementation of the production date initiative, a significant improvement in script receiving delays has been achieved. As outlined in Figure 12.1, the previous internal processing time frame from prescription date to rejection/production date was 46.5 days. The main reason for this delay was the time it took scripts to get to a specific DSV consolidation point, known as the DSV Meadowview facility in Johannesburg.

Once there, the scripts are consolidated into a script envelope bag and sent to the CDU in Cape Town, after which, the script is processed and scanned into an electronic processing silo. From this point the script can be rejected before it is allocated to a production date, as outlined in section 11.2.1. If the script is accepted, it becomes part of a production batch which then follows the operational description outlined in section 9.6.2. If a script is rejected, it takes a different path, following a process of returning the script back to the facility for corrective action to be taken. This process is outlined in section 11.2.1.1.

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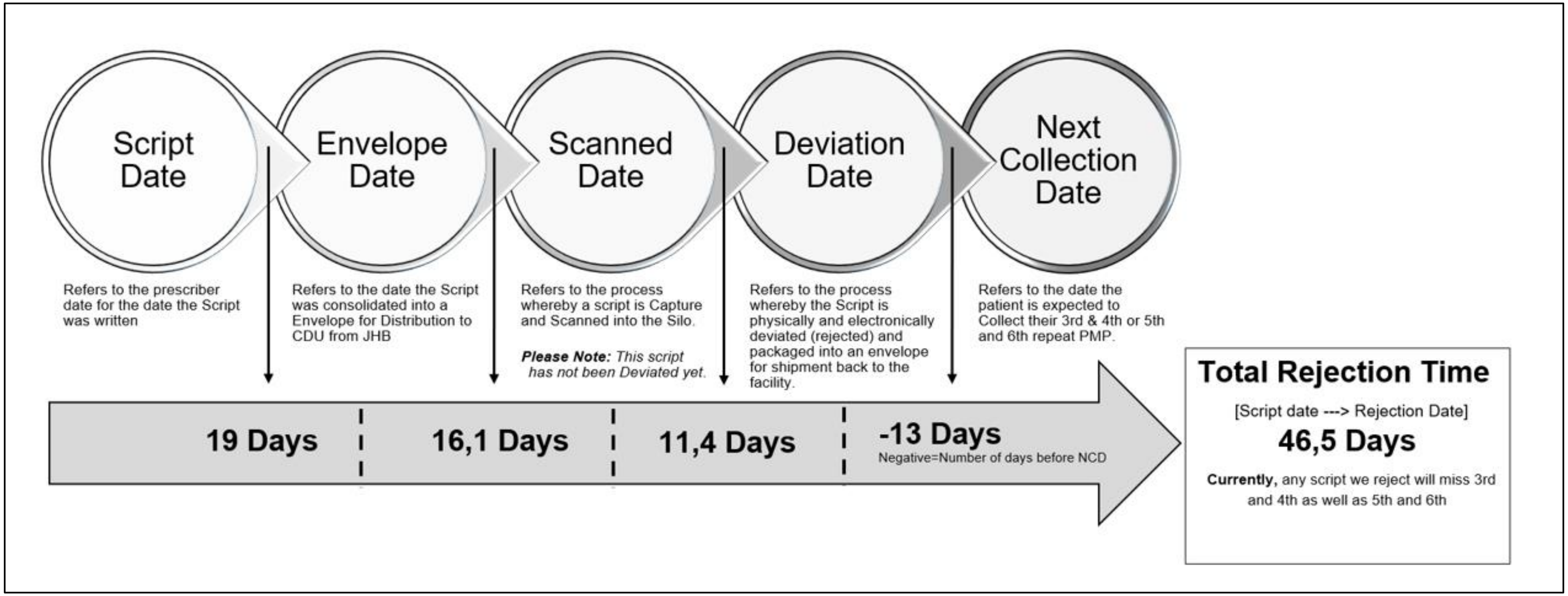


Figure 12.1: Script deviation time analysis – Before solution implementation

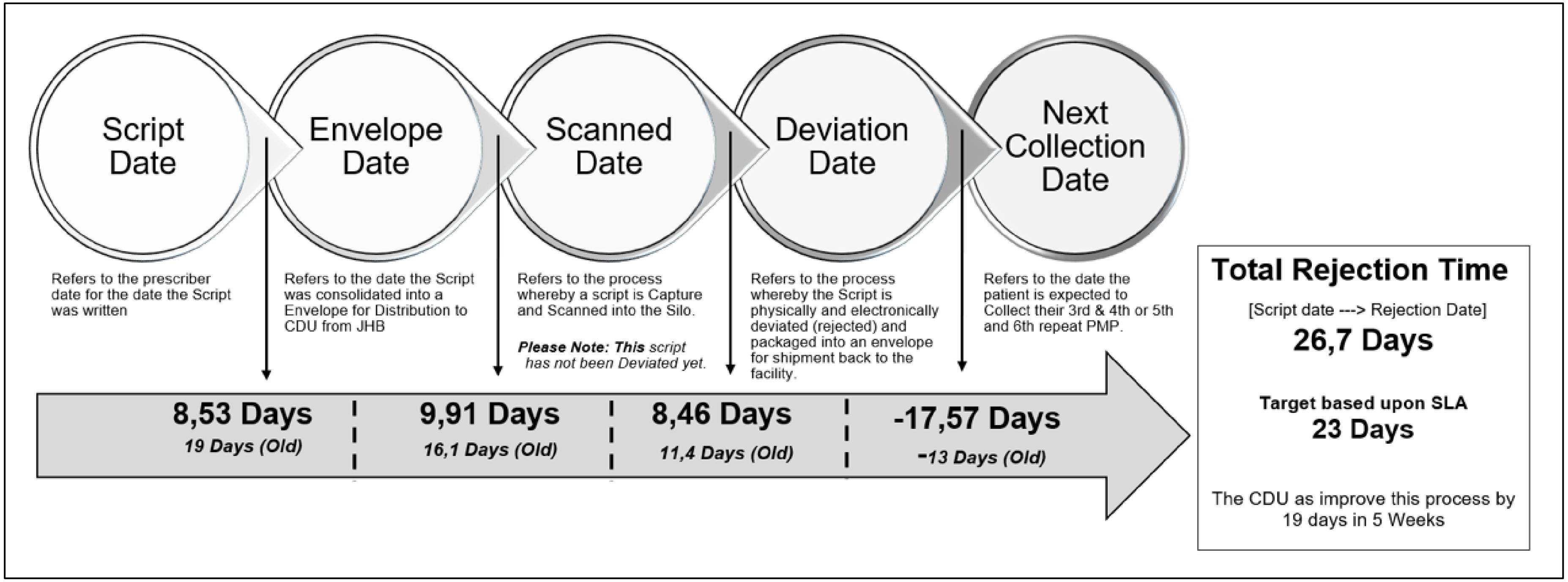


Figure 12.2: Script deviation time analysis – After Solution implementation

The implementation of this measure allows for progress to be tracked to determine the level of performance enhancement gained. These two analyses were conducted five weeks apart. The improvement for the script-receiving process is significant in terms of the shorter amount of time taken to complete the process. To put this performance improvement into perspective, the SLA defines the script-receiving time as a defined benchmark for the CDU. This means from script date to scanned date, at a target lead time of 23 days. Based on the analysis outlined in Figure 12.1 and Figure 12.2, the script-receiving time line is 26.7 days. This is a 19.8-day improvement across the script-receiving process, within 5 weeks, thus significantly increasing the CDU's capability to influence the POI and enhance the SLA performance achieved.

12.4.2.1. *The implementation of the new stock-receiving area*

The old returns area is situated on the southeast side of the building underneath the CDU operation floor. This returns area opens onto the yard area, via roller shutter doors. This yard area is used for all dispatching and receiving vehicles. It is also situated alongside the despatching operations floor, which is connected via another roller shutter door for easy MHE access for bulkier items. This area interlinks with the CDU operation floor via a conveyor system that was used to send stock that had been returned back up to the CDU for storing outlined in section 9.6.5.8.

This area is perfect for the receiving of stock due to the conveyor belt access as well as easy MHE access from Healthcare. This is important for several reasons, the first being that stock management and control can be better organised. With appropriate stock controls in place, no stock can be misplaced or misallocated as this area will control both the in- and outflow of stock, via an electronic scanning system.

This area also allows for better reticulation and flow of operations on the floor due to the accessibility and convenience of the conveyor belt. Currently, there is a delay in the picking of stock from the Warehouse and transfer of stock for Healthcare to the CDU. This new area can then forecast batch orders and receive the stock from the Warehouse and stage it while the previous batch is being processed. This action significantly reduces the downtime of operations personnel and machinery while eliminating mixing of different batches of stock.

12.4.3. Implementation of a new fine pick racking layout

The fine pick racking on the CDU floor was not conducive to stock reticulation and personnel flow throughout the operations floor as well as the pickers working in the racks. Furthermore, with the transition between tenders, and the added complexity of facilitating four provinces instead of one, the racking was not viable in its current layout to work for the CDU.

A project plan was drawn up and implemented with the understanding that from the current racking four smaller free-standing racks should be built in order to facilitate the division of stock for all four provinces. During the week of 18 to 22 February 2019 the stock control department began to break down the current racking structure in order to facilitate the rebuild scheduled to take place over the weekend 23 to 24 February 2019.

12.4.3.1. *Racking rebuild*

The breakdown of the old racking was essential as the old racking configuration would be set out perpendicular to its original positioning as well reconstructed into shorter sections. The purpose of this was to facilitate the development of four separate racks, one per province, in order to make stock control and inventory accuracy better going forward into the new National tender.

12.4.3.2. *Racking rebuild and new positioning*

The rebuilding of the existing racking was implemented very well. There is a total of four racking structures, six metres in length, three metres wide and five shelves high. The new design made use of the old racking as far as possible. From this, two supporting side panels had to be fabricated to be able to complete the fourth racking structure. This required existing pieces of racking to be measured out and cut then bolted together to fit the new design's measurements.

Once the new panels were built, all the racking could be rebuilt and constructed to fit the earmarked area for stocking operations, bearing in mind the floor constraints with supporting pillars as well as incorporating the design for the new conveyor system, which at the time was still due to be installed.

12.4.3.3. *Racking rebuild completion*

Overall, the new racking layout is far more ergonomic than the old layout, as the pickers can now transition between aisles with a much faster pick rate. The new layout permits stock control to be implemented on a province by province basis, limiting the amount of mixing/lost stock that occurs. This project has also freed up more usable space for all departments as well as a sizable area that could possibly be big enough for the new ARV labelling lane, that is due to be set up at the CDU. In conjunction with the new ARV project a new conveyor system is due to be installed, decreasing the handling of products at the labelling lanes. All these projects, in conjunction with some hard work from the CDU staff, have led to a successful project implementation and execution.

12.4.3.4. *Revised Labelling flow organisation*

The labelling process explanation in section 9.6.4, outlined specific issues regarding flow management and double handling by prepack and labelling personnel. This solution merely seeks to rectify the processes. Therefore, no physical changes are required. All that is required is to reorganise personnel and processes to eliminate wasteful actives. The following process explanation outlines an ergonomic analysis and implementation strategy for the labelling process. This proposed flow, illustrated by Figure E.4, demonstrates how an organised flow of materials through appropriate scheduling and movements could optimise output capacity.

Please Note: *for ease of discussion, the colour description and numbering have been kept the same as the explanation in Annexure E despite their change in position.*

Stage 1: Staging for product arrival at CDU

This proposed layout will be conducted in the exact same fashion as the description of current operations. Goods will be received via two methods, bulk, and tote conveyor. They will be scanned and staged for prepacking.

Stage 2: Movement of goods away from staging area

In this stage, like the previous one, goods will now be available for processing at the prepack stations. However, the pallets of staged goods must not be moved. They must be processed from area 1 (marked in red). The total distance travelled between the staging area and the prepack area is a total of 1.5 m. Therefore, once a carton/box or product type has been processing (prepacked) in area 2 (marked in blue), it is then staged in area 3 (marked in yellow).

Stage 3: Prepack and item sortation

This area requires an operator’s decision when staging prepack products. This decision is indicated by the broken arrows (marked in orange). The decision describes a process whereby goods that have completed the prepack process must be packed on a pallet; however, the operators must pack all product types onto one pallet. When that pallet is full, they may begin to use the next one. Therefore, the pallet closest to area 4 (marked in green) must be packed first. It is at this point that goods are required to be shifted for the first time since staging.

Stage 4: Labelling

Due to the flow of the product between, stage 3 and stage 4, the labelling team now has a designated destination to retrieve goods that need to be labelled. This dedicated retrieval area has many benefits to labelling operations. These are as follows:

No wasted time: In finding products between two different areas that have been prepacked but not yet labelled.

Tracking progress: The entire team, both prepacks, labelling and even sorting can visually see how much stock still needs to be completed at each stage due to the separation of products at different stages.

Reduced handling: Due to the flow, the products do not need to be handled as much.

Consolidation of goods movement: If products do need to be handled then they are handled in bulk via pallet jack, and not by individual carton.

Stage 5: Rolltainers staging

Due to the nature of the labelling machines, the products are then labelled and separated into either A boxes or B boxes. These boxes contain only one product type; therefore, they can be staged in area 5 on Rolltainers. These Rolltainers can be packed accordingly, meaning that all A boxes are packed onto a separate Rolltainers than B boxes. This activity again requires very little movement for the labellers to the Rolltainers staging area (marked in pink). When the entire branch is completed, the A and B boxes are already stored and staged, all they need to do then is move them to their respective sorting destinations on either side of the sorting machine.

Hand-labelling process: Because multiple lines are required for patient scripts, it is expected that some of these items have a unique shape, size and weight. For these products, the labelling process creates some difficulty as these products cannot be passed through a labelling machine. The revised layout for this process limits the amount of movement required for all products, while increasing the productivity of the automated labellers. *What does this mean for hand labelling?*

If the automated labelling machines are operating at high capacity, more staff (post-basic pharmacists) can be allocated to the hand-labelling process. Therefore, cross-training between different departments is also a necessity to ensure that all work, no matter which process, is being done as fast and as accurately as possible.

12.4.3.5. *Results of optimised process flow*

In the above-mentioned description, the product handling is reduced significantly. The only movement is between the pre-pack stations and the labelling operations. This activity is done in bulk, via pallet jack, to limit the amount of time spent walking between each area carrying one carton at a time. There is another area where movement is required and this is between the labelling machine and the Rolltainers (Areas 4 and 5). However, when a labeller has completed a full carton of either an A or B sort, they must retrieve another one, to collect the next set of products.

The movement of goods between these two areas is required to fulfil other activities. To further limit the disruption in the labelling process a replenisher or fine picker could then be made responsible of orchestrating the movement of the goods between prepack, labelling, rolltainers and sorter. The prepack and labelling operators must focus solely on output without worrying what needs to be done next. Furthermore, to increase communication between departments, the progress of each area can then be tracked visually to determine how much of a specific batch is left. Therefore, the sorting department can determine how long it will be until the next sort is required. For example: If prepack is completing the last prepack for a specific product type and labelling still must complete three product types over three labellers, the sorting machine team can estimate that the next batch will be available in 45 minutes to 1 hour.

This section of the analysis has been conducted in the hope of matching the capacity of output of labelling and the sorting capacity of the sorting machine outlined in section 9.6.5. This is further constrained because only a complete batch can be sorted. Labelling must complete labelling an entire batch before it can be sorted. Improving the flow and speed of labelling may increase the sorting and dispatch output to its full capacity of around 100 000 units a day. At its current capacity it is only running at 40%–50% of its capacity.

12.4.3.6. *Missing items/Sorter Solutions*

The missing items' solutions should focus on three levels of implementation, to practically and permanently impact the current performance environment to mitigate this specific problem. These three levels are described as follows:

***Immediate action*:** The action taken to quickly fix the impact of the problem so the *customer* is not further impacted (reason for missing items).

***Permanent*:** the action taken to eliminate the error in the affected process or product.

Preventive (systematic): The action taken to prevent the error from recurring on any process or product.

From this, it is imperative that these three implementation levels are achieved in order to eliminate the number of items sent to missing items dispensary:

***Mobile scanning unit*:** In order to solve the primary sortation issues, a mobile scanning unit could be employed to scan all the items that miss falling into the open spaces between the primary sortation boxes. This mobile scanning unit will be able to scan each item and indicate the correct primary box it should be placed into. By adopting this process, it will further reduce the secondary sorting issues as this limits the number of errors that will occur in the preceding processes. This mobile scanning unit is a laptop and scanner that is placed on a trolley. When the laptop is not required it will be plugged into a wall port by the supervisor's desk to recharge.

When the primary sort is underway, the trolley will be wheeled along the sorter to verify all the missing items. This solution is deemed to be a preventive solution as it requires marginal capital investment. It also requires a reorganisation of sorting SOP and training to ensure the process is followed properly.

***End of sort scanning*:** Instead of a mobile unit for a laptop, all items that drop during a primary sort, must be set aside till the end of the primary sort is over. Once the primary is completed, the operators of the primary sort must scan each item, indicate on it where each item belongs, based on its chute number and put it into the corresponding A or B box. This solution can also be considered a preventive solution as it requires the same infrastructure as the mobile scanning unit.

Prepacked solution explained: The prepack concept is something that occurs during the time the induction of a specific site has been completed up until that specific site has been dropped onto the belt. The induction operators normally sit and wait for this to happen. They should rather begin prepacking the next site. This solution, although not the most creative, can deliver a significant impact as it will limit the number of errors recorded as well as improve the induction/sorting times. There are no extra costs involved in implementing this solution and no need to change SOPs, therefore this solution is identified as an immediate action solution.

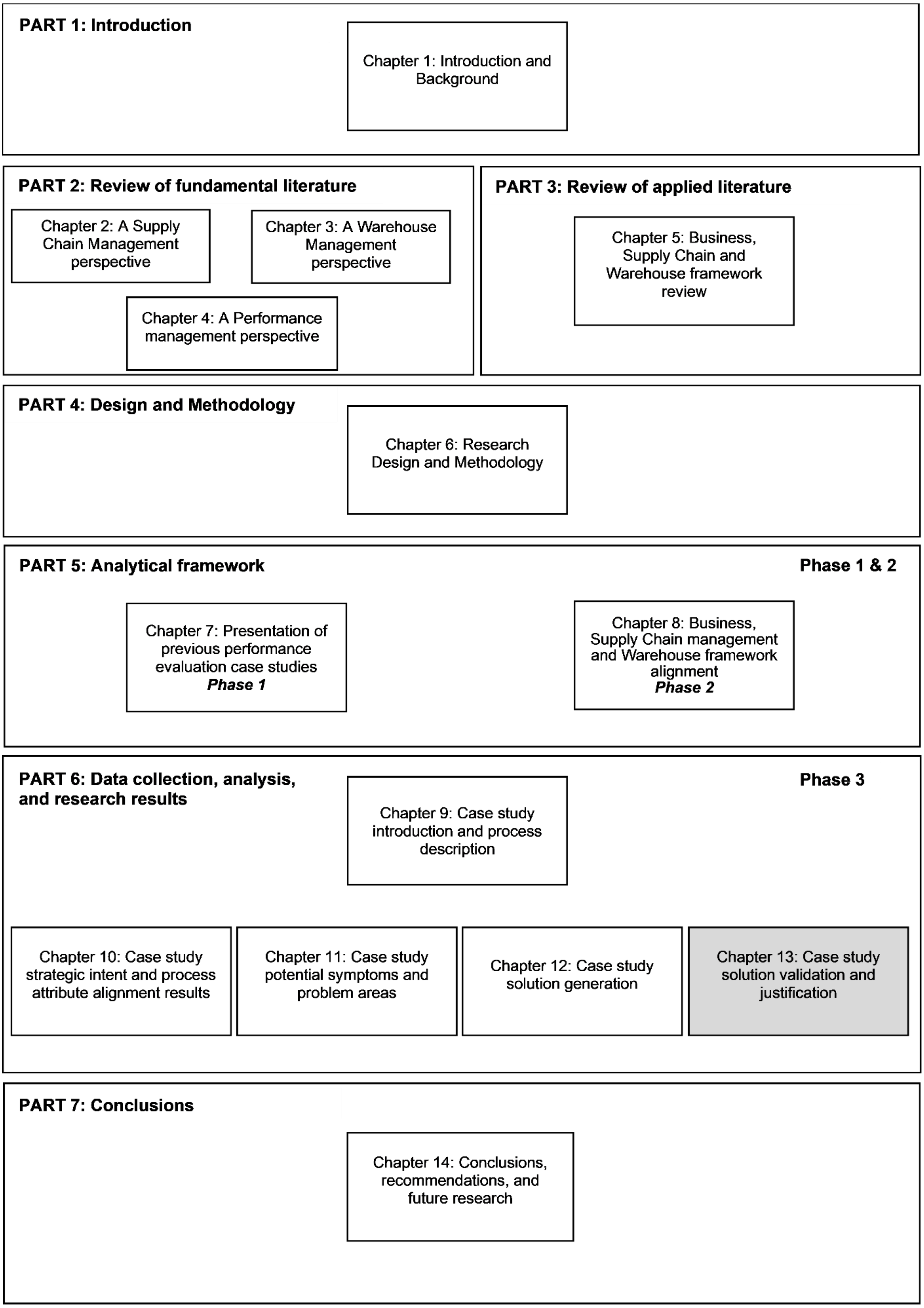
Sorter camera alignment: Due to the intense nature of the induction process, the sorting personnel sometime attempt to rectify the induction error and in doing so they bump the sorting camera. This will result in a significant number of rejects at the end of the drop. Therefore, before each batch is inducted the camera positions should be set correctly to limit the number of *missings*. This action requires significant capital investment, as the maintenance and upkeep of the sorter and its cameras require a qualified technician to be flown out from Europe.

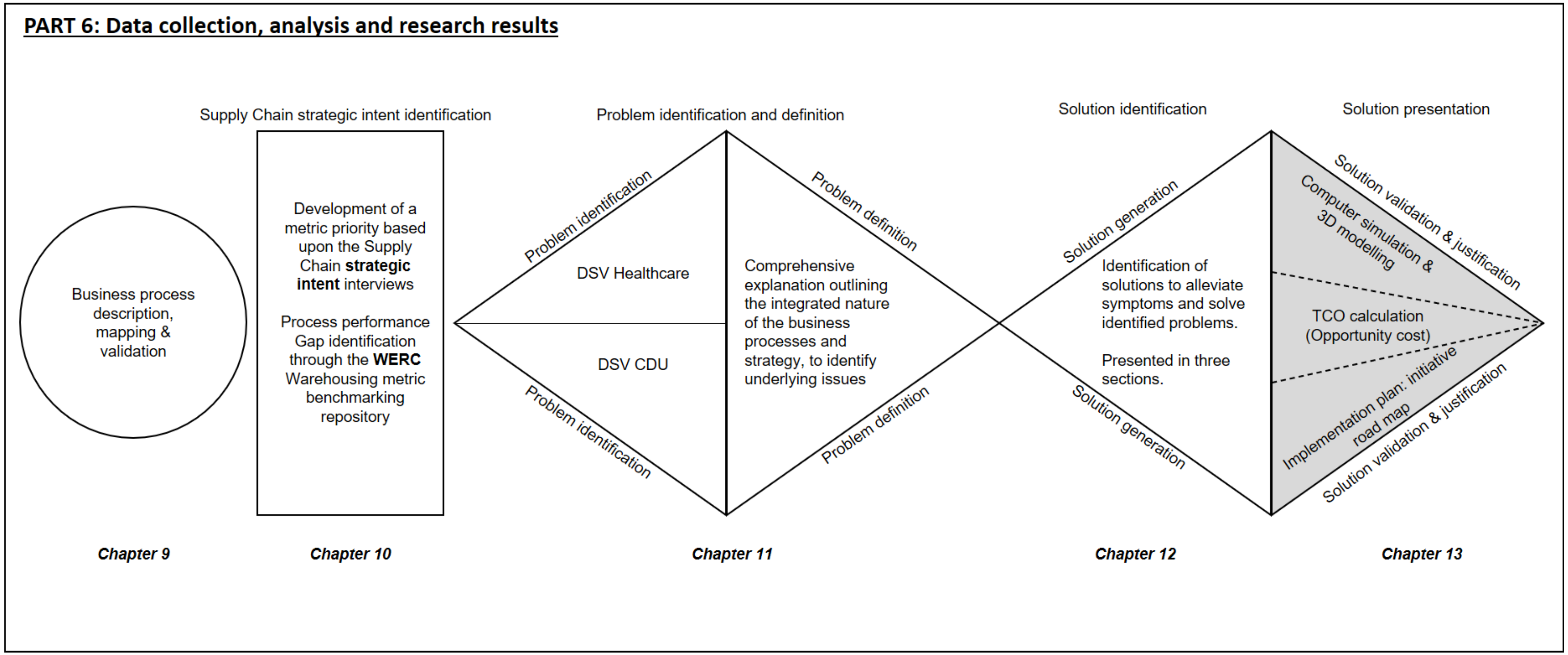
12.5. Summary of Solution determination

The methodology has outlined the need to understand the processes through an extensive process explanation in order to be able to identify case-specific and process-specific issues that surround the process during everyday operations. The issues further outline the current performance environment and identify and validate the gaps identified in the performance gap analysis. Hereafter, specific solutions are identified to outline a method to close the gaps and improve overall performance. These solutions are part of the recommendation to the company to help improve their current performance results and drive them closer to their desired performance objectives.

In order to validate these solutions, and identify the performance improvement potential that these solutions present, a computer simulation has been built to simulate the current operational environment. This environment can then be altered in line with some of the previously identified solutions to determine the overall performance results that could be achieved if these solutions were to be implemented. Added to the computer simulation a TCO section as well as initiative road map have also been developed to further the implementation and improvement process.

PART 6: CHAPTER 13
CASE STUDY SOLUTION VALIDATION AND JUSTIFICATION





PART 6: Data collection, analysis and research results
Supply Chain strategic intent identification
Problem identification and definition
Solution identification
Solution presentation
Business process description, mapping & validation
Development of a metric priority based upon the Supply Chain strategic intent interviews
Process performance Gap identification through the WERC Warehousing metric benchmarking repository
Problem identification
DSV Healthcare
DSV CDU
Problem identification
Problem definition
Comprehensive explanation outlining the integrated nature of the business processes and strategy, to identify underlying issues
Problem definition
Solution generation
Identification of solutions to alleviate symptoms and solve identified problems.
Presented in three sections.
Solution generation
Solution validation & justification
Computer simulation & 3D modelling
TCO calculation (Opportunity cost)
Implementation plan: initiative road map
Solution validation & justification
Chapter 9
Chapter 10
Chapter 11
Chapter 12
Chapter 13

Chapter 13: Case study Solution validation and justification

This chapter is comprised of three linked themes. Each of these themes outlines all the stated solutions in Chapter 12 and presents them within three different themes. Each theme outlines a method to test, validate and/or implement these solutions within the operational environment at the CDU. The first theme, which outlines the testing of solutions, was conducted through a computer-generated three-dimensional model. These findings helped validate the identified solutions as well as provide a simulated performance measure that could be achieved if these solutions were implemented. This chapter further outlines three total cost of ownership calculations, within the second theme. This calculation identifies potential performance improvements through cost saving as well as opportunity cost calculations, within the DSV operational process. The third and final theme presents an initiative road map, that provides a solution implementation programme for the remaining relevant solutions.

13.1. Computer Warehouse layout and simulation *(Theme 1)*

This report has outlined specific processes and their current performance levels, as well as the desired performance levels that management would like to see going forward. In order to achieve these desired levels of performance, specific solutions have been suggested. Some of these solutions have themselves been implemented and tested with great results. However, some solutions have not, yet these processes need to be improved in order to impact the POI and SLA. In order to do this a computer-based Warehouse layout and simulation of the DSV Healthcare and CDU facilities was built to simulate the possible impact the implementation of certain solutions could have on the POI and SLA performance levels (*Simulation specific images are presented within Annexure K: Simulation specific* images).

This simulation attempted to outline the improvement in processing performance that could be derived if the stock handover process, between Healthcare and CDU, was rectified. As outlined in section 10.2, the POI for Healthcare is currently in a *Typical* performance category, despite their measured performance set at a *Best-in-Class* performance category for private clients.

This simulation illustrates that if DSV CDU is given the same level of priority as DSV Healthcare's other clients, and the new receiving area is implemented, the overall performance, handover delays, back Orders/RTSs and headcount could improve across the board. In order to generate an accurate performance enhancement, two simulation cases were used.

The first simulation outlined the current process and the second outlined the operational process after the solutions were implemented. With this objective in mind, the computer simulation results were derived. Some of the model's images can be found it Annexure K.

13.1.1. Simulation KPIs

This simulation software used was developed and managed by Cirrus Logistics and is known as CLASS. This company specialises in simulated solutions for Warehouses, ports as well as simulation related to transport network development. This software allows for a two- or three-dimensional Warehouse model to be built to scale and overlays dynamic operational simulations over this structure to accurately represent day-to-day operations. This simulation software allows the operator to run a simulated week of operations based on the programming and derive KPIs for each process that is programmed into the model (Cirrus Logistics Ltd., 2017).

Once the base case for the case study was built and simulated, specific solutions and adjustments were made to the programming that allowed for a KPI measurement comparison to take place. Section 13.1.2 details the changes made to simulate the improved performance between Healthcare and CDU.

13.1.2. Simulated solutions

The areas chosen to be simulated have been used to impact the productivity and performance related to the reliability attribute, focusing deeper on the POI metrics. The case study description in Chapter 9, the Supply Chain strategic intent interviews in Chapter 10 as well as the problem identification and solutions development in Chapters 11 and 12 respectively, have led to this point. Suggested solutions will be tested to validate the potential improvement they would have if implemented. The following solutions were implemented in the simulated Warehousing model, which measured the performance output before and after the implementation.

Stock ordering quantities**:** This refers to the way the stock is ordered. The CDU will only order in case lot quantities, thus limiting the number of fine picks as well as the number of loose products being received at CDU. However, this solution is outlined in 13.1.4.1, there will be a significant amount of stock left over. This excess stock will be stored by province in the new racking layout**.**

Added MHE vehicles: The number of MHE vehicles were increased to accommodate the increase in bulk picking, outlined by the SOP to only order case lot quantities.

CDU Receiving area: The CDU has created a new bulk receiving area where the old returns department used to be. This receiving area has been fitted with a brand new conveyor belt to assist with the transportation of stock between the upper and lower levels.

Headcount productivity: Due to the increased use of MHE, the required number of operators has significantly decreased. These operators can now be redeployed to assist with other pick orders, improving performance further, as well as assist with housekeeping and manifesting of orders from Healthcare.

Reduction in Put-away/Retrieval times: The ability for Healthcare to increase case lot picking instead of fine picking, further increases their performance for the retrieval and put-away of stock. This increases overall dock to stock times in both directions (In and Out). This will benefit both companies as Healthcare does not have to waste time in fine picking specific orders for the CDU. The CDU will have reduced the number of backorders/RTSs due to the case lot quantities being stored in their own provincial racking.

13.1.3. Simulation results

Based on the above-mentioned solutions that were implemented, the following combined effect in KPIs was measured. This KPI comparison took place between the base case and the enhanced simulation case for all solutions proposed in section 13.1.2 These KPIs are presented in Table 13.1.

Table 13.1: Simulated KPI comparison-Before and After proposed solutions

Process Component	Key Performance Indicator (KPI)	Unit of Measure (UOM)	Before Suggested Solution	After Suggested Solution	% Variance
Inbound	Total Inbound Flow	Total Vehicles	6	6	0%
	CDU Receiving	Vehicles	8	10	20%
	Waiting Vehicles	%	43	31	-39%
	Waiting at dock	%	0	0	0%
	Waiting for handover	%	75	50	-50%
	Unloading waiting time	Hours	7,85	3,47	-126%
Put away	Total Put-away Flow	Pallets	70	80	13%
	Health-Care Bulk racking	Pallets	30	30	0%
	Fine Pick CDU	Pallets	40	50	20%
Outbound Flow	Late delivery to CDU	%	100	100	0%
	Late delivery to CDU	Hours	51,2	25,78	99%
	Health-Care Retrieval	Pallets	107	120	11%
Labour Usage	Overall Shift utilisation	%	56,2	74,5	25%
Infrastructure metrics	Dock Utilisation	%	95,5	68	-40%
	Marshalling Areas	%	172,4	70,2	-146%
	Material Handling Equipment (MHE) Usage	%	100	100	0%
	Storage Area Congestion	Hours	0,62	0,65	5%
	Outstanding Tasks	Tasks	21	0	100%

The computer simulation allowed for each of the selected solutions to be implemented as if in a real-world situation. As a result, the KPI results speak for themselves. The data outlines an significant improvement in the entire stock handover process between Healthcare and the CDU. The negative percentage change was not shown in red, the most common colour for negative results, because negative results outline a change in value that was less than the original. In some cases, this is a positive result, showing an improvement in performance.

For the purpose of this analysis, each process component will be discussed to provide context of the performance level achieved and its impact on the challenges previously identified in sections 11.1 and 11.2. Please remember that this simulation was used to test the effect of the proposed solution. This simulation was built to simulate the stock handover process only, but does presume to be a direct comparison with all DSV operations.

13.1.3.1. *Inbound activities*

The process category encompasses all activities surrounding the incoming flow of stock into the facility. This involves the receiving, unloading, and staging of vehicles. This category also incorporates the stock movements surrounding storage and put-away, as identified by Table 13.1.

13.1.3.2. *Waiting time improvements*

The most prominent improvement in this category lies in the unloading waiting time as well as the waiting for handover delays. This is due to the case lot quantities. All stock moved between Healthcare and CDU is now completed as bulk and therefore, there are fewer delays than in fine pick manifesting. This improvement reduces the total order cycle time for the CDU and further improves the lead time for operations, once scheduling is complete.

13.1.3.3. *Number of vehicles received*

This metric is specific to the simulation as it outlines the amount of stock that is received. Therefore, the more vehicles, the more stock. The reason for such a metric is based on the background programming and basic structure the simulation is built upon. The increase in the amount of stock being received is evident based on the case lot quantity solution. Remember that all excess stock will be stored for the subsequent batches.

13.1.4. Put-away activities

This category outlines the simple process of putting stock into its allocated location within the designated storage area. The following metrics represent Healthcare bulk racking as well as the CDU’s new four province racking.

13.1.4.1. *Fine pick CDU*

Due to the focus on the amount of stock that is required due to the stock ordering solution, the increase in stock being received at CDU is inevitable. This is important as it will limit the total amount of orders the CDU will have to place with Healthcare. This reduction in orders improves production lead times as well as increasing stock accuracy, while significantly reducing the number of back orders.

13.1.5. Outbound activities

This activity demonstrates how efficient the retrieval and dispatching process is between Healthcare and CDU.

13.1.5.1. *Late delivery Healthcare (Hours)*

This metric outlines the delay in total hours it takes Healthcare to fulfil a CDU order. This includes the delay experienced with RTS. The production managers outlined the delay for RTS to be between 2–3 days depending on other circumstances. Therefore, the initial metric of 51.2 hours is in effect, 2.13 days, which is well within the identified performance metric above. The simulated improvement puts this new figure at just over a day.

13.1.6. Labour usage

This metric category outlines the personnel and operators involved in the Healthcare and CDU process. Due to the stock changers as well as the increase in MHE requirements, the overall labour utilisation was determined. Please note that the recommendation for this solution is not to retrench these employees but rather to redeploy them to other activities in the Warehouse.

13.1.6.1. *Overall labour utilisation*

This metric is very straightforward, due to the implemented solutions the number of heads in this relevant departments could be used elsewhere, reducing the number of heads required to perform the same tasks. Coupled with this, was the increased use of MHE to account for the implementation of bulk stock order; all these changes outlined the 33% improvement in overall labour utilisation.

13.1.7. Infrastructure metrics

These metrics outline all those KPIs that measure the infrastructure within the Warehouse. These are the assets, areas and processes required to conduct business as usual.

13.1.7.1. *Dock and marshalling area utilisation*

Due to the limited amount of stock activities required for CDU orders, the amount of dock time and space are reduced. This is accentuated by the fact that the CDU orders are no longer made the last priority. Once the stock is picked, the delay in dispatch and receiving between the two facilities is reduced. This is good as it allows these areas to be used for other value-added activities or preparing other orders.

13.1.7.2. *MHE usage*

This metric looks very peculiar due to the fact that the overall usage removes unchanged. However, despite the marginal increase in the MHE required for the process, DSV Healthcare and CDU could make use of more MHE than was initially simulated. This MHE requirement remains uncalculated and could be identified as a good area for future research to be conducted.

13.1.7.3. *Storage area congestion*

The overall storage area congestion increased marginally as a result of the increase in MHE vehicles. The more vehicles the more congestion in a finite operational domain. However, the overall increase in storage area congestion is a small price to pay for the overall improvements determined by the simulation.

13.1.7.4. *Outstanding tasks*

The most prominent of these identified in Table 13.1, is the number of tasks completed. In the base case simulation, 21 tasks were left uncompleted, this represents the amount of missing stock from a normal order scenario. The need to perform an RTS for the remaining stock is now no longer required.

13.1.8. Simulation overview and summary

This simulation forms part of a larger solutions section, the reason for this is outlined in the number and type of solutions simulated. DSV is a very innovative and progressive company in terms of its operations and the type of Supply Chain solutions it offers to its clients. This solutions section outlines several operational processes that have already adopted these solutions with positive impacts while others remain as theories. This simulation helps outline the overall improvement in operation and strategic performance that can be achieved if these solutions were implemented.

This testing ground allows for solutions to be tested and measured to weigh up the pros and cons before they are implemented. It allows for mistakes to be made in a computer-generated world rather than the real one. This testing is critical for identifying the most beneficial solution, especially if a company has limited resources and a performance target. This chapter allows for another solution section to validate and justify the other presented solution; this is the *total cost of ownership* section, presented as theme 2 within the chapter. Section 13.2 will outline the possible cost saving that can be achieved if some of these solutions are implemented. These solution chapters, namely *Chapter 12* and *Chapter 13*, although separate, confirm that a total company performance realignment is possible from strategic intent down to operational processes, people, and systems.

13.2. The Total Cost of Ownership *(Theme 2)*

This chapter outlines the possible cost saving potential that lies within the current processes and activities within DSV. For the purpose and scope of this research document, this chapter will focus specifically on cost saving initiatives pertaining directly to CDU processes. These cost calculations will help outline the amount of lost revenue or wasted revenue due to issues being experienced within the CDU. For ethical reasons, a total percentage of cost-saving aggregated monetary values will be presented as specific financial values are regarded as case-sensitive and cannot be presented.

The total cost of ownership refers to the culmination of all costs involved in a product's life cycle from generation to consumption. It is important that all costs contributing to the product's current value and position within the Supply Chain be considered when calculating its TCO. Therefore, all direct, indirect, related and opportunity costs must be included in this calculation, in order to gain a true representation of what the product/service costs.

This calculation is critically important to the business and Supply Chain due to the need to cover costs before making a profit. If the product cost is higher than the sale price, there is no derived benefit from that product and therefore, no return on investment (ROI) or growth. Without an understanding of TCO, no business can survive (Burt et al., 2010:15). There are four major elements that make up TCO. These elements outline the critical cost that needs to be included in the calculation. These groups are known as:

Direct costs: These costs incorporate all those expenses that were incurred in the procurement of the product or service. This refers to the physical purchase of the item.

Related costs: These are costs that are incurred due to outside parties in order to use or maintain the product.

Internal costs*:* These costs predominantly refer to those costs incurred through the Logistics function within the supply chain. Such costs include: storage, transportation or value-added activities.

Opportunity costs: These costs are incurred based on the choice that was made to procure the current product. These costs are always incurred when a decision between alternatives is made. These costs are calculated as the cost of the opportunity that was lost by making the current purchase decision.

Most companies make use of their own TCO calculations in order to build in more costs than would normally be applicable in the normal industry. These companies generally operate with specialty goods that are much more expensive to procure and sell, while other companies are content with a standardised calculation of TCO, which incorporates a standardised set of cost variables. In any case, there is only one desired outcome, to understand how much the product costs to get it into a position and state that it can be sold. This understanding then facilitates the sales price. Therefore, the TCO calculation is critical for any business model as it determines how much the product is worth.

Businesses and supply chains need to understand the value their products have, in order to remain competitive as well as remain successful. Therefore, managing costs is a means of performance management. Based on this calculation, companies can make decisions about their procurement needs, logistical needs and Outlining, and understanding which costs need to be included in this calculation for the different products and services within a business can be difficult.

According to Louw (2016), the *Life cycle cost model* can be used to identify cost elements that should be included in the TCO calculation. Therefore, understanding the costs associated with the Warehousing service that is provided by a company is also challenging, as there are numerous cost components to be considered in order to derive a true reflection of what this Supply Chain element will cost.

This total cost of ownership section will focus on two independent calculations each pertaining to two very important solutions. These two solutions are identified as The *Delivery vs Collection management*, and the *missing items RCA*. To determine the amount of TCO reduction that can be attributed to each solution, each of them was extensively investigated. These investigations resulted in the following outcomes.

13.2.1. Delivery vs Collection TCO management

This component outlines the need to consolidate delivery and collections on a single trip to each facility. As part of the defined SLA for the current National government tender, DSV should deliver and collect from every facility each week. DSV CDU currently services over 1 600 facilities in 22 districts across four provinces, driven by the need to meet service delivery requirements defined by the SLA, but also to manage costs while in the process of meeting this agreement. In order to outline the impact that current lost opportunity costs had on the potential monthly turnover, the following TCO calculation was conducted. The calculation outlines the current gross turnover (*defined as 100%*) while subtracting the lost opportunity costs (*calculated as a percentage of total gross turnover)* to determine the net turnover.

Please note: *This calculation defines each lost opportunity cost element as a percentage of total gross turnover. This has been done to aggregate and desensitise potentially sensitive company- specific information.*

This calculation outlines lost opportunity costs in the provision of services within the Supply Chain and Warehousing processes used during the ordinary course of business. This means that the following *lost opportunity cost elements* are a result of inefficient activities, processes and performances within a given month of operations. The following lost opportunity elements are presented in Table 13.2.

Table 13.2: Gross turnover impact due to lost opportunity elements

Defined turnover	Lost opportunity cost elements	Percentage impact (%)
Gross turnover		100,00%
	Delivery vs collection	-1,17%
	Returns from despatch	-0,45%
	Late deliveries	-2,22%
	Missed scripts	-15,36%
	Parcel returns	-0,26%
	Out of stock	-0,26%
Net turnover		80,28%

The lost opportunity elements presented in Table 13.2 outline percentage impact calculated as a percentage of gross monthly turnover due to inefficiencies within the Supply Chain and Warehousing processes. Each of these opportunity elements outlines a problem or problems as defined in Chapter 11. Being able to quantify the financial impact current process problems have on the company's bottom line is critical to impact and influence *solutions generation* and help with the *justification* of solutions implementation. This type of measure helps drive *continuous improvement* initiatives to ensure that these cost elements are continuously monitored and managed. The impact these lost opportunity elements have on gross turnover is further presented in Figure 13.1.

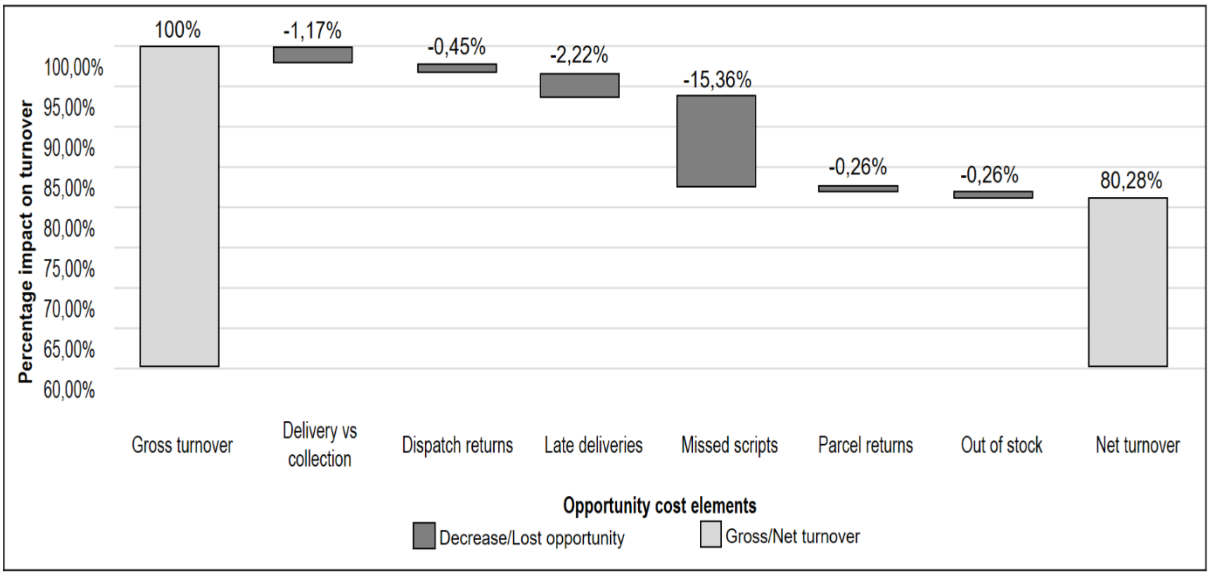


Figure 13.1: Total opportunity cost as a percentage of gross turnover

All the cost elements outlined in the calculation contribute to monthly losses in potential turnover. The cost implications associated with these operational processes and their impact on turnover potential of the company is critical to this section. The need to manage the delivery and collection of all parcels and scripts between the facilities and the CDU is critical to unlocking potentials in cost saving and ultimately profit potential.

The total cost-saving potential in terms of total revenue equates to a 19.72% opportunity cost due to inefficient processes for an average month. This equates to tens of millions of rand a year that could possibly be saved through continuous improvement solutions.

Considering those solutions that have already been implemented by the strategic management, as well as operational efficiencies and process changes that have taken place, the company is already well on its way in rectifying these inefficiencies. Understanding the need for such calculations and how they can improve and isolate issues within the organisational Supply Chain structure is very important. To take this understanding further, another TCO calculation was conducted to determine the opportunity cost of missing items that occur in operations.

13.2.2. Missing item TCO management

The total cost of ownership calculation can also be used to identify alternative costing structures depending on the outcome of a specific process. This concept is tested with the missing items issues in the dispensary department. Every time an item goes missing the entire PMP is sent to the dispensary. This item could possibly be found and booked into the missing storage area for the dispensers to pick the item, verify the PMP and send it to dispatch. However, in some cases, the item will have to be redispensed, labelled and consolidated into a new PMP bag, all of which will add more costs to the initial costs of the PMP had it gone through the normal production processes. Table 13.3 outlines the cost components to rectify a missing item.

The result of this missing item costing analysis identified two distinct costings, each dependent on the type of manual bag used to enclose the *redispensed PMP*. The labour costs and consumable costs remain unchanged no matter the size of the bag used. The total number of missing items on average per month is used to calculate the opportunity cost lost due to missing items. The CDU predominantly makes use of small ambient bags when completing the redispensing of missing items. Therefore, the total cost-saving potential if the missing item's challenges were rectified is a total of R600 000 *(aggregated per annum)*.

Table 13.3: Missing item cost component breakdown

Labour Cost Drivers	**Assumptions**	**Rand value**
Salary per PBP	Estimated	R XXXX
Per day	22 working days Per Month	R XXXX
Per hour	7,25 productive Hours per shift	R XXX
Per minute	60 Minutes in an Hour	R XXXX
Cost per item *(Labour)*	Cost per minute (above) x Ave Items P.M.	R1,45
PMP Cost Drivers *(Consumable material)*	**Assumptions**	**Rand value**
Bagger machine bag	Weight of bag @ 14.525 grams	R0,83
Bagger machine Label	1 per bag	R0,18
Cost per New Large bag	Procurement cost	R1,01
Cost per New Small bag	Procurement cost	R0,50
Dispensed Label	Procurement cost	R 0.11
Total material cost	N/A	**R2,52**
Cost Drivers *(based on bag size)*	**Assumptions**	**Rand value**
Total Cost- Large bag		R3,47
Total Cost- Small Bag		R2,96
Cost of missing items (*Single Batch)*	**Assumption**	**Rand value**
Total cost @ large bag	*Based on an average number of missing items per month*	R 60 000
Total Cost @ small bag	*Based on an average number of missing items per month*	R 50 000

13.2.3. Returns reprocesses

This process outlines a situation whereby a patient has not collected their PMP for their 3rd and 4th repeats, therefore this PMP has been returned to the CDU. Normally this PMP would be broken down (as in the above explanation). However, the patient's medication requirement does not change for a full six months, therefore, the medication that is in the returned PMP would in effect be the same as the next set of medication. If the parcel remains unopened, GPP dictates that the parcel is still deemed to have been dispensed correctly, if the outer PMP label were to be "updated" to identify the PMP as a 5th and 6th repeat with the new next collection date (NCD) as well as date to courier on it.

This PMP would not need to be remade but rather "redispensed" using the same medication that was used previously. In effect this PMP would bypass any/all processing and just be containerised and dispatched. This process would result in a major cost-saving for the CDU as well as help improve upon the SLA and service delivery to patients.

13.2.4. Cost implication

If we assume that the 3rd and 4th repeats that did not get collected are deemed to be a sunk cost, then the cost of producing a new PMP would ultimately define the amount of money saved depending on the new costing analysis. For example, using an Eastern Cape PMP, the following cost breakdown outlines the costs incurred in reprocessing a returned PMP outlined in Table 13.4.

Table 13.4: Cost contributors to PMP costs

Cost Category	Cost drivers	Costs
Material Costs	New PMP Label	R0,18
Material Costs	Container Label (inner)	R0,11
Material Costs	Box Cost - Size 2	R2,10
Material Costs	Waybill (outer)	R0,19
Material Costs	Gum Tape	R0,05
Labour Costs	Cost per PMP	R1,30
Labour Costs	Total Cost per Reprocessed PMP	**R3,93**

If an Eastern Cape PMP were to be reprocessed, the following cost structure is presented in Table 13.5. For ethical reasons the following sensitive information has been removed.

Table 13.5: Reprocessing Opportunity cost structure

PMP Initial cost break down	
Rate per PMP (Eastern Cape Example)	R XXX
Assumption: Profit margin 30%	R XXX
assumption: Cost associated to PMP creation I.E. Picking, sorting, labelling & Transport (Transport included)	R XXX
Less: Transport Costs (50% of Cost) *Transport must be incurred to get parcel to the patient*	-R XXX
CDU Cost per PMP	**R XXX**
Cost of Re processed PMP	**R3,93**
Estimated Normal cost for 5th and 6th Repeat PMP *if the PMP was made from scratch*	R XXX
Estimated actual cost for 5th and 6th due to reprocessing	R3,93
Potential Cost saving	**R9,01**

Assuming that the Profit margin is 30% of the total cost, therefore the remaining 70% would be allocated to all costs associated to getting that PMP into a suitable contribution for the patient. Therefore, if the cost to manufacture a PMP including its transport costs is 50% of total cost of manufacturing a PMP at the CDU.

Considering the *Cost of reprocessing* at R3.93 the total cost saving would equate to R9.01, added to this is the profit margin. If half the number of monthly returns can be reprocessed, then the cost saving amount of R9.01 x (number of returned PMP/0.5) = Cost saving. The opportunity cost of this process is outlined in Table 13.6.

Table 13.6: Revenue potential for reprocessing initiative

Potential Revenue Creation & Cost saving	
Volume of returns May	8446
Reprocessed Potential	4223
Cost saving based on Reprocessing	R 38 000
Total Business value potential including savings	R 85 000

The benefit of understanding the total costs assigned to all the different processes and activities within any organisation is critical, not only to identify cost-saving initiative but also to isolate and identify process inefficiencies. Understanding a problem is part-way to solving it, determining how to solve it can be brought about through a costing analysis, thus influencing the decision of which solution will be implemented. The TCO calculation is beneficial to derive performance enhancements and initiate cost-saving objectives but also identify which solution will be implemented.

13.3. Solution implementation: An initiative road map *(Theme 3)*

This *initiative road map* was developed to outline those operational solutions that could impact several of the problem areas outlined within *Chapter 11*. These solutions focus particularly on the sorting and dispensary processes outlined in section 9.6.3 and 9.6.5. The reason for this is based on the complexity of these processes as well as the potential costs involved in corrective action. In order to determine a hierarchy for implementation, each initiative is given a priority, which is allocated to each solution. This is done to make this proposed plan as efficient and impactful as possible, with a minimum of disruption and delay.

This road map is divided into different work projects outlined in Figure 13.2. Each work project focuses on an area, while outlining a possible, high-level timeline for each project. Within some work projects, there is also a cost and impact scale attached, to assist in the decision-making process. As a result, the following initiative road map is presented.

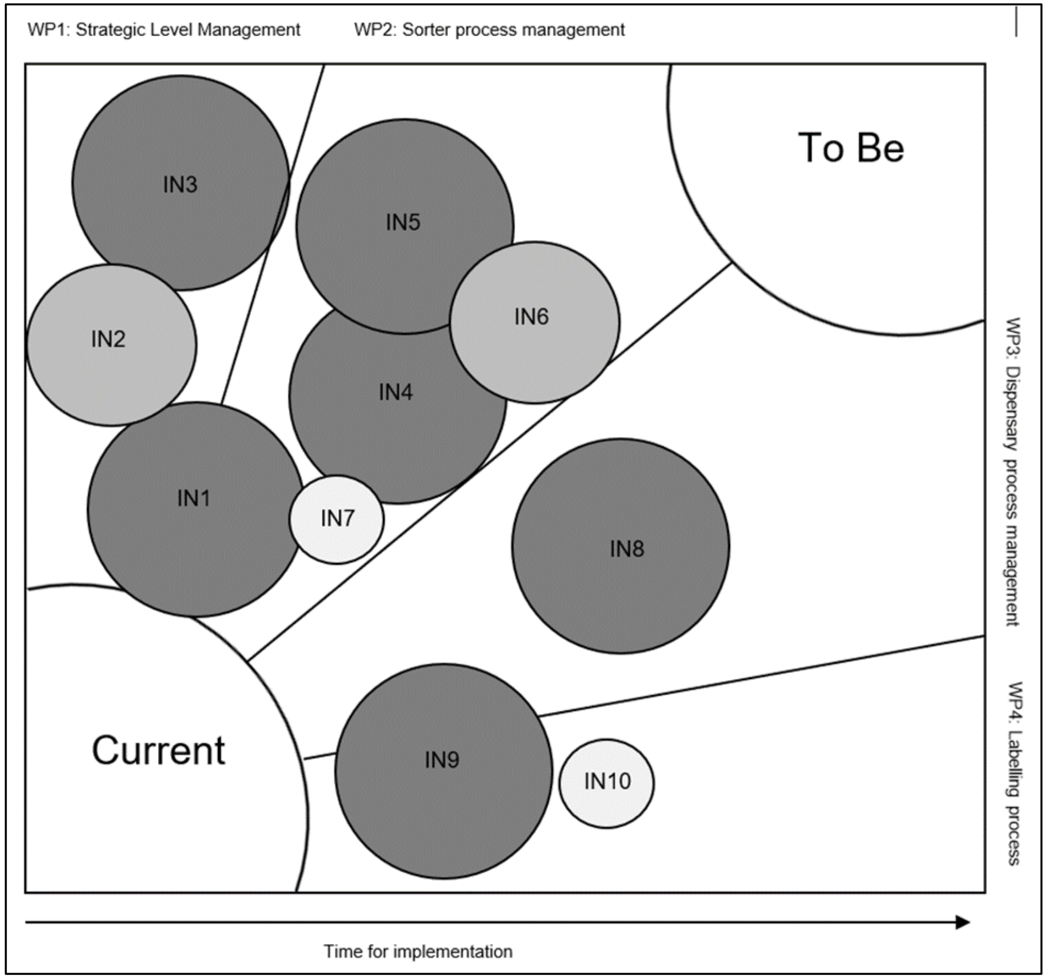


Figure 13.2: Initiative road map infographic for implementation

Size of circle reflects importance

High level of performance impact

Mid-level of performance impact

Low level of performance impact

Table 13.7: Initiative road map word project list

Code	Work project	Problem	Initiative	Solutions
P1	WP1.1	Shortages, Non-scans and Rejects	IN1	S1
P2	WP1.2	Interdepartmental communication	IN1	S2
P3	WP1.3	Planning, forecasting and decision making	IN1	S3
P4	WP1.4	Induction scanner accuracy for rejects	IN2	S4
P5	WP1.5	Miss drop items-Sorting process	IN3	S5, S6
P6	WP2.1	Shortages, Non-scans and Rejects	IN4	S6, S7, S8
P7	WP2.2	Lack of defined roles for GA's	IN4	S9
P8	WP2.3	Incorrect control sheets	IN4	S10
P9	WP2.4	Reintroducing chute verified items	IN5	S11
P10	WP2.5	Volume of work/items for missing items	IN5	S12
P11	WP2.6	Labelling, network and out of sequence	IN6	S2, S3
P12	WP2.7	Consumable stock losses	IN7	S13
P13	WP3.1	Label, shortages, missing, PMP verifications	IN8	S2, S3
P14	WP3.2	Missing items product storage issues	IN8	S14
P15	WP4.1	Machines breakdown, Downtime	IN9	S2
P16	WP4.2	Unmeasurable labelling performance	IN10	S3, S15

Table 13.8: Solutions description list used within implementation plan

Code	Identifier	Description
S1	Euro sort-maintenance	The original manufacturers need to be tasked to come and conduct in-depth maintenance to rectify any issues that could be caused by excessive use of the machine over the past few years.
S2	Error reporting/ Performance reporting	Refers to the new Batch reports & monthly performance reports that have been generated to track improvements within the CDU.
S3	Batch performance reports (trend analysis)	Refers to the new Batch reports & monthly performance reports that have been generated to track improvements within the CDU.
S4	Equipment upgrade (scanner & PC)	New equipment is required in the sorting platforms to ensure the accuracy of the scanning is improved,
S5	Sorter cleaning	Each induction tray needs to be cleaned on a regular basis in order to limit the number of miss drops and errors that are currently being experienced during the sorting process.
S6	Camera alignment	The induction teams must all be trained in how to realign the sorting camera to limit the number of rejects that have occurred in the past from a misaligned camera.
S7	Induction time per site (lengthen)	The induction teams should focus on inducting the products in the correct positions within the induction trays. Currently, there is a significant amount of downtime for both induction teams, that could be better utilised if accuracy was applied.
S8	Induction position of item	At the moment, there is no specific induction position being used by the induction teams. This creates a large variance in the camera's scanning ability due to the variety of placements for the product. Teams should focus more attention on repeatedly inducting in the same position within a sorting tray.
S9	Induction teams	The refers to defined the roles of the induction teams. There should be two operators inducting while the third operators are a QA and flipper for any products that are inducted incorrectly. These teams can revolve per drop however, each position must be filled during every drop.
S10	Control sheet collection/Drop boxes	New control sheets have already been implemented. However, each operator within the CDU must be responsible for dropping off and collecting their own control sheets before and after every batch.
S11	Rolltainer storage by sorter teams	This refers to the missing items re introduction process that was implemented during batch 217. This allows the operator of the missing item to verify the products and then categorise them for the induction teams. The operator, however, does not have the responsibility of finding the correct sites, it is the induction teams' responsibility to do this.

Table 13.8: Solutions description list used within implementation plan (Continued)

Code	Identifier	Description
S12	Two GAs required for the position	Due to the complexity and volume of work that the operator of the missing item is responsible to fulfil, it is recommended that this position be completed by two operators.
S13	Consumable recording procedure	Several consumables are used throughout the process, particularly within the sorting process. It is recommended that appropriate recording be implemented to monitor the use of these consumables in order to justify the current expense.
S14	Re-organise missing items storage for dispensary	The current storage of the missing items is highly complicated and very cluttered. With the Western Cape tender coming to an end, it is recommended that this area be expanded to help the dispensary operators to find the items they require with greater ease.
S15	Control sheets for each labeller	This refers to the implementation of a further reporting standard. However, these sheets are currently being used but no reports are being generated. Therefore, it is recommended that these control sheets be used.

In the following pages each initiative is described in more detail relating to the different work project presented in Table 13.8. Each of the following initiatives is covered in greater detail pertaining to cost and impact of implementation:

- *IN 1 & 2 Strategic level management*
- *IN 3,4,5,6 & 7 Sorter process management*
- *IN 8 Dispensary process management*
- *IN 9,10 Labelling process*

Please note: *The format of this document is different from conventional formatting as the layout helps outline and connect key concepts together. It is also presented in this format as it was when it was presented to the case company.*

Rating scale: The rating scale used in this *initiative road map* makes use of two rating scales. The first outlines the level of impact each initiative has. The second defines the cost implications of achieving these impacts. Therefore, the RAG (Red, Amber and Green) colours have been used to define each rating scale. Please note, for the impact rating scale, the green represents the highest level of impact, while the red is the lowest level of impact achievable. For the costing rating scale, the red dot represents the highest cost, while the green dot represents the lowest cost incurred to achieve the corresponding level of impact.

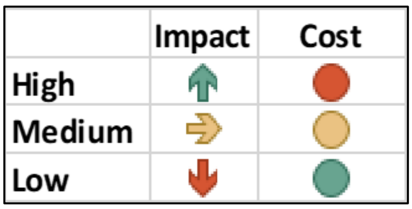


Figure 13.3: Initiative road map rating scales defined

DSV Initiative document	Version 1.1	Date: 30 August 2019
No: IN 1 & 2	**Strategic level management**	

Description: *What does the initiative entail*

The Strategic level management initiative refers to the overarching business management decisions required in both short-term and long-term business planning. Through this work project, high-level decisions regarding the implementation of new standard operating procedures (SOPs) can be taken while ensuring interdepartmental communication to achieve the outlined strategic level business objectives and identified initiative.

This initiative requires a variety of decisions to be made with a variety of cost implications. The appropriate level of approval is required in order to initiate the implementation of solutions. Furthermore, it is the responsibility of strategic level management to **coordinate** all **performance improvement initiatives**. This will ensure that appropriate levels of attention and training are provided to each department and process within the CDU.

Problem(s): *How will this initiative contribute to solving the problem(s)*

Work Project	Problem	Problem description	Solution	Priority	Level of priority	
WP1.1	P1	Shortages, Non-scans and rejects	S1		**High**	
WP1.2	P2	Interdepartmental communication	S2		**Medium**	
WP1.3	P3	Planning, forecasting decision	S3		**Low**	
WP1.4	P4	Induction scanner accuracy for rejects	S4			
WP1.4	P5	Miss drop items- sorting process	S5,S6			

Solution (s): *What solutions suggested could contribute*

Code	Solution	Impact	Cost		Impact	Cost
S1	Euro sort-maintenance	↑		**High**	↑	
S2	Error reporting/ Performance reporting	↑		**Medium**	→	
S3	Batch performance reports (trend analysis)	→		**Low**	↓	
S4	Equipment upgrade (scanner & PC)	↑				
S5	Sorter cleaning	→				
S6	Camera alignment	↑				

Actions, Process, mechanisms, Guidelines, and best practices: *To best get the initiative implemented*

In terms of implementation for these strategic-level management initiatives, it is critical to implement those solutions that have the **highest impact** with the **lowest cost** implications on the business. These solutions represent the "*low hanging fruit"* in terms of derived solutions. These solutions generally refer to the need for and importance of implementing/continuously reporting on CDU performance in all departments. These reports will allow appropriate decisions to be made regarding workflow planning in terms of time frames and collection dates.

In conjunction with the reporting standards interdepartmental communication is critical for the success or failure of this initiative. It is, therefore, the responsibility of the Business Unit Manager to coordinate the communication platforms and meetings between the relevant parties in order to successfully implement solutions for an effective result. Those solutions that have the highest cost incurred for implementation require strategic level management approval before they can be implemented into tactical or operational levels of management. However, the impact of these costly tasks could result in a greater impact on performance than the lower cost initiatives.

In conclusion, it is important to understand that this Work project is responsible for all high-level management decisions that will impact all other work projects. Therefore, understanding the management level of this initiative will impact the understanding of the initiatives to come and how they will be impacted by these decisions.

Responsible Stakeholder: *Who is responsible/will take ownership of initiative*

Business Unit Manager: Michael Rossi (DSV-CDU)

General Manager: Florian Menold (DSV)

Inhibiters to solution implementation: *Look out for killer concerns*

Solution implementation not a priority

Delay in implementation

Miscommunication in prioritisation of solution decisions

DSV Initiative document	Version 1.1	Date: 30 August 2019
No: IN 3,4,5,6 & 7	**Sorter process management**	

Description: *What does the initiative entail*

This initiative is responsible for all the induction, sorting and dispatching of all patient PMPs. This process is highly automated, thus requiring continuous monitoring to ensure that all performance targets are being met. This area has been the focus for several months of performance analysis to understand the trend for several issues that have been arising lately. The problems identified in this plan have been derived from that report. Furthermore, the extensive number of solutions derived for this process results from the fact that this process is the most problematic to date.

It is also important to mention that all the issues that result from this process are linked to the preceding processes known as **Dispensary process management** (WP3) in this report. Therefore, understanding that solving one issue within WP2 will alleviate significant issues in WP3. This is only applicable if these two work projects take the highest priority within this document. Despite this, the approval of WP1 is the *lynch pin* for the implementation of the solutions derived in WP2 and WP3.

Problem(s): *How will this initiative contribute to solving the problem(s)*

Work Project	Problem	Problem description	Solution	Priority	Level of priority	
WP2.1	P6	Shortages, Non-scans and rejects	S6,S7,S8		**High**	
WP2.2	P7	Lack of defined roles for GA's	S9		**Medium**	
WP2.3	P8	Incorrect control sheets	S10		**Low**	
WP2.4	P9	Re-introducing chute verified products	S11			
WP2.5	P10	Volume of missing items	S12			
WP2.6	P11	Labelling, Network and out of sequence issues	S2, S3			
WP2.7	P12	Consumable stock losses	S13			

Solution (s): *What solutions suggested could contribute*

Code	Solution	Impact	Cost		Impact	Cost
S1	Euro sort-maintenance	↑	🔴	**High**	↑	🔴
S3	Batch performance reports (trend analysi	→	🟢	**Medium**	→	🟡
S7	Induction time per site (lengthen)	↑	🟢	**Low**	↓	🟢
S8	Induction position of item	↑	🟢			
S9	Induction teams	↑	🟢			
S10	Control sheet collection/Drop boxes	↑	🟢			
S11	Rolltainer storage by sorter teams	↑	🟢			
S12	Two GAs required for position	↑	🔴			
S13	Consumable recording procedure	→	🟢			

Actions, Process, mechanisms, Guidelines and best practices: *To best get the initiative implemented*

In terms of implementation for these strategic level management initiatives, it is critical to implement those solutions that have the highest impact with the lowest cost implications on the business. These solutions represent the “low hanging fruit” in terms of derived solutions.

The predominant solution refers to a reorganisation of the existing SOP implementation. Furthermore, some retraining may be required due to the implementation of the new control sheets as well as a specific focus on the induction teams. This will reiterate the importance of good performance, as well as help reduce the number of errors that occur.

Finally, the inclusion of the operator of the missing item is critical to this process as most issues, if identified early enough, could be rectified without the need for the Dispensary. This position is critical to the continuation and dispatching of the batch and should be a very high priority.

Responsible Stakeholder: *Who is responsible/will take ownership of initiative*

Sorting supervisor: Judith Henricks

Business Unit Manager: Michael Rossi (DSV-CDU)

Inhibiters to solution implementation: *Look out for killer concerns*

Change management failure

Lack of retraining and implementation

Neglect by controllers to implement updated SOP

DSV Initiative document	Version 1.1	Date: 30 August 2019
No: IN 8	**Dispensary process management**	

Description: *What does the initiative entail*

This initiative refers to the activity conducted pharmaceutical personnel; therefore, this area results in a large cost centre due to the need for highly qualified personnel to fulfil the position (GPP). This department is responsible for not only all issue resolution with patients' PMPs but also for the dispensing of abnormal (size, shape, weight and quantity) medications. This process is not automated, therefore the number of items/Scripts requiring resolution has increased (based on previous study) and it is therefore is extremely time-consuming.

Although this department is not directly involved in the creation of the issues within the CDU, performance review is required to ensure that the appropriate level of output is being achieved. The following problems were identified.

Problem(s): *How will this initiative contribute to solving the problem(s)*

Work Project	Problem	Problem description	Solution	Priority	Level of priority	
WP3.1	P13	Label, shortages, missing items, PMP verifications	S2,S3		**High**	
WP3.2	P14	Missing items product storage	S14		**Medium**	
					Low	

Solution (S): What solutions suggested could contribute

Code	Solution	Impact	Cost		Impact	Cost
S2	Error reporting/ Performance reporting	↑		**High**	↑	
S3	Batch performance reports (trend analysis)	→		**Medium**	→	
S14	Re-organise missing items storage for dispensary	→		**Low**	↓	

Actions, Process, mechanisms, Guidelines, and best practices: *To best get the initiative implemented*

This initiative mainly requires performance reporting to better understand how effective each controller is at fulfilling the required number of PMPs per hour. This department report will be incorporated into the batch performance report to understand the number of corrections per batch over time, in order to facilitate an understanding if an improvement has been achieved. Furthermore, the reorganisation of the storage of the missing items should help promote better performance for the dispensers.

Responsible Stakeholder: *Who is responsible/will take ownership of initiative*

Dispensary supervisor: Antonio Els

Business unit manager: Michael Rossi

Inhibiters to solution implementation: *Look out for killer concerns*

Unknown

DSV Initiative document	Version 1.1	Date: 30 August 2019
No: IN 9,10	**Labelling process**	

Description: *What does the initiative entail*

This process is responsible for the labelling of all medication that is required to fulfil a patient's PMP. This process is partly automated and partly manual. This is due to the wide variety of products that are required. Therefore, not all products can be labelled via machine. However, the machines play a larger role than hand-labelling, therefore any machine issues experienced in this department will create a large backlog of work. Furthermore, understanding the importance of label accuracy is critical to avoid incorrect medication being sent to patients. Finally, the sorting process is reliant on this process as the induction cameras sort the product using three-dimensional barcodes. Thus, if the label is damaged or printed incorrectly, the item will not be scanned and will have to be rectified at the dispensary.

Problem(s): *How will this initiative contribute to solving the problem(s)*

Work Project	Problem	Problem description	Solution	Priority	Level of priority	
WP4.1	P15	Machines break down, downtime	S2		High	
WP4.2	P16	Unmeasurable labelling performance	S3,S15		Medium	
					Low	

Solution (s): *What solutions suggested could contribute*

Code	Solution	Impact	Cost		Impact	Cost
S2	Error reporting/ Performance reporting	↑		High	↑	
S3	Batch performance reports (trend analysis)	→		Medium	→	
S15	Control sheets for each labeller	→		Low	↓	

Actions, Process, mechanisms, Guidelines, and best practices: *To best get the initiative implemented*

The implementation of the above-mentioned solutions is relatively straightforward since the control sheets have already been implemented. Therefore, only the performance report templates need to be developed and the capturing of these stats needs to be conducted in order to execute the reporting procedure.

13.3.1. Outcome of the initiative road map

This theme outlines the potential differences between solutions. This is repeated through the impact and cost measures certain of these solutions have. The purpose of these categories is to outline the most cost-effective yet beneficial solution for a given problem. Often, there are very low-cost solutions that have high rewards in terms of output. These solutions are often referred to as low hanging fruit. It is for this purpose that this theme was developed.

Each of these themes has been developed to outline the possible directions problem identification and solution generation can take within a performance benchmarking and gap determination analysis such as this. The section outlines three different methods for solutions testing, validation and implementation to help the case company manage their performance/process exceptions as well as assist with change management. This will ensure that the problem, not the symptom, is diagnosed and fixed to derive lasting performance improvements. From this, specific conclusions and recommendations have been identified, based upon the entire research document, to summarise all relevant theories, findings, and outcomes of this research.

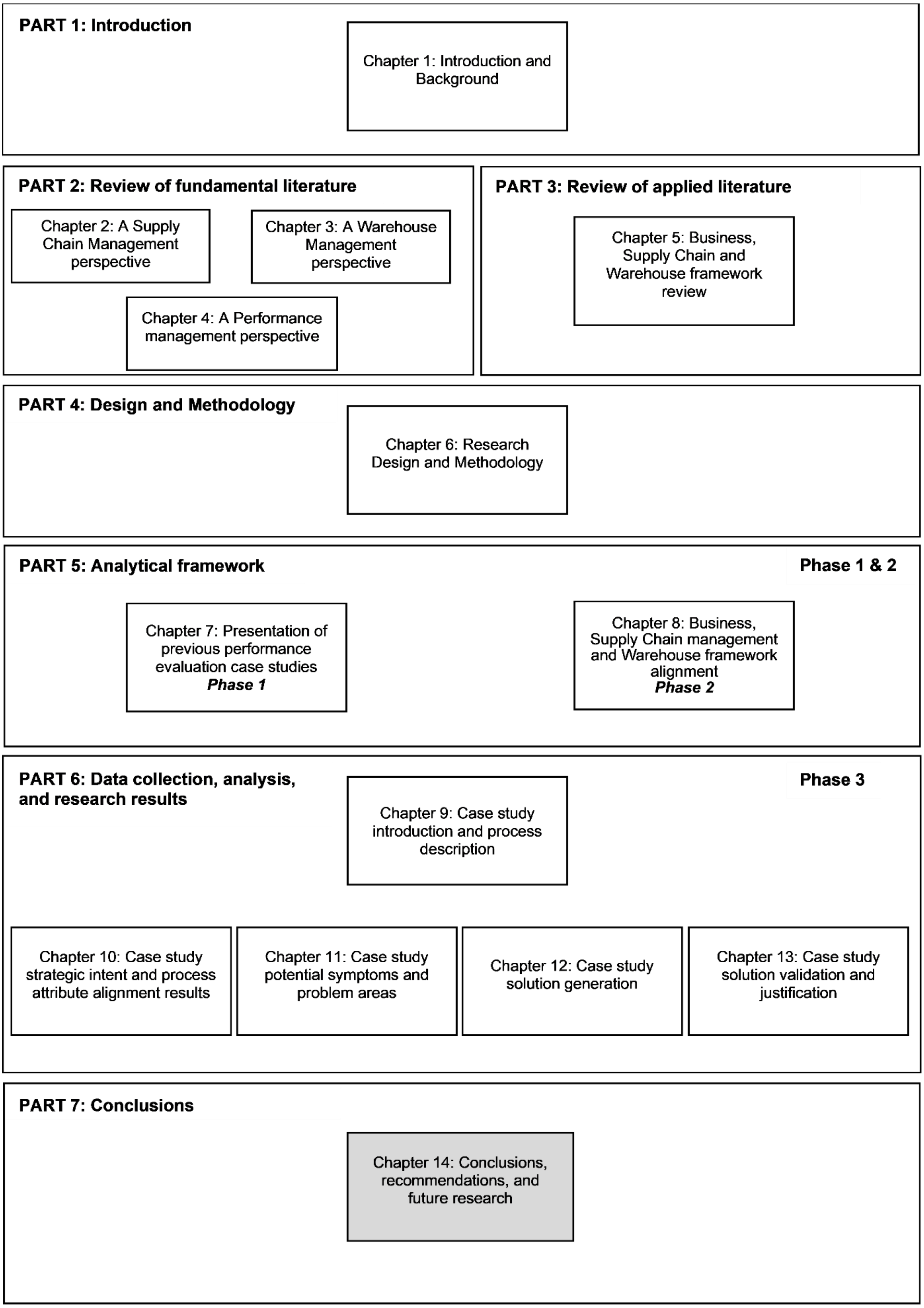
PART 7

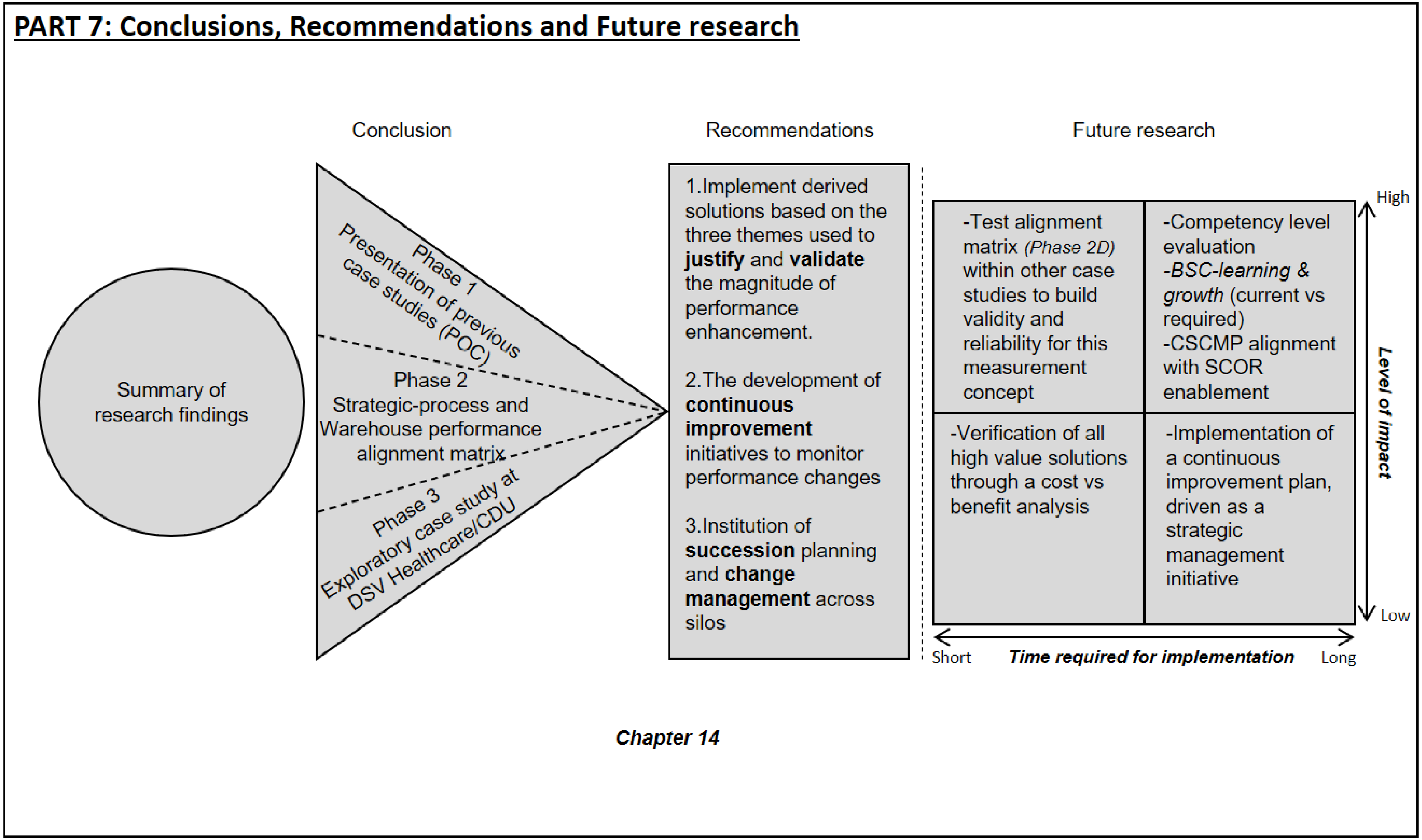
CONCLUSIONS

◈ Chapter 14: Conclusions, recommendations, and future research

This section of the report outlines the consolidated research results and conclusions derived from the three phases of research that were conducted. To conclude this research each phase's findings will be summarised and presented to validate the previously identified research objectives. Based on each phase's conclusions, recommendations have been made to the case company that helped address the performance gaps identified within the data collection, analysis and results presented in phase 3-Chapters 9,10,11,12 & 13. The final section identifies future research, this outlines focal areas, that can be studied further improve the findings of this research.

PART 7: CHAPTER 14
CONCLUSION, RECOMMENDATIONS AND FUTURE RESEARCH




PART 7: Conclusions, Recommendations and Future research
Conclusion
Recommendations
Future research
Summary of research findings
Phase 1
Presentation of previous case studies (POC)
Phase 2
Strategic-process and Warehouse performance alignment matrix
Phase 3
Exploratory case study at DSV Healthcare/CDU
1.Implement derived solutions based on the three themes used to justify and validate the magnitude of performance enhancement.
2.The development of continuous improvement initiatives to monitor performance changes
3.Institution of succession planning and change management across silos
-Test alignment matrix (Phase 2D) within other case studies to build validity and reliability for this measurement concept
-Competency level evaluation -BSC-learning & growth (current vs required) -CSCMP alignment with SCOR enablement
-Verification of all high value solutions through a cost vs benefit analysis
-Implementation of a continuous improvement plan, driven as a strategic management initiative
High
Low
Level of impact
Short
Time required for implementation
Long
Chapter 14

Chapter 14: Conclusions, recommendations and future research

The objective of this chapter is to provide a summary of the research conducted, a conclusion of the research within the document as well as the exploratory case study results. This will be done by reviewing the research problem and objectives regarding implementation and future research.

14.1. Research Problem

The problem statement is based upon the deductions made from the extensive literature reviews conducted in Chapters 2,3 and 4. The literature review results outline the identification of the problem statement.

The following deductions derived from the review of existing literature related to Supply Chain theories and concepts:

A review of the terms Supply Chain and Logistics outlines a progressive and sustainable change in thinking amongst practitioners regarding the different roles and responsibilities each of these terms have in the field of study and how each of them impacts the fast-paced consumer environment we live in today. The importance of customer involvement in the requirements and design of Supply Chains outlined the level of influence customers have on companies' Supply Chain strategies and processes in order to drive performance. This was furthermore confirmed by the identification of the five Supply Chain drivers used within the Chain. These drivers also helped to outline how responsive or efficient a supply chain could be based on the level of involvement each driver has.

In order to describe and manage performance in line with Supply Chain process strategy, Supply Chain process attributes were reviewed to help define the different focal points each Supply Chain could have, related to its desired objective.

In order to accurately measure a company's operational processes in line with its strategic intent, several Strategies and process frameworks were identified. To help outline what should be measured depending on the organisation's selected strategic intent. The following conclusions were derived from the review of previous Warehousing theories and literature:

A description surrounding the history of Warehousing was conducted to understand how the need, development and growth for this Logistics function has increased within the Supply Chain over recent years.

In order to better understand the role Warehouses play within the Supply Chain, all generic processes found in a typical Warehouse were outlined and described, to better understand the interconnectedness of Warehousing processes. Based on a process description of Warehousing processes, companies could then better understand whether Warehousing should be a core business process or not.

This outlined the need for a company to identify whether Warehousing should be a core business competency or not as outlined in the distinction between private or public Warehousing decisions. The need for Warehouse process performance measurement was identified through the different types of metrics that were identified, to understand what constitutes a good measure as well as what types of measures exist to ensure accurate measurements are derived. The need for continuous improvement of Warehousing processes in line with Supply Chain strategic intent and benchmarking potential performance, is critical to improved performance to facilitate Supply Chain success.

Based upon the findings of the identified problem statement the following conclusions were derived:

The Literature review conducted in Chapters 2,3 and 4 respectively outlined no integrated Business, Supply Chain framework measurement concept which is inclusive of a performance metric prioritisation. This lack of literature surrounding the integration and alignment of Warehousing process with Supply Chain strategic intent restricts the ability to complete performance evaluations. Furthermore, the availability of benchmarking results within the Warehousing field of study is very restrictive within the public domain.

As a result, the outcome and summary of both the literature reviews presented in Chapter 2, 3 and 4 respectively outlined the Gap within the theory, outlining the problem statement for the research. The problem statement outlined the need for specific research objectives to identify a fundamental research methodology to realise these objectives.

14.2. Research Objectives

The identified problem statement, deducted from the literature identified from the literature review outlines the need for several research objectives. As a result, the following research objectives were devised:

- To conduct a Business strategy, Supply Chain and Warehouse measurement framework evaluation, and to identify the underlying measurement principles that exist in each framework.

- These frameworks can be aligned with the SCOR reference model attributes which will then be integrated with operational metrics, to assist in prioritising metrics, to effect improvements in operations that are aligned with selected Supply Chain strategies.
- To develop a Warehouse performance evaluation method that can be utilized to conduct performance measurements within a given case. To perform a *gap analysis* to determine the reality of performance as well as identify the target/goal performance in each case.
- To implement this method of Supply Chain/Warehousing evaluation to complete an *exploratory assessment* to determine whether Supply Chain frameworks and operational metrics can be aligned through gap analysis determination, in Warehousing performance, on a specific case.

14.3. Major research conclusions

The following section outlines the conclusions derived from each of the three phases of research.

14.3.1. Application from case study examples – Phase 1

The presentation of the eight-case studies conducted as independent research projects within the Department of Logistics at Stellenbosch university, outlines two important findings. The first is that performance benchmarking, conducted on Warehousing operational processes could drive the development of case-specific solutions to improve performance. The second is that the ***applied methodology*** used in each case study example was successful in outlining an acceptable method for an exploratory case study review such as the one conducted within phase 3.

14.3.2. Strategy-process performance alignment matrix – Phase 2

The exploratory nature of this research has outlined several exciting results in the process of aligning both Business and Supply Chain strategic intent with Warehouse performance measurements within the field of Supply Chain Management and Warehousing respectively. Performance measurement is not a new concept; all companies rely on measures to monitor the success or failure of their operations. However, understanding how Supply Chain performance expectations can be filtered into an operational environment, to set priority level measures that can impact overarching Supply Chain success is the key focus of this phase of the research.

Through the extensive literature reviews of the different Supply Chain and Warehousing frameworks, links were found not only between the different Supply Chain models but also between the Warehousing repositories and the Supply Chain level one performance attributes of the SCOR model.

This led to the creation of the ***Strategic-process and Warehouse performance alignment matrix***. This alignment matrix outlines the link between strategic objectives and metrics as well as a method for a metric hierarchy creation within the applied method for metric evaluation process (APICS, 2017).

The links between SCOR and WERC identify a noteworthy finding within the field, for now this case study company can now determine what is most important and what is least important to measure, in terms of their selected Supply Chain strategy. This allows the organisation to identify a Supply Chain strategy and implement it throughout its Supply Chain, provided the different levels of management can agree that the chosen strategy is correct. This Strategy implementation allows for organisational alignment or realignment, depending on the outcome of the Strategic intent interviews, after which operational level metrics can be prioritised based on their importance to the overarching strategy (Tillman *et al.*, 2019).

In conjunction with this metric hierarchy creation is an objective for understanding strategic intent differences in the *current* and *desired* state of Supply Chain success, thus performance gaps can also be determined. These performance gaps then identify areas that need to be improved to drive performance success and align the company's current performance with its desired performance level, as outlined by the overarching corporate strategy. Organisations can now identify poor performing areas as well as the level of importance that each of these areas has on strategic fulfilment. This will help in the root cause analysis process, to identify possible problem areas which will ultimately identify implementable solutions to improve performance within the scope of Warehouse processes.

14.3.3. An exploratory case study: DSV healthcare – Phase 3

The exploratory nature of the research conducted within this case study, through the applied research design and methodology outlined in phase 2, successfully identified and explained all the relevant Warehouse processes within the operational environment at DSV Healthcare. These explanations led to the identification of operational Warehouse level metrics that could be used to measure the current state of the Warehouse performance. This performance could then be prioritised through the results of the strategic intent interviews regarding Supply Chain strategy.

The result outlined Warehouse performance gaps between the current and desired level of performance. From this metric prioritisation possible symptoms and problem areas were identified to outline the cause for the current performance gaps. These problem areas were then focused on generating possible solutions that could be implemented to improve overall operational performance in line with the reliability attribute.

The generation and justification of these case study solutions were tested through a computer simulation which was used to quantify the performance enhancements within a Warehousing layout simulation programme, known as CLASS (Cirrus Logistics Ltd., 2017). These performance enhancements could be achieved if these solutions were implemented into DSV's operational processes.

To further validate the need for performance improvements, three TCO calculations were conducted on operational processes to determine loss of opportunity costs due to inefficient processes. Finally, an initiative road map was developed based upon an identified *work project,* that could be completed in order to further derive increases in performance with the operational environment. All these findings outline a comprehensive technique to understand, measure and improve operational metrics to realign performance with overarching Supply Chain as well as close Warehouse performance gaps to unlock new potential for enhancement and ultimately customer service.

14.4. Review of research methods

The research methods outlined as the ***fundamental*** and ***applied methodologies,*** proved to be satisfactory in aiding information gathering required to answer the stated research questions and fulfil the research objectives. The decision to conduct this research with a phased design helped outline the flow and interaction between the chosen methodologies. These phases made use of specific methods to derive the relevant data required for each phase.

Phase 1 made use of secondary data in the form of quantitative data to present the existing case studies related to the applied methodology used within Phase 3. Phase 2 required a literature review to be conducted in two parts that outlined the various models and frameworks related to both Supply Chain management and Warehousing performance frameworks. This literature review allowed for a cross-mapping exercise to take place between these two concepts. This alignment allowed for a metric prioritisation, in line with overarching strategic intent, to take place at an operational level.

Phase 3 outlined a case study investigation based on the ***applied methodology***, identified in Phase 1, while testing the cross-mapping of Supply Chain models and frameworks with Warehousing operational metrics. The results of this phased approach and the methodologies used within each phase outlined how important research designs and methodologies are in conducting research as well as the success the chosen research methods had on the outcomes of this research.

14.5. Review of Literature findings

This thesis employed two literature review sections, presented in three separate Chapters. The purpose of the first literature review section, presented in Chapter 2, 3 and 4, were used to outline the theory surrounding both Supply Chain Management, Warehouse Management and Performance Management in order to define the roles and responsibilities of each, as well as to outline how these three concepts interlink.

The second literature review section, presented in Chapter 5, outlined the various Business strategy, Supply Chain Management strategic models and process frameworks available in the public domain. It was evident by the availability of this information that enough information related to Business and Supply Chain Management strategies and processes are available. There was, however, limited information surrounding the Warehouse process performance repositories within the public domain.

This meant that the WERC repository was the only benchmarking repository available within this context, as presented in Chapter 5. The limited availability of benchmarking repositories related to Warehousing outlines a gap, identified in the literature, where such information could be very useful to companies if made available. This limitation in available literature further outlines potential reasons as to why performance measurement within a Warehousing context could be perceived as being limited. Due to the lack of performance metric comparisons in terms of threshold values, companies actually do not have the resources to accurately compare their performance.

14.6. Contributions of research findings

The contributions made by the findings of this research document, presented in Chapter 8, are based on the repeatability of the research results. This research has demonstrated that a cross-mapping exercise between different Business strategy, Supply Chain strategy and process frameworks can be linked to a comprehensive Supply Chain process model.

Added to this cross-mapping exercise are further integrated Warehouse process metrics, were also aligned and used to benchmark Warehouse process performance within a case study company. The integrated nature of this cross-mapping exercise between Business strategy, Supply Chain strategy and process frameworks as well as intergrating Warehouse process performance frameworks allows a performance gap analysis to be conducted, taking overarching Business and Supply Chain process strategy and Warehouse process benchmarks and integrating them into an alignment matrix.

The Case study research findings, including the cross-mapping results are presented in the *Strategic-process and Warehouse performance alignment matrix* (outlined in Phase 2D in Chapter 8). This matrix identified a new focus for Warehouse performance measurement, which was previously not found within the available literature. Despite the exciting implications this research could have on future research, there are some limitations that need to be considered.

14.7. Limitation of the research findings

Although the research findings related to the case company were successful in terms of this research, there is not yet enough evidence to support this methodology for Supply Chain and Warehouse process performance alignment as theory, thus highlighting limitations within the conclusion of this research document.

The number of detailed case studies conducted with this applied cross-mapping methodology outlines the first limitation of this research. Despite the presentation of previous cases and this method being repeatable, more case study examples are required to further test and validate the outcomes of this research technique before a conclusive contribution to theory can be made.

14.8. Recommendations

Based on the findings of the research, several solutions have been recommended while some have been tested within a Warehouse layout simulation. It is critically important to be able to validate chosen solutions before an implementation decision can be made. The Warehouse layout simulation created a simulated operational environment in which these solutions could be tested. This allowed for these solutions to be *validated* in order to *justify* their selection.

The development of an initiative implementation plan took these recommended solutions and outlined a plan for their implementation in the case company. It is therefore recommended that this implementation plan be used as a guide to outline the different *work projects* and *initiatives* that need to be addressed in order to improve Warehouse process performance within DSV CDU.

These projects must be implemented and managed by a project stakeholder to ensure the facilitation of *change management* and *Continuous improvement*. It is recommended that those solutions that have the largest performance impact be implemented first, to derive the largest possible benefit as soon as possible. A prioritisation of the recommended solutions should be created, implemented, and managed by a project management team to ensure complete integration and success of the proposed solutions.

This prioritisation is outlined within the initiative road map presented in Chapter 13 (section 13.3), through *cost* and *impact indicators* outlined within the various work project descriptions. These indicators are linked to the identified *priority indicator*. These indicators act as a suggestive guide to the implementation teams that may take this research forward and execute the implementation plan. The purpose of Section 13.3 is to suggest how an implementation for the validated and justified solutions outlined in Chapter 13, could look and how they could be implemented.

14.9. Future Research

This research has left room for further research to be conducted. These topics, if studied, will contribute to the RCA framework for Warehouse performance evaluations. These areas fell outside the scope of this project, but nonetheless outlined a need for future research to be conducted in this area.

The potential future research surrounding this research is best described by an *impact vs time matrix* in Figure 14.1 which is based on the portfolio analysis matrix presented by Hussey (1978;2). This matrix prioritises four main topics that could be studied further to directly impact the *Supply Chain process and Warehouse performance framework alignment matri*x presented in this research.

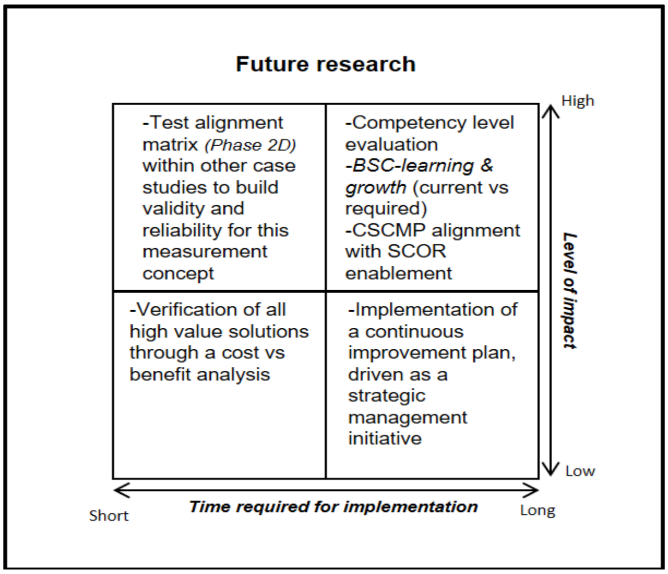


Figure 14.1: Future research impact vs time matrix
(Source adapted from Hussey, 1978:3)

This future research will not only benefit DSV Healthcare but potentially contribute to the validation of some of the findings of this research. Each of these future research concepts is outlined in the sections that follow.

14.9.1. Competency level determination and evaluation

One of the most underrated measurements that should be conducted as further research, is that of the competency level of the human element within a supply chain. This research will help outline the level of proficiency of skills related to specific Warehouse processes within a Warehousing operational environment. This is outlined by the inclusion of the Balanced Score Card (BSC) devised by Kaplan and Norton (1996:9–11) and described in section 8.1. This opportunity is outlined in Figure 14.2.

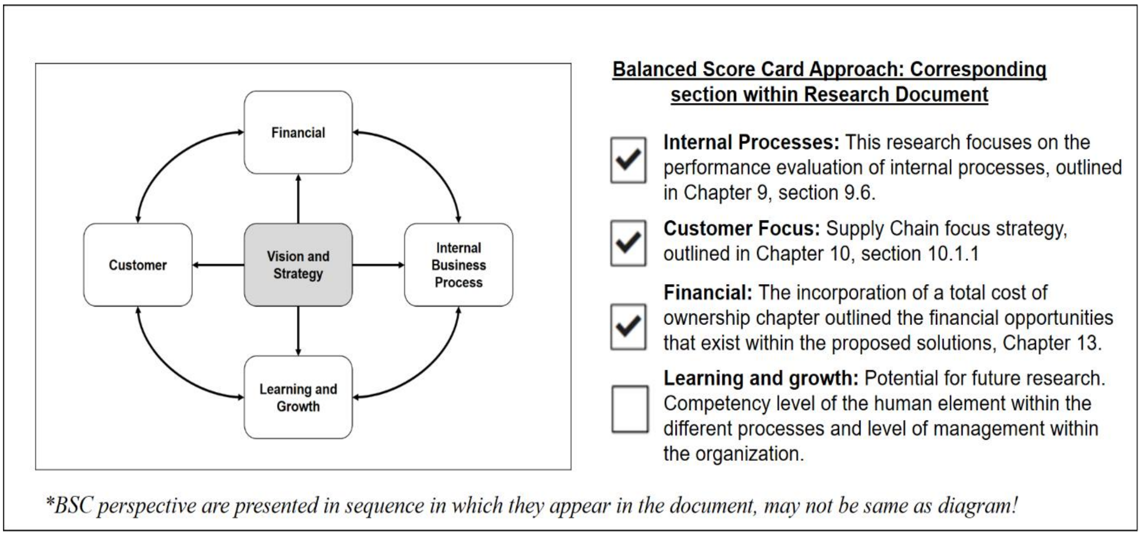


Figure 14.2: Future research opportunity – BSC approach
(Source Adapted from: Kaplan and Norton, 1996:9–11)

The BSC model is used to ensure that all elements of the organisation are measured to derive conclusive findings and ensure that a comprehensive analysis has been conducted. For the purposes of this research document's scope, three of the four elements of the BSC were used to outline the importance of performance measure.

This analysis can be taken one step further if it outlined the level of education and skill required throughout each step of the process. This would increase performance accuracy as well as efficiency within operations. This research could be very beneficial to DSV as it would increase the validity of the research topic as well as drive further performance enhancements.

14.9.2. Test alignment matrix on further case studies

In order to create reliability and validity around the use of the cross-mapping of Supply Chain strategy models and process frameworks with Warehouse process performance frameworks, the alignment matrix requires further case study examples to be conducted. The repeatability of the study in future research could outline possible advancements in the cross-mapping of such models and frameworks, further validating the alignment matrix within Warehouse performance measurement theories.

14.9.3. CSCMP management and support service integration with SCOR

The SCOR reference model presents six key categories as presented by APICS (2017) as outlined in section 2.4.4, this model presents an enablement category which describes the management of the Supply Chain once it is implemented. Therefore, a connection could be possible between the remaining CSCMP management and support services and that of the enablement category within SCOR.

14.9.4. Validation of specific high-value solutions

Based on the proposed solutions as well as the recommendations presented in section 14.8, further research could be conducted through testing to determine and outline which solutions should be implemented based on the present strategic process performance needs of the company. This could include the further development of an *initiative road map* (as outlined in section 13.3), that could be used to determine an implementation plan for this case. An example of this *initiative road map* has been presented within Chapter 13.

14.9.5. Implementation of continuous improvement initiatives

The need for continuous improvement in any Supply Chain is very important for the identification and maintenance of trends across all industries. The initiative road map outlined in section 13.3, provides a means to continuously improve on progress already made. Critical future research could be conducted around the initiative road map to implement the different work projects therein. Further research could derive analyses related to the different work projects and how each of them could be used to drive strategic management involvement within the Warehousing operations environment.

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Annexure A: The WERC respondent spread per management level and industry

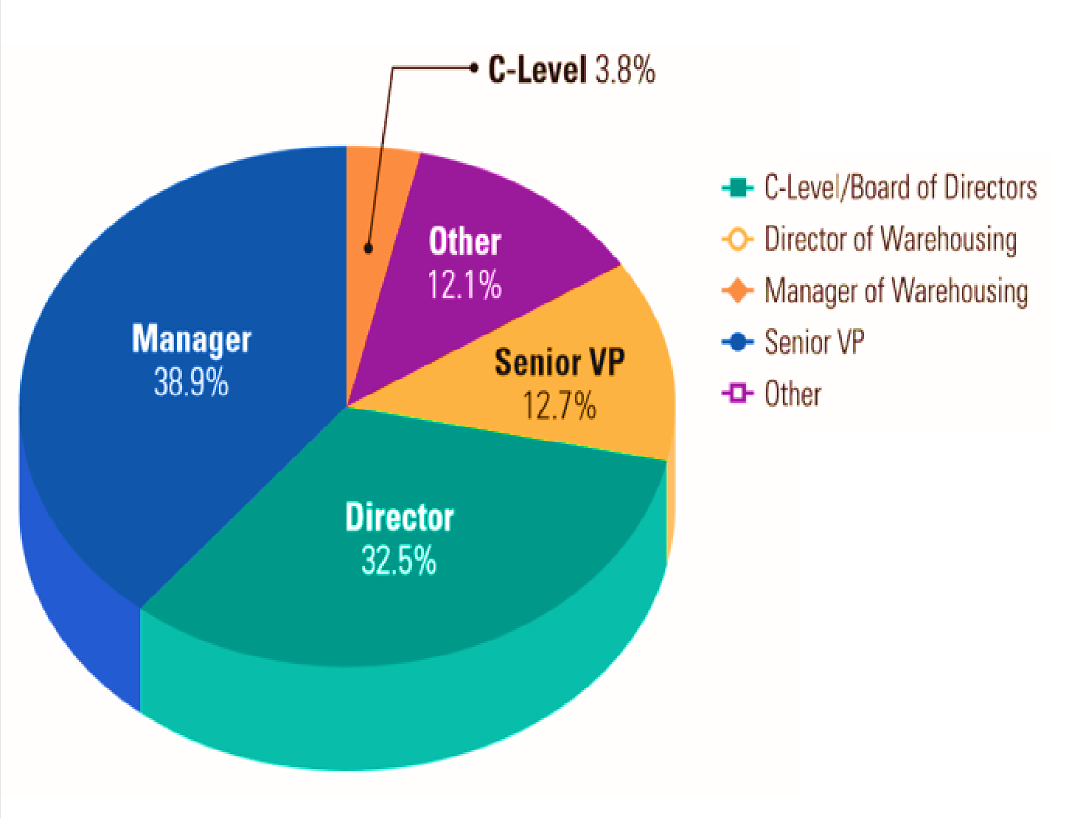


Figure A.1: WERC respondent breakdown in management level

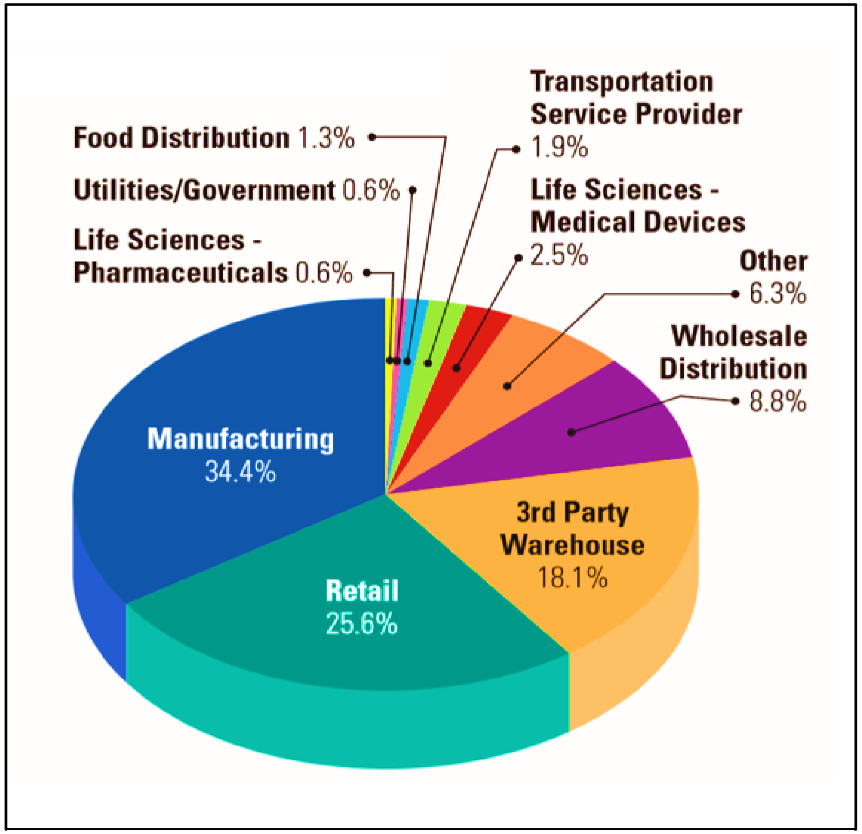


Figure A.2: WERC respondent breakdown in industry

Annexure B: Incorporation of Supply Chain models

Table B.1: APQC model alignment with SCOR and WERC

Metric Category	SCOR Strategy	SCOR Attribute	Actual Performance	Expected Performance	Level 1 Metric	WERC equivalent metrics
Process Efficiency	External Strategy (Customer Facing)	Reliability	S A P D	S A P D	Perfect Order Index/ Fulfilment	Perfect Order index Customer Metrics
Cycle Times	External Strategy	Responsiveness	S A P D	S A P D	Order Fulfilment	Operations Metrics (Inbound & Outbound)
N/A	External Strategy	Agility	S A P D	S A P D	Supply Chain Flexibility	Capacity/ Quality
Cost-effectiveness	Internal Strategy	Cost	S A P D	S A P D	Cost of Goods Sold	Financial Metrics
Staff Productivity	Internal Strategy	Asset	S A P D	S A P D	Return on Working Capital	Employee Metrics Capacity Metrics

Table B.2: CSCMP model alignment with SCOR and WERC

Main Process	Process subcategory	SCOR Strategy	SCOR Attribute	Actual Performance	Expected Performance	Level 1 metric	WERC equivalent metrics
Plan	Supply Chain planning Supply/Demand Alignment Inventory management	Internal Strategies	Cost & Assets	S A P D	S A P D	Cost of goods sold Return on Working Capital	Financial Metrics Employee Metrics Capacity Metrics
Source	Strategic Sourcing Supplier Management Purchasing Inbound Material management	External Strategies	Agile	S A P D	S A P D	Supply Chain flexibility	Capacity/ Quality
Make	Product engineering Partnership and collaboration Product or service customisation Manufacturing process Lean Manufacturing Make infrastructure Support Processes	External Strategies	Reliability	S A P D	S A P D	Perfect order fulfilment	Perfect Order index Customer Metrics

Table B.3: CSCMP model alignment with SCOR and WERC

Main Process	Process subcategory	SCOR Strategy	SCOR Attribute	Actual Performance	Expected Performance	Level 1 metric	WERC equivalent metrics
Deliver	Order management Warehouse fulfilment Customisation/Postponement Delivery infrastructure Transport E-commerce delivery Managing client/Customer partnerships Post-Sales technical support Customer Data management	External Strategies	Responsiveness/ Reliability	S A P D	S A P D	Order fulfilment	Operations Metrics (Inbound & Outbound)
Return	Receiving and Warehousing Transport Repair and replenishment Communication Manage Customer expectations	External/Internal Strategies	Responsiveness/ Cost	S A P D	S A P D	Order Fulfilment Cost of Goods Sold	Operations Metrics (Inbound & Outbound) Financial Metrics
Enable	Strategy and leadership Competitive benchmarking Product/Service innovation Product/Service data management Process validity and control Measurement Technology Business management Quality Security Industry Standards	External/Internal Strategies	All the above, based off prioritisation	S A P D	S A P D		

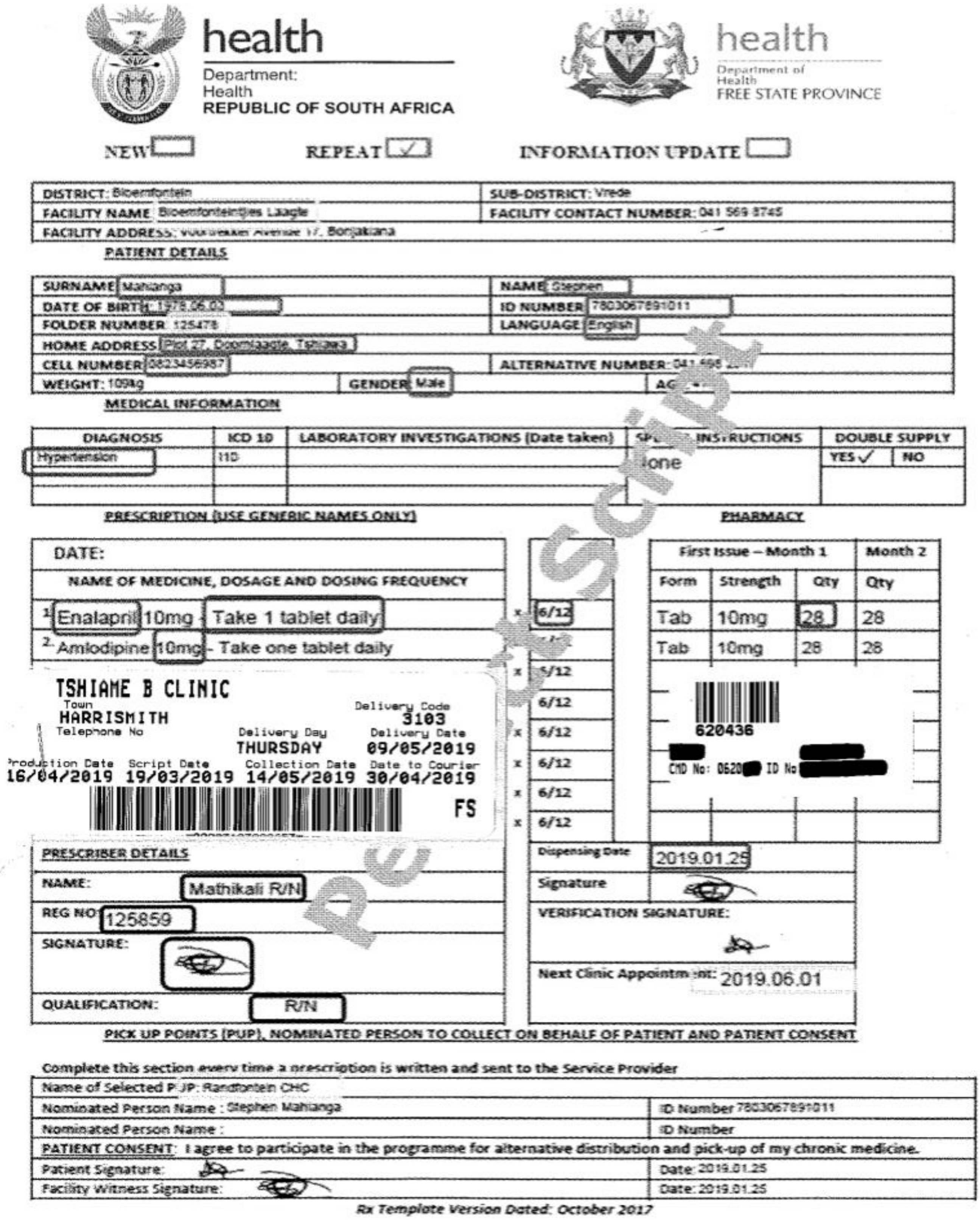
Table B.4: Gattorna model alignment with SCOR and WERC

Formulation of Supply Chain Type	Alignment Processes	Supply Chain Focus	SCOR Strategy	SCOR attribute	Actual Performance	Expected Performance	Level 1 Metric	WERC Equivalent metrics
Continuous Replenishment	Supply Chain alignment (Business strategy) Enablement Culture Channel Strategy Demand Response	Relationships Matter	External Strategy (Customer Facing)	Reliability	S A P D	S A P D	Perfect Order Index/ Fulfilment	Perfect Order index Customer Metrics
Lean Supply Chain		Efficiency and Lowest cost to serve	Internal Strategy	Cost/Asset	S A P D	S A P D	Cost of goods Sold Return on working Capital	Financial Metrics Employee metrics Capacity metrics
Agile Supply chains		Responsive	External Strategy	Responsiveness	S A P D	S A P D	Order fulfilment	Operational Metrics(Inbound & Outbound)
Fully Flexible Supply Chains		All Important	Internal and External	Agile	S A P D	S A P D	Supply Chain flexibility	Capacity/ Quality

Table B.5: Lambert model alignment with SCOR and WERC

Supply Chain business processes	**SCOR focus strategy**	**SCOR attribute**	**Actual performance**	**Expected performance**	**Level 1 metric**	**WERC equivalent metric**
Customer relationship management	External Strategy	Reliability	S A P D	S A P D	Perfect Order Index/ Fulfilment	Perfect Order index
Customer service management	External Strategy	Reliability/Agility	S A P D	S A P D	Perfect Order Index/ Fulfilment	Perfect Order indexCapacity/ Quality
Demand management	External Strategy	Responsiveness	S A P D	S A P D	Order Fulfilment	Operations Metrics (Inbound & Outbound)
Order fulfilment	External Strategy	Responsiveness	S A P D	S A P D	Order Fulfilment	Operations Metrics (Inbound & Outbound)
Manufacturing flow management	Internal	Cost/Asset	S A P D	S A P D	Cost of goods Sold/ Return on working Capital	Financial Metrics/Employee metrics Capacity metrics
Supplier relationship management	External Strategy	Agility	S A P D	S A P D	Supply Chain Flexibility	Capacity/ Quality
Product development & commercialisation	Internal	Cost	S A P D	S A P D	Cost of goods sold	Cost of goods sold
Returns management	External Strategy	All external measure	S A P D	S A P D	All external measure	All external measure

Annexure C: Perfect script template


health
Department: Health
REPUBLIC OF SOUTH AFRICA
health
Department of Health
FREE STATE PROVINCE

NEW ☐ REPEAT ☑ INFORMATION UPDATE ☐

DISTRICT: Bloemfontein	SUB-DISTRICT: Vrede
FACILITY NAME: Bloemfonteintjies Laagte	FACILITY CONTACT NUMBER: 041 569 8745
FACILITY ADDRESS: Voortrekker Avenue 17, Bonjakiana	

PATIENT DETAILS

SURNAME: Mahlanga		NAME: Stephen
DATE OF BIRTH: 1978.06.02		ID NUMBER: 7803067891011
FOLDER NUMBER: 125478		LANGUAGE: English
HOME ADDRESS: Plot 27, Doornlaagte, Tshiawa		
CELL NUMBER: 0823456987		ALTERNATIVE NUMBER: 041 498 2...
WEIGHT: 109kg	GENDER: Male	AGE:

MEDICAL INFORMATION

DIAGNOSIS	ICD 10	LABORATORY INVESTIGATIONS (Date taken)	SPECIAL INSTRUCTIONS	DOUBLE SUPPLY
Hypertension	I10		None	YES ✓ / NO

PRESCRIPTION (USE GENERIC NAMES ONLY)

PHARMACY

DATE:		First issue – Month 1: Form	Strength	Qty	Month 2: Qty
NAME OF MEDICINE, DOSAGE AND DOSING FREQUENCY					
1. Enalapril 10mg - Take 1 tablet daily	x 6/12	Tab	10mg	28	28
2. Amlodipine 10mg - Take one tablet daily	x 6/12	Tab	10mg	28	28
	x 6/12				
	x 6/12				
	x 6/12				
	x 6/12				
	x 6/12				
	x 6/12				

TSHIAME B CLINIC
Town
HARRISMITH
Telephone No
Delivery Code 3103
Delivery Day THURSDAY
Delivery Date 09/05/2019
Production Date 16/04/2019
Script Date 19/03/2019
Collection Date 14/05/2019
Date to Courier 30/04/2019
FS

620436
[redacted]
CMD No: 0620[redacted] ID No [redacted]

PRESCRIBER DETAILS

NAME: Mathikali R/N	Dispensing Date: 2019.01.25
REG NO: 125859	Signature
SIGNATURE:	VERIFICATION SIGNATURE:
QUALIFICATION: R/N	Next Clinic Appointment: 2019.06.01

Perfect Script

PICK UP POINTS (PUP), NOMINATED PERSON TO COLLECT ON BEHALF OF PATIENT AND PATIENT CONSENT

Complete this section every time a prescription is written and sent to the Service Provider

Name of Selected PUP: Randfontein CHC	
Nominated Person Name: Stephen Mahlanga	ID Number 7803067891011
Nominated Person Name:	ID Number
PATIENT CONSENT: I agree to participate in the programme for alternative distribution and pick-up of my chronic medicine.	
Patient Signature:	Date: 2019.01.25
Facility Witness Signature:	Date: 2019.01.25

Rx Template Version Dated: October 2017

Figure C.1: Perfect Script example including Capture & Scanning labels

Annexure D: Strategic Intent interview template

A performance management and Warehousing metric analysis, through Supply Chain alignment strategies: An exploratory study

Semi-structured Interviews to gain insight into the company's Supply Chain Strategy at DSV Chronic Dispensing Unit (CDU).

by
Matthew Kenneth Harvey
17797470

Consent for participation in research interview

I agree to participate in a research project conducted by Matthew Kenneth Harvey from the University of Stellenbosch (SU) in Stellenbosch, South Africa. Please read the following information which will help guide you through the interview process. Please note: that your participation is completely voluntary, you are welcome to decline participation at any time either prior you during the interview process. Voice recording equipment will be used to create a detailed account of the interview its self, to help outline the most important themes of the discussions. These recordings will be stored on the researcher's personal computer which is password protected and only accessible by the research himself. The privacy and confidentiality of this information will be protected throughout the entire research processes.

The following points outline guidelines to help you better understand how is process will be conducted as well as outline some helpful tips that you can use throughout the interview to make the process as comfortable for you as possible.

<u>Please review the following instructions below before continuing with this interview:</u>

1. I have been given enough information about this research project and I understand my role within the interview as well as the reasons for the interview being conducted. The purpose of my participation as an interviewee in this project and the use of the manner and use of the outcomes has been explained to me and is clear.

2. My participation as an interviewee in this project is voluntary. There is no explicit or implicit coercion whatsoever to participate and I do so freely and willingly.

3.My participation involves being interviewed by (a) researcher(s) from the Stellenbosch University. The interview will last approximately 30 minutes. I allow the researcher(s) to take notes during the interview.

4. I understand that I have the right not to answer any questions and if I feel uncomfortable in any way during the interview process, I have the right to withdraw from the interview with no repercussions.

5. I have been given the clear security that the researcher will not identify me by name in any reports that may be generated with the findings of this interview and that my confidentiality as a participant in this study will remain secure.

6. I have been given the guarantee that this research project has been reviewed and approved by Stellenbosch University Ethics Committee, prior to the interview being conducted.

7. I have read and understood the points and statements of this form. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

Please complete the following sections as indicated:

Participants departmental description/Job title:

____

____

____

Participant's Signature______________________________ Date _________________

Interviewer's signature_______________________________Date_________________

If you have any questions or concerns about the research, please feel free to contact:

Researcher:
Matthew Kenneth Harvey
Student Number: 17797470
Email: 17797470@sun.ac.za
Contact Number: 021 950 1225

Supervisor:
Professor JJ Louw
Email: jjlouw@sun.ac.za

RIGHTS OF RESEARCH PARTICIPANTS: You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research participant, contact Ms Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.
You have right to receive a copy of the Information and Consent form.

1. SCOR strategy definitions

This table identifies all the different possible supply chains, as they appear in the SCOR methodology as well as each Supply Chain strategies definitions. Please review, this table of attribute definitions before continuing to the following sections.

Table 1: Supply Chain definition description

Performance attribute	Performance attribute definition	Level 1 Metric
1.Supply Chain Reliability	The performance of the Supply Chain in delivering: the correct product, to the correct place, at the correct time, in the correct condition and packaging, in the correct quantity, with the correct documentation, to the correct customer.	1.1. Perfect order fulfilment
2.Supply Chain responsiveness	The speed at which a Supply Chain provides products to customers	2.1. Order fulfilment cycle time
3.Supply Chain Flexibility	The agility of a Supply Chain in responding to marketplace changes to gain or maintain competitive advantage.	3.1. Upside Supply Chain flexibility 3.2. Upside Supply Chain adaptability 3.3. Downside Supply Chain adaptability
4.Supply Chain Costs	The costs associated with operating the supply chain.	4.1. Supply Chain Management costs 4.2. Cost of goods sold
5.Supply Chain Asset management	The effectiveness of an organisation in managing assets to support demand satisfaction. This includes the management of all assets: fixed and working capital.	5.1. Cash-to-cash cycle time 5.2. Return on Supply Chain fixed assets 5.3. Return on working capital

(Source: APICS, 2017)

This interview is being conducted in the form of a focus group discussion, to get consensus among respondents in terms of the company's current Supply Chain strategies. These focus groups will consist of respondents from the business administration, distribution administration as well as operations supervisors. The objective of which is to explore the businesses current Supply Chain strategy.

This Interview is semi-structured and has been developed from the SCOR assessment framework to identify Supply Chain attributes and the associated metrics that correspond to this strategy (APICS, 2017)[25].

2. The Performance attributes available:

These following characteristics, outlined in table 1, are those that outline the most common Supply Chain strategies in the field of study today. The SCOR model allows for an association between strategy and metrics to take place, thus outlining possible measurement criteria to evaluate the current level of performance for a selected strategy.

Table 1: SCOR model Strategy description and association

Focus Strategy	Supply Chain Attribute	Level 1 Metric	What it entails
External Strategies (customer focus)	Reliability	Perfect order Fulfilment	On time? Undamaged?
	Responsiveness	Order Fulfilment Cycle	From Customer Request to Final Acceptance
	Agility (flexibility)	Supply Chain Flexibility	How long to scale up? How expensive to Scale Down
Internal Strategies	Cost	Cost of Goods Sold	Cost of Processes? Cost of Goods Sold?
	Assets	Return on Working Capital	Working Capital? Return on Investment?

3. Ranking a supply chain's performance:

The following table, Table 3, identifies the level of performance identified by the respondent within the discussion. For Comparative Ranking, a Supply Chain's performance can be rated as "S" for *Superior*, "A" for *Advantage*, "P" for *Parity* or "D" for *Disadvantage*. Each of the above attributes and metrics within the table, must be given a rating from Superior(S) to Disadvantage(D). Keep in mind a business can only have one Supply Chain Strategy, thus only one superior score can be designated.

[25] APICS. 2017. Supply Chain Operations Reference model (SCOR) v12. Chicago, IL: APICS. [Online], Available: http://www.apics.org/apics-for-business/products-and-services/apics-scc-frameworks/scor.

Table 3: Ranking attributes to determine current level of Supply Chain performance

Performance	Interpretation
Superior "S"	Highest performance
Advantage "A"	Selection of performance between Superior and Parity
Parity "P"	Performance with 50:50 split "Half better and half worse"-Therefore average performance.
Disadvantage "D"	Lowest performance

Example: How to complete the questionnaire table on page 5 & 6

Attribute	Metric	Importance Current state	Desired state	Descriptions and Notes
Reliability	Perfect Order fulfilment	**S A P D**	**S A P D**	

NB: Please complete the following table, based on the layout of the example provided above:

	Attribute	**Metric**	**Units of Measure**	**Importance Current State**	**Desired State (Goal to achieve)**	**Descriptions and Notes**
External Components (Customer)	Reliability	Perfect Order fulfilment	%	S A P D	S A P D	
	Responsiveness	Order Fulfilment Cycle Time	Number of Days	S A P D	S A P D	
	Agility	Supply Chain Flexibility	Number of Days	S A P D	S A P D	
		Supply Chain Adaptability	Number of Days	S A P D	S A P D	

	Attribute	Metric (strategic)	Units of Measure	Importance Current State	Desired State (Goal to achieve)	Descriptions and Notes
Internal Components	Cost	Total cost to Serve	%	S A P D	S A P D	
		Cost of Goods Sold	Rands	S A P D	S A P D	
	Assets	Cash to cash cycle	Number of Days	S A P D	S A P D	
		Return on Supply Chain Fixed Assets	%	S A P D	S A P D	
		Return on Working Capital	%	S A P D	S A P D	

Thank You for your Participation 😊

Annexure E: Physical process flow constraints

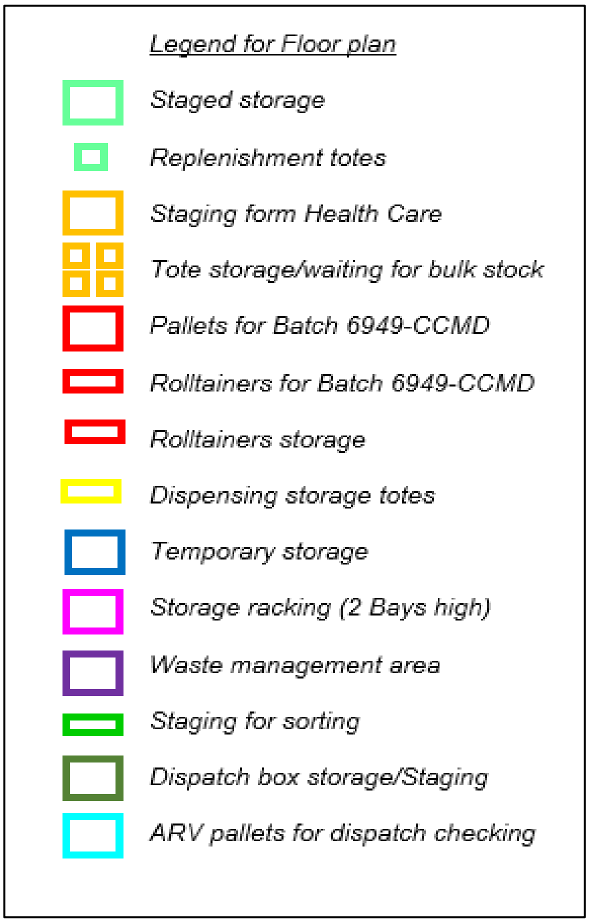


Figure E.1: Process flow constraint map legend

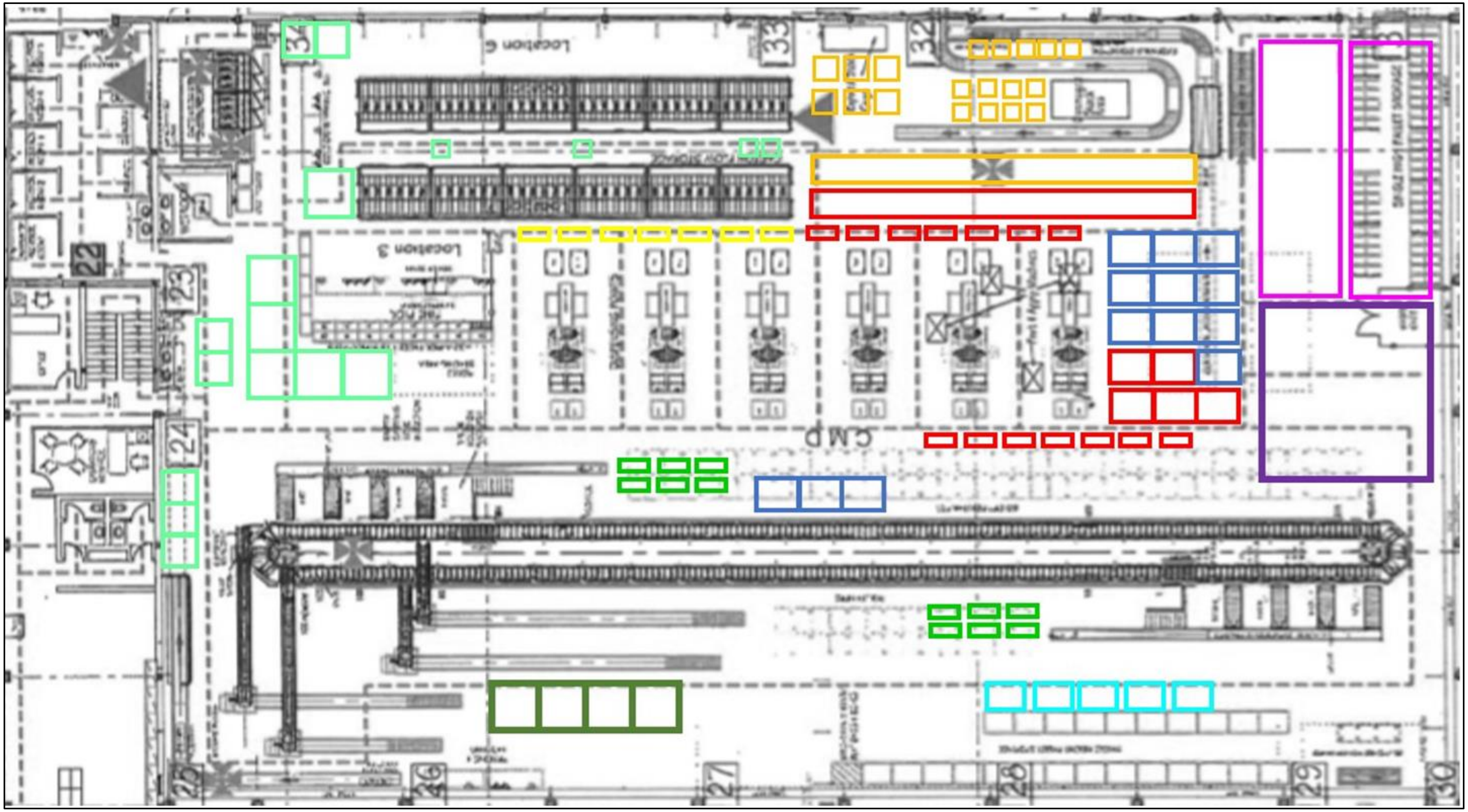


Figure E.2: Map outlining operational stock flows in typical operations

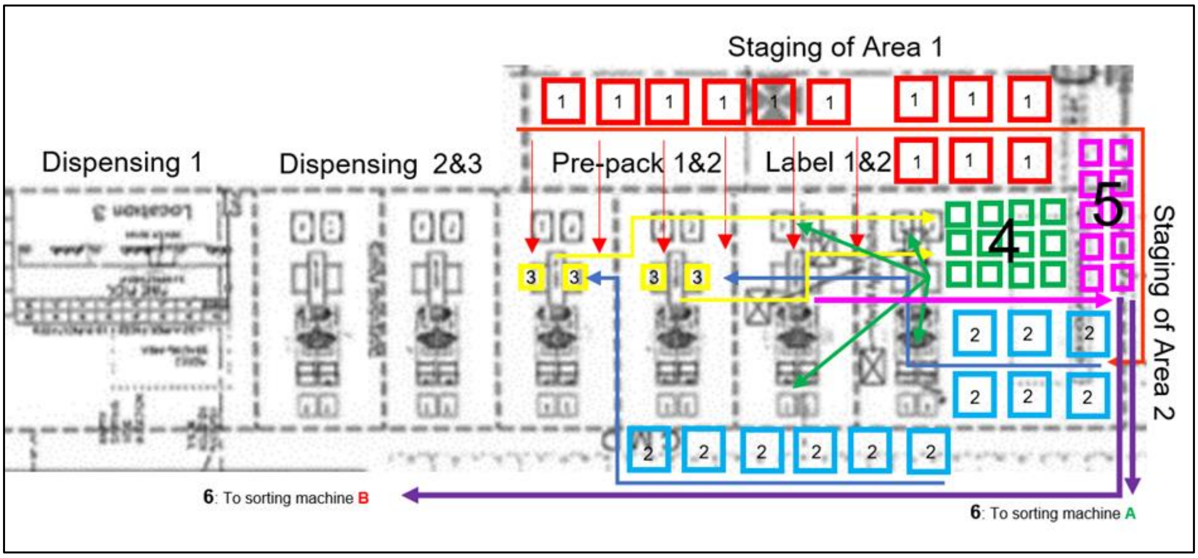


Figure E.3: Visualisation of the stock movement and workflow for staging, prepack and labelling

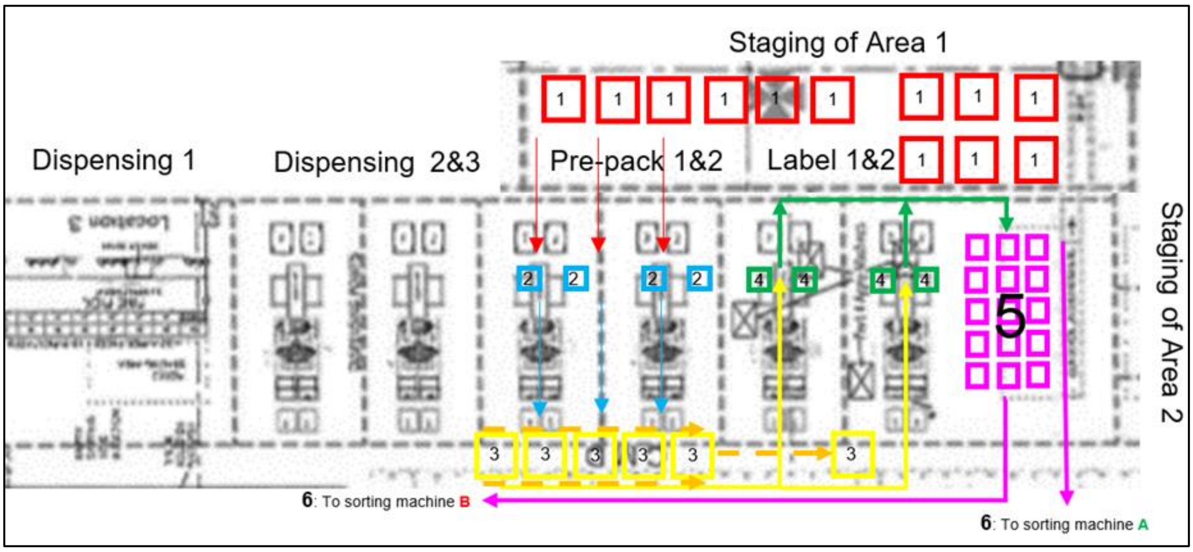
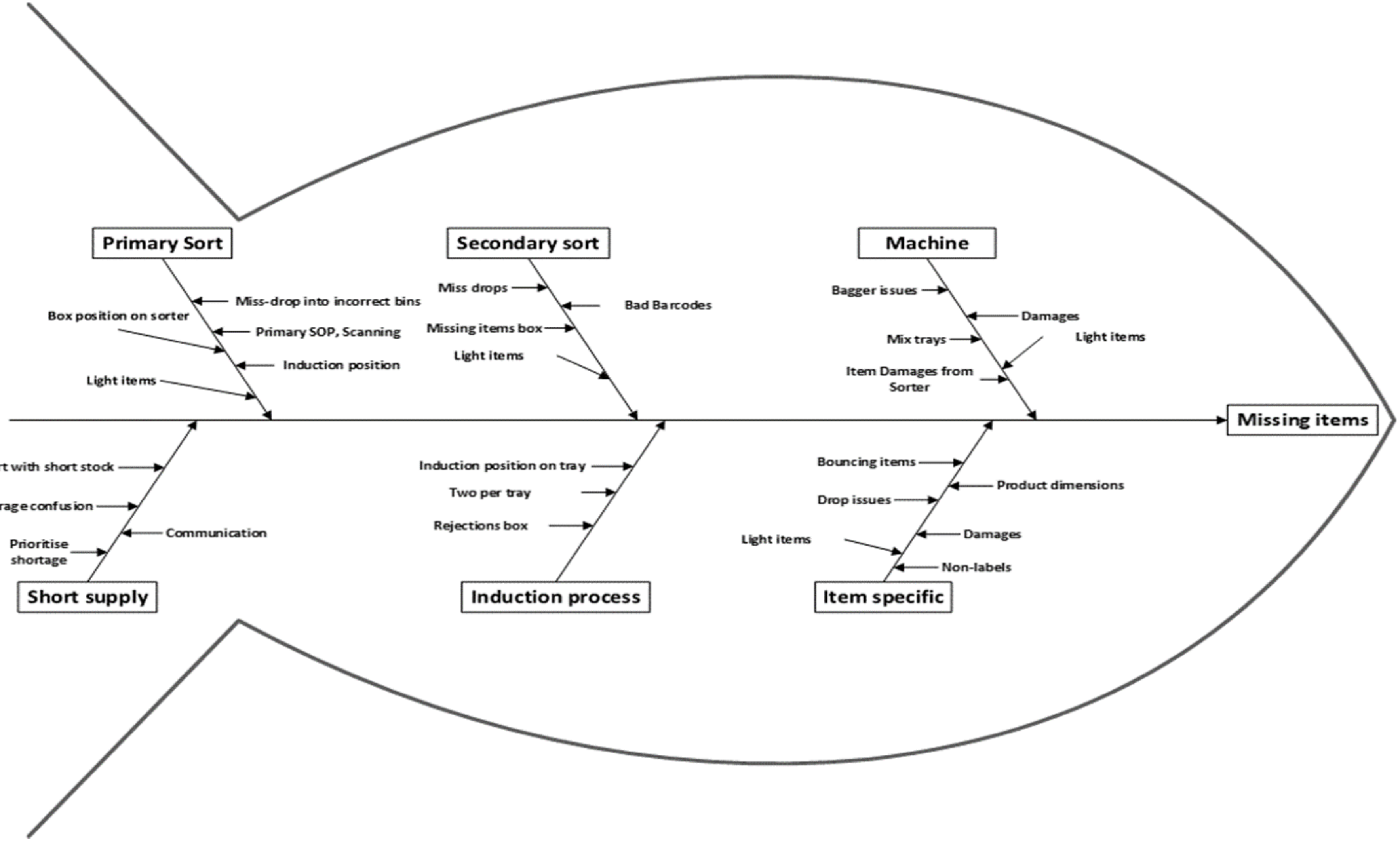


Figure E.4: Visualisation of the stock movement and workflow for staging, prepack and labelling. solution

Annexure F: Ishikawa diagram to isolate solutions for missing items issues



Annexure G: DSV Data collection approval letter

29 January 2019

Consent given for data collection: part of master's degree research

DSV Chronic Dispensing Unit

For master's student: Mr MK Harvey

University supervisor: Prof JJ Louw

We herewith give our consent that Matthew Kenneth Harvey, can access the required DSV company specific information.

In line with his master's research design and methodology, both qualitative and quantitative data will be needed. The qualitative information will be collected through semi- structured interviews with specific managers and operational staff. While the collection of Quantitative information will be through the in-house company IT (information Technology) systems.

This company data's scope will be from three different cost centres, known as:

1. DSV Healthcare
2. DSV Chronic Dispensary Unit (CDU)
3. DSV distribution at CDU

Florian Menold
General Manager

Michael Rossi
Business Unit Manager

Annexure G: DSV Management approval letter for data collection

Annexure H: Previous case studies

1. Case study 2 – A large E-retailer 2017

This case study was conducted on a leading e-commerce retailer in South Africa. This retailer coordinates the movement of thousands of various items across the country each day. In order to guarantee on-time delivery to each customer, Warehousing plays a pivotal role within this specific Supply Chain and its delivery performance. This e-commerce retailer operates from a 30 000 m^2 distribution centre within the greater Cape Town area. The scope of this case study was to help identify both outstanding areas of performance and potential areas of improvement pertaining directly to the storage and outbound function of the DC.

The available data that was collected has been presented in the WERC format. However, only metrics that pertain to the relevant storage and outbound activities were made available. This type of case study was very beneficial, due to the specific scope set out by the case company. It allowed specific solutions to be developed for the previously identified focal areas.

In the case study, the SCOR model was also used to identify the overarching corporate strategy and therefore, determine the accompanying metrics to determine a prioritisation for the collected metrics. This method of prioritisation allowed a performance gap analysis to take place, further emphasising the need for performance improvements to be derived. The result of the semi-structured interview identified the $Reliability$ attribute as the superior Supply Chain driver. Through the SCOR model the accompanying level one metric of POI was used to prioritise the metrics that were collected.

1.1 Data analysis and Results

The metrics prioritisation was then based on the SCOR assessment, whereafter the following metrics were collected. These metrics are presented in line with the WERC repository to conduct a benchmarking gap analysis. The reliability focused the metric evaluation towards the POI metrics. The results of these metrics have been presented within Chapter 10 for each of the four POI metrics. Case-specific solutions have been presented to close gaps and improve performance.

Table H.1.1: Metric data and benchmarking score for a large e-retailer

Metrics	Unit	Direction	Major Opportunity	Disadvantage	Typical	Advantage	Best in Class	Median
Operational metrics								
Dock-to-Stock Cycle Time, in Hours	Hours	< better	◆ 24	24	8	4,5	◇ 2	6,5
Suppliers Orders Received per Hour	Orders per Hour	better >	1	◆ 1	◇ 2,92	6,2	14,6	5
Lines Received and Put Away per Hour	Lines per Hour	better >	8,4	8,4	◆ 15	25	◇ 45,6	20
Percent of Supplier Orders Received with Correct Documents	%	better >	86%	86%	95%	98%	◈ 99%	96%
Percent of Supplier Orders Received Damage Free	%	better >	◆ 95%	95%	98%	◇ 99%	99%	98%
On-time Receipts from Supplier	%	better >	◆ 80%	80%	90%	95%	◇ 99%	93%
Operational metrics-Inbound								
Fill Rate – Line	%	better >	91%	91%	97%	99%	◈ 100%	98%
Order Fill Rate	%	better >	92%	92%	97%	99%	◈ 100%	98%
Orders Picked and Shipped per Hour	Orders per Hour	better >	2,49	2,49	5	8,2	◈ 24	6
On-time Ready to Ship	%	better >	95%	95%	99%	99%	◈ 100%	99%
Perfect order metrics								
Percent of Orders with On-time Delivery	%	better >	◆ 95%	95%	98%	99%	◇ 100%	99%
Percent of Orders Shipped Complete	%	better >	94%	94%	96%	99%	◈ 100%	98%
Percent of Orders Shipped Damage Free (Outbound)	%	better >	98%	98%	99%	100%	◈ 100%	99%
Percent of Orders Sent with Correct Documentation	%	better >	99%	99%	99%	100%	◈ 100%	100%
◆-Current State ◇ -Desired State ◈-Current and Desired State is equivalent								

1.2 Case-specific solutions

The solutions derived and developed from the metric analysis were also prioritised in terms of time. Both short-term and long-term solutions were developed to increase the overall POI score. These identified solutions were presented as follows:

1.2.1. Short-term solutions

These solutions are intended to have a short implementation time as well as a low cost of implementation. In effect, these are the easier more cost-effective solutions that will have an impact on the throughput of the distribution centre.

Effective Vehicle Scheduling: Vehicle arrival and departure scheduling encompasses planning when vehicles are arriving and departing with stock as well as ensuring that the correct stock is either put-away or picked at the right time. Some vehicles are still arriving at unwanted times. This company must encourage these vehicles to stick to the scheduled time slots, in the hope of improving the capacity and handling ability of stock coming in and out of the distribution centre, with focus on the receiving bay.

1.2.2. Long-term solutions

These solutions require slightly more planning and capital than the short-term solutions. The reason for this is that longer-term solutions require more significant changes to take place, based on metric and cost/benefit analysis. The proposed long-term solution for increasing throughput and reliability in the distribution centre follows:

Implementation of a Cross-docking Function: This cross-docking function would allow an area between the receiving marshalling area and the outbound marshalling area to be set up. The cross-dock function would in effect mitigate the need to store fast-moving/popular goods. These goods will be in transition between receiving and dispatch while orders are filled.

The implementation of this function will impact multiple areas, such as:

A Reduction in the number of employees: Since a limited number of employees are required to pick a multitude of orders in a smaller area, thus increasing the number of orders picked per person per hour.

Time reduction**:** This cross dock will significantly decrease the amount of time it would take the distribution centre to receive, store, pick, package and ship and order. This directly impacts the reliability attribute identified under the SCOR assessment model.

***Increased capacity and volume*:** More storage locations will become available in the distribution centre, allowing them to either keep more of the same stock or increase the variety of stock they can keep. This is critically important seeing as this company only stores 60 000 of the 10 000 000 types of products they sell online. This will further mitigate any supply issues they experience with lower-priority suppliers as they can start keeping more special stock items.

2. Case study 3 – A large Clothing brand 2018

This case study was conducted on a large apparel brand that is focused on the sporting arena. This company operates from a 3PL Warehousing provider that is situated within the greater Cape Town area, in the Western Cape province, South Africa. This 3PL is contracted to manage the Warehousing function with the apparel brand's supply chain, as it is not a core business competency for the brand. In terms of the data collection for this specific case, a qualitative approach was used to determine the gap between the current and desired state for the performance metrics identified within the WERC repository.

2.1 Data analysis and Results

Due to the sensitivity of the data as well as the Service Level Agreement (SLA) with the apparel brand, this was the most proficient manner for this case to be conducted. Despite the lack of quantitative data, this case's results presented useful solutions that were used to improve the identified performance gaps. Table H.2.1., identifies the derived metrics for both the current and desired levels of performance for the preselected metrics. The preselection of metrics is case-specific as they were identified as the key metrics that management wanted to be measured and improved this specific case.

Table H.2.1 Metric data and benchmarking score for a large apparel brand

Metric	Unit	Direction	Major opportunity	Disadvantage	Typical	Advantage	Best in class	Median
Customer Metrics								
On-time Shipments	%	better >	95%	95%	98%	◆ 99%	◇ 100%	99%
Total Order Cycle Time	Hours	< better	◈ 72	72	34,96	24	7	24
Internal Order Cycle Time	Hours	< better	◈ 31,2	31,2	18,8	8	3,8	10
Lost Sales (Percent of SKUs Stocked Out)	%	< better	6%	6%	◆ 3%	1%	◇ 0%	2%
Operational metrics-Inbound								
Dock-to-Stock Cycle Time, in Hours	Hours	< better	24	24	◆ 8	4,5	◇ 2	6,5
Operational metrics-Outbound								
Cases Picked and Shipped per Hour	Cases per Hour	better >	30	30	60	◆ 100	◇ 180	75,6
Capacity/Quality metrics								
Average Warehouse Capacity Used**	%	better >	75%	◈ 75%	81%	88%	93%	85%
Peak Warehouse Capacity Used**	%	better >	◈ 88%	88%	94%	98%	100%	95%
Inventory Count Accuracy by Location	%	better >	92%	92%	◆ 97%	99%	◇ 100%	98%
Order-picking Accuracy (Percent by Order)	%	better >	98%	◆ 98%	99%	100%	◇100%	99%
◆-Current State ◇ -Desired State ◈-Current and Desired State is equivalent								

2.2 Solutions

The first identified result was the lack of measurement by the 3PL. This lack of measurement is a finding on its own as it identified a major area of concern for the apparel brand. It was therefore recommended that this company begin a review process to ensure that key performance metrics are measured in order to determine the current operating performance within the Warehouse. Furthermore, by implementing measurement metrics, areas of operation can then be flagged for low performance and specific solutions derived and implemented.

Due to the nature of the 3PL, it should be noted that this service provider has been employed based off the SLA. Thus, the capacities and metrics are growing as the brand's demand waxes and wanes. It is very difficult for this 3PL to achieve sufficient metrics results to implement radical changes.

It is evident that there is room for improvement in all spheres of the WERC repository metric analysis. However, this case serves as an example to illustrate, not only the need to measure but also the gap between good Warehousing and great Warehousing solutions. Furthermore, this case study contributes to the development of the argument towards strategy and operations metric alignments as well as adding enough value to the development of a South African orientated Warehousing repository.

3. Case study 4 – A large Contract beverage manufacturer 2018

Case four to be evaluated is a large beverage manufacturer. This manufacturer operates from contract production runs. They are responsible for manufacturing, staging and storing all products required for specific contracts that they hold. A Warehousing performance and benchmarking analysis were conducted. The management of this beverage manufacturer outlined the current operating climate as well as the evaluation scope for this case.

3.1 Data analysis and Results

The scope encompassed all the applicable Warehousing processes that the manufacture conducted in everyday operations. A full metric analysis and evaluation was conducted, encompassing all available metrics. These metrics were presented in the WERC format to conduct a performance benchmarking analysis, outlined in Table H.3.1, Table H.3.2 and H.3.3.

Table H.3.1: Metric data and benchmarking score for a large beverage manufacturer

Metric	Unit	Direction	Major opportunity	Disadvantage	Typical	Advantage	Best in class	Median
Customer metrics								
On-time Shipments	%	better >	95%	◆ 95%	◇ 98%	99%	100%	99%
Total Order Cycle Time	Hours	< better	72	◆ 72	◇ 34,96	24	7	24
Internal Order Cycle Time	Hours	< better	31,2	◆ 31,2	◇ 18,8	8	3,8	10
Perfect Order Completion Index	%	better >	86%	◆ 86%	◇ 95%	98%	99%	97%
Lost Sales (Percent of SKUs Stocked Out)	%	< better	6%	6%	◆ 3%	◇ 1%	0%	2%
Operational metrics - Inbound								
Dock-to-Stock Cycle Time, in Hours	Hours	< better	24	24	8	4,5	◇ 2	6,5
Suppliers Orders Received per Hour	Orders per Hour	better >	1	1	2,92	6,2	◇ 14,6	5
Lines Received and Put Away per Hour	Lines per Hour	better >	◈ 8,4	8,4	15	25	45,6	20
Percent of Supplier Orders Received with Correct Documents	%	better >	86%	86%	95%	98%	◈ 99%	96%
On-time Receipts from Supplier	%	better >	80%	80%	90%	95%	◈ 99%	93%
◆ -Current State ◇ -Desired State ◈ -Current and Desired State is equivalent								

Table H.3.2. Metric data and benchmarking score for a large beverage manufacturer

Metric	Unit	Direction	Major opportunity	Disadvantage	Typical	Advantage	Best in class	Median
Operational metrics - Outbound								
Fill Rate – Line	%	better >	91%	◆ 91%	◇ 97%	99%	100%	98%
Order Fill Rate	%	better >	◆ 92%	92%	◇ 97%	99%	100%	98%
Orders Picked and Shipped per Hour	Orders per Hour	better >	2,49	2,49	◆ 5	◇ 8,2	24	6
Cases Picked and Shipped per Hour	Cases per Hour	better >	30	30	◆ 60	100	◇ 180	75,6
Pallets Picked and Shipped per Hour	Pallets per Hour	better >	5	5	◆ 14,94	23,2	◇ 35	20
On-time Ready to Ship	%	better >	95%	95%	◆ 99%	◇ 99%	100%	99%
Financial Metrics								
Distribution Costs as a Percent of Sales	%	< better	11%	11%	◆ 7%	◇ 4%	2%	5%
Distribution Costs as a Percentage of COGS	%	< better	19%	19%	◆ 9%	◇ 5%	2%	6%
Distribution Costs per Unit Shipped	$	< better	5	5	◆ 1,41	◇ 0,72	0,3	1,04
Days on Hand Finished Goods Inventory	Days	< better	83,8	83,8	◆ 45	◇ 30	15	40
Inventory Shrinkage as a Percent of Total Inventory	%	< better	2%	2%	◆ 1%	◇ 0%	0%	0%
Capacity/Quality metrics								
Average Warehouse Capacity Used**	%	better >	75%	75%	81%	88%	◈ 93%	85%
Peak Warehouse Capacity Used**	%	better >	88%	88%	94%	98%	◈ 100%	95%
Honeycomb Percent	%	better >	14%	14%	50%	79%	◈ 90%	65%
Inventory Count Accuracy by Location	%	better >	92%	92%	◆ 97%	◇ 99%	100%	98%
Order-picking Accuracy (Percent by Order)	%	better >	98%	98%	◆ 99%	◇ 100%	100%	99%
Material Handling Damage	%	< better	2%	2%	◆ 1%	◇ 0%	0%	0%
Equipment/Forklifts Capacity Used	%	better >	67%	67%	◆ 80%	◇ 87%	97%	84%
Employee metrics								
Annual Workforce Turnover	%	< better	20%	20%	10%	◆ 4%	◇ 1%	N/A
Productive Hours to Total Hours	%	better >	75%	75%	85%	◈ 87%	93%	85%
OSHA Day Count Rate	Days	better >	0	0	◆ 13,4	151,6	◇ 300	77
OSHA Recordable Rate (TRIR)	Rate	< better	5	5	◆ 1,98	0,622	◇ 0	1,15
OSHA Days Away from Work Cases Rate (DAWC)	Days	< better	5,42	5,42	◆ 1	0	◇ 0	0

◆-Current State ◇ -Desired State ◈-Current and Desired State is equivalent

Table H.3.3. Metric data and benchmarking score for a large beverage manufacturer

Metric	Unit	Direction	Major opportunity	Disadvantage	Typical	Advantage	Best in class	Median
Perfect order metrics								
Percent of Orders with On-time Delivery	%	better >	95%	95%	◆98%	99%	◇100%	99%
Percent of Orders Shipped Complete	%	better >	94%	94%	◆96%	99%	◇100%	98%
Percent of Orders Shipped Damage Free (Outbound)	%	better >	98%	98%	◆99%	100%	◇100%	99%
Percent of Orders Sent with Correct Documentation	%	better >	99%	99%	◆99%	100%	◇100%	100%
Cash-to-cash metrics								
Inventory Days of Supply	Days	< better	90	90	◆55,8	30	◇ 17	39
Average Days Payable	Days	< better	60	60	◆ 45	31	◇ 30	35
Average Days of Sales Outstanding	Days	< better	54	54	◆ 37	30	◇ 5	32
◆-Current State ◇ -Desired State ◈-Current and Desired State is equivalent								

3.2. Solutions

The following solutions and recommendations were suggested to the management of the beverage manufacturer. These solutions were specifically focused on improving specific metrics, to help prioritise and improve a specific metric presented in the tables below.

On-time shipments: These metrics focused on improving the number of orders shipped on time. It was recommended than an extra forklift be added to the fleet as well as trained drivers to operate them within the Warehousing area. By assigning a dispatch staging area that is organised to correctly stage outbound products for transportation would also help in this regard. Finally, in order to improve this metric, it was recommended that an extra gate be added to the existing yard, in order to alleviate the congestion within the designated yard. The reason for this was to load trucks as efficiently as possible to improve the outbound stock metric.

Perfect order Index: This metric is comprised up of four perfect order metrics, which when multiplied together would derive the index measure. Therefore, for this solution directed specifically to the beverage manufacturer, it was specified that delivering goods on time, damage-free and complete with correct documentation could be improved through the following suggestions: increase organisation of the dispatching area; and outline specific areas pertaining to specific transport loads, so as to avoid confusion between batches.

Fill Rate: This suggestion focused on the ability to fill a customer's order correctly; this is very important within a service provision industry. This solution, like the POI and on-time shipments, also recommends that better staging coordination take place. The confusion between batches is impacting their performance of several metrics. Therefore, this is a highly important focal area for the manufacturer to focus on.

Productive hours to total hours: This metric repeats the issue of staff within the DC being overworked. This can be rectified thought the introduction of shifts to ensure that all members of the DC are productive for a designated and specified amount of time.

OSHA days away from work cases rate: This metric is focused on decreasing the injury rate. In order to do this, the management needed to implement greater safety procedures and checks to ensure the operations are being carried out correctly. It was proposed that random safety drills and checks be carried out more frequently. Furthermore, through the appropriate assignment of shifts, operators could take enough leave and rest days to ensure that they are well-rested before returning to work. Through the hiring and training of more staff, the correct mix between hours of work and productive output could be achieved.

4. Case study 5 – A 3PL Educational resource distributor 2017

In this case, a large educational materials brand was evaluated. This educational brand makes use of a 3PL service provider for all their stage and distribution operations. All the inventory that is required for this brand is stored in a central facility, from which all distributions occur. It is essential for this project to reflect on the DC's ability to meet its customers' specific operational demands. The following data was collected from the DC to establish their current and desired performance based on the several semi-formal interviews that were conducted by the evaluation teams.

4.1. Data analysis and Results

Due to the sensitivity of the data as well as the project scope the metrics and information gathered during these semi-formal interviews, were identified based on average performance. This is due to the complex relationship between service provider, client and outside project investigators. Despite this, Table H.4.1, outlines the available metrics as well as the WERC benchmarking results. These results are presented in two columns. The first is the current WERC attributes aligned with the identified metric values. The second is the potential WERC attribute targets set by the company and the investigating team.

4.2. Solutions and recommendations

Decrease the bottlenecks: These are being experienced within the packaging and consolidation areas in the Warehouse. This can be done through appropriate flow management within the Warehouse. It was recommended that the DC conduct a further study in this regard.

Space optimisation: It was recommended that the 3PL find an alternative use for the unutilised portion of the DC. This unutilised space was not generating any form of return and was therefore limiting the profitability of the utilised areas.

Comprehensive WMS implementation**:** Due to the ineffectiveness of their multitude of WMS issues that was plaguing the DC, it was recommended that the DC implement a WMS throughout the entire facility. This would improve visibility for all functional areas, as well as derive more accurate measures where the company could implement changes.

Prioritisation of the Labour force: The final solution was to appropriately prioritise the labour workforce within the DC. Thus, the most important tasks will be completed first, allowing more delivery dates and customers to be reached.

Table H.4.1. Metric data and benchmarking: A large Educational resource distributor

Metric	Unit	Direction	Major opportunity	Disadvantage	Typical	Advantage	Best in class	Median
Customer metrics								
On-time Shipments	%	better >	95%	◆ 95%	98%	◇ 99%	100%	99%
Total Order Cycle Time	Hours	< better	72	◆ 72	34,96	◇ 24	7	24
Operational metrics-Inbound								
Dock-to-Stock Cycle Time, in Hours	Hours	< better	24	24	8	◈ 4,5	2	6,5
Percent of Supplier Orders Received with Correct Documents	%	better >	86%	86%	95%	98%	◈ 99%	96%
Operational metrics-Outbound								
Order Fill Rate	%	better >	92%	92%	◆ 97%	◇ 99%	100%	98%
Orders Picked and Shipped per Hour	Orders per Hour	better >	2,49	◆ 2,49	5	◇ 8,2	24	6
Cases Picked and Shipped per Hour	Cases per Hour	better >	◆ 30	30	60	◇ 100	180	75,6
Pallets Picked and Shipped per Hour	Pallets per Hour	better >	◆ 5	5	14,94	◇ 23,2	35	20
Financial metrics								
Inventory Shrinkage as a Percent of Total Inventory	%	< better	2%	2%	1%	◈ 0%	0%	0%
Capacity/Quality metrics								
Average Warehouse Capacity Used**	%	better >	◆ 75%	75%	81%	◇ 88%	93%	85%
Peak Warehouse Capacity Used**	%	better >	◆ 88%	88%	94%	◇ 98%	100%	95%
Inventory Count Accuracy by Location	%	better >	92%	92%	◈ 97%	99%	100%	98%
Order-picking Accuracy (Percent by Order)	%	better >	◆ 98%	98%	◇ 99%	100%	100%	99%
Material Handling Damage	%	< better	2%	2%	1%	0%	◈ 0%	0%
◆-Current State ◇ -Desired State ◈-Current and Desired State is equivalent								

Table H.4.2. Metric data and benchmarking: A large Educational resource distributor

Metric	Unit	Direction	Major opportunity	Disadvantage	Typical	Advantage	Best in class	Median
Employee metrics								
Annual Workforce Turnover	%	< better	20%	20%	10%	4%	◈ 1%	5%
Perfect order metrics								
Percent of Orders Shipped Complete	%	better >	94%	94%	◆ 96%	99%	◇ 100%	98%
Percent of Orders Shipped Damage Free (Outbound)	%	better >	98%	98%	99%	100%	◈ 100%	99%
Cash-to-cash metrics								
Average Days Payable	Days	< better	60	◈ 60	45	31	30	35
◆-Current State ◇ -Desired State ◈-Current and Desired State is equivalent								

(continued)

5. Case study 6 – A large direct selling company 2018

This case study was conducted on a large direct selling company that owns and operates its own Warehousing facility. The business is a family-run enterprise that sells a variety of products comprising of crockery, glassware, tableware, and kitchenware. This company distributes nationally to many provinces within South Africa as well as other surrounding sub-Saharan African countries. The Warehousing operations for this direct seller are operated from two separate distribution facilities. However, the second Warehouse only dispatches stock to the main Warehouse, whereafter the goods are sent to the customer.

This study comprises of a metric evaluation of key operational metrics that endeavour to measure the overall performance of the operations within the direct selling enterprise. The following metrics and performance gaps were identified through both qualitative and quantitative analyses.

5.1. Data analysis and Results

The data collection for this case was difficult due to the nature of the available data. It was established that the company does not measure in the traditional sense but rather makes use of several high-level metrics while evaluating other metrics when needed. The data collection for this case specifically comprised of both qualitative and quantitative data capturing. Thus, the following gap analysis, identified in Table H.5.1 was derived based on the above-mentioned data-capturing criteria.

Table H.5.1: Metric data and benchmarking score for a large direct selling company

Metric	Unit	Direction	Major opportunity	Disadvantage	Typical	Advantage	Best in class	Median
Customer metrics								
On-time Shipments	%	better >	95%	◆ 95%	98%	99%	◇ 100%	99%
Perfect Order Completion Index	%	better >	◆ 86%	86%	95%	98%	◇ 99%	97%
Lost Sales (Percent of SKUs Stocked Out)	%	< better	◆ 6%	6%	3%	1%	◇ 0%	2%
Backorders as a Percent of Total Orders	%	< better	◆ 10%	10%	5%	2%	◇ 0%	2%
Backorders as a Percent of Total Dollars/Units	%	< better	◆ 9%	9%	3%	1%	◇ 0%	2%
Operational metrics-Outbound								
Fill Rate – Line	%	better >	◆ 91%	91%	97%	◇ 99%	100%	98%
Order Fill Rate	%	better >	◆ 92%	92%	97%	◇ 99%	100%	98%
On-time Ready to Ship	%	better >	95%	◈ 95%	99%	99%	100%	99%
Capacity/Quality metrics								
Average Warehouse Capacity Used**	%	better >	75%	75%	◈ 81%	88%	93%	85%
Peak Warehouse Capacity Used**	%	better >	◈ 88%	88%	94%	98%	100%	95%
Inventory Count Accuracy by Location	%	better >	92%	◈ 92%	97%	99%	100%	98%
Order-picking Accuracy (Percent by Order)	%	better >	98%	◈ 98%	99%	100%	100%	99%
Employee metrics								
Annual Workforce Turnover	%	< better	20%	20%	10%	◈ 4%	1%	5%
Productive Hours to Total Hours	%	better >	75%	75%	85%	◈ 87%	93%	85%
OSHA Day Count Rate	Days	better >	0	0	13,4	◈ 151,6	300	77
OSHA Recordable Rate (TRIR)	Rate	< better	5	5	1,98	◈ 0,622	0	1,15
OSHA Days Away from Work Cases Rate (DAWC)	Days	< better	5,42	5,42	1	◈ 0	0	0
Perfect order metrics								
Percent of Orders with On-time Delivery	%	better >	95%	95%	98%	99%	◈ 100%	99%
Percent of Orders Shipped Complete	%	better >	◆ 94%	94%	96%	◇ 99%	100%	98%
Percent of Orders Shipped Damage Free (Outbound)	%	better >	98%	98%	99%	100%	◈ 100%	99%
Percent of Orders Sent with Correct Documentation	%	better >	99%	99%	99%	◆ 100%	100%	100%
Cash-to-cash								
Inventory Days of Supply	Days	< better	90	90	55,8	30	◈ 17	39
◆-Current State ◇ -Desired State ◈-Current and Desired State is equivalent								

5.2. Short-term Solutions and recommendations

The derived solutions for this case are presented through a time analysis. This means that both short-term and long-term solutions have been derived in order to help close the performance gap in this specific case.

Develop a KPI for stock-outs: The implementation of measurements for all KPIs is critical for the improvement of operational metrics. The need for such measurement implementation is critical, particularly for stock-outs, as these issues result in lost sales and decreased profits. This solution results from a specific mandate from the case company as experience suggests this is an area that needs to be measured.

Create a returns management staging area: Currently in the facilities layout, no returns area has been earmarked for such an activity, though the implementation of such an area would specifically improve the inventory count accuracy by location metric.

5.3. Long-term solutions and recommendations

Increased focus on order planning: The company is struggling with stock-outs. Therefore, the implementation of an improved procurement process is recommended, as well as forecasting orders through the involvement of suppliers and the use of historical data to better anticipate customers' requirements for specific products.

Development of a cross-functional team: Communication between the various departments was identified as a major constraint in operations within this operation. Therefore, the need for cross-functional integration between departments is critical to help coordinate and improve upon the current performance being experienced. This departmental cooperation will also eliminate bottlenecks and flow constraints within the DC in order to help improve the Level 1 metric of perfect order fulfilment.

6. Case study 7 – A large South African container depot 2018

The focus of this case was directed to a large container depot situated within the greater Cape Town area. This facility is one of the largest facilities specialising in handling the import and export of goods. This business also facilitates a complete Supply Chain solution in terms of storage, break bulk, consolidation, and distribution for its customers. Despite the deviation from a traditional Warehousing concept of pallets and cartons, the distribution centre functions for this type of operation are orchestrated and run in the same fashion as a *regular Warehouse* except that the SKUs are a lot *larger*.

6.1. Data analysis and Results

The data collection for this project was collected through semi-structured interviews to determine the current and target performance for each case. Furthermore, the SCOR model was also incorporated so as to attempt to prioritise this performance based on an identified corporate strategy. The superior attribute identified for this company was *responsiveness;* therefore, the following metrics presented in Table H.6.1 identify the derived metrics for this case.

6.2. Short-term Solutions and recommendations

Employee efficiency measures: This performance analysis presented significant downtime for Warehouse staff which was observed over a period of six weeks. This downtime accumulated to several hours per day excluding breaks and lunch. Therefore, it was recommended that a measurement platform for employee efficiency be implemented to better understand and track operational personnel within the DC.

Scheduling receiving loads: This solution is aimed at improving the *on-time shipments from supplier's* metric due to the continuous congestion being experienced during receiving. This delay at receiving has a knock-on effect within the DC and therefore delays all other processes within the DC. Therefore, if loads were scheduled, the bottleneck for inbound products would be eliminated and a steady flow of inbound products could be established through this low-cost high-impact solution.

6.3. Medium-term solutions and recommendations

***Elimination of double handling*:** The movement process from storage to shipping comprises of multiple stages due to the nature of the business structure within this DC. However, double handling can be eliminated within this process if appropriate handover and QC activities are conducted at key stages of the process. Unfortunately, the details of this process are unavailable due to the sensitivity of the information and parties involved. Despite this, the process can be streamlined through a restructuring of responsibilities and movement flows within the DC.

***Segregation of Cross-docking storage area*:** Due to the high volume of products that are cross-docked within this DC, it is recommended that this area be given enough space to facilitate this operation. It is important for DC operators to identify this area as a cross-dock. This area of operations must be segregated from other processes to ensure increased efficiency of storage and retrieval of fast-moving products, which will help improve metric performance within the DC.

Table H.6.1: Metric data and benchmarking score for a large container depot

Metric	Unit	Direction	Major opportunity	Disadvantage	Typical	Advantage	Best in class	Median
Customer metrics								
On-time Shipments	%	better >	95%	95%	98%	99%	◈ 100%	99%
Total Order Cycle Time	Hours	< better	72	◆ 72	34,96	24	◇ 7	24
Internal Order Cycle Time	Hours	< better	31,2	31,2	18,8	8	◈ 3,8	10
Perfect Order Completion Index	%	better >	86%	86%	95%	98%	◈ 99%	97%
Operations metrics-Inbound								
Dock-to-Stock Cycle Time, in Hours	Hours	< better	24	24	8	4,5	◈ 2	6,5
Suppliers Orders Received per Hour	Orders per Hour	better >	1	1	2,92	◆ 6,2	◇ 14,6	5
Lines Received and Put Away per Hour	Lines per Hour	better >	8,4	8,4	15	25	◈ 45,6	20
Percent of Supplier Orders Received with Correct Documents	%	better >	86%	86%	95%	98%	◈ 99%	96%
Percent of Supplier Orders Received Damage Free	%	better >	95%	95%	98%	99%	◈ 99%	98%
Operational metrics-Outbound								
Fill Rate – Line	%	better >	91%	91%	97%	99%	◈ 100%	98%
Order Fill Rate	%	better >	92%	92%	97%	99%	◈ 100%	98%
Orders Picked and Shipped per Hour	Orders per Hour	better >	2,49	2,49	◆ 5	8,2	◇ 24	6
Cases Picked and Shipped per Hour	Cases per Hour	better >	30	30	60	100	◈ 180	75,6
Pallets Picked and Shipped per Hour	Pallets per Hour	better >	5	5	14,94	◆ 23,2	◇ 35	20
On-time Ready to Ship	%	better >	95%	◆ 95%	99%	99%	◇ 100%	99%

◆-Current State ◇ -Desired State ◈-Current and Desired State is equivalent

Table H.6.2: Metric data and benchmarking score for a large container depot (Continued)

Metric	Unit	Direction	Major opportunity	Disadvantage	Typical	Advantage	Best in class	Median
Capacity/Quality metrics								
Average Warehouse Capacity Used**	%	better >	◆ 75%	75%	◇ 81%	88%	93%	85%
Peak Warehouse Capacity Used**	%	better >	◆ 88%	88%	◇ 94%	98%	100%	95%
Inventory Count Accuracy by Location	%	better >	92%	92%	◆ 97%	99%	◇100%	98%
Order-picking Accuracy (Percent by Order)	%	better >	98%	98%	◆ 99%	100%	◇100%	99%
Equipment/Forklifts Capacity Used	%	better >	67%	67%	◈ 80%	87%	97%	84%
Employee metrics								
Annual Workforce Turnover	%	< better	20%	20%	10%	◆ 4%	◇ 1%	5%
Productive Hours to Total Hours	%	better >	75%	◆ 75%	85%	◇ 87%	93%	85%
OSHA Day Count Rate	Days	better >	0	0	13,4	◆ 151,6	◇ 300	77
◆-Current State ◇ -Desired State ◈-Current and Desired State is equivalent								

6.4. Long-term solutions and recommendations

Bulk area development: The nature of the receiving process for bulk items creates confusion between Warehousing operators as no defined receiving operation has yet been implemented within the DC. Due to the lack of management support and a defined operating area, this area is a major cause of congestion and delay within the DC. It is recommended that significant time, effort, and management be applied to this area to generate and implement a SOP to rectify and maintain organisation within the area of operations. This implementation will also allow different categories of items to be identified and stored appropriately.

Data gathering and target setting: For real change to be experienced within the DC, this company needs to implement appropriate measurement techniques through data gathering. This will allow the company to measure and benchmark their processes and operations more effectively, while also being able to set performance level targets for high-level (level 1) processes.

7. Case study 8 – A large clothing retailer 2018

This case study was conducted on a large South African clothing retailer which forms part of an umbrella corporation. This company has hundreds of outlets around the country which are serviced by several strategically placed DCs in various areas. For the purpose of DC performance analysis, only one DC was measured, which is situated within the greater Cape Town area. This company does not manufacture any of its products; it is a large importer and distributor of clothing. The company is focused on servicing the customer with the latest trends within the clothing industry and their *reliability* is deemed to be their selected Supply Chain strategy.

7.1. Data analysis and Results

The data-gathering procedure for this case study was conducted through semi-structured interviews with Warehousing managers and operational employees in order to derive the current performance levels for each of the identified metrics. The metrics are presented within the WERC format, even though the DC measures itself on different criteria. For this case only the metrics that aligned with the WERC benchmarking repository were presented.

Table H.7.1: Metric data and benchmarking score for a large clothing retailer

Metric	Unit	Direction	Major opportunity	Disadvantage	Typical	Advantage	Best in class	Median
Customer metrics								
On-time Shipments	%	better >	◆ 95%	95%	98%	99%	◇100%	99%
Perfect Order Completion Index	%	better >	◆ 86%	86%	95%	98%	◇ 99%	97%
Operational metrics-Inbound								
On-time Receipts from Supplier	%	better >	80%	80%	◈ 90%	95%	99%	93%
Operational metrics-Outbound								
Order Fill Rate	%	better >	◆ 92%	92%	◇ 97%	99%	100%	98%
Financial metrics								
Distribution Costs per Unit Shipped	$	< better	5	5	1,41	0,72	◈ 0,3	1,04
◆-Current State ◇ -Desired State ◈-Current and Desired State is equivalent								

Table H.7.2: Metric data and benchmarking score for a large clothing retailer (Continued)

Metric	Unit	Direction	Major opportunity	Disadvantage	Typical	Advantage	Best in class	Median
Capacity/Quality metrics								
Average Warehouse Capacity Used**	%	better >	75%	75%	81%	88%	◈ 93%	85%
Peak Warehouse Capacity Used**	%	better >	88%	88%	◈ 94%	98%	100%	95%
Inventory Count Accuracy by Location	%	better >	92%	92%	◈ 97%	99%	100%	98%
Order-picking Accuracy (Percent by Order)	%	better >	98%	◆ 98%	◇ 99%	100%	100%	99%
Employee metrics								
OSHA Recordable Rate (TRIR)	Rate	< better	5	5	1,98	◆ 0,622	◇ 0	1,15
◆-Current State ◇ -Desired State ◈-Current and Desired State is equivalent								

7.2. Short-term solutions and recommendations

Planning counterbalance truck routes: The implementation of a route planning schedule for the counterbalance vehicles will help improve the put-away and picking efficiency and speed. Through the implementation of this schedule, the trucks' maintenance and utility will improve, further benefiting the company's overall performance and ROI.

Conduct ABC analysis for stock layout: To reduce the distance travelled in order to complete a picking instruction, it is recommended that all fast-moving items and highly profitable inventories be positioned closer to the dispatching area in order to reduce travel time for operators.

Alternative system identification: The DC has had issues in the past with network and system problems, hence the WMS no longer operates. It is recommended that a system of painted lines and cones be used in order to identify which stage a set of items is in, thus operations can still be effective during these periods of downtime.

7.3. Long-term solutions and recommendations

Facility layout changes: In order to eliminate the need for double handling and long travel distances it is recommended that the facility optimise their current floor layout within the facility. The main rationale for this recommendation is to eliminate wasteful processes that do not add value and congest the processing flow within the DC.

Use of virtual picking equipment: It was recommended through several interactions with the DC management that smart glasses could benefit the picking accuracy within the DC. These smart glasses will be used in the SKU picking racks in order to improve efficiency and accuracy of the picks, as the current process is very time-consuming and inaccurate.

Annexure I: European Foundation Quality model diagrams

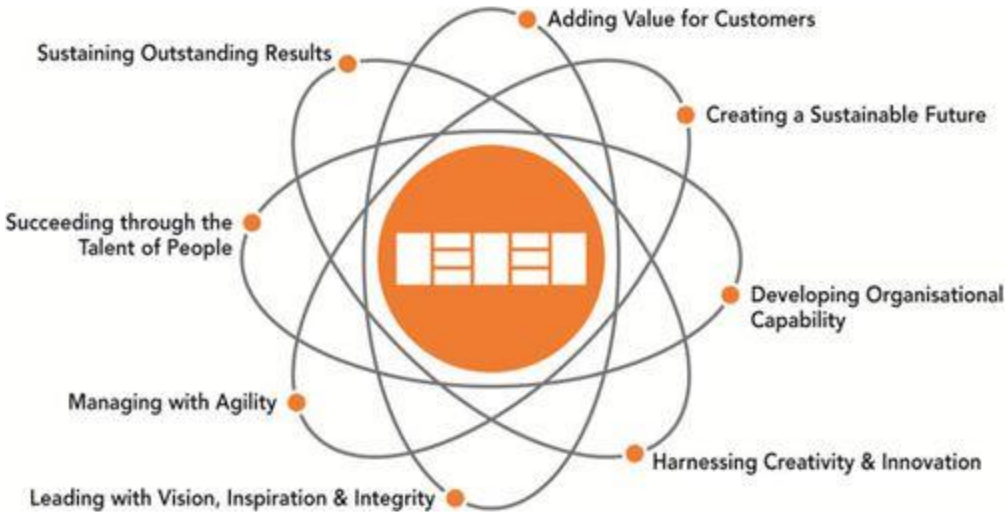


Figure I.1: Fundamentals of excellence model

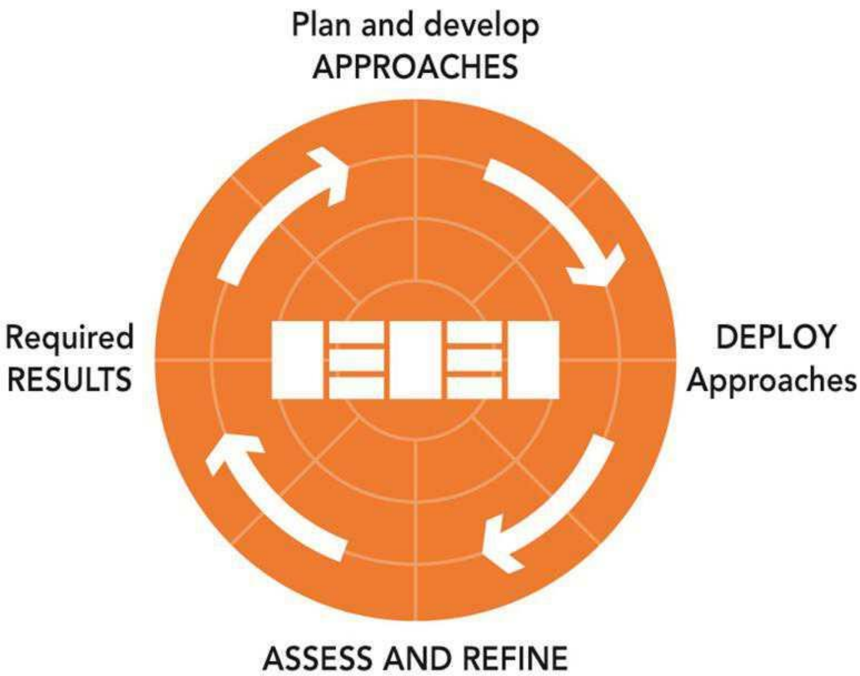


Figure I.2: EFQM Radar logic with EFQM excellence model at its centre

Annexure J: Consolidated comments from Strategic Intent interviews

The following write-up outlines a summary of all the comments, examples and discussion conducted during the Strategic Intent interviews.

Reliability Total Comments

Tough decision between cost and Patient. Current issues and corporate decision-making drives decision towards cost from top management. Issues with SLA achievement as well as departmental issues related to cost cutting suggest that cost is a significant priority in the operational and strategic management decision making process of the company. Handover and communication between different role players as well as Business functions suggest internal issues restricting performance. Government facilities play a major role in the operational decisions as well as the impact they have on the current SLA performance achieved. The business relies heavily on he supporting systems the surround operations. New implementations cause for issues regarding SLA achievement due to the need to adapt and change current operations to meet new plans and objectives, example Synch scripting initiative. This metric is particularly important in the agreed upon SLA with the Government. It is a good personnel and professional performance indicator and measure. Is currently the go to measure for the business success or failure regarding the National Government tender.

Patients must be priority as this is the drive towards the tender and SLA agreement. Siyenza drive is a focus of the government on the ARV patients thus far. There are political ties to Reliability performance Government is deemed to be responsible in the eyes of the patient through the DSV SLA. Is constantly measured for improvement and current performance for SLA. Critical government monitoring metric. Due to the nature of the product being supplied, patients must receive correct medication. Life or death Situation.

OTIF is used to generate new business. OTIF is DSV’s selling point to new clients that we can achieve all their business needs. Average 98.5% OTIF highest OTIF achieved is 99.6%. Difficult hitting 100% due to the use of 3PL’s therefore out of control in certain areas. Very difficult to manage, delay in handover between alternative carriers. Good OTIF must be achieved through lowest possible cost. Furthermore, if any issues do occur there is a review process not real time/forecasting. Only hear about it later. Service and expectation from all client’s ins a major factor. Must delivery on time. / Therefore, all other process become a support process. Good customer service currently at 99.6% on average. Best in class. Finding new business is based on the service delivery that can be achieved.

Good service delivery is critical to the longevity of the business. System issues do threaten the business. Without the automated system products cannot be picked. Process must then move to paper picking (time consuming and costly). In the event of a system issue wholesalers/CDU are ignored only private clients are focused on. Corporate vs Retail, finical gain must be considered. However, for the in terms of the reason, the How and Why? Is based upon the Patients and therefore the SLA before the Money. Financial gain must be considered however, it is not the end goal of the Supply chain. Currently the company is fractioned/Misaligned between what is deemed to be important and what is supposed to be considered important (distractions).

Currently Supply Chain functions (Healthcare) see's CDU as less of a priority than their own clients. Due to new system and optional changes Healthcare now plays a lesser role in the processing of PMP and Medication therefore could directly impact the POI and SLA positively, while maintaining the misalignment.

Current restrictions in POI and SLA achievement besides for the state misalignment is based upon the current supply and stock issues. Currently stock is being received from the department and not the suppliers that have been awarded the tender. Number of medication errors. Patient errors are a critical measure for the RP as they determine the ultimate success or failure for the programme. Patients are the most important focus for my function. Life or death. GPP and patient legislation is critical factor if our business. Better late than not at all and better late than never. CDU deals with critically ill/stable patients however, if not serve the patients will need to make other arrangements, they could have gone to a PUP instead of a pharmacy (location dependant). KPI for RP is number of medication errors as a % of total line/ Patients served. Currently 0.0% error rate for the last three months. However, must continuously manager this performance Essential focus should always be on the patients. Distribution is critical for on time deliveries. GPP plays a supporting role in how patients are serviced. Logistics function is the facilitator of for best in class service delivery within the organisation. Prioritised based of the SLA requirements, Patient is Critical for SLA achievement, need to prioritise patients as people, yes there is a financial angle but first and for most, each script is a person/Patient. Critical for patient requirements and needs. Current state: Challenges with equipment (Computers and printers) limits the amount of productivity that can be achieved in each time frame. Critical for date sensitive process. Last Exit. No POP management is impossible yet still responsible for analysis with no equipment to record it. Faulty equipment or delay in upgrade results in down time and therefore costs that are not allocated to profitable activities. In reality department is responsible for patient and script facilitation. Patient are priority while script correctness is a crucial aspect but also a current/recurring challenge for mailroom.

Script quality is an everyday issue despite departments best efforts. Patients and service delivery for SLA achievement. There is room for concern and room for improvement. Province/District and facility level involvement to proactively influence the number of rejections that occur. A rejection results a in lost revenue and a patient not served. Challenges due to scripting quality causing rejections. Three or four major recurring challenges that could be impacted. Distribution plays a pivotal role in the ability to service patients. Fighting a losing battle due to date priority's and the delays in distribution. Rejections are critical to closing the Gap and achieving consistent SLA.

Responsiveness Comments Consolidated

Responsiveness is restricted based on the issues around master data and external influences/ openness of data accuracy. People can request changes that are deemed to be necessary that may not reflect as an improvement on the SLA of OTIF measures. Communication barriers further impact the ability to achieve responsiveness. Master data errors. Refers to Quality and lead times. These are fixed within the SLA but still play a major role in the SLA provision to the patients. In terms of responsiveness DSV is restricted based of the amount of control they have over certain factors. For example: Rejects play a big role in the responsiveness categories as they directly influence the number of patients served under the SLA agreement as well as GPP. OTIF still important, is directly influenced through cycle time and Order fulfilment. (correctness is critical to good service provision). Consolidation of Private clients critical to cost management, however, causes delays in lead times and delivering on time. Documentation is currently a critical components of Order fulfilment. Currently all clients have a built-in lead time. However, each day is different, therefore very difficult to plan and execute a forecasted plan. JHB overflows of stock cause issues for cape town distribution. Example: JHB has a limited about of containers, therefore a customer's order/Stock replenishment could be half packed into the last container and then closed and shipped. Distribution then holds the half in cape town as they wait up to 3 days for the rest of the stock to get to cape town before this stock can be distributed. (massive delays). Priority shipping could be used in JHB to prevent this. Ties in to the OTIF measurement. Distribution/Transport plays a major role in the ability to be responsive. Healthcare is reliant on distribution in order to be responsive. Area of influence and area of control is important of understand. Sometimes responsiveness falls outside of control due to cost management/availability of distribution. Stock replenishment from JHB also causes an issue. Since stock delays in JHB impact the rest of the chain in Cape Town. Current tender and SLA dictate current objectives regarding lead times and acceptable norms of operation. Strategic management making changes in optional level that directly impacts the ability of operational staff to conduct daily business. Terminology discrepancy based of strategic changes drive operations into certain issues. System changes creating issues that were not present before. Current trade-offs between being responsive and able to maintain order fulfilment and uncontrollable stock issues. Compared to our industry competitors we are deemed to be more responsive to the needs of the patients. We have a more dynamic and difficult tender and market due to the location and variety of the four provinces currently under tend at CDU. It is not a one size fits all approach different provinces want different things. O Stability comes from contract/Tender itself. there suppliers (Medi-post) only must cater to the needs of one province.

No Responsiveness, no stock, current stock issues currently limit the amount of responsiveness for CDU to actively take corrective action. Stock issues are currently out of CDU control. Communication is also currently an issue regarding Strategic decisions and how those decisions impact the operational performances. No filtering/trickling down of information (break in the chain). Example: System changes/Public holidays/lead time changes. Mail room department focused on revenue. Without scripts there is not rest of process. Therefore, improving script quality directly impacts revenue and patient satisfaction. Current process limits responsiveness due to lack of exception management. Exception management plan must be put in place in order to have a direct impact on performance. Exception management must be focused on Process, collection, Late scripts. Rejection issues and errors.

Agility Consolidated Comments

The implementation of E-scripting would directly impact the speed to which patients could be added to the tender programme. Good for revenue potential. Currently being driven by the government with large capital expenditure. E-Scripting has attached to it a higher risk factor due to possible master data errors. Administrative process is up to scratch. However, the GPP and System risks associated with the implementation of this programme creates specific concerns regarding the accuracy of the patient medications parcels. E-Scripting scripts, the ability to adapt to new processes such as E-scripting. This would allow for the increase in number of patients added to the system reached as well as remove some of the administrative processes that are currently employed. However, there is some risk regarding GPP. This would result in possible medication errors. Therefore, appropriate measure needs to be taken in order to have a direct benefit the patient. External factors also play a major role in our business. An Example of this would be Hijackings. This is beyond the companies control but still something we must facilitate in order to maintain delivery performance regarding our patients. Must adapt each day to current demands, forecasted plans don’t always work.

Particularly in reference to CDU, due to current production date changes volumes of PMP's/Containers a larger truck could be needed by the afternoon that was not planned for to get the Stock to JHB on time. Therefore, a reshuffling of Trucks and routes will take place to ensure that stock leaves on time. Even after a planned consolidation, dispatch and delivery, the client could reject the delivery due to a lack of space on their side, this truck will then return to DSV, in this instance no revenue will be generated. Zone controllers dispatch incorrect loads to incorrect destinations (due to lack of experience). Clients tend to grow therefore, the transport requirements change depending on the type of client, market place fluctuations as well as seasonal influences. System issues result in a less flexible environment. No voice picking (electronic System) must revert to paper picking. Therefore, CDU not priority only private clients. (In terms of CDU Healthcare is not deemed to be flexible). Hijacking example: Stock will be replaced within a timely fashion however; it was felt that more could be done to implement this issue in to an SOP. Priorities are working fine, very variable and therefore not much within control on this matter. Factors out of control must be remembered. Implemented measures. Ability to be flexible to accept current changes that may benefit the productivity of the companies as well as the ability to improve the performance metrics. If implemented could directly benefit the POI. E-scripting removes restrictions for operational processes in increase script volumes. E- scripting has higher risks but increases possible benefits.

Responsibility and risk of E-scripting could decrease potential gains due to the GPP protocol. Agreed upon SLA at tender procurement, despite this, the government changes what is required of the SLA and therefore DSV must be flexible enough to achieve better SLA results and therefore supply more patients directly impacting the profitability. Consolidation is a critical element for the operations at CDU. We do everything possible to accommodate service delivery to as many patients as possible. ISO90001 attempt to do what is required from a points perspective to get the qualification but nothing more. Very similar to the rest of the metrics we should measure but should no focus all our time on being best in class. Therefore, should only focus on those metrics that are patient/Service delivery facing (driving factors for success or failure). Government tender (tight margins) therefore must be able to do the utmost in order to derive profit. The management of cost is important but until a certain point. No need to be flexible, fixed term contract. Too many gaps to be filled/SLA is guide to patient satisfaction in order to maintain tender. NO Fixed PUP's continuously changes, thus creates issues for service delivery/Consistency. Master data is critical, ever changing environment. CCMDD tender, market fluctuations limited Synch scripting next hurdle.

Fixed variability due to SLA and government contract, very standardised market strategy/Client type. Growth of market steady, not a drastic as initially predicted. Cost current limited the ability to be more flexible/adaptable. E-Scripting is beneficial to the company due to revenue generation (less revenue but cheaper processing) massive revenue upside for DSV.

This process was not originally part of the initial tender process there DSV has done well to be flexible enough with our processes to be able to take this process on. There is however considerable risk for the Responsible Pharmacist as well as DSV regarding medication errors as SLA performance achieved. DSV is limited in terms of its adaptability regarding unforeseen circumstances, this is further hindered by the lack of exception management.

Assets Consolidated Comments

Current system is priceless. Very important to be aware of supporting processes that make operations possible. Cash to cash is not deemed to be a priority due to the nature of the business and the tendering process. Return on all capital investment is critical for business success, however, the focus of cost management and cost saving initiatives is critical for business success. Current assets are worth more to the current operations that they in terms of book value. Sorter is paid for, therefore only costs incurred in operations is preventative maintenance. Sorter and the surrounding process is a selling point for Government and tendering process and directly facilitates the SLA achievement. There is an allocated DSV billing department. These metrics have no direct impact on the day to day operational decision due to the corporate decision to be asset light. (No fixed assets). POD management for billing is essential for this to from a corporate/operational responsibility. DSV currently assets light. Therefore, only conduct storage and distribution function for client's stock. Facilitation service. Cannot operate without fixed assets however, currently not many fixed assets for Health-Care. Quality investment decisions. What was invested in is working, no real complaints for current operations. DSV business model is restrictive in the amount of working capital as well as assets required to generate returns. They don't own the stock, only store and process the movement and flow of stock. Assets light business model is more beneficial to capital expenditure management. Need to generate returns and measure the continuously as working capital helps SLA and POI. Cash to cash, not a real concern for our tender process? State/government involvement. Political environment is a fickle place, they are held by their people and votes for the next elections (no service no votes) Fixed assets- Sorter is paid off, big expenses are finished, important to conduct preventative maintenance, however currently operating in an asset light environment. Working capital- Drive costs down, consolidate deliveries.

Cheap suppliers/ government medications (stock issues) Employees are critical element, cost saving to move from locum to permutant employment. Cash to cash management helps focus expenditure and returns on improving service delivery by isolating capital expenditure that would impact service delivery/quality management. Working capital is essential for this tender (Employees). Minimally important, focus on getting PMPs' to patients. Good service delivery patient should be number 1 priority.

Maintenance on Euro-sort sorter. Without preventative maintenance, any breakdown will cost a fortune. (no strategic level buy-in). Result internal issues regarding working capital. Resolve current processes before moving/making any improvements to current processes. Cash to cash cycle is not relevant to run and operate department, is it required, Yes. Fixed assets are necessary resources that need to made a priority (equipment such as PC/Scanners and Printers) Without which no business can be conducted. Currently is a major issue for mail room department as this department is the engine of the company. Any break down or down time costs the company money and results in delayed benchmarks and target deliveries/SLA. Must have an exception management plan in place, alternative supporting vendors. (scanner example). Working capital is critical for the company to survive in the future therefore some attention must be focused on this aspect from a strategic point of view.

Cost Consolidated Comments

Considered the main driver or focus of the Supply Chain strategy selection for the company. Due to the current focus on the upper management's focus on cost saving initiatives. Direct impact on ability to serve the customer. Further focus is required on how operations can be made more efficient to save cost. Always do better. by decreasing the costs more revenue can be achieved based of the balance sheet of the company's financial statements. Cost vs Revenues is important to understand. However, in our business money must be spent in order to make money. Therefore, some capital investment or expenditure must be incurred in order to generate meaningful profit. At the moment the revenue does not justify the costs. Costs cannot be decreased beyond a certain point otherwise we erode the profit potential and do more harm the good. In terms of cost management, the decision must be made based on the impact on the SLA as well as the patients. The Supply Chain strategy will be directly affected through the POI calculation if costs are decreased beyond a reasonable point. Diminishing returns. POD management could use more focus based on the current issues with the 3PL service providers. DSV strategic design to be asset light. Therefore, current operating with 27 vehicles, all of which are leased. Current transport costs estimated for the year R17,2 million as of the end of June budget R24 million actual by the end of the year.

In transport, the management of costs is critical due to external influences, most important of Which is Fuel prices. South Africa has had major fluctuations in fuel prices resulting in unpredictable variable costs for transports, Affecting the accuracy of cost forecasts. Currently R400 000 over budget, however, considering the fuel price variability. Employee overtime is critical to manager as these costs skyrocket exponentially during busy periods. Volumes dictate cost. Fixed costs are easily manageable. Variable costs must be managed. Currently on Par from projected budget (good news).

Cost saving initiatives are vital for the survivability of the company. No use no controlling costs. Cost drivers play a massive role in business productivity and generation of new business. KPI's are in place to manage the costs for the Healthcare Business. Balance sheet point of view, operational function there have no control or impact on the financial statements. Therefore, no need concern operational decision as a priority if no control can be found. Risk involved in the script verification through cost saving initiatives (label) removal). Example: Mislabelled PMP could cause issues with SLA and patient accuracy. Cost saving initiative scrapped due to the risk impact it had on the SLA and Patient. Cost saving could increase risk (GPP). Government tender seeks to identify the least amount of expense to provide a service there most of the available profit margin is lost. Government tenders are not "Cash Cows". There is more money available in private contracting than in state tendering. We are limited by legislation and government terms and conditions. Restricted by SLA and SOP's outlined by the government. However, we must still be open and adaptable to their processes, suggestions and changes, Synch scripting. Corporate Point of view yes cost is a focus and should be managed. However, from a patient point of view no Cost should not play a factor is service delivery to patients. Believed there should be a balance between great service delivery and cost cutting action. Current environment of cost cutting hurting current service delivery. Impact future of the business. Perhaps on a shorter-term contract cost could play a more significant role. Reconsider continually. Number of PMP's vs Box sizes. Consolidation is necessary for cost saving to take place. Further costing initiative on packaging could be achieved. Consumables management is critical for operations to manage. Decrease revenue due to slow growth resulted in Cost cutting (headcount reductions). This directly impacted POF and SLA achieved.

Confusion between facilities/Account managers and patients/prescribers. Lack of ownership and training to rectify the problem and therefore issues are ongoing. Yes, cost management is important and should be measured and managed. Resulting in higher revenues for the company. Related to cost management it building revenue streams, therefore increase number of scripts and number of patients served directly impacts revenue but also cost, the management of such cost is critical. Costs are difficult to manage due to the administrative process surrounding the script and the time it takes to save an incomplete or possible rejected script.

Annexure K: Simulation specific images

DSV Pharma: Simulation generated images-Gallery 1

Figure K.1: Pharma and CDU facility

Figure K.2: Pharma and CDU facility receiving gate

Figure K.3: Pharma receiving and unloading points

Figure K.4. Pharma bulk receiving into main storage area

Figure K.5: Pharma bulk storage area with simulated put away processing

Figure K.6: Pharma order release, fine picking activities and refrigerator storage area

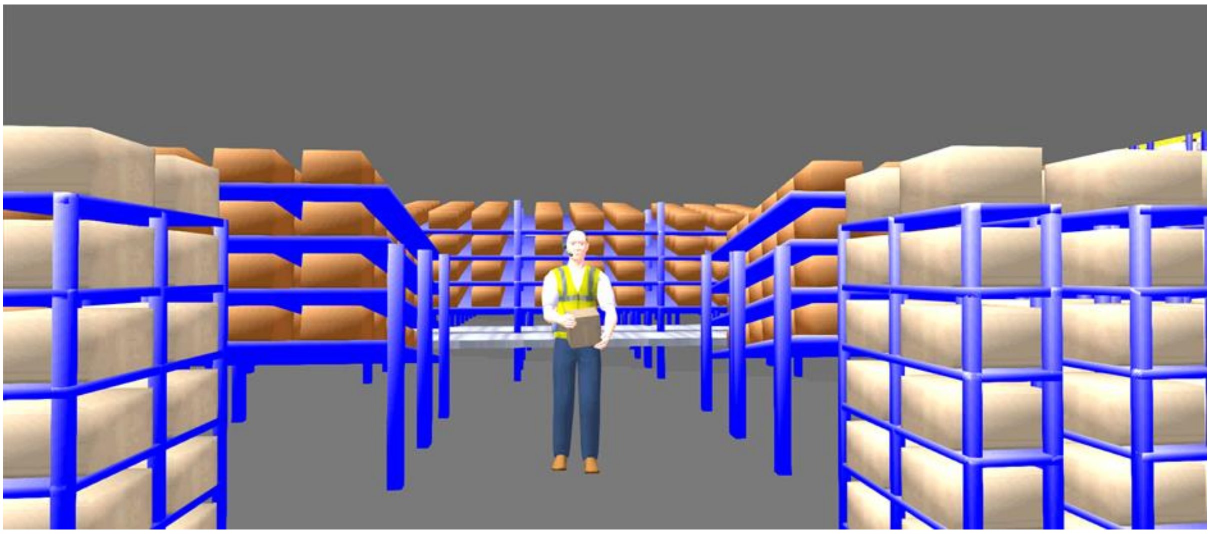


Figure K.7: Pharma fine picker using voice picking system to complete an order

Figure K.8: Pharma fine pick tote receiving and manifesting area (perspective 1)

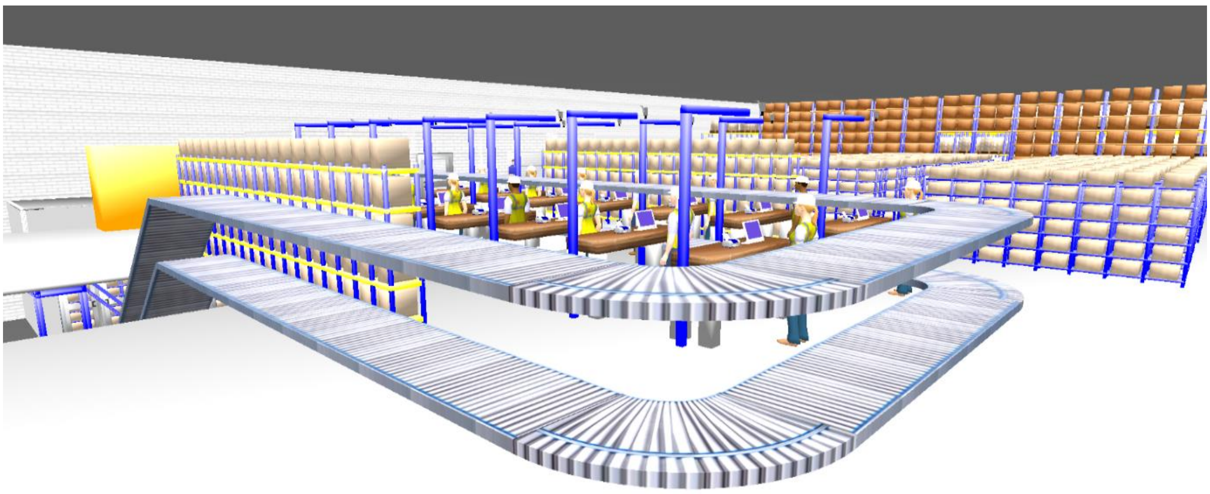


Figure K.9: Pharma fine pick tote receiving and manifesting area (perspective 2)

DSV CDU: Simulation generated images-Gallery 2

Figure K.10: CDU mail room and script processing department

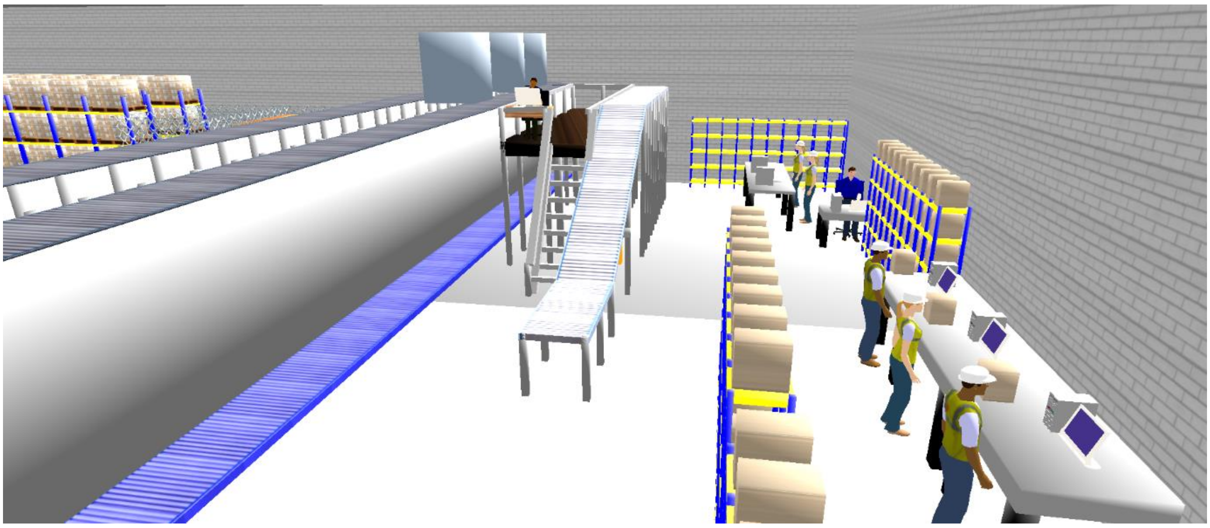


Figure K.11: Sorting machine, missing items, and manual despatch process (perspective 1)

Figure K.12: Sorting machine, missing items, and manual despatch process (perspective 2)

Figure K.13: Sorter bagging machine, Labelling and containerization process

Figure K.14: Manual dispensing and missing items corrections process (perspective 1)

Figure K.15: Manual dispensing and missing items corrections process (perspective 2)

Figure K.16: DSV distribution palletisation and staging (perspective 1)

Figure K.17: DSV distribution palletisation and Staging for loading

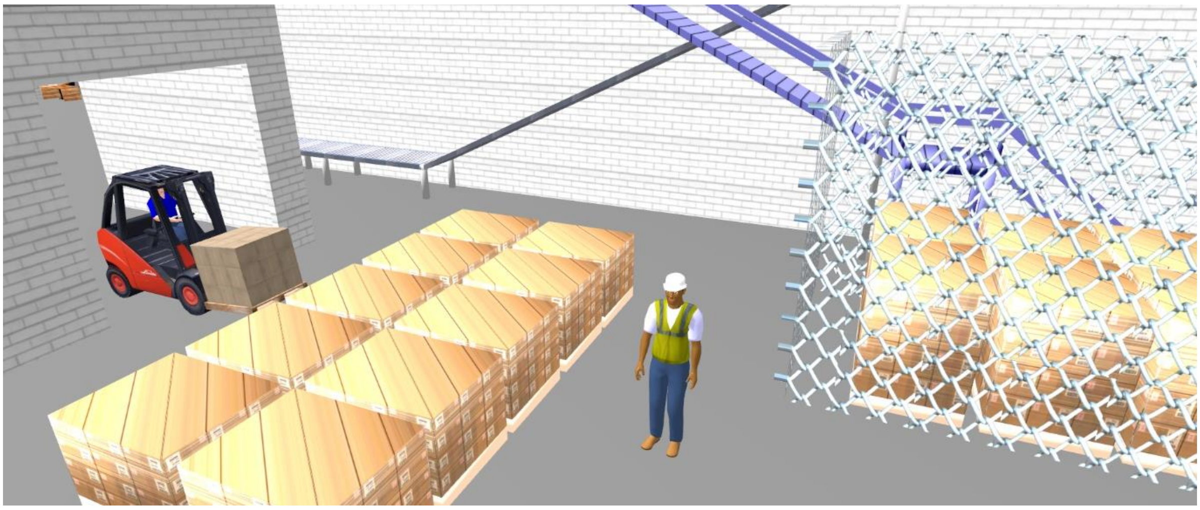


Figure K.18: CDU bulk returns department

Annexure L: Certificate of Editing

Anne Erikson
Copy Editor, Technical Writer and Indexer

CERTIFICATE OF EDITING

To whom this may concern

This is to certify that I have copy edited the full thesis of

MATTHEW KENNETH HARVEY
Student Number: 17797470

"A Warehouse process performance evaluation, testing alignment with Supply Chain performance aspirations: An exploratory study"

submitted in fulfilment of the requirements for the degree

Masters of Commerce (Logistics Management)

in the Department of Economic and Management Sciences

at

Stellenbosch University

for spelling and grammatical errors.

Any changes made following my submission
of the edited document to the student are not attributable to me.

Date: 11 July 2020

MA Erikson

M A Erikson
BA (UKZN), BEd (Wits)
Full Member of Professional Editors' Guild
Member of ASAIB (Association of Southern African Indexers and Bibliographers)

Tel: 072 808 0153
Email: anne.erikson@gmail.com